Deep-Sea Archaeology in the Exclusive Economic Zone of Cyprus



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This thesis is submitted in part fulfilment of the requirements for the degree of Doctor of Philosophy in Archaeology

Trinity, 2022

PREFACE

This study was developed purely out of luck, curiosity and persistency. In 2016, when I was studying for my MA degree in Maritime Archaeology at the University of Southampton, I emailed NOBLE Energy Cyprus, asking if 'the company had discovered any Underwater Cultural Heritage (UCH) assets (i.e. shipwrecks) when surveying for natural resources'. After weeks of persistent emailing, reminders and many phone calls, to my surprise, I was forwarded a Field Memo report presenting a preliminary evaluation of a shipwreck discovered made in 2011, located in Block 12 in the immediate vicinity of the 'Aphrodite' gas deposit. In the light of this unexpected information, that UCH discoveries were being made accidentally in the deep waters off Cyprus during the course of oil and gas operations, the idea of a DPhil study was born.

The project *Deep-Sea Archaeology in the Exclusive Economic Zone of Cyprus* was developed out of a consulting initiative led by the author, who initially suggested to the responsible heritage agency, the Department of Antiquities Cyprus (DoAC), that an academic study on the issue of deep sea archaeology, based on datasets generated during the course of deep sea oil and gas explorations, could effectively contribute towards the implementation of Article 18A of the '2014 (amended) Antiquities Law of Cyprus'. This importantly states that: 'Any archaeology on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on' (The Antiquities (amended) Law Cyprus, 2014, 1120). The project was discussed and agreed at the DoAC in 2017 with the author receiving access, under confidentiality restrictions, to video-photography and geophysical datasets, generated by fourteen offshore oil and gas contractors. These official documents of data access and confidentially restrictions are presented below. The observations and results that emerge from this thesis are based on these submitted datasets; they reveal that there is a need for developing new policies to better regulate how the offshore oil and gas industry operates and treats the accidental discovery of deep sea UCH. This pertains to both

how video-photography and geophysical datasets are produced for best detecting, surveying, *in situ* protecting, preserving by record and reporting of any archaeological/historic assets discovered accidentally during the course of natural resource surveys (NRS). The result of the study is the creation of a deep sea monument record for Cyprus and the development of a series of different levels of survey with the associate minimum professional by-standards that it is hoped to be implement in new policies into the 'regulatory administrative acts of 2022' of the 'Antiquities Law of Cyprus' or to supplement the unspecific Scope of Work (SoW) set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus* following the completion of the thesis.

The nature and scope of this study is interdisciplinary and expands across a spectrum of marine sciences. The academic contribution of this project is primarily relevant to the sub-discipline of maritime archaeology and targets academics and heritage managers in the field. Nevertheless, the results will also likely be of interest to deep sea specialists, marine scientists, heritage consultants, environmental consulting firms, offshore oil and gas consultants, maritime lawyers and to future contractors/subcontractors who are planning to undertake any kind of deep sea commercial operations, primarily relevant but not explicit to oil and gas activities (such as cable and pipeline laying projects and in the future deep sea mining) in the deep seas of Cyprus and the eastern Mediterranean more broadly. It is my position that this study is also aligned with the interests of international organisations concerned with setting the relevant heritage and industry standards such as: the United Nations Educational Scientific and Cultural Organisation (UNESCO), the Chartered institute of Archaeologists (CifA), the International Association of Oil & Gas Producers (IOGP), and the International Petroleum Industry Environmental Conservation Association (IPIECA).

PREFACE

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5th October 2017

Mr. Achilleas Iasonos
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Dear Mr Iasonos,

SUBJECT: ACCESS TO ARCHAEOLOGICAL DATA CONCERNING THE RESEARCH IN THE SEA OF THE CYPRIOT EXCLUSIVE ECONOMIC ZONE/VOLUNTEER WORK AT THE DEPARMENT OF ANTIQUITIES.

I am referring to your e-mail of the 14th November 2016 and 3rd July 2017 and our meetings at the Department of Antiquities on the 20th and 28th of July and I would like to confirm our commitment to our collaboration concerning the above subject.

Following the approval given to the Department of Antiquities by the Ministry of Foreign Affairs, on the letter dated 10th January 2017 and File number A. 08.04.10, to the Permanent Secretary of the Ministry of Energy, Commerce, Industry and Tourism and the Permanent Secretary of the Ministry of Transport, Communications and Works, and the approval given by the Ministry of Transport, Communications and Works with their letter dated 2nd October 2017 and File number 7.19.4, we can now grant you access to this data, for your Post Graduate Studies, for the Doctor of Philosophy in Archaeology at the University of Oxford, beginning 9th October 2017 as well as for volunteer work at the Department of Antiquities.

Yours sincerely,

Dr. Marina Solomidou-Ieronymidou
Director
Department of Antiquities

MMa/mma

PREFACE

REPUBLIC OF CYPRUS
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NON DISCLOSURE CONFIDENTIALITY AGREEMENT

This Confidentiality Agreement is entered into as of **10 January 2017** by and between the **Department of Antiquities,** Ministry of Transport, Communications and Works, Republic of Cyprus and Mr. **Achilleas Iasonos** (the Recipient), PhD candidate at the University of Oxford, England.

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PREFACE

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IN WITNESS WHEREOF, the undersigned parties have executed this Confidentiality Agreement as of date first written above.

Dr. Marina Solomidou-Ieronymidou
Director
Department of Antiquities

Achilleas Iasonos
(PhD Candidate)

ACKNOWLEDGEMENTS

This DPhil is dedicated to My Grandmother.

My sincere gratitude and deepest appreciation goes to my supervisor Dr Damian Robinson, for his continuous support, effective supervision, and guidance in shaping this study. His ideas, attitude, flexibility, kindness and personality have brought out the best of me and have helped me to develop both as an individual and an early career researcher. Thank for your time, commitment and effort throughout the course of four years.

Special thanks also must be given to the A.G. Leventis Foundation for granting me a three year scholarship and partially covering the tuition fees of my study.

Furthermore, I am sincerely grateful to the Honor Frost Foundation for fully funding this project for one year and a half.

Last, but not least, I am sincerely grateful to the Department of Antiquities Cyprus (DoAC) — the data provider— and in particular Dr Despina Pilides who supported and supervised this study. Thank you for your time, understanding, advice, and mentorship that has contributed to me developing both as a person and a researcher. From the DoAC, I want to also recognise and express my gratitude to Maria Makri for her invaluable contribution in carrying out the necessary data requests on behalf of the DoAC. Maria, thank you for your time and effort. Without the DoAC's support this study would not have been possible and for this reason I am eternally grateful. Thank you for allowing me this rare opportunity that has enabled me to explore and expand my passion, knowledge and interest through becoming a specialist of the deep seas of Cyprus.

TABLE OF CONTENTS

List of Figures……..i-ix
List of Tables……..……...…...x-xiii
Abbreviation List…….…….....…….….xiv-xvi

ABSTRACT……...…….……...….1

Chapter 1: INTRODUCTION…….……..2-14

Chapter 2: LITERATURE REVIEW……...……15-56
[2.1]. Introduction……..15
[2.1.1]. The History of Maritime Archaeology in Cyprus……..16
[2.2]. The History of Deep Water Archaeology…….……31
[2.2.1]. Deep Sea Archaeology in the eastern Mediterranean and the Exclusive Economic Zone of Cyprus……45
[2.2.2].A New Model of Research……....51

Chapter 3: UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW……...57-112
[3.1]. Introduction…….……57
[3.2]. What is an Exclusive Economic Zone and where is the Continental Shelf?..... 62
[3.3]. Underwater Cultural Heritage in the Exclusive Economic Zone and Continental Shelf according to the United Nations Law of the Sea Convention…..... 64
[3.4]. The Development of the International Law on Underwater Cultural Heritage prior to the '2001 UNESCO Convention on the Protection of Underwater Cultural Heritage' Initiative ……...…….……..69
[3.4.1]. The Council of Europe's "Roper Report" and 'Recommendation 848 (1978)'..……...…...…….…….....…....69
[3.4.2]. Draft European Convention 1985 on the Protection of Underwater Cultural Heritage……...…….....……71
[3.4.3]. The European Convention on the Protection of Archaeological Heritage (Revised) (1992) ('The Valletta Convention')…….……73
[3.4.4]. The 1995 Convention for the Protection of the Mediterranean Sea against Pollution ('The Barcelona Convention')…….....74
[3.4.4.1]. '1995 Protocol Concerning Specifically Protected Areas and Biological Diversity in the Mediterranean' (SPA/BD Protocol)…….…..……75
[3.4.4.2]. 'Protocol for the Protection of the Mediterranean Sea against Pollution resulting from exploration and exploitation of the Continental Shelf and the Seabed and its Subsoil'……..……..……..77
[3.4.5]. International Law Association Draft Convention on the Protection of Underwater Cultural Heritage ('The ILA Draft Convention')…….……78
[3.4.6]. The 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage ('2001 UNESCO Convention')……..……....79

TABLE OF CONTENTS

[3.5]. Overview of different National Legislations concerned with the protection of UCH on the Continental Shelf and in the Exclusive Economic Zone, in the European Economic Area and elsewhere…….……....85
[3.5.1]. Common Practices in National Laws for the management and *in situ* protection and preservation by record of cultural heritage resources discoveries accidentally during the course of oil and gas explorations……95
[3.6]. The National Legislation of Cyprus and its Safeguarding of the Underwater Cultural Heritage of the Island……...101
[3.7]. Discussing the National Legislation of Cyprus……..105
[3.8]. Conclusion…….…..109

Chapter 4: UNDERWATER CULTURAL HERITAGE DISCOVERIES IN THE EXCLUSIVE ECONOMIC ZONE OF CYPRUS…….……...……..113-181
[4.1]. Introduction……...……..…….....…….....113
[4.2]. The Underwater Cultural Heritage Discoveries of the Ocean Exploration Trust in the Exclusive Economic Zone of Cyprus……...……...……..114
[4.2.1]. The 2010 Ocean Exploration Trust Survey……...……..……..115
[4.2.1.1]. Scatter of Materials noted from the 2010 Ocean Exploration Trust Expedition……..…115
[4.2.1.2]. Shipwrecks noted from the 2010 Ocean Exploration Trust Expedition……..……..….117
[4.2.1.2.1]. The ‘Iron Anchors’ wreck……...117
[4.2.1.2.2]. The ‘Ottoman Pistol’ wreck…….....……121
[4.2.2]. The 2012 Ocean Exploration Trust Survey……...…….……123
[4.2.2.1]. Scatter of Materials noted from the 2012 Ocean Exploration Trust Expedition……..124
[4.2.2.2].‘Eratosthenes C’ wreck…….…...……125
[4.3]. Discussion Section of the 2010 and 2012 Ocean Exploration Trust Scatter of Materials...…….……..……...…..…...126
[4.4].*Oil and Gas Archaeology* and Underwater Cultural Heritage Discoveries made in the context of Natural Resource Surveys……..132
[4.4.1]. The shipwreck site of ‘Aphrodite-Noble’…….…..……133
[4.4.1.1].ROV Video-Photography data and the site……..……..…….135
[4.4.1.2]. The identification of amphorae ‘Aphrodite-Noble’……..……..……136
[4.4.1.3]. Amphorae Type 1 Analysis……..……138
[4.4.1.4]. Additional information about Amphora Type 1……....…...…….139
[4.4.1.5]. Amphorae Type 2 Analysis……...……..…140
[4.4.1.6]. Additional information about Amphora Type 2……..…..……141
[4.4.1.7]. Amphorae Type 3 Analysis……..……...142
[4.4.1.8]. Additional information about Amphora Type 3……144
[4.4.1.9]. Other unidentified artefacts…….……..……145
[4.4.1.10]. Conclusion: ‘Aphrodite-Noble’……147

TABLE OF CONTENTS

[4.4.2]. The shipwreck site of 'Eratosthene-Eni'……..……..……...150
[4.4.2.1].ROV Video-Photography data and the site…….....…….……..….150
[4.4.2.2]. The identification of amphorae of 'Eratosthene-Eni'…….....….....….153
[4.4.2.3]. Amphorae Type 1 Analysis…… .....…154
[4.4.2.4]. Additional information about Amphora Type 1…..……...…...…..155
[4.4.2.5]. Amphorae Type 2 Analysis……...……156
[4.4.2.6]. Additional information about Amphora Type 2……157
[4.4.2.7]. Conclusion: 'Eratosthene-Eni'……..……158
[4.4.3]. The Amphorae 'Alley I-block 8' site…….…….....…….160
[4.4.3.1]. Archaeological and topographical interpretations emerging from Figure 27…….....……...…. ….....…..……163
[4.4.3.2]. Conclusion: 'Alley I-block 8'…….…..…..164
[4.4.4]. The shipwreck site of 'Calypso Appraised – ENI&TOTAL'……...……..166
[4.4.4.1]. Data and interpretations…….…….....……166
[4.4.4.2]. The identification of amphorae of 'Calypso Appraised – ENI&TOTAL'…...168
[4.4.4.3]. Amphorae Type 1 Analysis……...169
[4.4.4.4]. Additional information about Amphora Type 1…….....…….169
[4.4.4.5]. Conclusion: 'Calypso Appraised – ENI&TOTAL'…….....170
[4.5]. Discussing the Deep Sea archaeology of Cyprus..…….....…..172
[4.6]. Conclusion…….. …..…….....……..…….....180

Chapter 5: GEOPHYSICAL AND VIDEO-PHOTOGRAPHY DATASETS AND THE STUDY (Analysis and Observations)….182-236
[5.1]. Introduction……...……...…...……...……..…….182
[5.2]. Data and the study……...……..…….....……...…….182
[5.2.1]. Insights into ROV Video-Photography data generated during oil and gas activities……...……..…….....191
[5.3]. Geophysical datasets……...……..…….....201
[5.3.1]. Side-Scan-Sonar……...…….....…...203
[5.3.1.1]. Side-Scan-Sonar geological features and seabed geomorphology.....204
[5.3.1.2]. Shipwrecks with amphorae cargo and geological features.…….....213
[5.3.1.3]. Ancient and modern anthropogenic debris…….....214
[5.3.1.3.1]. Ancient pots, cooking vessels, and amphorae……...…..215
[5.3.1.3.2]. Modern debris and marine refuse…….…….……218
[5.3.2]. Side-Scan-Sonar concluding remarks…….....222
[5.3.3]. Multibeam-Bathymetry and Backscatter data……...……...…..223
[5.3.3.1].'Anthea-1' prospect site…….....227
[5.3.4]. Multibeam-Bathymetry and Backscatter data concluding remarks……..231
[5.4]. Conclusion…….....……..234

TABLE OF CONTENTS

Chapter 6: POLICY RECOMMENDATIONS (Survey Levels and Minimum Professional by-standards)…..……...…….....…237-316
[6.1]. Introduction……..……...……..……...…237
[6.2]. The operational framework of upstream hydrocarbons and the discovery of archaeological/historic assets…….……..…240
[6.3]. The risks and impacts of upstream operations on archaeological/historic assets……..…….....……..…245
[6.4]. Review of archaeological by-standards and offshore oil and gas operations……..…….....……...…..…...249
[6.5]. Minimum Professional by-standards for safeguarding deep-sea archaeological/historic assets found in the Exclusive Economic Zone. Guidelines for offshore oil and gas contractors/subcontractors conducting Marine Environmental Baseline Surveys, Geohazard Investigations [or any other Supplementary Hydrographic Surveys], preceding the drilling of wells……...……...259
[6.5.1]. Minimum Professional Survey by-standards…….……....260
[6.5.2]. Definition of Deep Sea Cultural Heritage (archaeological/historic assets)...265
[6.5.1.1]. General prerequisites ……..…….....…….....266
[6.5.1.2]. Level 1 – Appraisal Surveys and the identification of areas, features or anomalies of 'high archaeological potential' and 'shipwreck-like character'.....…….....269
[6.5.1.3]. Level 2 – Visual inspections of features or anomalies of 'high archaeological potential' and 'shipwreck-like character'..……..…….....…….....…….....274
[6.5.1.4]. Level 3 – Reconnaissance surveys of confirmed archaeological sites (i.e., shipwrecks)……..…….....…….....…….....277
[6.5.1.5]. Level 4 – Sampling of artefacts and structural components.....…….....280
[6.5.1.6]. Level 5 – Excavation…….....…….....282
[6.5.3]. Minimum Professional Data Submission by-standards……..…..……..283
[6.5.4]. Minimum Professional Reporting by-standards……..…...……..…..286
A. Non-technical summary and baseline conditions…….…...…...288
B. Legislation…….....…289
C. Filed data……..…….....…....292
D. Seafloor Feature Analysis…….....…293
E. The discovery of a shipwreck/or scatter materials (archaeological analysis)…..298
F. Risk Assessment and Mitigation Strategies…….…….....300
G. Summary and conclusion……..…….……302
H. Official Statements…….……...……..…...303
[6.6]. Archiving of datasets……...…….....……..……...…...305
[6.6.1]. Archive Sustainability Strategy……..……307
[6.7]. Conclusion……..…….……..315

Chapter 7: CONCLUSION……..…….....……317-335

TABLE OF CONTENTS

Chapter 8: APPENDIX……..……...…….……..336-394
[8.1]. Section 1, The 2010 Ocean Exploration Trust, Scatter of Materials…....336
[8.1.1]. Table 1, Analysis of the Scatter of Materials noted during
the 2010 Ocean Exploration Trust Expedition……..….....…344
[8.2]. Section 2, The 2012 Ocean Exploration Trust, Scatter of Materials…..…..359
[8.2.1]. Table 2, Analysis of the Scatter of Materials noted during
the 2012 Ocean Exploration Trust Expedition……..….....….....371
[8.3].figure 59……..…...…..……..…….....393
[8.4]. Chronological Table of the Study ...…….…….....394

Chapter 9: BIBLIOGRAPHY……...…..395-432

LIST OF FIGURES

[Chapter 2.2.2].**Figure 1**: Oil and gas explorations up-to 2021 with additional information pertaining to deep sea UCH discoveries. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 56

[Chapter 3.2].**Figure 2**: The maritime zones set by UNLOSC. Source: image from UNESCO. (2018). *Protection of Cultural Heritage in International Waters.* http://www.unesco.org/new/en/culture/themes/underwater-cultural heritage/protection/protection-of-cultural-heritage-in-international-waters/ [accessed 22-11-2018].

Page 62

[Chapter 3.2].**Figure 3**: The layout and outer boundaries of Cyprus EEZ and the thirteen Blocks of the Continental Shelf as established under the enactment of the Exclusive Economic Zone and Continental Shelf Law (No. 64(I)/2004). Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 63

[Chapter 3.4.4.1].**Figure 4**: The protected Pelagos Sanctuary. Source: image from Agardy, T., Cañadas, D., de Soto, A. N., and Engel, H. M. (2007). A Global Scientific Workshop on Spatio-Temporal Management of Noise. *Report of the Scientific Workshop.* 1-44.

Page 76

[Chapter 4.2.1.1].**Figure 5**: The exact location of the 2010 OET noted scatter materials and the two shipwreck sites. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ

Page 116

[Chapter 4.2.1.2.1].**Figure 6**: All three iron grapnel anchors of the 'Iron Anchors' wreck recorded by the OET in the 2010 expedition. Source: image © DoAC.

Page 117

LIST OF FIGURES

[Chapter 4.2.1.2.1].**Figure 7**: Part of the preserved hull of the 'Iron Anchors' wreck. Source: image © DoAC.

Page 119

[Chapter 4.2.1.2.1].**Figure 8**: The iron canon recorded *in situ* at the site of 'Iron Anchors' wreck. Source: image © DoAC

Page 120

[Chapter 4.2.1.2.2].**Figure 9**: The 'Ottoman Pistol' wreck with the top image exhibiting the intact admiralty anchor and the attached chain; and the bottom image exhibiting a flintlock musket pistol and a bottle (squared in yellow and red, respectively). Source: image © DoAC

Page 122

[Chapter 4.2.1.2.2].**Figure 10**: The possible bottle types found at the 'Ottoman Pistol' wreck. Source: image from Marx, F. R. (1975). *The Underwater Dig. (New York). 25.*

Page 123

[Chapter 4.2.2].**Figure 11**: The exact location of the 2012 OET noted scatter materials and the shipwreck of 'Eratosthenes C'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 124

[Chapter 4.3].**Figure 12**: The analysis suggests two possible areas of 'high archaeological potential' (squared in white), and its' based on the classification of three main groups of amphorae. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 127

[Chapter 4.3].**Figure 13**: The map reveals the distribution of a total of roughly 100 identified amphorae, grouped according to amphorae type, in relation to 22 survey lines, with the distribution of them suggesting two broader areas of 'high archaeological potential' (squared in red and purple). Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 131

LIST OF FIGURES

[Chapter 4.4.1].**Figure 14**: The exact location of the 2011 Noble Energy shipwreck discovery ‘Aphrodite-Noble’. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 134

[Chapter 4.4.1.1].**Figure 15**: The shipwreck site, cargo and hull-outline of ‘Aphrodite-Noble’. Source: image © DoAC.

Page 135

[Chapter 4.4.1.3].**Figure 16**: Amphora Type 1. Source: image © DoAC.

Page 139

[Chapter 4.4.1.5].**Figure 17**: Amphora Type 2. Source: image © DoAC.

Page 141

[Chapter 4.4.1.7].**Figure 18**: Amphora Type 3. Source: image © DoAC.

Page 143

[Chapter 4.4.1.9].**Figure 19**: Amphora Type 4. Source: image © DoAC.

Page 146

[Chapter 4.4.1.9].**Figure 20**: A storage jar probably small pithos. Source: image © DoAC.

Page 146

[Chapter 4.4.1.9].**Figure 21**:Two roof tiles, potentially reflecting the remains of an on-board structure and other additional unidentified artefacts. Source: image © DoAC.

Page 147

[Chapter 4.4.1.10].**Figure 22**: The origins of the identified amphora in relation to the shipwreck site of ‘Aphrodite-Noble’. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 149

[Chapter 4.4.2].**Figure 23**: The exact location of the 2017 ENI shipwreck discovery ‘Eratosthenes-Eni’. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 151

LIST OF FIGURES

[Chapter 4.4.2.1].**Figure 24**: The wreck site of 'Eratosthene-Eni' as recoded by ENI's subcontractor company Lighthouse S.p.A., with the image displaying two sets of different amphorae types. Source: image © DoAC.

Page 152

[Chapter 4.4.2.4].**Figure 25**: The proto-Rhodian type 5/VARIANT I-A amphorae, found at the Kyrenia shipwreck. Image taken at the Kyrenia museum storage room. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 155

[Chapter 4.4.2.7].**Figure 26**: The hypothetical sailing route of 'Eratosthenes-Eni'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 158

[Chapter 4.4.3].**Figure 27**: The linear trail of 'Alley I-block 8' of eight scatter materials, extending approximately 1.6 km. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 160

[Chapter 4.4.3].**Figure 28**: The three unidentified artefacts recorded as part of ENI's 2017 survey. Source: image © DoAC.

Page 161

[Chapter 4.4.3].**Figure 29**: Cooking wares, recorded as part of ENI's 2017 survey. Source: image © DoAC.

Page 161

[Chapter 4.4.3].**Figure 30**: Three Late Roman/Early Byzantine amphorae of different types, recorded as part of ENI's 2017 survey. Source: image © DoAC.

Page 162

LIST OF FIGURES

[Chapter 4.4.4].**Figure 31**: The exact location of the 2019 ENI/TOTAL shipwreck discovery 'Calypso Appraised – ENI&TOTAL'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ

Page 167

[Chapter 4.4.4.3].**Figure 32**: The homogenous amphora cargo of the wreck site of 'Calypso Appraised – ENI&TOTAL'. The image was taken by the Field Memo report. Source: image © DoAC.

Page 169

[Chapter 4.4.4.5].**Figure 33**: The pithos of the 'Calypso Appraised – ENI&TOTAL' wreck. The image was taken by the Field Memo report. Source: image © DoAC.

Page 171

[Chapter 4.5].**Figure 34**: The trade routes of the eastern Mediterranean as described by ancient cartographers and mapped by Arnaud. Source: image from Arnaud, P. (2005). *Les routes de la navigation antique. Itineraires en Mediterranee.* Errance: Archéologie. 212.

Page 180

[Chapter 5.2].**Figure 35**: The results of the project's (geo)database and the locations of eight wreck sites, 300 scatters of materials, one amphorae alley and 22 SSS targets. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 190

[Chapter 5.2.1].**Figure 36**: An illustration of a commercial ROV operating in a pre-programmed line-path-survey. Source: image by Kongsberg. (2020). *HiPAP: High Precision Acoustic Positioning.* 1.

Page 191

LIST OF FIGURES

[Chapter 5.2.1].**Figure 37**: Data from four different NRS projects with different camera and lighting systems. **Image A**: 2011 ‘Aphrodite-Noble’ shipwreck discovery; **Image B**: 2017 ‘Eratosthene-Eni’ shipwreck discovery; **Image C**: 2019 ExxonMobil data, modern marine-debri; **Image D**: 2019 Cronos survey, ancient amphorae. Source: images property © DoAC

Page 195

[Chapter 5.2.1].**Figure 38**: The results of the orthomosaic model of ‘Eratosthene-Eni’ displayed from three different angles (A, B and C). Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 197

[Chapter 5.2.1].**Figure 39**: A jug discovered by ExxonMobil in 2018, and surveyed in a circular manner, capturing the artefact in all angles. This survey results can be effectively postprocessed into a 3D model. Source: image property © DoAC.

Page 199

[Chapter 5.3].**Figure 40**: The location of the ‘Anthea’, ‘Glaucus’ and ‘Pegasus’ prospection projects. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 202

[Chapter 5.3.1.1].**Figure 41**: SSS data accompanied by ROV images illustrating the geomorphology of the deep seabed of Block 10, with evidence of rocky outcrops. Source: SSS and ROV images © DoAC.

Page 204

[Chapter 5.3.1.1].**Figure 42**: A rocky outcrop found in Block 10, at the prospect site of ‘Glaucus’. Source: SSS and ROV images © DoAC.

Page 206

LIST OF FIGURES

[Chapter 5.3.1.1].**Figure 43**: An area of seabed with high acoustic reflectivity and protruding geological features. Source: SSS and ROV images © DoAC.

Page 207

[Chapter 5.3.1.1].**Figure 44**: An 'eye' pockmark. Source: SSS image © DoAC.

Page 208

[Chapter 5.3.1.1].**Figure 45**: Microdepressions (also called 'intrapockmarks') found throughout the deep seas floor of Block 10, recorded at the prospect site of 'Anthea-1'. Source: SSS and ROV images © DoAC.

Page 209

[Chapter 5.3.1.1].**Figure 46:** Different soil effects manifested in the SSS data, with image A: exhibiting slumping/sliding effect; and image B: presenting evidence of soil creeping effect. Source: SSS image © DoAC.

Page 210

[Chapter 5.3.1.1].**Figure 47**: A rocky outcrop mount casting an acoustic shadow abutting a second rocky outcrop mount. Peculiarities in the sonograph are marked in yellow. Source: SSS image © DoAC.

Page 211

[Chapter 5.3.1.1].**Figure 48**: The sub-cropping of hard sediments. Source: SSS and ROV images © DoAC.

Page 212

[Chapter 5.3.1.2].**Figure 49**: The site of 'Eratosthene-Eni' as seen in the SSS data. Source: image from Lighthouse S.p.A. (2017). *Environmental Baseline Survey: Eratosthenes South (Block 8); Cuttlefish (Block 3); Calypso (Block 6)*. 30.

Page 213

[Chapter 5.3.1.2].**Figure 50:** A rocky outcrop partially covered by sediment. Source: SSS image © DoAC.

Page 213

[Chapter 5.3.3.1].**Figure 51**: The overall topography of the 'Anthea-1' prospect site, in 2D, with evidence of graben outcrops, resembling a valley (orange square), enclosed by two uplifted blocks (blue squares) and an area of normal faults (white square). Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 226

[Chapter 5.3.3.1].**Figure 52**: Evidence of landslides (red squares) following the direction of the seabed's slope. Screenshot taken from Figure 51: The overall topography of the 'Anthea-1' in MBES.

Page 227

[Chapter 5.3.3.1].**Figure 53:** Screenshots A, B and C present the main anomalies seen in Figure 51: The overall topography of the 'Anthea-1' in MBES data.

Page 228

[Chapter 5.3.3.1].**Figure 54**: The wider topography of the 'Anthea-1' prospect site, with the backscatter data being superimposed onto MBES data. This analysis reveals insights into the broader character of the seafloor and on features of 'high archaeological potential'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 233

[Chapter 5.3.3.1].**Figure 55:** Images A and B present evidence of a rocky outcrop area with: Figure 55 image B zooming into a high acoustic anomaly of a possible target of 'high archaeological potential' (marked in purple). Screenshot taken from Figure 54: The overall topography of the 'Anthea-1' in MBES data with backscatter data superimposed.

Page 230

LIST OF FIGURES

[Chapter 6.1].**Figure 56**: The general outline of the offshore hydrocarbons upstream segment operations. This diagram is a customised representation of the upstream segment and excludes information that is irrelevant for the purpose of this chapter. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 239

[Chapter 6.3].**Figure 57**: The effects of drilling and sediment/rocks resuspension and disposal. Source: image from Cordes et al. (2016). Environmental Impact of the Deep-Water Oil and Gas Industry: A Review to Guide Management Strategies. *Frontiers in Environmental Science* 4:58, 4.

Page 245

[Chapter 6.6.1].**Figure 58:** The Archive Sustainability Strategy for the database and (geo)database of the project *Deep-Sea Archaeology in the Exclusive Economic Zone of Cyprus*. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Page 307

LIST OF TABLES

[Chapter 3.1].**Table 1**: A summary of the international and national legislation analysed in this chapter that are relevant to the case study of Cyprus.

Page 60-61

[Chapter 4.4.1.2].**Table 2**: Observable features of **Amphorae Type 1** as seen in the ROV video dataset of 'Aphrodite-Noble' (see figure 16, page 139)

Page 137

[Chapter 4.4.1.2].**Table 3**: Observable features of **Amphorae Type 2** as seen in the ROV video dataset of 'Aphrodite-Noble' (see figure 17, page 141)

Page 137

[Chapter 4.4.1.2].**Table 4**: Observable features of **Amphorae Type 3** as seen in the ROV video dataset of 'Aphrodite-Noble' (see figure 18, page 143)

Page 138

[Chapter 4.4.2.2].**Table 5**: Observable features of **Amphora Type 1** of 'Eratosthene-Eni' as seen in the ROV video dataset (figure 24, page 152)

Page 153

[Chapter 4.4.2.2].**Table 6**: Observable features **Amphora Type 2** of 'Eratosthene-Eni' as seen in the ROV video dataset (figure 24, red square, page 152)

Page 154

[Chapter 4.4.4.2].**Table 7**: The identity of the 'Calypso Appraised – ENI&TOTAL' amphorae cargo, as seen in the Field Memo report (figure 32)

Page 168

[Chapter 5.2].**Table 8**: A summary of data generated from oil and gas explorations, collected and [partly] evaluated in the context of this thesis for the period of 2017 to 2021.

Pages 187 - 189

LIST OF TABLES

[Chapter 5.3.1.3.1].**Table 9:** Ancient pot as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 215

[Chapter 5.3.1.3.1].**Table 10:** Ancient cooking pot as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 216

[Chapter 5.3.1.3.1].**Table 11:** Intact amphora as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 216

[Chapter 5.3.1.3.1].**Table 12:** Broken amphora as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 217

[Chapter 5.3.1.3.1].**Table 13:** Intact amphorae as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 217

[Chapter 5.3.1.3.1].**Table 14:** Intact amphorae as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 218

[Chapter 5.3.1.3.2].**Table 15:** Iron cable as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 219

[Chapter 5.3.1.3.2].**Table 16:** Barrel as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 219

LIST OF TABLES

[Chapter 5.3.1.3.2].**Table 17:** Iron barrel lid as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 220

[Chapter 5.3.1.3.2].**Table 18:** Perhaps military equipment with iron wire as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 220

[Chapter 5.3.1.3.2].**Table 19:** Fibre optic cable as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 221

[Chapter 5.3.1.3.2].**Table 20:** Rubbish bag as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Page 221

[Chapter 6.5.1.1].**Table 21:** The overreaching General prerequisites that offshore oil and gas contractors/subcontractors need to consider and factor in from the design phase of NRS projects.

Pages 266-269

[Chapter 6.5.1.2].**Table 22**: Survey level 1 prerequisites and technical and methodological parameters for geophysical surveys and reporting on SSS anomalies of 'high archaeological potential'

Pages 271-274

[Chapter 6.5.1.3].**Table 23**: Survey level 2 prerequisites technical parameters for conducting ROV visual inspections after the completion of geophysical surveys

Pages 275-277

LIST OF TABLES

[Chapter 6.5.1.4].**Table 24**: Survey level 3 prerequisites and technical specification for ROV video surveying and conducting Structure from Motion (SfM) surveys on confirmed shipwrecks

Pages 278-280

[Chapter 6.5.3].**Table 25**: The specifications necessary for data submission generated during the course of Environmental Baseline Surveys (EBS), Geohazard Investigations [or any or any other Supplementary Hydrographic Surveys] as part of natural resource surveys (NRS).

Pages 284-285

[Chapter 6.6.1].**Table 26**: The ideal formats for archiving word orientated document(s). Relevant to Data Submission by-standards 01, 02 and 04, pages 284-285.

Page 309

[Chapter 6.6.1].**Table 27:** The 'container' and video codec formats for archiving ROV video(s) datasets. Relevant to Data Submission by-standard 03, page 285.

Page 310

[Chapter 6.6.1].**Table 28**: An overview of the main data formats suitable for the submission and/or the conversion of each of the submitted geophysical dataset.

Pages 311-312

ABBREVIATION LIST

UCH	Underwater Cultural Heritage
DoAC	Department of Antiquities Cyprus
NRS	Natural Resource Survey
SoW	Scope of Work
UNESCO	United Nations Educational, Scientific and Cultural Organization
IOGP	International Association of Oil & Gas Producers
IPIECA	International Petroleum Industry Environmental Conservation Association.
TS	Territorial Sea
OET	Ocean Exploration Trust
EEZ	Exclusive Economic Zone
ROV	Remotely Operated Vehicles
SSS	Side-Scan-Sonar
MBES	Multibeam-Bathymetry-Echosounder
EBS	Environmental Baseline Survey
HFF	Honor Frost Foundation
AUV	Autonomous Underwater Vehicles
SBP	Sub-Bottom-Profiler
ESHIA	Environmental Social Impact Health Assessment

ABBREVIATION LIST

EIA	Environmental Impact Assessment
CS	Continental Shelf
CSR	Corporate Social Responsibility
M.A.P.	Maritime Archaeology Project
BOEM	Bureau of Ocean Energy Management
CifA	Chartered institute of Archaeologists
NM	Nautical Miles
CPD	Cost Per Day
CZ	Contiguous Zone
UNLOSC	1982 United Nations Convention on the Law of the Sea
2001 UNESCO Convention	2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage
MSR	Marine Scientific Research
CPZ	Cultural Protection Zone
SPA/BD Protocol	Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean
SPAMI	Specially Protected Areas of Mediterranean Importance
CHZ	Cultural Heritage Zones
ILA	International Law Association

ABBREVIATION LIST

AIA	Archaeological Impact Assessment
DoGC	Department of Geology Cyprus
HD	High Definition
SD	Standard Definition
UHD	Ultra High Definition
KHz	Kilohertz
SfM	Structure from Motion technique
TIN	Triangulated Irregular Network
DTM	Digital Terrain Model
ADS	Archaeology Data Service
NOAA	National Oceanographic and Atmospheric Association
ISO	International Organization for Standardization
BAG	Bathymetric Attributed Grid
EMODnet	European Marine Observation and Data Network

A B S T R A C T

Cyprus is currently undergoing something of a hydrocarbon explorations boom in its Exclusive Economic Zone (EEZ) with multiple companies undertaking survey work in deep waters and reporting the accidental discovery of Underwater Cultural Heritage (UCH) sites. This is a double-edged sword, as while the oil and gas industry funds and undertakes the majority of deep-sea explorations in which these new discoveries are made, the datasets disclosed to the relevant authorities remain largely confidential and inaccessible for further academic studies. This thesis provides a rare insight into how the oil and gas industry generates geophysical and Remotely Operated Vehicle (ROV) video-photography datasets and highlights that datasets are primarily produced for industry purposes and thus lack the appropriate recording strategies for the adequate documentation and thereby preservation by recorded of accidental UCH discoveries. In the absence of national standards specifying how UCH discoveries should be adequately surveyed and reported when discovered during oil and gas operations, the main contribution of this thesis is the proposal of a robust set of minimum professional by-standards that can be specified by national heritage agencies to oil and gas companies operating in the deep waters of the EEZ. These derive from the analysis of ROV video-photography, side-scan-sonar (SSS), multibeam-bathymetry-echosounder (MBES) and backscatter datasets submitted by fourteen oil and gas contractors operating in the deep waters of Cyprus, for a period of roughly a decade (2011 to 2021). The observations emerging from these datasets are worked to different levels of surveying with the associated by-standards presented therein pertaining to how offshore oil and gas contractors/subcontractors may best adapt marine geophysical surveys and their data outputs to incorporate elements of maritime archaeological surveying. These guidelines intend to promote the best practical solutions at a technical and operational level and are concerned with the effective detection, survey, *in situ* and by recorded preservation, reporting, data-submission and archiving of output datasets and UCH discoveries made in the EEZ of Cyprus during the course of deep-water oil and gas explorations.

1. INTRODUCTION

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has estimated that three million shipwrecks are spread across ocean floors around the planet. At present, however, most of these sites of Underwater Cultural Heritage (UCH) are located in the shallow waters of the Territorial Sea (TS) with only very few being reported in the deep waters of the Exclusive Economic Zone (EEZ) (UNESCO, 2018). In 1976, Willard Bascom in his book *Deep Water, Ancient Ships*, first commented on this by stating that 20% of the total estimated number of shipwrecks are most likely situated in open waters (Bascom, 1976, 5). This means that from the three million wrecks estimated by UNESCO, six-hundred thousand are situated in open waters. Today Bascom's statement is more relevant than ever as 'modern technology is opening the deeper parts of the world's seas and oceans to maritime archaeology, beyond the depths in which scuba divers can operate' (Bass, 2013, 15).

Discoveries of deep water gas fields in Israel, Cyprus, and Egypt, have renewed the interest of the oil and gas sector in conducting offshore natural resource surveys (NRS) in the eastern Mediterranean Sea. From a maritime archaeological perspective, this raises the probability of new accidental discoveries of UCH in these deep waters and the opportunity for scholars to investigate them and publish their results. For example, recent deep water surveys for exploration and education purposes have discovered deep sea UCH (Ballard, et al, 2017), demonstrating the potential for the extensive and systematic NRS to reveal further sites of importance. Unfortunately, while discoveries are made in the context of these surveys, a disconnect exists between the oil and gas companies and academia that results in information and datasets about them not making the transition from data producer to academic and public consumer. This has a negative impact on the field of maritime archaeology since valuable information is either 'lost' within unreleased corporate datasets or else are bound to remain 'unknown', concealed by confidentiality agreements between companies and coastal States. This thesis concerns the EEZ of Cyprus and seeks to evaluate the current state of knowledge of

UCH discoveries made up-to 2021 with explicit emphasis placed on the new shipwreck/scatter artefact discoveries made accidentally during the course of oil and gas explorations.

Offshore oil and gas operations are divided into three major segments —upstream, midstream, and downstream— with this study focusing on the upstream sector[1] and explicitly on the *Exploration /Appraisal* phase. Phase 1 (*Exploration*) entails a seismic survey (or seismic data interpretation) which aims to narrow down specific locations where prospection drilling(s) will take place. For specific prospect locations, a second *Appraisal* phase of Environmental Baseline Survey (EBS) and Geohazard Investigations [or other types of Supplementary Hydrographic Surveys] is usually subcontracted to a marine survey company(ies) who undertakes marine geophysical surveys. Technically, these include surveys using operational machinery such as Remotely Operated Vehicles (ROVs) and Autonomous Underwater Vehicles (AUVs), mounted with geophysical equipment such as: multibeam-bathymetry-echosounder (MBES) and backscatter (Woods Hole Coastal and Marine Science Centre, 2019), side-scan-sonar (SSS) (Burguera and Oliver, 2016), and sub-bottom-profiler (SBP). With the completion of these marine geophysical surveys, further ground truthing investigations take place via ROV video-photography. It is during this *Appraisal* phase that accidental discoveries of archaeological/historical assets may occur. The data generated during the *Appraisal* phase are studied and developed in Geohazard Investigation and EBS reports, which are then integrated into the final Environmental Social Impact Health Assessments (ESHIA) or Environmental Impact Assessments (EIA) studies, primarily for the purpose of determining the most suitable location(s) for drilling and minimising any risks to the environment.

[1] The term upstream sector refers to different phases of offshore oil and gas operations such as: the searching for potential prospect offshore oil and gas fields; the drilling of exploratory wells; and the subsequent recovery and production of the ‘trapped’ hydrocarbons. For more information about the different development phases of the upstream sector refer to **Chapter 6**, Figure 56, page 239.

1. INTRODUCTION

The potential to conduct deep water research using geophysical and visual datasets generated from NRS is an exciting one that offers a low-cost solution to a notoriously expensive form of maritime research (Calvo, et al, 2009; Trobbiani, et al, 2018). The data are already being produced by companies operating in the oil and gas sector and archaeologists and heritage managers need to gain access to it and to ensure that the types of data documenting UCH are fit for purpose. To demonstrate the potential of this approach, accidental finds from oil and gas companies operating in the EEZ of Cyprus since 2011 have revealed three new shipwreck sites and one amphorae alley. These wreck-sites along with the additional scatters of materials are examined in **Chapter 4**, where a detailed analysis of the observable cargo is undertaken to propose an approximate date for the wrecking of the ships. The composition of the cargo also provides information pertaining to the ship's original route and possible destination. The data from these wreck case studies clearly highlight the current deficiencies in the recording strategies of commercial companies undertaking NRS. They were simply not collected with an archaeological analysis in mind and as a result are often difficult to interpret. This emphasises the requirement for a clear, practical, and operationally robust set of minimum professional by-standards for 'cost-effective'[2] UCH surveys conducted during the *Appraisal* phase —such as EBS and Geohazard Investigations [or other types of Supplementary Hydrographic Surveys]— preceding the drilling of wells. For surveys that need to incorporate elements of maritime archaeology surveying, the output survey levels and the minimum professional by-standards of

[2] While implementing the suggested survey levels and the associate minimum professional by-standards of the study, in EBS and Geohazard Investigations [or other types of Supplementary Hydrographic Surveys], may well add time and by extent cost to the operational framework of the project, I believe that the overall amount will most certainly be proportional and more 'cost effective' than requesting supplementary marine archaeology *reconnaissance* surveys. Therefore, for the purpose of this thesis the term 'cost effective' relates to the difference between spending a little more time surveying potential deep sea UCH anomalies and discoveries and using up-to-date survey equipment in ways and frequencies that are more suited to the discovery of UCH compared to the cost of mounting a second supplementary survey missions completely dedicated to revisiting or resurveying sites of UCH significance. For further clarifications about these technical and methodological clarifications refer to **Chapter 5** and for the 'cost-effective' by-standards refer to **Chapter 6**.

the study will ensure that this is done in a methodologically correct way, but without prolonging the operational activities of contractors/subcontractors with lengthy time-consuming tasks or putting an unacceptable financial burden on the surveying company. Both survey levels and the associate by-standards were worked to specify the *minimum* requirements that different oil and gas contractors should consider implementing, with these being tailored specifically to the operational framework of deep-water oil and gas explorations. The levels of surveying and the subsequent minimum professional Survey, Data Submission, and Reporting by-standards presented therein, are seen in **Chapter 6** and were developed based on observations made from the operational activities of fourteen offshore hydrocarbon projects that took place in the EEZ of Cyprus (see **Chapter 5**) and derive from suggestions made by both national and international regulatory agencies, such as the Bureau of Ocean Energy Management (BOEM), the European Union, the Australian Government, the Chartered institute of Archaeologists (CifA), the International Association of Oil & Gas Producers (IOGP), and the International Petroleum Industry Environmental Conservation Association (IPIECA).

In addition to the data generated by oil and gas surveys, exploration cruises by the Ocean Exploration Trust (OET) in 2010 and 2012 have also revealed an additional three shipwreck sites, and a staggering 300 scatters of materials in the deep seas of Cyprus. Two of these shipwrecks were examined superficially and as a result are re-examined in **Chapter 4** in an attempt to address the typology of the artefacts observable in the data and by extension the chronology[3] and approximate wrecking dates of these sites (Wachsmann, et al, 2011; Ballard, et al, 2017). The aim here is to re-examine in greater detail all archaeological evidence of deep sea UCH discovered up-to 2021 and to cross-examine them in relation to the prevailing theories of the economic development of the eastern Mediterranean. Furthermore, the issue of scatters of material will be considered for what they can offer to the interpretation of deep water UCH.

[3] For the chronological table of the study see **Appendix**, Chronological Table of the Study, page 394.

It is suggested that through regarding them as debris trails from wrecking events or vessels in danger seeking to lighten their loads, and analysing these scatters spatially, they may prove indicative of dangerous sea routes and areas of 'high archaeological importance' worthy of further surveys. Debris trails from multiple vessels have never been studied in this detail before (Foley and Ballard, 2004) (see **Chapter 4**).

For the past four years, this study has been supported and closely monitored by the Department of Antiquities Cyprus (DoAC), to whom I am truly grateful, and has thus far contributed to the development of a database of 1.7 TB. This consists of reports, different types of geophysical data, and ROV video-photography datasets, most of which were generated in the EEZ of Cyprus. From these datasets, a (geo)database in ArcGIS of 6 GB was developed containing the site coordinates of 300 scatters of materials, one amphorae alley, and eight shipwreck sites, of which six were examined in **Chapter 4** (Figure 35, **Chapter 5**, page 190). The remaining two sites were excluded from the analysis as there are found situated in the EEZs of Lebanon and Egypt. The output (geo)database represents the first monument list of deep water archaeological sites and artefacts for Cyprus and will help to ensure their *in situ* stewardship from future commercial projects relevant but not explicit to oil and gas, such as cable and pipeline laying projects and in the near future deep sea mining. For more information pertaining to the database and (geo)database of the project refer to **Chapter 5**.

While the six shipwreck sites, one amphorae alley and 300 scatters of materials (i.e. amphorae) from the EEZ are not substantial enough to augment the maritime archaeological framework of the island, **Chapter 2** demonstrates that there is much that can be learnt about deep water seafaring when considering the scale of the new discoveries more broadly. To my knowledge, both published and unpublished data, suggest that the deep sea of the eastern Mediterranean Sea from the late 1990s up to 2021 have yielded 42 shipwreck sites. Unfortunately, these seem to be excluded from synoptic studies on the maritime history of the

eastern Mediterranean, even though authors have long accepted that ancient mariners have been actively sailing in open water since the Neolithic period (Arnaud, 2005b). As a result of this academic tendency, the maritime archaeological framework of the island, and that of the eastern Mediterranean more broadly, is mostly written from nearshore finds. This is developed further in the conclusion section of the study —**Chapter 7**— which postulates that further research into deep sea UCH can potentially shed new light on the prevailing theories of long-distance trade, economic development and interconnectivity of the wider eastern Mediterranean region. To address this, the last section of **Chapter 2** charts the historic development of deep water UCH discoveries, highlighting that they are made primarily in the context of commercially or military driven surveys. This proposes that in order to supplement the fragmentary archaeological record of deep water discoveries, academic research should turn to past and current industrial and military driven projects. Hence, this renders a new model of research necessary with the term *Oil and Gas Archaeology*[4] coined here, postulating that maritime archaeologists need to collaborate with national heritage agencies so as to bridge the gap between the offshore oil and gas industry and academia to ensure that datasets concerning UCH

[4] The term *Oil and Gas Archaeology* coined here, refers to academic studies utilising video-photography and geophysical datasets exhibiting the discovery of deep sea UCH assets made accidentally in the context of natural resource surveys (NRS). For the purpose of this term, deep sea UCH refers to sites situated over 100 metres of depth, defined based on the '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage' **Article 1(a)** general definition of UCH: All traces of human existence of cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years such as: **(i)** sites, structures, buildings, artefacts and human remains, together with their archaeological and natural context; **(ii)** vessels, aircraft, other vehicles or any part thereof, their cargo or other contents, together with their archaeological and natural context; and **(iii)** objects of prehistoric character (UNESCO, 2001, 2); And the **General definition** ascribed to archaeology under the '2014 (amended) Antiquities Law of Cyprus': 'Any object, whether movable or part of immovable property and is considered to be a work of architecture, sculpture, graphic art, painting, or generally any form of art which has through human effort been produced, sculptured, inscribed or painted in Cyprus or abroad. The aforementioned should be 100 years old, or older, produced in any manner whatsoever and from any material, and were found, discovered or excavated or recovered in Cypriot territory both on land or at sea. This includes any such object(s) or part thereof which has at a later date been added, reconstructed, readjusted or replaced subsequently' (The Antiquities Law Cyprus, 2014, 1120).

—such as reports, geophysical and video-photography— are being extracted and studied in an academic setting.

Through gathering, re-analysing, archiving, and requesting follow ups on reports and datasets for the purpose of this study, this thesis has provided a framework for communication between the DoAC and offshore oil and gas contractors that has proven to be mutually beneficial. It has contributed towards the effective implementation of Article 18A of the '2014 (amended) Antiquities Law of Cyprus': 'Any archaeology on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on' (The Antiquities (amended) Law Cyprus, 2014, 1120). In effect, because UCH in the deep waters of the EEZ of Cyprus has been granted a protected status, discussions between the author and Dr. Despina Pilides, Curator of Museums, and Dr. Marina Solomonidou-Ieronymidou, Director of the Department of Antiquities Cyprus (DoAC), initially instigated in December 2016 and concluded in July 2017, agreed that a three to four year pilot study in the context of DPhil thesis, with an explicit research scope focusing on deep water archaeology discoveries made during oil and gas operations in the EEZ and CS of Cyprus, would contribute to implementing the protection of UCH for the areas beyond the 'accessible' waters of the TS. This was taken as the starting point of this thesis and the data collection exercise that took place from the oil and gas companies who have been operating in the deep water of the EEZ of Cyprus for the period 2010 to 2021. This study has effectively achieved this, with **Chapter 3** arguing that UCH in the EEZ and on the CS of Cyprus is legally protected by offshore oil and gas operations (i.e. drilling), both under national and international law, including that which is relevant but not explicit to heritage law. To address this, **Chapter 3** charts the development of the frameworks relevant to the protection of UCH in deep waters, with the second part of this chapter presenting an analysis of different national laws in addition to Cypriot national law, pertaining to how different States of European Economic Area (EEA) and

elsewhere are using their national frameworks to ensure the effective protection of UCH in the deep waters of the EEZ. These States were selected because they are currently active in oil and gas explorations in deep-waters and their national heritage and hydrocarbon/petroleum laws present similarities to Cypriot law. This is relevant to an overreaching argument which has different maritime States operating, managing and legally asserting control over deep-sea UCH in the EEZ and on the CS in more or less same way. The end argument of this section postulates that Cypriot heritage and hydrocarbon/petroleum laws, and other national policies and soft policies of different States and international frameworks operate at a high level and lack the technical specifications necessary for discovering, surveying, reporting, and *in situ* preserving and by record of archaeological/historical assets found accidentally during the course of NRS. In the light of this observation, the final objective of the thesis is the development of a set of minimum professional guidelines for offshore commercial contractors operating in Cypriot waters, with these being worked specifically to different levels of surveying that are explicitly relevant to NRS activities and *Appraisal* surveys. The adoption of the survey levels and the associate by-standards will provide the prerequisites necessary for guaranteeing that the likelihood of any heritage assets situated within the broader prospect area(s) have been identified and received the appropriate consideration (see **Chapter 6**). Ideally, the output survey levels and the minimum professional by-standards will be implemented in the 'regulatory administrative acts of 2022' of the 'Antiquities Law of Cyprus', or will set to further clarify the undetermined prerequisites Scope of Work (SoW) set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus,* following the completion of this thesis.

The data gathering exercise has demonstrated that many different data collection standards are currently used in operations in the Cypriot EEZ, which is largely an issue associate with project specifications and lack of national and international regulations and guidelines.

Continuing with a profusion of data types of varying quality will undoubtedly lead to further problems into the future, including issues of how national [heritage] agencies will ensure the deposit of such datasets with them, as well as how they will be effectively integrated into existing systems, archived, and migrated in the future as software and information standards change (BOEM, 2015; 2017). This situation has arisen mainly because the private companies that are usually responsible for generating or analysing such datasets, are also unofficially in charge of archiving them as well, rather than it being deposited with the appropriate heritage agency (Firth, 2011). The range of data sets that are currently being produced and the implications of this for their long-term storage and accessibility within the DoAC, and their interoperability with other departments within government, will be set out in **Chapter 6**. For this reason, a series of recommendations pertaining to developing a sustainable strategic plan for digital archiving is also evaluated. This aims to monitor the state of the datasets annually, convert them to new formats when necessary, and ensure that datasets are backed-up in different medias, thus creating a pathway for their digital archiving and potential later reuse.

In the knowledge that new discoveries of UCH are being made during deep water oil and gas activities, it is incumbent upon the archaeological community —both heritage managers and researchers— to collaborate with the wider offshore industry. This will alert the commercial companies undertaking such work of the likelihood that they will encounter UCH during the course of their surveys, provide them with the appropriate guidelines so that they can effectively record them, report these findings to the relevant heritage agencies, and deposit the data associate with them for management and research purposes in a suitable way. In this respect, this research is advocating a partnership between exploration companies and heritage agencies to ensure the notification and preservation of data on UCH from the deep-seas. To this end, this project should be considered a bench-mark case-study, which demonstrates the feasibility and necessity of creating a repository for deep sea heritage data in Cyprus, not only for the purpose

of managing and conducting academic studies, but also for preserving this rare, sensitive, and expensively acquired data for the future (Figueiredo and Bernardes, 2010).

The creation of different levels of surveying with the enclosed by-standards provided therein, play a significant role in this thesis. Here the analysis of geophysical datasets such as MBES and backscatter, SSS, and ROV video-photography datasets undertaken in **Chapter 5** forms the technical background that has helped to inform the output minimum professional by-standards of the study (see **Chapter 6)**. The results of this analysis provide an in-depth understanding to how the oil and gas industry currently conduct visual inspections of archaeological/historic assets made accidentally during the course of NRS; how the offshore oil and gas industry produces geophysical datasets; and what information can be deduced from each dataset. In a broader sense, the purpose of using such datasets in this study seeks to further enhance the methodological aspect of the subdiscipline. The analyses of geophysical datasets argues that SSS, MBES and backscatter datasets should be purpose-driven beyond simple seabed characterization and geohazard investigation. Because of this, the results of a developing template, a data 'Atlas', of SSS and MBES and backscatter datasets is presented that illustrates how geomorphological features are manifested in these datasets. The end objective of this is to discuss what resolution and frequency is needed to generate SSS and MBES and backscatter data that will enable better data clarity and thus aid distinguishing between modern and ancient debris, as well as shipwreck sites and geological features with less ambiguity. Similarly, the study of ROV video-photography datasets in **Chapter 5** suggests that accidental discoveries of UCH by oil and gas projects demonstrates the lack of a cohesive methodology for surveying [and thus preserving by record] archaeological/historic assets. From a technical perspective, contractors/subcontractors utilise different ROV camera and light systems, the result of which is that visual inspection of UCH generally produces results that are problematic, limiting how much archaeological information can be deduced from them. These technical and

methodological parameters derive from the analysis of the data submitted by fourteen oil and gas contractors operating in the deep waters of Cyprus for a period of roughly a decade (2011 to 2021) and are based on suggestions made by other archaeological geophysical, geotechnical and upstream operational guidelines, composed by both national and international regulatory agencies. The observations emerging from these datasets directly informed the development of the survey levels and the associate minimum professional by-standards, the adoption of which Cyprus would ensure the effective protection of UCH both by record and *in situ* (see **Chapter 6**). These guidelines aim to promote the best practical solutions for the effective discovery, survey, reporting, *in situ* and by record safeguarding, data-submission, and archiving, of output datasets and UCH discoveries made in the EEZ of Cyprus. They can also be used as a template for adoption by other custodial agencies in the eastern Mediterranean where there is currently a similar amount of oil and gas exploration taking place and also more broadly during NRS elsewhere.

To summarize, EBS and Geohazard Investigations [or other types of Supplementary Hydrographic Surveys] undertaken in the context of *Appraisal* surveys, for the purpose of NRS, do not produce the same results as a maritime archaeology survey, as they are conceived and undertaken with different objectives in mind. This thesis intends to bridge the gap between the requirements of the offshore industry and those of heritage managers and academia and provide insights into how the oil and gas industry operates, generates data and thereby preserves by record the discovery of accidental deep-sea UCH and how this can be improved to satisfy the needs of both in a cost-effective way. This is addressed through the analysis of geophysical and ROV video-photography datasets, where I argue that in the absence of minimum professional by-standards regarding the Survey, Data Submission and Reporting of UCH assets, offshore oil and gas contractors/subcontractors, cannot be held liable if archaeological/historic assets are inadequately surveyed, not surveyed at all, or even damaged or destroyed altogether. Even

though the oil and gas industry is a clear threat to deep-sea UCH preservation, it should also be considered an undeniable 'data-source' that can yield new insights into the deep seas (UNESCO, 2018). This statement acts as a reference point for this study and seeks to first publish [the hitherto unpublished] accidental deep water discoveries made during the course of oil and gas explorations as well as to evaluate and re-examine the site-discoveries made in the context of other explorational projects such as the 2010 and 2012 OET survey cruises. Since the introduction of Article 18A of the '2014 (amended) Antiquities Law of Cyprus', UCH in the EEZ of Cyprus has been granted a protected status both under national and international frameworks, however, the wider Cypriot public lacks exposure to and thus an awareness and appreciation of its' deep-sea heritage. This is unfortunate as this study has demonstrated that there is indeed a considerable amount of archaeological and other environmental, geological and biological evidence in the deep seas of the island. The data gathered as part of this thesis, however, represents the first monument list of deep water archaeological discoveries found in the open waters of Cyprus up-to 2021 and could be used as a step towards rectifying this unfortunate lacunae in the public appreciation in deep sea heritage. **Chapter 7** aspires to convey these insights to the broader public, by presenting different ideas for raising awareness and promoting public outreach regarding the rich and diverse heritage of the deep seas of Cyprus. It is my position that by presenting ROV videos and photographic data collected in the context of this study through different public outreach projects, the offshore oil and gas industry is given the opportunity to highlight its' Corporate Social Responsibility (CSR) in discovering, surveying and preserving both by record and *in situ* the deep sea [cultural] heritage of the island. The project ideas presented in **Chapter 7** are aligned with the aims and objectives of the *United Nations Decade of Ocean Science for Sustainable Development, Goal 14*, paragraph 1, 'by 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-

based activities, including marine debris and nutrient pollution' (United Nations Sustainable Development Goals, 2020).

2.LITERATURE REVIEW

"The soul of the past is in deep water"
(Phillippe Diolé, 1954)

[2.1].Introduction

For millennia, Cyprus served as a strategic connection for seafaring and trade between the Aegean, Near East and Mediterranean maritime worlds. While 'the fact that Cyprus is an island is sufficient to explain its dependence on the sea' (Karageorghis, 1995, I), it was the abundance of copper that helped to promote the island into the wider orbit of the Mediterranean. Cyprus' relationship with the sea thus became a defining feature of its history when its name was synonymous with copper (Davies, 1928). Maritime trade and interconnectivity are, therefore, inevitably linked with both the history and archaeology of the island. In this chapter, I intend to give an account of the previous scholarship pertaining to maritime archaeology in Cyprus, which is concentrated in the waters close to its shore in its Territorial Seas (TS). Yet, as recent discoveries in oil and gas surveys in the Exclusive Economic Zone (EEZ) have shown, there is also much that can be learnt about deep water seafaring from these sites. Discoveries since 2010 have been excluded from synoptic studies on the maritime history of the island (cf. Demesticha, 2018), which has left an unfortunate lacuna. There now exists good evidence for six shipwreck sites, of which three are unpublished, and approximately 300 additional scatters of archaeological materials (i.e. amphora) and one amphorae alley. Such finds clearly demonstrate that the maritime history of the island should not be written simply from nearshore finds and that these deep water sites should be added to the picture. They have the potential, in the near future, to augment existing studies simply through the addition of the wrecks of ships, and scatters of their cargoes, that were undertaking blue water, as opposed to coastal, sailing. It is obvious that the Underwater Cultural Heritage (UCH) from deep water should play a significant role in any interpretation of the maritime archaeological framework of the island. In support of this argument, the last section of **Chapter 2** charts the historic development of deep water UCH discoveries, made both in the eastern Mediterranean and elsewhere, highlighting that

discoveries are made primarily in the context of commercially or military driven surveys and other education/exploration surveys, that were usually not archaeologically inspired. This pertains to a central argument of this chapter, which is that academic research in deep waters for the sole purpose of discovering UCH is problematic due to its great expense. In effect, this renders a new model of research necessary with this study postulating that maritime archaeologists need to collaborate with national heritage agencies so as to bridge the gap between the offshore oil and gas industry and academia to ensure that datasets concerning UCH make the transition from data producer to heritage manager and then to academic and public consumers. The study is the result of this new model of research, with the term *Oil and Gas Archaeology*[1] coined here, referring to academic studies utilising video-photography and geophysical datasets exhibiting the discovery of deep sea UCH assets made in the context of natural resource surveys (NRS).

[2.1.1].The History of Maritime Archaeology in Cyprus

The first reporting of maritime UCH in Cyprus can be seen in the archaeological notebook of Hogarth's 'Devia Cypria' (Hogarth, 1888). Hogarth, a Classical archaeologist, visited Cyprus in 1887 for a period of six months, during which time he identified harbour remains at the ancient sites of Nea Paphos, Akanthou, Ourania (in the locality of Aphentrika), and Karpasia (Leonard, 1995). In Nea Paphos, Hogarth describes in detail the remains of the northern breakwater, which was 'formed like the wall of rough cemented core, faced with massive Blocks clamped together with metal' (Hogarth, 1888, 7). This resembles the much later description of Joan du Plat Taylor, in her preliminary report of 1935 at Agios Philion, Karpasia, in which she identified and surveyed 'a sheltered bay, enclosed by two rocky arms, on which may be seen the foundations of ancient moles of cut stone, held together by metal ties. The shoreward ends of these two moles are joined by a stout wall of cut stone, enclosing the area

[1] For the definition of the term *Oil and Gas Archaeology*, refer to **Chapter 1**, page 7, footnote 4.

immediately above the harbour' (Taylor, 1935, 24; Demesticha, 2018; Harpster, 2008). This fascinating description was only formally published decades later (Taylor, 1980), which is 'characteristic of the significant, albeit sporadic record of underwater and maritime archaeological projects in Cyprus, from the earliest days of the discipline' (Demesticha, 2018, 64). Nevertheless, from the activities of early pioneers such as Hogarth and du Plat Taylor prior to the invention of the aqualung, it can be argued that archaeologists working in Cyprus never turned a blind eye to the sea (Demesticha, 2018). Such an engagement was amplified following the independence of the island in 1960 when Dr Karageorghis, then director of the Department of Antiquities, adopted an archaeological policy welcoming foreign maritime archaeological missions to conduct research (Demesticha, 2018; Harpster, 2008). This policy helped to make Cyprus the maritime archaeology research hub of the eastern Mediterranean in the years between 1967 and 1974: during these seven years, roughly seventeen maritime projects were fostered (Harpster, 2008; Leonard, 2008).

Following the invention of the aqualung in 1943, the first underwater survey in the island probably took place between 1959 and 1961 led by the amateur archaeologists and now well-known English explorer John N. Blashford-Snell. Lieutenant Blashford-Snell led a small group of British military divers in the harbour at Nea Paphos as part of 'Operation Aphrodite' where they 'recovered numerous artefacts, from the harbour and the waters of the surrounding coastlines, including 'a charming little marble of Aphrodite, now in the Paphos museum' (Hohlfelder, 1995, 193). The report of this work was never made available for the public; however, it is archived at the Department of Antiquities Cyprus (DoAC) and has been consulted and cited by various authors, popular historians, writers and travel guidebooks (ibid., 196). According to Harpster, further amateur surveys were also conducted off Lara Bay, Akamas in 1961 and 1962 by the British Joint Services Aqua Club, where among other artefacts, the

recovered stone anchors were studied and published by Honor Frost in 1970. Frost's study was further extended in 1985 to encompass the stone anchors from Kition (Frost, 1985).

Additional projects of a maritime character, such as the Lapithos fish tanks survey, demonstrated that maritime research should be carried out both underwater and also on the foreshore (Nicolaou and Flinder, 1976). To this end, Kyriakos Nicolaou, who was probably the only Cypriot archaeologist at the time promoting actively a maritime agenda in the DoAC, publishing two fundamental studies on the visible maritime architectural remains on sites such as the important ports of Nea Paphos and Kition, as well as at least nineteen additional ancient harbour sites around the island (Nicolaou 1966; 1966b). It is clear that Nicolaou composed the earliest, and probably the largest, holistic study of the visible remains of harbour installations on the island and managed to preserve them by record, as sites such as Nea Paphos, Marion-Polis, and Lapithos have, unfortunately, been subsequently affected by modern development.

In 1965 Daszewski conducted the first professional underwater archaeological survey of the harbour of Nea Paphos (Daszewski, 1981). His much-delayed article is the first underwater survey to give a detailed analysis of the architectural layout of the ancient harbour. Like the work on the shoreline of Nicolaou, this was undertaken prior to the development of the modern quay installation, which unfortunately now completely covers the ancient western breakwater (Daszewski, 1981; Hohlfelder, 1995). A geophysical survey around and at the entrance of the harbour took place in 1969 by a German team. The results of this survey were never published and thus we can only speculate that they were searching for shipwreck sites; the lack of evidence for which resulted in the lack of publication (Åström 1971; Hohlfelder, 1995; Leonard, 2008).

In 1971, the Israeli scholars Elisha Linder and Avner Raban mapped various harbour sites such as: Nea Paphos, Salamis, Kyrenia, Lapethos, and Marion (Latchi). While the results of the Israeli expedition were never published in detail, Raban's 1995 article about the 1971

survey presented some of the results of the project. According to Raban, beyond training underwater archaeology students from the University of Haifa in harbour recording methods, the Israeli project aimed to discover the closed walled harbours of the island (*Limen Kleistos*), as well as to draw architectural parallels with other Phoenician harbours in the wider eastern Mediterranean (Raban, 1995). Unfortunately, due to modern development and the poor preservation of several sites, Raban was unable to identify any additional *Limen Kleistos* beyond that of Nea Paphos (ibid., 167). This was challenged by Nicholas Flemming in 1972 who conducted a second survey at the harbour of Salamis and suggested that 'further research might reveal more evidence of fortification and harbour works in the southern basin since there is a possibility that a jetty or a break water was built in front of the harbour' (Flemming, 1974, 170).

While much of the early work of maritime archaeologists on the island was devoted to harbour studies, Cyprus also played an important role in the development of shipwreck archaeology. In 1967, Teddy Hall, then director of the Oxford Research Laboratory for Archaeology, came to Cyprus with his student Jeremy Green to conduct extensive geophysical surveys using magnetometry and a metal detector at different location that were reported to be of 'high archaeological potential' (Leonard, 2008; Green, 1973). The team, including Susan Katzev, found five potential wreck sites off the Akamas peninsula along the west coast of the island and three further potential sites of 'high archaeological importance'. As the wrecks were situated at a maximum depth of four metres, the state of their preservation was poor. They were tentatively dated via their cargoes of amphorae, which suggested that they were from the Late Cypro-Classical to the Late Roman/Early Byzantine periods (5th BC to 7th century AD) (Bass and Katzev, 1968, 168-169). During the summers of 1969 and 1970, Green continued his efforts to locate intact shipwreck sites at the north-east end of the island at Cape Andreas. His systematic survey, which involved a preliminary hydrography survey, metal detecting, and

guided dives doing swim line surveys, revealed a total of ten pottery sites; four were thought to be wrecks and the remaining six possible cargo spillage or jettisoning areas (ibid., 168-169; Green, 1970). As these four wrecks were not sufficiently intact to warrant excavation, *in situ* preservation and preservation by record was carried out. Similarly, in 1972 and 1973, a Swedish team, directed by Paul Åström, conducted an underwater survey at Cape Kiti, Larnaca, aiming to find the harbour and possible shipwrecks off the nearby Late Bronze Age site of Hala Sultan Teke (Åström, 1986; Demesticha, 2018). With the completion of two additional seasons in 1977 and 1980, Åström proposed that ancient sailors favoured the cape as an anchorage, yet also found it a hazard with hidden reefs that may have brought at least three ships, of Cypro-Classical, Roman and Byzantine date, to their destruction (Åström, 1986; Leonard, 2008). This theory gains further validity when considering that the 2008 and 2009 Cape Kiti survey project, revealed three additional sites of scattered amphora pieces. Analysis of the amphora fragments and mapping of the distribution of the pottery suggested the presence of three additional Roman wrecks in the area (Demesticha, 2015).

With the notable work of Jeremy Green, who later went on to codify much of this important early work on survey techniques in his *Maritime Archaeology: A Technical Handbook* (Green, 2003), alongside the work of other early pioneers of maritime archaeology, such as Honor Frost and Susan and Michael Katzev, it is clear that Cyprus was one of the key early areas in the development of the subdiscipline. It was under these favourable conditions that Andreas Cariolou, a councilman and sponge diver, directed Susan and Michael Katzev to a small exposed, and yet perfectly preserved, mound of approximately 80 amphorae, roughly half a kilometre off the shore of Kyrenia in 1968 (Katzev, 1969; Katzev and Katzev, 1974). The Kyrenia wreck had previously been surveyed by Green in 1967 at an initial pre-disturbance survey and revealed a site of 19 x 10 metres in an excellent state of preservation (Harpster, 2008; Green, et al, 1967; 2003). Realising the importance of the find, as well as the potential

for hull preservation, began the excavation of the site the following summer. Simply put 'the results of that excavation, which occurred in 1968 and 1969, are now legendary' (Harpster, 2008, 5). As expected, the exceptional preservation of the wooden hull, as well as extant cargo of the vessel, 'represented a cutting-edge study for its time, whose results still resonate and inform today' (Leonard, 2008, 134). Indeed, with 30% of its wooden hull preserved and its painstakingly detailed study, the Kyrenia wreck has been considered a milestone in the history of nautical archaeology (Steffy, 1985). Further study and analysis of the excavated amphorae suggested that the Kyrenia wreck was a small Classical-era merchant vessel coming from the islands of Rhodes, Samos or Paros, with a cargo predominantly of approximately 300 Rhodian amphorae containing almonds, small oil jugs, mill stones from Nisyros, iron ingots and other tools and utensils used by the crew (Harpster, 2012). With the completion of the excavation project in 1969, the hull of the vessel was disassembled underwater, then raised, conserved, and reassembled by Richard Steffy in 1971 in the Kyrenia castle, where it is currently on display. In the words of Loren Steffy, who describes her father's work in her book *The Man who Thought Like a Ship*, 'the Kyrenia Ship was the first ship in human history to be built twice' (Steffy, 2012, 2). Subsequently, Steffy assembled and thus presented the very first museum display of an ancient wooden hull. Post-excavation work on the wreck is still on-going and the wreck itself is the subject of systematic conservation, with activities to include 'cleaning, physical and chemical stabilization, and preventive conservation' (Cutulle, 2015, 3). Furthermore, a major publication has been announced in 2018 and believed to be forthcoming.

Based on Steffy's analysis of the ship's hull, a replica of the Kyrenia wreck, called the Kyrenia II, was built between 1982 and 1985 in the Manolis Psaros shipyard in the Piraeus of Athens. It completed its first voyage to Cyprus after a few days at sea, an experimental voyage that provided an opportunity for scholars to experience life on board, while also enabling the testing of various theories related to its performance (Tzalas, 2007; Katzev, 1990). The 1986

voyage of the Kyrenia II from Mandraki harbour, Rhodes, to Maa, Paphos, demonstrated that ancient mariners would require at least three days of open sea sailing with favourable wind conditions. The return sailing in 1987 from Maa to Mandraki, however, had unfavourable winds and required at least half a day more (Bakirtzis, 1997). Kyrenia II is currently on display at the Thalassa museum in Ayia Napa. It proved to be such a valuable research tool that it was succeeded by the Kyrenia Liberty replica, which continues to be used for experimental studies (ibid; Harpster, 2012; Leonard, 2008).

In the late 1960's and early 1970's Cyprus was a leading centre for maritime archaeology, indeed the then newly founded Institute of Nautical Archaeology, with which the Kyrenia excavation was associated, was preparing to establish a research centre on the island. Unfortunately, the Turkish military invasions of the island in 1974 meant that such plans were abandoned, and thereafter the momentum of maritime archaeology on the island was lost (Harpster, 2008). As the Turkish military invasions coalesced into a long-term presence on the island, maritime archaeology in Northern Cyprus stagnated, with this being due to the fact that archaeological investigations in occupied territories, are prohibited under the '1954 UNESCO Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict' (Articles: 6, 9, 10, 12, 16). This has resulted in the uneven development of maritime archaeological research, awareness and preservation on the island. Only two maritime projects have reportedly taken place in the occupied part of Cyprus in the years up to 2008; however, this number is unlikely reflecting the reality of the situation as many more projects are likely to have taken place but have not been reported or published (Harpster, 2008). Consequently, further analysis and collaboration with Turkish-Cypriot maritime archaeologists, is needed in order to systematically investigate the issue, and so to understand the current and past state of research into UCH in Northern Cyprus.

2. LITERATURE REVIEW

The military invasions and the illegal occupation of the north of the island resulted in 'international teams along the southern coastline halt[ing]ed their work, waiting for stability to return to the island' (ibid). Maritime work resumed with the underwater survey of Stuart Swiny, in 1981, at the Akamas peninsula, where he led a team of British Force divers to conduct a verification survey on a wreck that had been reported at 40 metres of water to the Cypriot authorities by scuba divers. The survey demonstrated that although the remains of what became known as the Mazaki wreck had been disturbed, the surviving cargo was primarily Roman and non-homogenous. Furthermore, in 1983 and 1986, the University of London conducted an extensive survey along a 13 km stretch of coastline in the western part of the island, from Keretidhi Bay, Maa to Lara Bay, Akamas (Giangrande, et al, 1987). A year later, Jean-Yves Empereur, of the French school at Athens, conducted the first underwater harbour excavation in 1984 and 1986 at Amathus, Limassol (Empereur, 1985; 1987; and Empereur and Koželj, 2018). Similarly, Hohlfelder renewed investigations of the ancient harbour at Nea Paphos in 1991 and 1992 and applied geoarchaeological methods for the first time on the island in 1996, revealing the full extent of the original harbour's basin.

The little-known harbour at Dreamer's Bay on the south coast of the Akrotiri peninsula was surveyed and published by the amateur archaeologists Frank Haggerty in 1990. Haggerty's report on the massive ancient breakwater of Dreamer's Bay provoked further studies in the area, both underwater and along the coast (Haggerty, 1990; Haggerty, 1990b). A year later at the same site, Leonard conducted an underwater reconnaissance survey during which he noted architectural and ceramic materials on the seabed (Leonard, 2008). He returned in 1999 and 2003 to carry out a surface collection of pottery and also produced a detailed top plan of one of the large coastal warehouses at the site. The sites recorded by Leonard, as well as harbour works and stone quarries of the peninsula's seafront, have been the subject of survey and excavation by Professor Simon James since 2015 (James and Score, 2015; 2016; 2017; 2018). Underwater

surveys in the area were further conducted in 2006, 2007 and again in 2018, revealing the remains of a large area of concreted pottery which is believed to be a Roman wreck, as well as various anchorage-sites along the Akrotiri peninsula (Leonard and Demesticha 2004; Blue, 2019). Incorporating a maritime approach to terrestrial projects has continued in more recent work and the Episkopi-Bamboula, Kioni and the Maroni-Tasroukkas anchorages were surveyed as part of the wider terrestrial excavation projects: the Episkopi survey, Ancient Akamas and Tsaroukkas Mycenaeans and Trade projects (Leonard 1995; Manning, Swell and Herscher, 2002; Leonard, 2008; Leidwanger 2005; 2005b).

Beyond the investigation of anchorages, projects have also used geoarchaeology methods for the purpose of understanding sea-level change and the wider question of how the landscape has developed over time. The work of the University of Lyon at Kition-Bamboula brought to light a well-preserved complex of ship sheds, at a distance of roughly 1 km from the coast (Yon, 2000). This investigation of a submerged landscape resulted in further geomorphological studies at the Larnaca Salt Lakes, which aimed to understand the position of the palaeo-coastline and, thus, the potential location of the ancient harbour of Kition (Devillers, Brown and Morhange, 2015). The results suggested that the wider Larnaca area developed from coastal progradation, thus shipwrecks and the ancient harbour are more likely situated on land. Similarly, geological coring in 1996 suggested that during the Roman period (1st BC to 4th century AD) the palaeo-shoreline of Kourion was probably located as much as 20 metres further in land from its present position (Leonard, 2005). This challenged the preliminary survey results of the Kourion harbour project of 1990-1991, implying that the recorded breakwater probably developed much later than was initially believed. More recently, three underwater geoarchaeology surveys were carried out in 2011, 2013, and 2014, between Tochni-Lakkia and Maroni-Tsaroukkas areas, Larnaca. The purpose of the first two seasons was to reveal information regarding the maritime past of the wider area of Tochni-Lakkia, with a particular

focus to see if there was any evidence of an anchorage site in the area (Swell, 2013). Beyond the discoveries of several anchorage-sites, the 2011 and 2013 surveys reported that the wider area has been affected by erosion. To this end, in 2014, the project mapped comprehensively the coastal and underwater environment of the area from the Vasilikos River to the Pentaschoinos River and suggested that approximately 30 metres of land have been claimed by the sea during the past sixty years (Andreou and Swell, 2014, 77).

Archaeological research in harbour projects, anchorage-site investigations, general underwater and coastal investigations, as well as shipwreck surveys and excavation, have all confirmed the importance of the seafront and the sea for the island. Yet, it was studies of ship graffiti that underlined further the importance of keeping a maritime perspective in mind, even for sites situated further in land. For instance, following Westerberg's 1983 study of ship graffiti (Westerberg, 1983), Demesticha's 'KARAVOI' project presented the results of a (geo)database with 233 ship graffiti from 44 different churches dating roughly from the 15th to the 20th centuries (Demesticha, et al, 2017). The results were spatially analysed, revealing that maritime activity flourished in the hinterland adjacent to the coastline between Larnaca and Famagusta. According to Demesticha, this is because sailors and pilgrims, when anchoring at these two main ports prior to sailing to the Holy Land, explored nearby sites probably in order to attend certain religious events for the purpose of receiving blessings of protection for their maritime undertakings (ibid). In this instance, the ship graffiti were interpreted as evidence of established routes of seamen and pilgrims who, when on land, 'followed routes associated with popular local cults' (ibid., 372).

Similarly, terrestrial research relevant to maritime history, social archaeology studies, as well as international conferences, instigated discussions of complex ideas of micro and macro interconnectivity for the island (Horden and Purcell, 2000). Conferences such as the 1993 'Cyprus and the eastern Mediterranean from Prehistory to Late Antiquity', the 1994 'Res

Maritimae: Cyprus and the eastern Mediterranean from Prehistory to Late Antiquity', and more recently the 2017 'Under the Mediterranean: The Honor Frost Foundation Conference of Mediterranean Maritime archaeology' brought together the maritime archaeology community to discuss the role of seafaring and trade in the wider eastern Mediterranean Sea. From all of the studies presented, and for the purpose of this study, Bakirtzis' perspective of analysing historical sources from a maritime angle stands out. His argument about 'the annual transfer of corn from Egypt to Constantinople' during the Byzantine period (8th to 12th centuries AD), effectively highlighted that it is essential to recognize that Cyprus played a bigger role in macroregional connectivity, not as a main exporter of goods but instead as an island stop between the trade-route of Alexandria, Rhodes, Chios, Tenedos, and Constantinople (Bakirtzis, 1997). Even though his argument is valid in terms of suggesting that Cyprus had a bigger role in the wider orbit of long-distance trade, his decision to name Cape Drepano and Maniki Bay as the main anchorages is very much debatable when considering that both anchorages have limited enclosed space. These sporadic ideas of micro and macro regional connectivity and Cyprus's role in long-distance trade, evaluated by Bakirtzis and others scholars, were further developed by Bernard Knapp into a synthetic overview into the maritime framework of the island, with his colossal contributions of 2008, 2013, 2016 and 2018, putting forward the idea that 'the study of maritime connectivity is one subject in which the Mediterranean history has most to learn from prehistory' (Blake and Knapp, 2008; Knapp, 2013; 2018; Knapp and Demesticha, 2016; See also, Horden and Purcell, 2000, 133). Undeniably, his studies advanced the maritime perspective of the island, beyond the 'lame use of "trade" as a self-explanatory force' (Knapp and Demesticha, 2016, 1) and provoked further studies and surveys related to the subject (Yamasaki, 2015; Moutsiou, 2019).

From a funding perspective, the establishment of the THETIS foundation in 2004 and the Honor Frost Foundation (HFF)[2] in 2011 have been important in supplying the necessary financial means for underwater research in Cyprus and the wider eastern Mediterranean, thus, making maritime archaeology research on the island financially possible. In 2007, for example, the THETIS Foundation funded a Chair of Maritime Archaeology at the University of Cyprus. It also funded the first maritime project conducted solely by a Cypriot organisation (Demesticha, 2018) on the Mazotos shipwreck, which has been ongoing since 2007 and is concerned with the excavation of a perfectly preserved 4th century BC wreck of roughly 500 amphorae (Demesticha, 2010). The wreck lies at a depth of roughly 45 metres, 14 nautical miles (nm) south-west from the village of Mazotos, Larnaca, and approximately 1.5 nm from the shore (ibid). Undeniably, the Mazotos shipwreck represents the most important shipwreck excavation project in the maritime archaeological history of the island since the Kyrenia and has the potential to provide insights about shipbuilding-technology for the periods between the 5th and 3rd centuries BC (Maritime Archaeology Research Laboratory 2019). The academic impact of this discovery is expected to be invaluable, especially when considering that Mazotos chronologically falls between the excavated wrecks of Kyrenia (beginning of 3rd century AD) (Steffy, 1985) and the Ma'agan Michael (end of 5th century AD) (Linder, et al, 2003). Thus, the preserved hull of the wreck covers a crucial gap in the development of nautical technology and can potentially reveal changes or continuity in the practices of shipbuilding in the eastern Mediterranean region (ibid). It is also worth recognising that the Mazotos wreck project has played a decisive role in furthering the maritime infrastructure and legislation of the island. For instance, all of the excavated artefacts from the wreck, as well as those of other maritime related projects such as the Nissia wreck (Maritime Archaeology Research Laboratory 2019b), are preserved at the Conservation Laboratory for waterlogged artefacts. The laboratory was created

[2] Link to the Honor Frost Foundation website, https://honorfrostfoundation.org/ [accessed 15-04-2020].

in 2010 specifically for this and has been generously sustained by the HFF ever since. At a legislative level, the same project has contributed further to the amending of the regulatory administrative acts of the DoAC in 2016, leading to the adoption of the annex Rules of the '2001 UNESCO Convention on the Protection of Underwater Cultural Heritage' (Regulatory Acts of 2016 Antiquities Law, 2016).

In 2019 excavation continued on the Mazotos wreck as well as a final season of the underwater survey project at the opportunistic port of Dreamer's Bay, Akrotiri. Lastly, in June 2019, two divers reported the discovery of an ancient wreck with transport amphorae at the Protaras area near Kavo Mares (Department of Antiquities Cyprus, 2019). The wreck was investigated by a team of archaeologists, students and volunteers of the Maritime Archaeological Research Laboratory, led by Dr Stella Demesticha, tentatively suggesting that the wreck dates to the Roman period and most probably carried transport amphorae from Syria and Cilicia (ibid).

The future for maritime archaeological research in Cyprus is bright. The establishment of the HFF in 2011, with its specific agenda towards supporting maritime archaeology research in the eastern Mediterranean (mainly for the regions of Cyprus, Syria, Egypt and Lebanon), has so far funded at least 21 projects on the island, out of which eleven were mentioned above[3]. From 2015 to 2017, three underwater field schools were organised in collaboration with the Nautical Archaeology Society UK at three different sites, the Xylophagou anchorage and the Maozotos and Nissia shipwrecks, where roughly 35 students and divers received training in underwater scientific recording methods and excavation techniques (Demesticha, 2018). In the same context of capacity building, in 2015, the Maritime Archaeology Outreach Bus project, travelled to a series of targeted destinations, such as museums, schools, community centres, and

[3] For additional information about funded projects so far, refer to the Honor Frost Foundation interactive map at, https://honorfrostfoundation.org/grants-awarded/interactive-map/ [accessed 15-04-2020].

universities, and raised the profile of maritime archaeology on the island (Maritime Archaeology Trust, et al, 2015). On an academic level, the foundation generously funds Cypriot students who wish to study maritime archaeology at master's or PhD level, both in Cyprus, the United Kingdom and elsewhere. So far, four PhD students have been funded, three of which are studying in the UK and two of who have just completed their thesis. In addition, more than ten students have received full or partial funding to study the master's program 'Field Archaeology on Land and under the Sea' at the University of Cyprus.

This survey of the development of maritime archaeological activity on the island of Cyprus has demonstrated that it played a major role in the history of maritime archaeology even before its generally accepted establishment as a scientific discipline in the 1950s following the development of the aqualung. Pioneering projects such as those of Hogarth and Taylor demonstrate that maritime archaeology, or the maritime way of thinking, was always part of the archaeological framework of the island. The excavation of the Kyrenia wreck, as well as the associated research in the following years, has come to represent more than the recovery of a unique assemblage of archaeological material (Harpster, 2012). In fact, it can be argued that scientific techniques and the academic practice of nautical archaeology was developed on the island, as the discovery, excavation and reassembling of the Kyrenia wreck took place when the subdiscipline of maritime archaeology was no more than ten years old (ibid). Also, the work of Jeremy Green who have codified much of the early fieldwork survey techniques of maritime archaeology, is still taught, used and largely considered an invaluable contribution to the methodological development of the subdiscipline of maritime archaeology. While the invasion of Cyprus severely curtailed this form of research, recent decades have seen maritime archaeological research regaining its prominent position, with much of the work reflecting wider intellectual trends within the subdiscipline, such as the growth of the use of geoarchaeology and geophysics. With a chair of maritime archaeology at the University of

Cyprus and a master's course in 'Field Archaeology on land and under the Sea', as well as research students active in the field, and a funding-body supporting all this, the most effective period of the history of maritime archaeology in Cyprus has yet to come. Nevertheless, it is worth recognising that all of the above projects took place in the shallow waters of the TS and as a result the syntheses of the maritime archaeological framework of the island is largely written from the perspective of coasting or near-shore voyaging. This is unfortunate when considering that the survey cruises of the Ocean Exploration Trust (OET) in 2010 and 2012 noted an abundant presence of scatter materials and three shipwreck sites. For this matter, the following section aims to charts the historic development of deep water archaeology, followed by a holistic evaluation focusing explicitly on the deep water discoveries made in the EEZ of Cyprus and the eastern Mediterranean Sea more broadly. The purpose of this is to underline that deep water discoveries are made primarily in the context of explorational/educational, commercial and military driven surveys, with information on deep sea UCH sites made accidentally during the course of oil and gas explorations being largely absent. As it will be argued below, even though archaeological work in the deep seas of the eastern Mediterranean Sea has hitherto been limited, information of deep water finds exist and should be included in the maritime framework of the island and that of the region more broadly. This is relevant to one of the overarching arguments of the chapter: the oil and gas industry in the deep waters off the coast of Cyprus has the potential of adding to the developing maritime framework with new deep sea UCH discoveries, thus opening a window onto this neglected area of maritime knowledge (see **Chapters 4**). This thesis, consequently, represents the first project of its type in Cyprus and the eastern Mediterranean Sea more broadly, highlighting the enormous potentials that *Oil and Gas Archaeology* has in supplementing the fragmentary recorded of deep water archaeology.

[2.2].The History of Deep Water Archaeology

'The remoteness of the deep sea leads to a heavy reliance on technology to provide the information needed to carry out forefront research, and as equipment has improved over the years, we have begun to see the deep sea environment with increasing clarity' (Cochonat, et al, 2007, 5). Deep water archaeology is an ever-changing field due to advances in control platforms such as Autonomous Underwater Vehicles (AUV) and Remotely Operated Vehicles (ROV), geophysical sensor machinery, cameras and lighting rigs, and software technology; much of it generated within the oil and gas sector. Technological advances have thus enabled higher resolution mapping in previously inaccessible parts of the ocean, at depths up to 6000 metres, bringing around 98% of the world's ocean floor within reach and dramatically increasing the possibility of discovering deep sea shipwreck sites (Foley and Mindell, 2002).

The potential for the discovery of UCH in deep waters was realised early in the history of deep sea exploration, although –like the modern discoveries in the EEZ of Cyprus during NRS– these sites were not found as a result of archaeologically inspired surveys, or indeed undertaken by archaeologists. The first amphora wreck to be discovered in deep water (760 m), for example, was the by-product of the search in 1952 for the wreckage of a commercial airliner off the island of Elba in the Mediterranean (Søreide, 2011, 23). This was supplemented in 1954 when 24 intact ancient wrecks were supposed to have been discovered during a pipeline route survey from France to Africa (ibid.). Other incidental deep water finds included 'two intact ships at 610 metres, with their masts still standing and the cannon projecting from the gun-ports' by the crew of the submersible *Aluminaut* in 1966, while searching for a lost hydrogen-bomb (ibid). Unfortunately, many of these early discoveries were not adequately documented –if documented at all– and thus our knowledge of these sites is frustratingly sparse. An exception to this is the work of Oceaneering International, one of the first subsea companies, who discovered and documented a Roman amphora wreck somewhere in the Tyrrhenian Sea at 3,453 metres (ibid). Here the potential for UCH sites to provide ideal training grounds for deep

water divers and other professionals working in the oil and gas sector resulted in the collaboration between Sub Sea Oil Services of Milan and the Institute of Nautical Archaeology on the Capistello wreck. The consequent project in 1977 represented the first attempt to combine saturation diving and archaeology. Reviewing this project from the perspective of the current research, the Capistello wreck effectively demonstrated that archaeologists require the help of the industry in order to conduct research in deep waters (Frey, Hentschel and Keith, 1978). While these early reports did not receive much scientific attention, they demonstrated the possibility of finding shipwrecks in deep waters and indicated to the maritime archaeological community that developing scientific methodologies for discovering deep sea UCH required more experimental and theoretical research.

In 1976 Willard Bascom published a ground-breaking book entitled *Deep Water, Ancient Ships*, arguing that deep sea UCH should be first surveyed with underwater CCTV, and then raised intact to be excavated in shallow waters (Bascom, 1976;, 139 Søreide, 2011, 25;). Even though some of his ideas about deep sea UCH excavation were deemed naïve and dangerous to site preservation (Søreide, 2011, 25), Bascom put forward for the very first time the idea of conducting surveys of archaeological targets with ROVs. He suggested that deep sea UCH should be surveyed with underwater positioning systems, cameras and sonars, in order to first know where exactly the wreck is situated, and second, to produce an accurate photomosaic plan, supplemented by high resolution side-scan-sonar (SSS) data. Following data acquisition, he suggested that this should be post-processed in software for the purpose of constructing a complete 3D site plan. Bascom's ideas were ahead of his time and today are considered integral to the scientific surveying of UCH (Wachsmann, 2012, 204; Bascom, 1976).

About a decade after its publication, Bascom's ideas were put into practice. In 1987, the 494-ton round-sterned, wooden steam freighter wreck of the New Jersey was surveyed by means of an ROV. SSS was used to produce a high-resolution map of the wider area, with

cameras used to create a detailed photomosaic of the wreck, and an ultrasonic high accuracy ranging and position system marked the exact location of the site (Shomette, 1988). Even though the New Jersey wreck was situated only at a depth of 25 metres, this marked the 'first ever attempt to show that archaeological investigations could be done with ROVs and various remote sensing equipment' (ibid; Søreide, 2011, 26-27). The project was successful, and thereafter underlined Bascom's fundamental concept that the archaeologists are not removed from the work; 'rather he is kept at the surface where he can think and act more effectively. He is no longer a diver but a thinker who can spend his time directing a shipboard laboratory, manipulating the devices below, and examining the finds. He is freed of the thousand small problems of diving operations' (Bascom, 1976, 141). In many respects, the success of the New Jersey project, takes us back to the earliest days of underwater archaeology where the archaeologist remained on the boat and divers did the work. What's different here though is that ROV's have become the archaeologist's eyes, enabling archaeologists to still 'dive' the wreck, be intimately involved with the data recovery process, and thereafter avoid repeating the failures of the early years of the sub-discipline of maritime archaeology when mistakes were made because archaeologists were unable to visit the site and direct the work based on their observations.

Nevertheless, it was only two years later, in 1989, when Bascom's fundamentals of scientific UCH surveying were first applied in deep water. Robert D. Ballard, famous for locating the RMS *Titanic* in 1985, conceived and directed what is now referred to be the first deep water archaeology project (Ballard and Durbin, 2008; Coleman and Ballard, 2008; Ballard and Drew, 2021; Ballard and Archbold, 1990; Ballard and Archbold, 1995). The JASON Project involved the survey and excavation of a 5th century Roman trading ship sunk in approximately 1000 metres of water in the area known as the Skerki Bank. The discovery of the wreck was possible due to systematic seabed surveying with marine geophysical survey

machinery, which was primarily developed for military and oceanographic exploration purposes, demonstrating quite effectively the potential of integrating this technology in discovering deep sea UCH. During the course of three seasons, in 1989, 1995, and 1997, the JASON Project reported the discovery of eight deep sea shipwreck-sites and thereafter contributed to altering the academic perception that had ancient seafarers hugging the shoreline for safety (Wachsmann, 2012; Davis, 2000). From an outreach perspective, the JASON Project utilised ROV technology and produced and distributed a series of live streaming educational programs to a network of students (McCann and Oleson, 2004; Abbott, et al, 1997). The live broadcast was presented through the lens of the most up-to-date communication technology of that time and was transmitted through a network of universities, museums, research institutions and other centres to an audience of schoolchildren. According to McCann and Oleson, the live broadcast reached some 225,000 children in both USA and Canada and inspired the education of students through real science and exploration during a period when 'it was not fashionable to study science at school'[4] (Abbott, et al, 1997, 111). This proved that deep sea UCH can be used to reach out to a wider audience via telepresence technology and it remains an invaluable concept applied in numerous deep sea UCH exploration projects ever since[5] (Ballard and Durbin, 2008). Live-streaming and telepresence is still applied today with the most recent examples presented through the work of the survey team of the R/V Petrel[6] –that has been generously funded by the Paul G. Allen Family Foundation[7] since 2015– and has reported the discovery of 24 WWII wrecks, with other research vessels such as the E/V Nautilus, reporting the discovery of various ancient wrecks since 2008. For more information about the academic

[4] To know more about JASON Learning refer to, https://www.jason.org [access 13-05-2019].
[5] For additional information pertain to the use of telepresence technology in deep sea exploration for the purpose of public outreach refer to: Nautilus Live website, https://nautiluslive.org [access 13-05-2019]; and the Schmidt Ocean Institute website, https://schmidtocean.org/ [accessed 10/04/2020].
[6] Link to the R/V Petrel website, https://www.rvpetrel.com/ [accessed 21-05-2019].
[7] For more information visit Paul G. Allen Family Foundation website, https://pgafamilyfoundation.org/ [accessed 20-07-2019].

publications and video-photography data of E/V Nautilus refer to their website[8] and YouTube channel[9].

The discovery of the RMS *Titanic* and the live broadcasting of the JASON Project popularised deep sea archaeology and historic wreck surveying. Further projects followed, (Ballard, et al, 2000; 2002; Wachsmann, et al, 2011; Wachsmann, 2012; Church and Warren, 2008; Foley, et al, 2009; Ballard, et al, 2017), both in lakes (Beasley, 1991; Ballard and Durbin, 2008) and the sea, in which deep sea UCH was either the subject of intentional surveying (Blot, 1996; Croizeau, 1996; Delaporta, et al, 2006) or the secondary by-product of other offshore commercial activities (Ford, et al, 2010; Sakellariou, et al, 2015; Søreide, 2011). The following analysis presents evidence from both commercially driven projects and explorational/education inspirited surveys, postulating that offshore development projects, where UCH was reported as a by-product have led to further reconnaissance surveys with an explorational character. As a result of these early projects, national custodian agencies are now requiring from future offshore commercial contractors to protect any already known deep-sea UCH sites as well as to report, and preserve both *in situ* and by record any new discoveries. This pertains to regardless in which context deep-sea UCH has been discovered and whether the survey of UCH was part of an official project agenda or not, all projects have contributed in developing the archaeological repertoire of deep-water discoveries and raising the awareness necessary.

For instance, the Black Sea Maritime Archaeology Project (M.A.P.) of the University of Southampton, has effectively presented just how little we know about the deep seas and yet how much potential there is in discovering deep sea UCH in every dive. Iinitially, the project aimed to investigate the changes in the paleo-environment of the region including the impact of sea-level change following the last glacial maximum and the formation of the Black Sea.

[8] E/V Nautilus website, https://nautiluslive.org/ [accessed 20-07-2019].
[9] E/V Nautilus, YouTube channel, https://www.youtube.com/user/EVNautilus [accessed 20-07-2019].

However, as a by-product of this, it reported the discovery of at least 60 shipwreck sites, dating from modern to Hellenistic times, at depths ranging from 150 up to 2000 metres. These discoveries were made during the course of three field-seasons, from 2015 to 2018, and were recorded in Bulgaria's EEZ, situated in an anoxic environment, that prevents the decay of wood and artefacts, and thus allows the preservation of vessel features and elements of ship construction, 'that until now have not been preserved on ships of this age' (National Geography, 2018). Of particular interest, and subject to international newspaper coverage, was the discovery of a 25 metre long ship that appears to be similar to the merchant vessels depicted on the ancient Greek 'Siren Vase' that can be seen at the British Museum (Rawlinson, 2018; University of Southampton, 2018). A sample piece from the wreck, and subsequent radiocarbon dating, dated the wreck around the 5th century BC, confirming it to be 'the world's oldest intact shipwreck' (ibid). The standing mast, ropes, spars, rowing benches, captured the fascination of millions globally, and retold the story during 'a time when Greek city-states were frequently trading between the Mediterranean and their colonies along the Black Sea coast' (Romey, 2018). According to the principal investigator of the Black Sea project, Jon Adams, other discoveries include many sunken Ottoman shipwrecks dating them from the 16th to the 18th centuries, as well as several other 19th century ships. In addition, a medieval Italian vessel that most probably dates to the 14th century was also discovered and has been described to have a characteristic *cocha*, or a 'round' ship quarterdeck (Romeo, 2016). If this is the case, Adam's argues that it is then fair to assume that this vessel most probably sunk during Venice's golden era, during when Marco Polo recorded his adventures (ibid).

The archaeological value of these finds reinforces what has been demonstrated from different expedition —shipwrecks are in abundant presence and in an excellent state of preservation— with the Black Sea M.A.P. discoveries offering a glimpse into the commercial networks that linked Europe with the eastern Mediterranean all the way to Indian Ocean, for

a continuing period of over half a century (ibid). From an educational perspective, the project, also aimed to inspire the next generation of STEM Scholars and introduce them to marine-science-careers by inviting them on-board the R/V Stril Explorer. During the course of the Black Sea M.A.P., more than thirty teenagers from around the world, joined Adam's team of interdisciplinary scientists. They experienced science in action and were given the opportunity to work alongside scholars, filmmakers, ship-crew and ROV pilots and developed their own research projects, based on their interests. The work carried out as part of the Black Sea M.A.P. represents a rare but pioneer example of how large-scale funding, in marine sciences and archaeology can enable cross-disciplinary research and effectively contribute to outreach, education and documentary entertainment, with the latter being account through a two-part documentary series *Ghosts of the Deep: Ancient Shipwrecks* (Pacheco-Ruiz, Adams, and Pedrotti, 2018; and 2019).

According to Jon Adam, the wrecks recorded as part of the Black Sea M.A.P., and the subsequent development of a (geo)database of shipwreck-sites, allows the Bulgarian authorities to exercise more direct monitoring of companies holding hydrocarbon prospection licences. Companies such as the Royal Dutch Shell and Total as well as other offshore commercial development projects (i.e., pipeline and cable-laying projects and in the near future deep-sea mining), are now required to liaise with Bulgaria's Centre for Underwater Archaeology prior to surveying and development, ensuring that the companies and contractors/subcontractors involved in the work are aware of know finds of UCH as well as the likelihood of new discoveries (University of Southampton, 2018). Presumably, the protected status given to deep-water wrecks now applies to other discoveries made in the past, such as the 2,300 years old Greco-Roman shipwreck, recorded in 2002 during Ballard's survey in the Territorial waters of Bulgaria (Coleman, and Ballard, 2007). The survey standards of the Black Sea M.A.P. exceeded UNESCO's *in situ* and by record survey practices, and have shaped policy on cultural heritage

management in the Black Sea region and beyond. For this reason, **Chapter 5** of the study will evaluate the technical and methodological survey parameters carried out as part of this project and will adopt the methodological aspects of ROV video-photography surveying in particular, as part of the output policy recommendations of the study, seen in **Chapter 6**.

The scale of deep-sea discoveries in the Black Sea is impressive as the unique nature of the oxygen-deprived deep-water-environment 'has long intrigued undersea explorers' (Søreide, 2011, 52). For instance, in 2000 Ballard carried out a deep-water survey along the northwest coast of Turkey, from the Bosphorus to the Turkish seaport of Sinop, and reported the discovery of three shipwrecks. One of these was dated to the 5th to 6th centuries AD and was recorded situated in 320 metres of water (ibid). This Byzantine shipwreck —named Shipwreck D or Sinop D— was revisited in 2003 and again in 2007, where further surveying, amphorae sampling, and the excavation of a few minor test pits, provided the data that were latterly cross-examined with an another Byzantine shipwreck —Chersonesos A— that was also discovered by Ballard in the Territorial waters of Ukraine, as part of his 2006 Archaeological Oceanography program (Bernnan, et al, 2011; Ballard, et al, 2001). Clips from the ROV video-photography data from the 2003 and 2007 expeditions can be seen online via YouTube.[10]

Similarly, discoveries of deep water shipwrecks in a state of near-perfect preservation have been reported from the Baltic Sea. Due to the low salinity levels, the absence of seaworms (*Teredinida*e), and cold sea temperatures, the Baltic Sea has been characterised as a unique reservoir for maritime archaeology. These unique environmental conditions have contributed

[10] Videos of the Shipwreck D or Sinop D as well as other site discovered as part of the 2003 and 2007 surveys follow the links of the:
2012, E/V Nautilus, *Shipwreck: Sinop D | Nautilus Live* at, https://www.youtube.com/watch?v=wprhoSMNFLI [accessed 26-07-2021];
2012b E/V Nautilus, *Shipwreck: Sinop F | Nautilus Live* at https://www.youtube.com/watch?v=VK33-DtRTA8 [accessed 26-07-2021];
2012c E/V Nautilus, *Shipwreck: Sinop E | Nautilus Live* at https://www.youtube.com/watch?v=iKjWPnjQLwo [accessed 26-07-2021].

to the discovery and subsequent recovery and display of the world's best preserved wreck such as the Vasa, as well as other less-known wrecks such as the Vrouw Maria and the 'Ghost wreck' (Spökvraket) (Sjöhistoriska, 2020). From the nine countries surrounding the Baltic Sea, thousands of shipwrecks have been reported, with new ones discovered each year. Douglas estimates that roughly more than 100,000 wrecks lie in the semi-enclosed Baltic Sea with the WRECKPROTECT project advocating that at least at least 6000 are of 'high archaeological importance' (Douglas and Dahm, 2020). These wrecks were recorded along the trade routes that run from Denmark, Germany and Poland to the Baltic states to Russia and Finland, and are either of wood construction, dating primarily from the Viking period to the 15th and 17th centuries AD, or are battleships and submarines of the First and Second World Wars (Søreide, 2011; Douglas and Dahm, 2020; Dockrill, 2020). In the deeper waters where the boundaries of the EEZs of Russia and Germany meet, surveys as part of the Nord Stream gas pipeline have reported the accidental discovery of more than 40 shipwrecks and hundreds of side-scan-sonar (SSS) targets. From these pre-noted SSS targets, additional reconnaissance surveys were conducted in 2019, as part of the later Nord Stream 2 pipeline project, revealing the remains of a late 15th - early 16th century shipwreck (MMT, 2019). According to Rodrigo Pacheco-Ruiz, the principal archaeologists and photogrammetry specialist of the project, the shipwreck 'is probably the best preserved Early Modern period shipwreck ever to be discovered in recent times' and most probably predates the Swedish warship Mars (1564 AD), but not the Vasa (1628 AD) (ibid; Eriksson and Rönnby, 2017; Eriksson, 2019)

In Norway, the possibility of archaeological sites discovered as by-product of offshore petroleum related activities was recognised early on, with UCH receiving a protected status under '1978 under the Cultural Heritage Act'. In brief, under this act developers are required to undertake the expenses for surveying and even excavation, as it is necessary to preserve any accidental damages 'that may run counter to the purpose of protection' (Ministry of Climate

and Environment, 1978). This led to the establishment of a University inspired partnership between the Institute of Marine Technologies and the Institute of Archaeology, of Norwegian University of Science and Technology (NTNU), the aim of which was the exploitation of petroleum resources and for the advancement of marine sciences and archaeology (Søreide, 2011). In 1994, scientists from the abovementioned institutes, carried out archaeological reconnaissance surveys on a 'planned pipeline route from the oil and gas reservoirs on Haltenbanken' after concerns were raised about the possible adverse effects on the remains of a 18th century Russian ship (Søreide and Jasinski, 1998; Søreide, 2000). The aim of these reconnaissance surveys was to determine the shallow boundaries of the wreck, map the trail of artefacts in the immediate vicinity of the site, and document the remaining parts of the hull and cargo in the deep ends of the site, at 250 to 280 metres of depth. During the course of three seasons, from 1994 to 1996, supplementary hydrographic surveys via different geophysical means and ROV video-photography inspections, recorded and thereby preserved by record the wreck in its entirety and 'determine[d] whether the pipeline could damage parts of the wreck'.

The Haltenbanken project illustrated to offshore contractors 'that cultural remains on land and under the sea are to be protected in the same way' and deep water archaeology requires detail study and *in situ* and by record protection, prior to development (Søreide, 2011, 62; Søreide, 2000). Since then, commercial projects have led to the discovery of various shipwrecks sites in the Norwegian open-waters with UCH discovered accidentally as a by-product of offshore commercial development plans. For instance, in 1997, the Trondheim Harbor project revealed a staggering 50 to 60 shipwrecks, half of which were previously unknown. From these new discoveries, the remains of the Den Waagende Thrane (Waking Crane) wreck were identified, dating the wrecking of the site around the 17th-18th centuries AD. Both projects contributed to the full implementation of the 1978 'Cultural Heritage Act' of Norway, highlighting to contractors that marine archaeology investigation and an archaeological

clearance is a prerequisite prior to any ‘construction work planned on the seafloor’ (ibid). This is one aspect of Norwegian heritage law, with the case study of the 2003 Ormen Lange project demonstrating that contractors are also require to meet certain data expectations (Kingsley, 2011). In the scenario that these expectations are not met and datasets are not generated at frequencies and output resolutions sufficient enough to provide clear insights with reasonable clarity for the detection of targets in the area around and within the proposed pipeline route, additional supplementary surveys are usually requested by the responsible custodian agency (Søreide and Jasinski, 2005). For the Ormen Lange project, further surveys were deemed necessary and additional geophysical and ROV video-photography surveys were conducted, focusing within an area of known ‘rich maritime history’ and ‘maritime tragedy’, in which the proposed pipeline route was passing through. This led to the discovery of four modern and two historical shipwrecks with further surveys and test-pit-excavations commencing on a particular historic site that was tentatively dated to the late 18th early 19th centuries AD. The two seasons that followed in 2004 and 2005, on this early modern wreck aimed to determine to what extent the site could be damaged by the pipeline, as well as to learn more about the shipwreck itself and its construction. The excavation took place at 170 metres of water and contributed to the recovery of nearly 5,000 artefacts and a golden Dutch coin dating to 1802 (ibid). This coin along with the date written on the recovered bell suggested that the ship most probably sunk after 1745 AD but no later than 1802 AD (Søreide, 2011). Further archaeological analysis of the remains of the wreck and the recovered artefacts, suggested that it was a merchant ship that carried a cargo of spirits, grains and salt and most probably sailed along the Norwegian coast to/or from Britain to the Netherlands, and most probably originated from Russia. The survey and excavation of wreck was financed by the Ormen Lange licence company —Shell— and other partners with the total cost reaching an approximate 10 million US dollars (Søreide, 2000).

2. LITERATURE REVIEW

In recent years, deep-water shipwrecks have been surveyed and partially excavated as part of mitigation agreements between offshore development companies (i.e., oil and gas drilling and pipeline projects) and the responsible custodian agency in the Gulf of Mexico. This is because the Bureau of Ocean Energy Management (BOEM) of the Department of the Interior, USA, and its predecessor agency, the Minerals Management Service (MMS), have set as a prerequisite that the drillings of offshore oil and gas wells, and the construction of pipelines, planned to take place on the Continental Shelf (CS) and the EEZ, require an archaeological clearance. To fulfil this, the *in situ* and by record protection of UCH should be achieved, with MMS and the latte successor custodian agency BOEM requesting further surveys and/or even excavations, especially when proposed projects are taking place within areas 'where archaeological sites are likely to be found' (Søreide, 2011, 27). As a result of this 'archaeological lease stipulations' MMS and BOEM estimates that 400 shipwrecks have been discovered on the CS and the EEZ as a result of oil and gas and pipeline related activities, with thousand more shipwrecks estimated to have sunk in the Territorial Seas and the Contiguous Zone (ibid; Ford, et al, 2010). From this vast archaeological repertoire of shipwreck discoveries in the Gulf of Mexico, five wrecks were recorded at depths over 1000 meters and can be virtually accessed at BOEM's *Virtual Archaeology Museum*[11] website.

According to MMS and BOEM, the earliest discoveries made in the Guld of Mexico, as a results of this archaeological lease stipulations, were the Civil War Union gunboat USS Hatteras; the Western Empire wreck (U.S. Department of the Interior Minerals Management Service Gulf of Mexico OCS Region, 2001); the side-wheel steamer Josephine; 'and the World War II German submarine the U-166 and the passenger freighter the S.S. Robert E. Lee' (ibid). Of notable interest are also the 2002 Steam Yacht Anona and the 2001 cooper-sheathed wreck

[11] To experience BOEM's, *Virtual Archaeology Museum* follow the link, https://www.boem.gov/Virtual-Archaeology-Museum/ [accessed 21-05-2019].

(BOEM, 2021b; Church, et al, 2005; Atauz, et al, 2006). These sites were discovered between 1,200 and 833 metres of water and were initially discovered as part of a larger lease block survey for offshore hydrocarbon by BP Exploration join-venture and ExxonMobil's development company as part of a planned pipeline survey (BOEM, 2021). Both sites were re-examined with the involved companies funding additional archaeological reconnaissance surveys, with the latter 2001 cooper-sheathed wreck, being the subject of excavation and the selective recovery of artefacts (U.S. Department of the Interior Minerals Management Service Gulf of Mexico OCS Region, 2001). In the same area and six years later, Warren et al published in detail the results of the geophysical survey of the Mardi Gras' shipwreck (Warren, et al, 2010). The site was accidentally recorded during an offshore pipeline reconnaissance and was then partly excavated as part of a mitigation agreement between the Okeanos Gas Gathering Company and the MMS, with the excavation results published in detail by Ford (Ford, et al, 2010; BOEM, 2008). The results of this almost two years effort were also produced in a documentary —namely *The Mystery Mardi Gras Shipwreck*— that tells the story of the 2007-2009 excavation expedition and subsequent recovery and conservation of artefacts from an early 19th century shipwreck, lying in roughly 1,200 meters of water.

According to BOEM, at least sixteen shipwrecks were discovered in water depths greater than 1,000 metres (Irion, 2001, 1-2). From these sixteen shipwrecks, six were casualties of the World War II and were revisited in 2004 as part of the Deep Wrecks Project. Composed of a multidisciplinary team of oceanographers, archaeologists, biologists, professional surveyors, filmmakers and ROV operators, the Deep Wrecks Project sought to investigate and determine if these sites function as artificial reefs in deep waters, as well as to positively identify all sites and to determine the boundaries of each wreck (Church, Warren and Irion, 2009). The aims of the project were achieved with the data gathered suggesting that when it comes to the investigation of metal-shipwrecks maritime archaeology and marine biology are intertwined

disciplines that have much to benefit from each other (ibid., 60). Based the principle of interdisciplinary research and collaboration with the offshore industry, the Europe's Lost Frontiers project, also known as the Doggerland project, took a slightly different approach as to how to conduct research in the open seas of the North Sea. Through utilising pre-existing datasets that were generated for industry purposes, the scientists of the Doggerland project attempted to map the submerged prehistoric landscape that once connected the UK, Scandinavia and continental Europe (Gaffney, et al, 2009; Gaffney and Thomson, 2007; Coles, 1998). The mapping has been achieved mainly by using 3D seismic data donated by Petroleum Geo-Services (PGS) —that are predominantly used by the industry for the detection of 'trapped' hydrocarbon deposits— with the results of the analysis resulting in maps showing the lakes and rivers, hills, coastlines and estuaries, wetlands and salt marshes. The seismic datasets which covered 45,000 km^2 and combine the survey results of more than 60 different oil and gas surveys, together they present a holistic insight to the changing geomorphology and ecology of a now submerged landscape —Doggerland— for the period of the 'Holocene around 10,000BC until its eventual total inundation around 5,500BC (Gaffney and Thomson, 2007). The data used in this project, enabled research in an area 'regarded as archaeological marginal or even ignored as an convenience data gap' at practically no cost (Gaffney, et al, 2009). These approach highlighted the importance of maritime archaeology 'piggy-backing' onto ongoing surveys or reusing previous data for conducting cost-effective research: the launching of new 'archaeological' surveys would have costed millions (ibid).

The review has presented information about deep-water projects postulating that deep-sea maritime archaeology is a technologically enabled field, with UCH being frequently discovered as a by-product of offshore commercial activities (i.e., pipeline and cable laying projects and offshore drilling) and other educational/exploration survey projects. In the last 30 years since maritime archaeology began adapting deep-water technology from the petroleum

and sub-sea cable industry, researchers, custodian heritage agencies and Universities are collaborating more closely with the offshore energy industry, the result being that interdisciplinary surveys have led to the successfully discovery, identification and even the excavation of sites in the Gulf of Mexico, the Mediterranean, the Black and the Norwegian Seas. As a result of these collaborations, now deep-sea UCH is being routinely reported and for researchers interested in the field, this means that they need to secure access to such datasets, and utilise them beyond their industry purpose in an attempt to expand our knowledge about the deep-seas with practically no cost. This is exactly the principle that renders this study possible, the aim of which is to demonstrated that it is possible to conduct academic research and add new information to the developing record of deep water UCH through studying datasets generated during oil and gas exploration.

[2.2.1].Deep Sea Archaeology in the eastern Mediterranean and the Exclusive Economic Zone of Cyprus

While deep sea archaeology may well be an established branch of the sub-discipline, as the '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage'[12] states, it is still in its infancy in the eastern Mediterranean Sea (defined here as the deep seas of Cyprus, Israel, southern half of Turkey's main region, Egypt, Palestine, the Greek Dodecanese islands, and Syria). For instance, in 1997 two shipwrecks were discovered during an Israeli navy search effort in hope of finding the Dakar, an Israeli submarine lost in the 1960s (Ballard, et al, 2000; Ballard, et al, 2002). The wrecks were investigated by Robert Ballard in 1999, some 33 nm off Egypt and the Gaza Strip in 400 metres of water. They were both deemed to be of Phoenician origin, dating to the 8th century BC, making them the oldest wrecks found in the deep seas so far (Søreide, 2011). The wrecks were named Tanit and Elissa and contained a cargo of 350-400

[12] **Article 9(1):** 'All State Parties have a responsibility to protect Underwater Cultural Heritage in the Exclusive Economic Zone (EEZ) and on the Continental Shelf in conformity with this Convention' (UNESCO 2001, 6).

visible amphorae each and were surveyed via means of photomosaic and micro-bathymetry. The results of this expedition are detailed in Ballard's article *Iron Age Shipwrecks in Deep Water off Ashkelon, Israel*.

In 1999, Nauticos Corporations LLC located the wreckage of the Dakar submarine, and discovered at least twelve shipwreck-like SSS contacts, and video-recorded the remains of one Hellenistic wreck, situated in the EEZ of Egypt at 3,000 metres depth. The video of the Hellenistic wreck, currently online on YouTube,[13] was studied and published by Lawall in 2005, dating the Nauticos wreck to the end of 3rd beginning of 2nd centuries BC, with an amphora cargo from the islands of Kos, Rhodes and Knidos (Lawall, 2005). Besides the wreck itself, what it is also interesting is that in the wider area of the Naturicos wreck, several other SSS targets were interpreted by David Jourdan and his crew 'as a collection of shipwrecks that lie along the ancient sea lanes' (Jourdan, 2009, 170). This is fascinating, and if such targets are visually examined in the future and proven to date roughly to the same period as the Nauticos wreck, we can then extract invaluable insights 'about long-distance trade over open water at specific moments in history' (Søreide, 2011, 98). The archaeological results of this survey expedition and SSS data were submitted to the author from the Seaword Foundation[14] and are displayed in Figure 35, **Chapter 5**, page 190.

In 2010 the American OET, whose president and principal investigator is Robert Ballard, conducted two survey seasons in the EEZ of Cyprus for the purpose of recording the bio-ecological and geological nature of the Eratosthenes Seamount[15]. Although initially archaeology was not part of the survey agenda, a wide array of scattered archaeological materials (mainly amphorae) were accidentally recorded. In total, 70 isolated amphorae were

[13] For the video of the Nauticos wreck go to EMMA Foundation, *International waters – Nauticos Ancient wreck* link, https://www.youtube.com/watch?v=JODkFrRmxF4 [accessed 10/04/2019].
[14] Link to Seaword Foundation website, http://seaword.org/ [accessed 10/04/2019].
[15] For information about the Eratosthene Seamount refer to **Chapter 4**, page 114, footnote 1.

surveyed (Ballard, et al, 2017), out of which 38 were securely identified; the earliest amphora dated to the Cypro-Archaic period (8th to 7th centuries BC) and the latest to the Byzantine period (8th to 12th centuries AD) (Cornwell, et al, 2013, 42). Adding to the catalogue of discoveries, two shipwreck sites were noted and dated approximately to the 19th century (ibid., 30) (Figure 5, **Chapter 4**, page 116). From the results of the 2010 survey expedition, it became clear that the Eratosthenes Seamount not only offered ideal conditions for the preservation of UCH, but also confirmed it as an area of archaeological importance. This was of no surprise as it was already known since the 1990s when geological surveys on the Seamount's plateau posited the presence of granite and basalt stones, with authors Mart and Robertson postulating that such finds may reflect the first evidence of passing ships or possible shipwrecks in the area (Mart and Robertson, 1998). In the absence of visual data (ROV video-photography) these speculations remained unconfirmed until the OET's first visual surveys of the Seamount in 2010. This resulted in the 2012 survey agenda being expanded to encompass the recording of archaeological materials, which marked the first deep sea survey within the EEZ of Cyprus where deep sea archaeological documentation was officially part of a project agenda. The survey lasted for nine days, taking place between the 14th and the 25th of August of 2012, where the underwater seabed was further surveyed via a deep-tow long-range SSS, with the most promising targets being visually assessed using an ROV (Mitchell, et al, 2013). As a result, 149 isolated amphorae were revealed, out of which 91 were successfully dated from the Hellenistic to the Byzantine periods (Cornwell, et al, 2013, 42). Additionally, a Hellenistic shipwreck, named 'Eratosthenes C', with roughly 100 visible amphorae and two pithoi was discovered and dated to the 4th to 5th centuries BC (ibid., 43). The results of both expeditions of the OET were briefly mentioned (in Wachsmann, et al, 2011; Cornwell, et al, 2013; Ballard, et al, 2017), with Ballard's article *Deep-water archaeological discoveries on Eratosthenes* being the only one to

present the results in a coordinated manner. The generated data from both of the expeditions were submitted to the author and will be presented and revaluated in **Chapter 4**.

Additional surveys around Bodrum and Datca Peninsulas in southwestern Turkey conducted by the OET between 2008 and 2013, revealed approximately 26 shipwrecks dating from the Hellenistic to the modern times. Unfortunately, the results from these survey cruises remain largely unpublished, with these discoveries only being mentioned schematically in one symposium handbook[16] and one summary report.[17] Characteristic of this, is the 2012 publication of Brennan that examines five wrecks discovered as part of the 2008 to 2010 surveys, where he used these finds as case studies in the context of a broader argument relevant to the impact and extent of deep sea trawling on wrecks (Brennan, et al, 2012). The results of this research suggest that many wreck sites in the Aegean Sea are heavily damaged by modern fishing activities and thus require immediate protection. As a solution to this, the study concludes that the creation of protected areas or regions where bottom trawling is prohibited may well increases the chances of preserving both known and unknown cultural resources *in situ*, ultimately allowing better documented and thereby adequate preservation by record (ibid). Up to this day, from these 26 shipwrecks, only three have been analysed from a maritime archaeological perspective, in Opaiţ, Davis, and Brennan's 2018 article, *Roman Commerce and Elite Markets in the eastern Mediterranean: A Case Study of three 2nd century Shipwrecks off Knidos*. The remaining 23 wreck sites are currently unpublished although information relevant to roughly ten shipwrecks discovered around Knidos can be seen only on the E/V Nautilus channel on YouTube.[18].

[16] Refer to Brennan's, Turanh's and Davis's 2014 article, *Archaeological Oceanography in the Mediterranean and Black Sea: A Symposium on the E/V Nautilus STS Bodrum Expedition to Turkey, 2009-2013.*

[17] Refer to Roman's et al, 2013 article, *New tools and methods for precision seafloor mapping*.

[18] Video examples of the 2008 and 2010 OET wreck discoveries made around the Knidos follow the links of the: 2012, E/V Nautilus, *Mediterranean Shipwreck: Knidos F | Nautilus Live* at, https://www.youtube.com/watch?v=TXOMCW4Xf9Y [accessed 26-07-2019];

2.LITERATURE REVIEW

In 2020, articles shared by the popular newspaper 'The National', reported the discovery of eleven shipwrecks made in the EEZ of Lebanon, by the UK-based company Enigma Recoveries, whose principal archaeological investigator and spokesman, Dr Sean Kingsley, stated that 'nothing like this has been found before. This is the archaeological equivalent of finding a new planet' (The National, 2020). An unpublished report send to the author, revealed that these discoveries pertain to one wreck dating to the Hellenistic period, two wrecks the Roman period, one dating possibly to the 7th to 8th centuries AD, and seven Ottoman sites, with additional data and information about them remaining thus far unpublished (Kingsley pers com; Enigma Recoveries Statement, 2020). According to this report, the sites were initially discovered during surveys in 2010 with excavations commencing on one particular site in 2015 with Dr Kingsley stating that this 17th century Ottoman wreck 'is truly a ground-breaking [site], one of the most incredible discoveries in the Mediterranean', with goods and belonging of fourteen different civilizations, spanning from all across the globe (MEMO, 2020). The site was found situated at 1,900 metres deep, covering a maximum area of 158 x 90.5 metres, with the hull of the wreck estimated to be 43 metres long and 10.7 metres wide, and having an approximately cargo capacity of 700 tons. Preliminary analysis of some of the excavated artefacts has revealed a cargo of Egyptian flax, Chinese porcelain, Indian pepper, Ottoman tobacco pipes, Persian Gulf glazed jars, Yemen *qualal* jars and coffee cups and Montelupo jugs (Italy), from what is postulated to be an Ottoman wreck that was most probably sailing along

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2012b, E/V Nautilus, *Mediterranean Shipwreck: Knidos K | Nautilus Live* at, https://www.youtube.com/watch?v=vVc-WwaQ8fI [accessed 26-07-2019];
2012c, E/V Nautilus, *Mediterranean Shipwreck: Knidos M | Nautilus Live* at, https://www.youtube.com/watch?v=A8sopAnOQFw [accessed 26-07-2019];
2012d, E/V Nautilus, *Mediterranean Shipwreck: Knidos N | Nautilus Live* at, https://www.youtube.com/watch?v=IiidwwokJ9E [accessed 26-07-2019];
2012e, E/V Nautilus, *Mediterranean Shipwreck: Knidos R | Nautilus Live* at, https://www.youtube.com/watch?v=M3DSg_kHXpM [accessed 26-07-2019];
2012f, E/V Nautilus, *Mediterranean Shipwrecks: Knidos X & Y | Nautilus Live* at, https://www.youtube.com/watch?v=bNNZ98qIx0k [accessed 26-07-2019].

the portion of the Maritime Silk Road running from Alexandria to Constantinople (Enigma Recoveries, 2020). Overall, approximately 45% of the site has been excavated and some 588 artefacts were impounded, by the Cypriot Customs due to an administrative oversight in the cargo manifest with the remaining 988 still lying *in situ* (ibid). The confiscated artefacts are the result of an on-going legal dispute between Enigma Recoveries and the Cypriot government (pers com Dr Sean Kingsley). Because this on-going legal dispute, additional information, official reports, and video-photography data have yet to be released. This, of course, may change when the legal dispute reaches a conclusion.

Nevertheless, of particular interest are the results of the unpublished report composed by the Maritime Observatory, Maritime Archaeology Sea Trust and OceanMind partnership. The report gives account to the navigation path of Enigma's vessel, prior to its arrest in Limassol on the 24th of December 2015, with data being collected from the Automatic Identification Systems transmissions of the vessel and mapped in Google Maps, referring to the vessel's real time position (Maritime Observatory, et al, 2020). The navigation path of the vessel are presented at the figure 59, **Appendix**, page 393, revealing that perhaps one illegal survey was carried out in the EEZ of Cyprus, with the output report disclosing that Engima's vessel spent roughly 4 hours on a particular site, when the Automatic Identification transmitter switched off for approximately 2.5 hours (ibid). From this we can only speculate whether a shipwreck was discovered, visually assessed or even excavated, however, considering the context of operation and the time spent on a single location, it is reasonable to argue that this needs to be investigated further as the data gathered surely mark a possible area of 'high archaeological potential'.

Conducting deep-sea surveys beyond the territorial waters of a state for Underwater Cultural Heritage (UCH) is often beyond the capacity of national heritage agencies and university-based researchers due to its great expense. Despite the potential demonstrated by the abovementioned projects, deep sea investigations for the purpose of discovering UCH in

the eastern Mediterranean Sea are rarely undertaken. This is certainly the case for the deep-seas off the coast of Cyprus, the result of which is that research in maritime archaeology has largely been focused in more 'convenient' and 'accessible' areas such as the shallower waters of its Territorial Seas (TS) with the deeper waters largely overlooked. In fact, deep water UCH finds were discovered during the 2010 and 2012 OET survey cruises and many more shipwreck sites are likely to exist in the deep water of the Exclusive Economic Zone (EEZ) of Cyprus. The cost of finding them, however, remains problematic and for the foreseeable future it is likely that the majority of new discoveries —as this study intents to demonstrate— are likely to be made accidentally during the course of oil and gas operations.

Ballard in 2008 stated that the operational cost for using an ocean-class research vessel starts from $20,000 cost per day (cpd)' (Coleman and Ballard, 2008, 3) and increases by $10,000 cpd, depending on how many different geophysical technologies are used, and at what resolution and frequencies are the output data expected to be generated (ibid., 3). More recently, Søreide proposed that the cost of a work-class ROV vessel and its crew begins at $50,000 cpd (Søreide, 2011, 21) and in some cases, depending on the complexity of the job, time and specific machinery and tasks, can raise the average cost up to $250,000 cpd (Krieger and Buxton, 2012, 272). Bearing these figures in mind, it is clear that cost constitutes the principal obstacle to the development of deep sea UCH investigations. For this reason, Bass accurately points out that 'because of the expense of excavating [or surveying] at great depth, however, perhaps a new model is needed' (Bass, 2013, 16): his statement is ground-breaking and acts as a reference point for this study.

[2.2.2].A New Model of Research

Alongside deep sea UCH discovered as a result of exploration activities by universities, research institutes and military activities, many more important sites have been surveyed in recent years during the exploration, development, and production of oil and gas resources and

pipeline surveys. This has received emphasis in the section above highlighting that indeed, deep-water discoveries have been identified, surveyed and even excavated as part of commercially driven projects. This however is only possible in case that UCH is subject to a protected status under national [heritage] law and an archaeological clearance is required prior to any planned development in the deep waters of the CS and the EEZ. As it will be argue in **Chapter 3**, because this legal prerequisites are seen in Cypriot, heritage, environmental and hydrocarbon laws, it is worth asking: is the oil and gas industry in the EEZ of Cyprus also coming across deep sea UCH sites?

Deep sea exploration for the purpose of detecting natural resources in the EEZ of Cyprus and the wider eastern Mediterranean is on the rise. This is principally because it is now economically and technically feasible to exploit oil and gas fields situated in more extreme, hostile, and hard-to-reach environmental conditions (Shulka and Karki, 2016). Consequently, the oil and gas industry has been increasingly focusing on detecting untapped deep water fields to keep up with the ever-increasing demand for energy. In the eastern Mediterranean Sea this has been ongoing since Israel discovered the first deposit in 2009 (Ratner, 2016). Subsequently, a series of deep sea NRS have followed leading to the discovery of the 'Aphrodite', 'Calypso' and 'Glafcos-1' deposits within the EEZ of Cyprus in 2011, 2017 and 2018/2019 respectively (Figure 1, Blocks 8, 10 and 12, page 56), as well as the Zohr deposit of 2015 in the EEZ of Egypt (ibid). This is currently a rapidly developing field and in the EEZ of Cyprus alone, from a total of thirteen Blocks available, nine Blocks are now licensed, namely Blocks 2, 3, 6, 7, 8, 9, 10, 11, and 12. From these thirteen Blocks, seven belong to the ENI Cyprus Limited and TOTAL E&P Cyprus BV join venture, from which three Blocks also include KOGAS Cyprus Limited as part of this partnership. Block 10 belongs to ExxonMobil Exploration and Production Cyprus (Offshore) Limited in partnership with Qatar Petroleum International Upstream LLC and Block 12 at the 'Aphrodite' deposit sees a joint venture between Noble

Energy International Ltd, Delek Drilling Limited Partnership and BG Cyprus Limited (Cyprus Hydrocarbons Company, 2020). To my knowledge, fourteen prospect projects have completed supplementary geophysical surveys as part of Environmental Baseline Survey (EBS) and Geohazard Investigations [or other types of Supplementary Hydrographic Surveys] in six different Blocks, and three projects are pending surveys (Blocks 2, 7 and 9). These projects are listed underneath:

- 2011 Noble Energy International Ltd, Delek Drilling Limited Partnership and BG Cyprus Limited, Block 12 (at the prospect site of 'Aphrodite');
- 2017 ENI Cyprus Limited and TOTAL E&P Cyprus BV join venture, Block 11 (at the prospect site of 'Onisiforos');
- 2017 ENI Cyprus Limited, Blocks 3, 6, and 8 (at the prospect sites of 'Eratosthenes South', 'Cuttlefish' and 'Calypso' respectively);
- 2018 ExxonMobil Exploration and Production Cyprus (Offshore) Limited in partnership with Qatar Petroleum International Upstream LLC, Block 10 (at the prospect sites of 'Anthea-1', 'Glaucus-1', 'Delphine-1', 'Pegasus' and 'Pegasus-extension');
- 2019 ENI Cyprus Limited and TOTAL E&P Cyprus BV join venture, Blocks 6, 7 and 8 (at the prospect sites of 'Cronos', 'Calypso Appraised' and 'Eratosthenes Main', respectively);
- 2019 TOTAL E&P Cyprus BV, Block 11 (at the prospect site of 'Alphee').

From these fourteen projects, so far seven appraisal wells in four different Blocks have been drilled by licenced contractors, with at least another three wells drilled as a result of Turkey's illicit exploration actions in Cyprus's EEZ. This information is mapped in Figure 1 at the end of the chapter, to illustrate the state of offshore oil and gas exploration projects and also includes information about all deep sea UHC sites that have been discovered in the deep waters

of Cyprus EEZ from 2011 up to 2021 and excludes information pertaining to the 300 scatter of materials discovered as part of the 2010 and 2012 OET survey cruises. This information is subject to alternations and may exclude information that currently may have been kept confidential, outside public and academic domain. The archaeological information presented in Figure 1 will be analysed in **Chapter 4** of the study.

From an energy perspective, the discovery of three exploitable deposits has significantly enhanced the role of Cyprus in the eastern Mediterranean as an emerging energy hub (Karbuz, 2012). The result is that more surveys, for natural resources, or other oil and gas related activities (i.e. the construction of offshore pipelines and cable-laying projects) are more likely to occur in the near future. This means that we are facing a potential scenario in which deep sea explorations may lead to new deep sea UCH discoveries during survey operations and their potential destruction during construction and exploitation phases. Thus, it is of clear importance to use the data already acquired during NRS for research and the protection of UCH discoveries in these areas. The work in the deep seas of Cyprus consequently offers an important test case for the eastern Mediterranean and beyond to illustrate how it is possible for antiquities authorities to work with the oil and gas industry to ensure that the protection and preservation of UCH does not hinder the economic development of the state. Indeed, through working in partnership this thesis aims to demonstrate how both of these aims can be fulfilled. The following chapter takes this statement a step further, arguing that partnerships between the oil and gas industry and national heritage agencies, namely in this instance the DoAC, are mutually beneficial and serve to fulfil the legal prerequisite set under Article 18A[19] that foresees an archaeological clearance to be issued preceding the drilling of wells. This is because deep sea UCH has been granted a protected status both under national and international regulations and

[19] **Article 18A:** **'**Any archaeology on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on' (The Antiquities Law Cyprus, 2014, 1120).

as a result any activities that may be proven to be harmful to its *in situ* protection (i.e. from drilling, pipelines and cable laying, anchoring and in the future deep-sea mining) should be regulated and mitigated accordingly. **Chapter 3** examines this and demonstrates that the data gathering exercise undertaken as part of this study is also in accordance with Article 18B-(1) of the '2014 (amended) Antiquities Law of Cyprus' that asserts the right to the DoAC to monitor activities of *licenced agencies, contractors or individuals operating in the Exclusive Economic Zone and on the Continental Shelf of Cyprus* and if discoveries of deep sea UCH are made, licenced contractors (such as those related to offshore oil and gas activities) *are required to report to the Director of the Department of Antiquities Cyprus the discovery of any UCH sites and objects regardless of such discoveries were made intentionally or not, and for this manner they should submit geographical coordinates and additional information* (The Antiquities Law Cyprus, 2014, 1120). In effect, this renders research into finds of cultural heritage in deep water legally possible with this study to have effectively contributed to the implementation of both Articles 18A and 18B-(1). **Chapter 3** provides a legal review pertaining to the end argument of the study, which has the research model of *Oil and Gas Archaeology* being legally permissible in every country that has similar rules or articles related with the protection of UCH from offshore commercial operations in the deep waters of the EEZ and on the CS. As it will be argued in the following section, this is relevant to both national and international environmental and hydrocarbon legislation and guidelines in addition to heritage law, with examples from different countries for the European Economic Area (EEA) and elsewhere enforcing this argument. Consequently, in order to supplement the fragmentary record of deep sea UCH discoveries, academics and heritage managers need to first ensure that the relevant frameworks are implemented through pursing national heritage agency to collect dataset documenting deep sea UCH discoveries, and latterly gain access and publish their results.

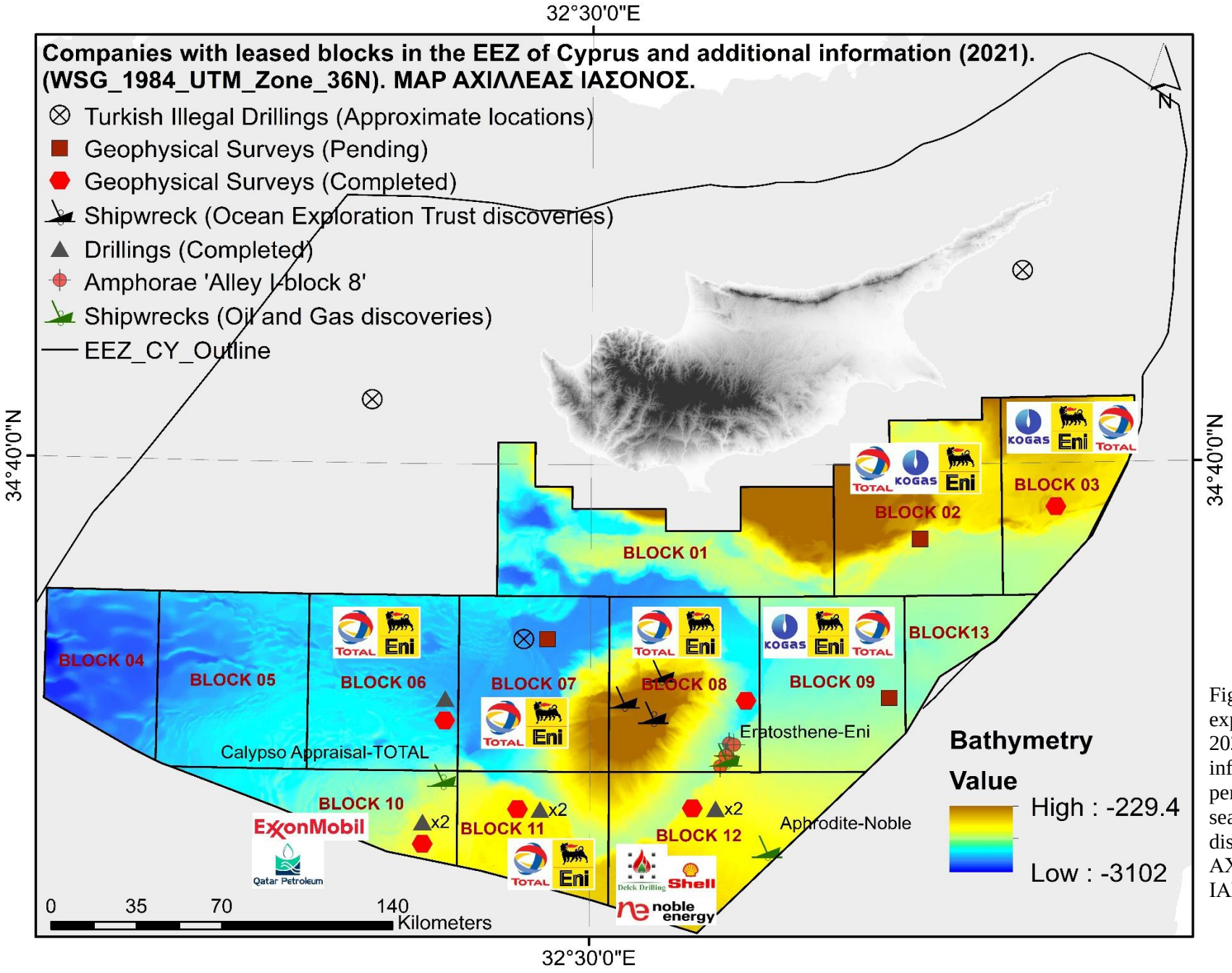


Figure 1: Oil and gas explorations up-to 2021 with additional information pertaining to deep sea UCH discoveries. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

3.UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

[3.1].Introduction

Until recently the marine environment was ideal for safeguarding Underwater Cultural Heritage (UCH) from anthropogenic interference. This changed in 1943 with the invention of the aqualung, which made underwater exploration more widely accessible to the general public. As a result, UCH within the limits of recreational diving has being the subject of looting, destruction, and illegal salvaging ever since (Strati, 1995). In an article from the foundational years of maritime archaeology, however, it was the scientific benefits of diving that were accentuated with Goggin suggesting that 'while the usage of these devices [aqualungs] has become a world-wide sport, their application to serious problems involving biology, geology, history and archaeology has become equally significant' (Goggin, 1960, 348). By the turn of the millennium, however, the true impact of the development of sport diving on UCH became clear: 'sport divers have done more harm to archaeological sites in the sea than all the forces of nature in three millennia' (Norton, 2000, 260; Frost, 2004). This is an ongoing issue; regardless of whether UCH is situated in the Territorial Sea (TS), the Contiguous Zone (CZ), or even the Exclusive Economic Zone (EEZ), and the Continental Shelf (CS) (figure 2, page 62), it remains under threat from various anthropogenic agencies with treasure hunting (Adams, 2007), anchor-dragging and commercial trawling (Brennan, et al, 2012) constituting the main threats to deep sea UCH. In addition, recent 'technological advances, and increasing demand for offshore resources, are ushering in a new era of human exploitation of the deep-seas' (UNESCO, 2018). This is something of a double-edged sword, as while the industry funds and undertakes the majority of deep sea explorations in which these new discoveries are being made, it is during the context of these very same prospect projects and subsequent operational activities (i.e. drilling and cable and pipeline laying) that threats to, or even the distraction of deep sea UCH may occur (ibid).

3. UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

This chapter aims to first define the legal right, duties and obligations that a coastal States has in the EEZ and on the CS and then chart the development of international law with respect to the issue of UCH in the deep seas (Table 1). This will cover the earliest initiatives of 'Recommendation 848 (1978)', through the '1982 United Nations Convention on the Law of the Sea' (UNCLOS), up to the development of the '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage' (2001 UNESCO). The aim of this review is to address under which international frameworks UCH in the EEZ has been granted a protected status, and if so, what legal actions are permissible for the *in situ* safeguarding of deep water archaeological/historic assets from offshore commercial activities that can be potentially harmful (i.e. drilling). The second part of the chapter will present an analysis of different national laws in addition to Cypriot national law, pertaining to how different States of the European Economic Area (EEA) such as: Greece, Norway, the Netherlands, Ireland, Spain, Denmark, Bulgaria, Poland, and elsewhere such as the UK, Australia and the USA are using their national frameworks to ensure the effective protection of UCH in the deep waters of the EEZ. These States were selected because they are currently active in deep-water oil and gas explorations and their national heritage and hydrocarbon/petroleum laws present similarities to Cypriot law. This is relevant to an overreaching argument of the section which has different maritime States operating, managing and legally asserting control over deep-sea UCH in the EEZ and on the CS in the same way, with the common practices identified here, setting the examples that may inform the formation of customary international law[1] in the near future. The

[1] The concept of 'customary international law' does not have a standardised definition, however, for the scope of this chapter and argument I believe the definitions provided by Tullio Treves and Shabtai Rosenne apply the most. 'Customary international law' 'consists of rules of law derived from the consistent conduct of different States acting out' according to how they choose to interpret international frameworks and refers to the 'process through which certain rules of international law are formed' (Treves, 2006, 1; Rosenne, 1984).

aim of this analysis is to establishing precedents for the policy recommendations that will be set out in **Chapter 6** and identify areas of consistency in national policy and practices in respect to how countries assert, protect, preserve, and manage cultural resources found in the EEZ and on the CS.

In this chapter, I intent to argue that different legal frameworks exist and thus different actions are permissible under both Cypriot and international law for the effective protection of UCH, which are relevant but not explicit to heritage law. The extent that such frameworks have been exploited and implemented by national heritage agencies and oil and gas partnerships or by academics, however, remains a debatable issue. In effect, this will lead to a discussion of to how effectively UCH is protected during offshore oil and gas activities and what kind of obligations contractors/subcontractors must meet (if any) to ensure the adequate surveying and thereby preservation by record of deep sea UCH when it is discovered during the course of natural resource surveys (NRS) in the deep waters of Cyprus. A review of different national laws reveals that some common practices indeed occur between Cypriot national law and other countries of the EEA and elsewhere such as the UK , the USA and Australia and this is relevant for frameworks beyond heritage law also. In fact, the analysis below reveals that UCH in the EEZ and on the CS has been granted a protected status by different States and that it is legally protected by offshore development activities. This is also the case in regards to how UCH is protected and managed *in situ* with different States having implemented more or less the same rules and regulations. In terms of the prerequisites that offshore contactors must meet to ensure the effective survey and thereby preservation by record of UCH discoveries made accidental during the course of NRS in the deep-waters of the EEZ and on the CS, the analysis suggests that this is achieved through the assertion of soft laws and different guidelines with the example primarily of the USA, the UK and other States, informing the output survey levels and the

associate minimum professional archaeological Survey, Data Submission and Reporting by-standards set out in **Chapter 6**. These by-standards are explicitly linked to the operational framework of oil and gas explorations and aim to ensure the adequate discovery, survey, reporting, data submission and *in situ* preservation and preservation by record of data outputs and any UCH assets found accidentally during the course of NRS activities.

Table 1: A summary of the international and national legislations analysed in this chapter that are relevant to case study of Cyprus

Date	Name of Framework	International or National	Signed / Not Signed / Ratified / Implemented
1955	'Outer Continental Shelf Land Act' of the USA	National	Implemented
1967	'Petroleum (Submerged Lands) Act' of Australia	National	Implemented
1969	'National Environmental Policy Act' (NEPA) of the USA	National	Implemented
1973	'Protection of Wrecks Act' of the UK	National	Implemented
1976	'Australian Historic Shipwrecks Act'	National	Implemented
1976	'Prospecting, Exploration and Exploration of Petroleum (Hydrocarbons) and the Settlement of Related Matters' of Greece	National	Implemented
1978	The Council of Europe's 'Roper Report' and 'Recommendation 848 (1978)'	International	Signed
1978	'Cultural Heritage Act' of Norway	National	Implemented
1987	'National Monuments (Amendment) Act' of Ireland	National	Implemented
1982	'1982 United Nations Convention on the Law of the Sea' (UNCLOS)	International	Ratified
1985	'Spanish Historical Heritage law'	National	Implemented
1985	'Draft European Convention 1985 on the Protection of Underwater Cultural Heritage'	International	Not Signed
1988	'International Law Association (ILA) Draft Convention on the Protection of Underwater Cultural Heritage' ('The ILA Draft Convention')	International	Not Signed
1992	Council of Europe (1992), 'The European Convention on the Protection of Archaeological Heritage (Revised)' (aka. 'The Valletta Convention')	International	Ratified

3.UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

Date	Name of Framework	International or National	Signed / Not Signed / Ratified / Implemented
1994	'Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil'	International	Ratified
1995	'Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean' (SPA/BD Protocol)	International	Signed
1995	'Prospecting Exploration and Exploitation of Hydrocarbons and Other Provisions' of Greece	National	Implemented
1996	'Petroleum Act' of Norway	National	Implemented
2000	'Dutch Heritage law' —the '*Wet op de Archeologische Monumentenzorg*'—	National	Implemented
2001	'Museum Act' of Denmark	National	Implemented
2001	The '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage' ('2001 UNESCO Convention') and Annex Rules	International	Not Signed but Annex Rules implemented
2001	Polish 'Maritime Code'	National	Implemented
2002	'Greek Heritage law, on the Protection of Antiquities and Cultural Heritage in General'	National	Implemented
2003	'Mining Act' of Netherlands	National	Implemented
2005	'The Assessment of Impact on the Environment of Certain Plans and Programs' of 2005 of Cyprus	National	Implemented
2007	'The Hydrocarbons (Prospection, Exploration and Exploitation Law), of 2007' of Cyprus	National	Implemented
2008	'Offshore Petroleum Amendment (Greenhouse Gas Storage) Act' of Australia	National	Implemented
2007 and 2009	'The Hydrocarbons (Prospection, Exploration and Exploitation) Regulations, of 2007 and 2009)' of Cyprus	National	Implemented
2011	'Pre-Seabed Disturbance Survey Mitigation' of the USA	National	Implemented
2014	'2014 (amended) Antiquities Law' of Cyprus	National	Specific Articles Implemented
2016	'Regulatory administrative acts of 2016 of the Antiquities Law' of Cyprus	National	Implemented
2020	'Regulations to Act Relation to Petroleum activities' of Norway	National	Implemented

3.UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

[3.2].What is an Exclusive Economic Zone and where is the Continental Shelf?

The Exclusive Economic Zone (EEZ) was ascribed a legal definition in Part V (Articles 55-75) of the '1982 United Nations Convention on the Law of the Sea' (UNCLOS). It was defined because States were claiming differing amounts of the seas away from their coastlines in which they could undertake and protect commercial fishing in the Exclusive Fishery Zone (Rothwell and Stephens, 2016). This led to the genesis of a new zone, where coastal States can claim sovereignty rights over a large area of sea, extending out to a distance of up-to 200 nautical-miles (nm) (370 km) from the baseline of the TS (the baseline being the shoreline) (Article 57) (figure 2) (UNCLOS, 1982; Leanza and Caracciolo, 2015). In the EEZ the coastal State enjoys sovereignty rights primarily of economic character, as it asserts the right to explore, exploit, conserve, and manage, both the living and non-living resources, which are found within the water column, on the seabed or under the sea floor's subsoil (Article 56, para. 1(a)) (Kwiatkowska, 1989). These non-living resources are mostly found on the Continental Shelf (CS), and as such Article 56, paragraph 3 recognises also that their exploitation should be carried out in accordance with Part VI, Articles 76-85 of the Continental Shelf framework. As it will be argued below, this excludes the survey and thereby protection of UCH in the EEZ but asserts that coastal States have the rights to the use of artificial islands,

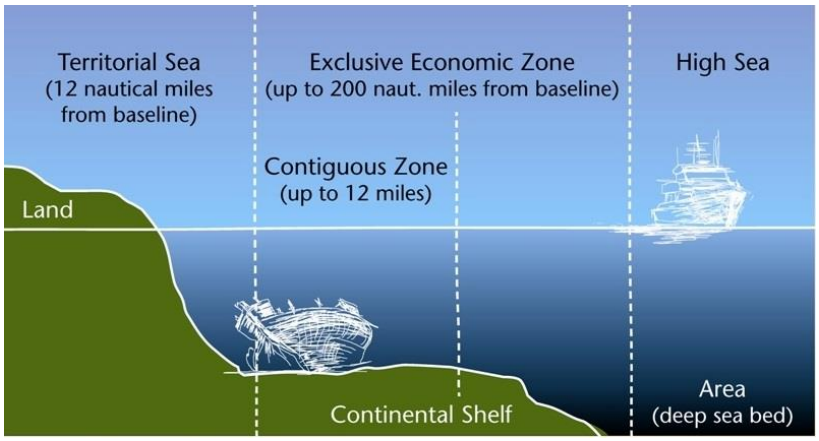


figure 2: The maritime zones set by UNLOSC. Source: image from UNESCO. (2018). *Protection of Cultural Heritage in International Waters.* http://www.unesco.org/new/en/culture/themes/underwater-cultural-heritage/protection/protection-of-cultural-heritage-in-international-waters/ [accessed 22-11-2018].

installations and structures, conduct and outsource Marine Scientific Research (MSR), and protect the marine environment by establishing marine protected areas (Andreone, 2015; Rothwell and Stephens, 2016).

The EEZ is a unique zone with its own distinct arrangements. It asserts sovereign rights primarily of an economic character to the coastal State, but it does not assert sovereignty (Nelson, 2008). The EEZ has been described as a 'multifunctional' zone, in which third-party States enjoy the freedoms identified in Articles 58(1) of navigation, right of innocent passage, overflight, the laying of submarine cables and pipelines and 'other internationally lawful uses of the sea related to these freedoms' (i.e. immunity to warships, the suspension of piracy, the nationality of the ship and the duties of flag States) (UNCLOS, 1982, 44; Sinjela, 1989).

At present, 168 States are parties of the UNCLOS and almost all of them are claiming an EEZ. The Republic of Cyprus established its EEZ in 2004, with the enactment of the Exclusive Economic Zone and Continental Shelf Law (No. 64(I)/2004)[2] and the delimitation of maritime boundary agreements thus far, with Egypt in 2003, Lebanon in 2007, and Israel in 2010 (ibid). For information about the EEZ of Cyprus such as its size, shape,

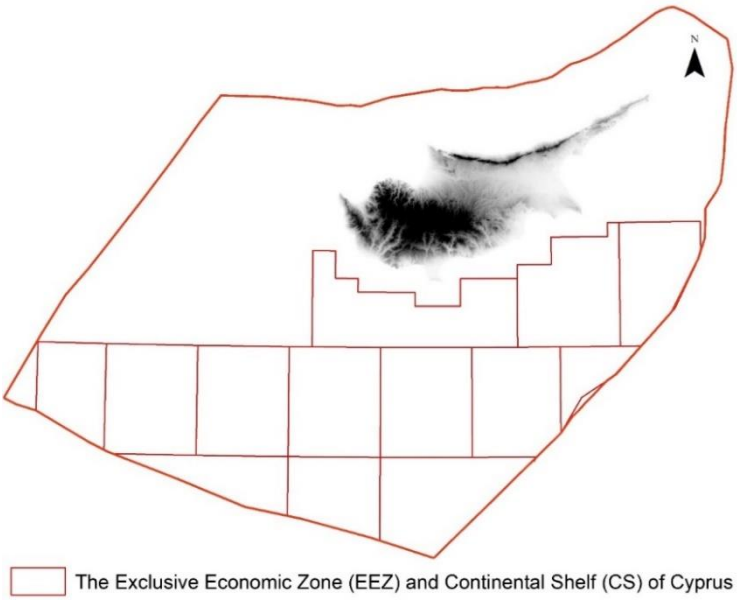


Figure 3: The layout and outer boundaries of Cyprus EEZ and the thirteen Blocks of the Continental Shelf as established under the enactment of the 'Exclusive Economic Zone and Continental Shelf Law' (No. 64(I)/2004). Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[2] For the enactment visit the Ministry of Foreign Affairs of Cyprus website, http://www.mfa.gov.cy/mfa/mfa2016.nsf/index_en/index_en?OpenDocument [accessed 15-04-2019]

leased and available blocks and key oil and gas companies involved up to 2021, refer to Figure 3 and Figure 1, **Chapter 2**, page 56.

[3.3].Underwater Cultural Heritage in the Exclusive Economic Zone and Continental Shelf according to the United Nations Law of the Sea Convention

The framework provided by the UNCLOS relating to the protection of UCH is composed of only two provisions (Articles 149 and 303), both which are relatively inapplicable within the entirety of the EEZ (Scovazzi, 2014) (figure 2, page 62).

In Part XI (the Area) of the UNCLOS, Article 149,[3] establishes the protection of archaeological and historic objects in the Area (figure 2) and declares that if such objects are discovered they 'shall be preserved or disposed of for the benefit of the mankind as a whole' (UNCLOS, 1982, 74). According to Scovazzi, this provision prevents the removal of UCH for personal gain and trade, thus it makes activities such as treasure hunting and metal salvaging from historic wrecks illegal (ibid). Furthermore, Article 149 implies that States which only have a link with the objects or the site, namely, the 'State or country of origin, or the State of cultural origin, or the State of historical and archaeological origin' are given preferential rights to act (UNCLOS, 1982, 74).

Although Article 149 does not specify either the content of these rights or the manner in which States should agree upon the concept of 'benefit of mankind as a whole', it set the foundations for the better protection of heritage in the Area and for close coordination between the International Seabed Authority and the United Nations Educational, Scientific and Cultural Organization (UNESCO) (Scovazzi, 2014b, 450-451). Additional clarifications on the

[3] **Article 149**: 'All objects of an archaeological and historical nature found in the Area shall be preserved or disposed of for the benefit of mankind as a whole, particular regard being paid to the preferential rights of the State or country of origin, or the State of cultural origin, or the State of historical and archaeological origin' (UNLOSC, 1982, 74)

protection of UCH in the Area are stated in two regulations that explicitly mention the exploration and exploitation of mineral resources. In fact, through Articles 150(i) and 153(4) contractors are required to agree to survey, preserve by record, and prevent the destruction of UCH, even in the scenario where UCH is discovered accidentally during the course of unrelated offshore commercial activities.

Unlike in the Area where archaeology is protected under Articles 149, 150(i) and 153(4), UCH in the EEZ and on the CS seems to be unprotected or not even recognised. For instance, Article 303(i)[4] in Part XVI (General Provisions) gives account to a general obligation that applies to UCH objects and sites, wherever at sea they are found, with this to be explained by Brown as an 'unattributed right' when it comes to the protection of UCH in the waters of the EEZ and on the CS (Brown, 1996). This is because the protection of UCH is in conceptual contradiction with Article 56, paragraph 1(a)[5], which asserts that coastal States, in the EEZ, have sovereign rights exclusively linked with the exploitation of living and non-living recourses and draws a distinction between the rights of the coastal State and the freedoms incumbent for other States (Rothwell and Stephens, 2016). This means that sovereignty rights of the coastal State in the EEZ and on the CS cannot be extended beyond the exploitation of 'natural resources', which therefore excludes the coverage of historical and archaeological sites and objects (Strati, 1995). Thus, wrecks, cargoes, and other potentially significant artefacts, could on no account be described as 'natural resources' of the seabed and are not protected in the EEZ

[4] **Article 303(i)**: **'**States have the duty to protect objects of an archaeological and historical nature found at sea and shall cooperate for this purpose' (UNLOSC, 1982, 138).

[5] **Article 56(1).a**: 'In the exclusive economic zone, the coastal State has: (a) sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters suprajacent to the seabed and of the seabed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds;' (ibid., 74)

under Article 303(i). In this respect, it is worth asking what legal actions are permissible under UNCLOS for safeguarding UCH in the EEZ and on the CS?

Article 58(1)[6] envisages additional freedoms beyond solely the exploitation and exploration of natural resources in the EEZ. For instance, Article 56(1)(b)(ii)[7] recognises that coastal States have the right to conduct or outsource Marine Scientific Research (MSR) (Andreone, 2015; Strati, 1995). MSR, as defined in Part XIII of the UNCLOS, Articles 238-265, refers to scientific research primarily dedicated to the study of: the oceans, the rational exploitation of the sea's resources, safer navigation, military use of the sea, the preservation of the marine environment and ecosystem, and the better general understanding of the earth (Article 246) (Pavliha and Gutierrez, 2010; Croff, 2009; Dromgoole, 2010; Oxman, 1988; Birnie, 1995). From that it can be argued that MSR involves ocean sciences such as: marine biology and chemistry, geophysics, hydrography, oceanography, geology and ocean drilling (ibid), and excludes archaeology underwater. This is largely because maritime archaeology does not 'qualify' as part of the actual physical properties of the marine environment and its recourses. In the words of Dromgoole, when UNCLOS was discussed in the 'later 1960s and 1970s maritime archaeology was barely a scientific discipline at all and understanding of the potential historical and archaeological value of UCH was limited and undeveloped' (Dromgoole, 2010, 38). To this end, it is clear that any activities towards UCH in the context

[6] **Article 58(1)**: 'In the exclusive economic zone, all States, whether coastal or land-locked, enjoy, subject to the relevant provisions of this Convention, the freedoms referred to in Article 87 of navigation and overflight and of the laying of submarine cables and pipelines, and other internationally lawful uses of the sea related to these freedoms, such as those associated with the operation of ships, aircraft and submarine cables and pipelines, and compatible with the other provisions of this Convention'. (ibid., 44)

[7] **Article 56(1)(b)(ii)**: 'In the exclusive economic zone, the coastal State has: (b) jurisdiction as provided for in the relevant provisions of this Convention with regard to: (ii) marine scientific research;' (ibid., 43)

of MSR are not permissible. This, however, does not mean that 'States are deprived of the right to conduct archaeological research' (Strati, 1995, 265).

In the EEZ, Article 303(ii) permits the removal of 'objects of an archaeological and historical nature' in the CZ (12 nm – 24 nm) only and provides 'reference to Article 33 according to which coastal States, [within the CZ], may exercise the control necessary to prevent infringement of its customs, fiscal, immigration, or sanitary laws and regulations' (figure 2) (Scovazzi, 2014b, 445). Beyond the 24 nm up to the 200 nm limit of the EEZ, if a coastal State wants to assert jurisdiction over UCH activities related to surveying or excavation they must act on the basis of the resolution of conflicts under the 'elusive' provision of Article 59[8], which asserts that when a conflict arises between two States with respect to unattributed activities (such as the surveying or excavation of deep-sea UCH sites and artefacts) within the 24 nm – 200 nm zone, it should be resolved on a case-by-case basis with equity and in the light of all the relevant circumstances as it is stated in Article 59 (Dromgoole, 2013).

Even though the outcome of this process is uncertain, the possibility of using Article 59 and winning a legal case is weakened due to the legal vacuum left by Article 303(iii) (Scovazzi, 2014; Dromgoole, 2013). According to Bederman, this is because Article 303(iii) explicitly reserves the rights of salvage under traditional maritime law:

> 'Nothing in this article affects the rights of identifiable owners, the law of salvage or other rules of admiralty, or laws and practices with respect to cultural exchanges' (Article 303(iii)) (UNCLOS, 1982, 138; Bederman, 1998).

[8] **Article 59**: 'In cases where this Convention does not attribute rights or jurisdiction to the coastal State or to other States within the exclusive economic zone, and a conflict arises between the interests of the coastal State and any other State or States, the conflict should be resolved on the basis of equity and in the light of all the relevant circumstances, taking into account the respective importance of the interests involved to the parties as well as to the international community as a whole'. (ibid., 44)

In fact, Strati states that this Article comes into conflict with the general objectives to protect UCH stated in Article 303(i)[9], which foresees the 'unattributed right' of the protection of UCH in all maritime zones, especially in the EEZ, to the extent which Scovazzi interprets Article 303(iii)[10] as an active encouragement to the unregulated recovery of UCH for private commercial gain (i.e. treasure hunting and metal salvaging) (Brown, 1996; Scovazzi, 2014; Strati, 1995). To this end, scholars have argued that Articles 149 and 303(iii) are in conceptual contradiction with each other, with Article 149[11] asserting the preservation and protection of UCH 'for the benefit of mankind' in the Area, whereas Article 303(iii) has been interpreted as an invitation to salvors to loot UCH (Scovazzi, 2017).

Undoubtedly 'the regime for UCH established by the UNCLOS is complicated and not complete' (Scovazzi, 2014b, 450). UCH in the EEZ is left unprotected and very much unrecognised, since the right of surveying and excavation in deep waters remained unaddressed. This, perhaps, was the reason for drafting paragraph four of Article 303(v):

> 'This article is without prejudice to other international agreements and rules of international law regarding the protection of objects of an archaeological and historical nature' (Article 303(v)) (UNCLOS, 1982, 138).

Scovazzi and Dromgoole interpret this as extending an invitation to different international organisations [or even to party States of the Convention] to elaborate upon, and complete, 'the drafting of more specific treaty regimes which can ensure better protection of UCH' (Dromgoole, 2013, 36). The problematic nature of Articles 149 and 303 that specifically address archaeological and historical remains renders them unhelpful for the promotion and effective

[9] See footnote 4, page 65.
[10] Refer to page 67.
[11] See footnote 3, page 64.

protection of deep sea UCH assets in the area beyond the TS up to the EEZ (i.e. in the 12 nm – 200 nm) (Blake, 1996).

[3.4].The Development of International Law on Underwater Cultural Heritage prior to the '2001 UNESCO Convention on the Protection of Underwater Cultural Heritage' Initiative

Since UNCLOS, international initiatives have attempted to formulate new approaches for the protection of UCH, seeking to fill the legal vacuum left in the area between the 12 nm to the 200 nm limit. Some have been more successful than others, raising the question as to whether UCH in the EEZ is protected under international laws.

[3.4.1].The Council of Europe's 'Roper Report' and 'Recommendation 848 (1978)'

In 1978, John Roper published a report on behalf of the Committee on Culture and Education of the European Council, entitled *The Underwater Cultural Heritage*. The reasons for drafting this report were the considerable interest of Europe in protecting UCH and the growing sense of frustration with the slow progress of 'Third United Nations Law of the Sea Conference' in preparing of the UNCLOS treaty, as well as the low status given to UCH in relation to other ecological, environmental, economic and strategic considerations (Roper, 1978; Blake, 1996). Widely referred to as the 'Roper Report', it proved to be hugely influential. It identified the different factors threatening UCH and provided some of the basic definitions of the subdiscipline of maritime archaeology, by analysing the national legislation of 23 member States of the Council of Europe with respect to heritage/antiquities law (ibid). The report concluded with the *minimum* legal requirements needed for the effective protection of UCH in all maritime zones in a set of formal recommendations: 'Recommendation 848 (1978)'. This urged member States of the Council of Europe to review their domestic legislation and, where necessary, to implement the *minimum* requirements mentioned in the Annex of 'Recommendation 848 (1978)' (Dromgoole, 2013; Roper, 1978; Blake, 1996).

3.UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

The requirement to amend the national legislation of different States was underlined by Lyndel Prott and Patrick O'Keefe, who studied those of 23 member state and published the results in section III of the Appendix to the 'Roper Report', where they stated that UCH was not legally protected beyond the TS (Roper, 1978). As a result, 'Recommendation 848 (1978)' proposed that national jurisdiction over UCH should be extended up to the full 200 nm limit and that existing salvage and wreck law should not apply to items and sites older than 100 years throughout the entire EEZ (Annex Rules IV and V) (Roper, 1978). The report identified anthropogenic interference as the main threat to UCH (i.e. commercial and amateur treasure hunting, sports divers, anchor dragging, trawling and dredging). More specifically, in section 2.6.1 it emphasised that oil and gas exploration and exploitation was the emerging threat, at the time, for UCH sites situated in the deep waters. As a counter measure to these activities, the report proposed mutual cooperation and 'goodwill' between coastal States and contractors/subcontractors in avoiding the unintentional destruction of sites, and where sites are discovered, the report suggested that UCH should be protected under the legal regime of a "Cultural Protection Zone (CPZ)", laid out in Annex Rule IV of the 'Recommendation 848 (1978)' stating that:

> 'National jurisdiction should be extended to the full 200-nautical mile limit, and with an international agreement providing for reciprocal treatment of cultural goods landed in countries other than those in whose cultural zone they were found' (Roper, 1978, 16).

The proposal of 'Recommendation 848 (1978)', and the idea of a CPZ, were adopted by the Parliamentary Assembly of the Council of Europe in October 1978, which encouraged the 23 member States to implement in their national legislation 'full jurisdiction competence (both legislative and enforcement jurisdiction) over UCH' throughout the entirety of the EEZ

(Dromgoole, 2013, 40; Franckx, 2005; Roper, 1978; Blake, 1996; Lin, 2019; Beckman and Davenport, 2012; Andreone and Cataldi 2014). This was probably the first time that a committee supported the concept of a CPZ despite concerns being identified as an issue of 'unattributed right' (Brown, 1996). In fact, the committee argued against this concern, by stating that in case a party State seeks to establish a CPZ, they should do so only via adopting a common European treaty in which 'none of these States would be prepared to challenge a similar assertion by another' (Roper, 1978, 57).

'Recommendation 848 (1978)' was rightfully described by Strati as 'a brave and scientifically sound attempt based on recommendations made by marine archaeologists' (Strait, 1995, 87), with Drogmoole further stating that it has been widely interpreted as extending an invitation to other competent international organisations [and by extent to States] to 'elaborate upon, and complete, this incipient new branch of law in a subject-specific instrument' (Dromgoole, 2013, 36). In a sense this was an open invitation to the UNESCO to elaborate upon and draw a more complete and explicit Convention in regard to the protection of UCH in the deep waters of the EEZ and on the CS.

[3.4.2].Draft European Convention 1985 on the Protection of Underwater Cultural Heritage

The work carried out in 'Recommendation 848 (1978)' was taken to the Parliamentary Assembly of the Council of Europe to draw up a European Treaty. A specific committee was established, namely the Ad Hoc Committee of Experts of UCH (CAHAQ), which was responsible for drafting the '1985 European Convention on the Protection of Underwater Cultural Heritage'. The CAHAQ held six meetings between 1980 and 1985 and submitted the Convention to the Committee of Ministers for approval but unfortunately it was never proposed for signature due to Turkey's objection with regards to the difficulties over questions relating

to the jurisdictional scope and 'consequent potential problems of delimitation between Greece and Turkey in the eastern Aegean' (Blake, 1996, 824; Strati, 1995; Dromgoole, 2013). The final text remains confidential with only an earlier draft currently available. From this draft of the Convention, it becomes apparent that the CAHAQ did not adopt the CPZ concept and instead it followed the approach of UNCLOS (Blake, 1996; Dromgoole, 2013).

Despite the fact that it was never ratified, the Convention remains a significant text for the development of international legislation in the field of UCH protection and contains many useful provisions for future reference. It asserted, probably for the first-time, coastal State jurisdiction over oil and gas contractors working on the CS and the requirement to report archaeological discoveries made while surveying for natural resources, stating that:

'Each Contracting State, in the excise of its jurisdiction over the exploration and exploitation of the natural resources of its Continental Shelf, shall take appropriate measures for the protection of underwater cultural property in accordance with the objectives of this Convention' (Dromgoole, 2013, 43)

In effect, the Council of Europe demonstrated that there was recognition within Europe of the need for a treaty framework to afford protection to UCH in the deeper waters of the EEZ. The '1985 Draft Convention' laid out an extremely valuable framework, especially by recognising the need to protect UCH discoveries made during the course of oil and gas activities, as it identified for the first time oil and gas exploitation (i.e. drilling) as a threat to the *in situ* preservation of UCH. Finally, it also underlined the necessity of a reciprocal database to ensure that all information on UCH sites discovered or otherwise known to be managed and made available by publication as early as possible (Article 7) (Blake, 1996; Dromgoole, 2013; Strati, 1995; Forrest, 2002).

[3.4.3].The European Convention on the Protection of Archaeological Heritage (Revised) (1992) ('The Valletta Convention')

The abandonment of the '1985 draft European Convention on the Protection of Underwater Cultural Heritage' made the Council of Europe reconsider the question of UCH protection from the viewpoint of revising the existing the '1969 European Convention of the Protection of the Archaeological Heritage' (Blake, 1996; O'Keefe and Nafziger, 1994). Among other provisions, the revised text of what is now generally referred to as 'The Valletta Convention', reintroduced the duty of state parties to protect archaeological remains, objects and other traces of mankind (Article 1(2))[12], 'whether situated on land or underwater' (Article 1(3)) (Council of Europe, 1992, 2). For the Convention to provide legal coverage to sites situated underwater, however, 'they must be located in any area within the jurisdiction of the parties' (Article 1(2)(iii)) (ibid). This is because UNCLOS provides specific sovereignty rights but not complete jurisdiction. Naturally, this includes UCH situated in the TS but unfortunately it excluded any sites in other maritime zones such as the CZ, the EEZ, and on the CS (figure 2, page 62).

Even though 'The Valletta Convention' did not build on 'Recommendation 848 (1978)' and the '1985 draft European Convention on the Protection of Underwater Cultural Heritage', it has proved to be a remarkably successful treaty. According to Dromgoole and Strati, this was possible due to the unspecified nature of the Convention regarding issues of national jurisdiction over sites and objects of archaeological and historical significance in the EEZ (Dromgoole, 2013; Strati, 1995). 'The Valletta Convention' came into force in 1995 and has been ratified and implemented across 44 members States of the Council of Europe, including

[12] **Article 1(2)**: 'To this end shall be considered to be elements of the archaeological heritage all remains and objects and any other traces of mankind from past epochs: i) the preservation and study of which help to retrace the history of mankind and its relation with the natural environment; ii) for which excavations or discoveries and other methods of research into mankind and the related environment are the main sources of information; and iii) which are located in any area within the jurisdiction of the parties' (Council of Europe, 1992, 2).

Cyprus. The unique aspect of 'The Valletta Convention', however, is that it provides leeway for individual party States to include sites situated in all maritime zones, excluding the high seas and the Area, depending on the legislation of individual coastal States (Blake, 1996; Dromgoole, 2013; Strati, 1995b; Willems, 2007).

[3.4.4].The 1995 Convention for the Protection of the Mediterranean Sea against Pollution ('The Barcelona Convention')

Following 'The Valletta Convention', the '1976 Convention for the Protection of the Mediterranean Sea Against Pollution', was amended and renamed in '1995 the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean'. It was initially adopted by the European Community and 16 Mediterranean countries and was concerned with the protection of the Mediterranean marine environment from anthropogenic pollution. It gradually became more of an 'umbrella' framework (widely refer to as 'The Barcelona Convention') as it developed encompassing six additional Protocols[13] which: A) ensure the sustainable management of natural marine and coastal resources; B) enable the integration of the environment in social and economic development; C) foresee the prevention and reduction of pollution and protection of the marine environment and; D) promote the protection and safeguarding of natural and cultural heritage (Raftopoulos, 1992). So far, 'The Barcelona Convention' has been signed by the European Community and 22 countries of the Mediterranean Sea, including Cyprus.

[13] For more information refer to the 2005, United Nations Environmental Program Mediterranean Action Plan, *Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols* document seen at, https://planbleu.org/sites/default/files/upload/files/Barcelona_convention_and_protocols_2005_eng.pdf [accessed 04-09-2019].

[3.4.4.1].'1995 Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean' (SPA/BD Protocol)

Neverthless, of specific interest is the '1995 Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean' (SPA/BD Protocol). This Protocol asserts the right to contracting parties to establish protected zones, strengthened by the establishment of one or more safety zones around them (commonly referred to as buffer zones). According to Article 8(2) (Establishment of the List of Specially Protected Areas of Mediterranean Importance) of the SPA/BD Protocol, State parties are obliged to undertake actions necessary in order to 'safeguard sites of biological or ecological value, such as those of particular genetic diversity, as well as of satisfactory populations levels of species, including their breeding grounds and habitats along with representative ecosystems as well as ecological process and other sites of scientific, aesthetic, cultural or educational levels' (United Nations Environmental Program Mediterranean Action Plan, 2005, 80). Sites qualifying based on Article 8(2) and the additional guidelines listed in the SPA/BD Protocol in Annex I, can be then listed as 'Specially Protected Areas of Mediterranean Importance' (SPAMI). The SPAMI list aims to promote cooperation amongst contracting State parties of the Mediterranean region, whilst ensuring the 'organisation of planning and management systems, the prohibiting on dumping and discharges along with the regulation of the use of the area for navigation, fishing and seabed-exploitation, prohibiting the destruction of plant and animal life, the regulation of the introduction of species and the taking of any other measures aimed at safeguarding ecological and biological processes'(Dux, 2011, 333; Article 6, Protection Measures).

SPAMI sites can be established in 'marine and coastal zones subject to the sovereignty or jurisdiction of the parties and in zones partly or wholly on the high seas' (Article 9(1)(a) and (b)). Scovazzi interprets this more broadly and suggests that the SPA/BD Protocol, in general, 'is applicable to all the marine zones of the Mediterranean, irrespective of their legal condition,

as well as to the seabed, its subsoil and to the terrestrial coastal areas designated by each party, including wetlands' (Scovazzi, 2018, 310). This means that party States are allowed to establish protected zones in the EEZ, which is demonstrated in the example of the Pelagos Marine Sanctuary (figure 4) that covers about 90,000 km^2 in the north-western Mediterranean Sea between Italy, France and the Island of Sardinia. This area includes Corsica and the Archipelago Toscano with 53% of the overall area being encompassed in the EEZ of France, and also part of Italy's Ecological Protection Zone[14] (ibid).



figure 4: The protected Pelagos Sanctuary. Source: image from Agardy, T., Cañadas, D., De Soto, A. N., and Engel, H. M. (2007). A Global Scientific Workshop on Spatio-Temporal Management of Noise. *Report of the Scientific Workshop.* 1-44.

UNCLOS claims that coastal States are not prohibited from establishing marine protected areas in the EEZ, however, they need to conform with international laws and should not go beyond the jurisdictional framework of the UNCLOS. This means that State parties should not interfere with the right of navigation, overflight, and innocent passage and should cooperate for the management and protection of SPAMI by establishing bilateral and regional agreements (Strati 1995; Dux 2011; United Nations Environmental Program Mediterranean Action Plan, 2005). In fact, according to Article 21 (Specially Protected Areas) of the '1994 Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from

[14] For more information about the protected Pelagos Sanctuary refer to the Atlas of Marine Protection website, http://www.mpatlas.org/ [accessed 04-09-2019].

Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil', within these specially protected areas, offshore oil and gas companies are prohibited from undertaking any industrial activity (Article 21a(ii)). In effect, this means that UCH is officially protected and thereby listed under environmental law, thus in case it is accidentally discovered during the course of oil and gas activities, it should be assessed and reported in Environmental Impact Assessments (EIA) and Environmental Social Health Impact Assessments (ESHIA).

Theoretically, this is possible, as the SPA/BD Protocol asserts the rights of party States to establish SPAMI for 'other sites of scientific, aesthetic, cultural or educational levels' in the EEZ, however, we have yet to see examples of protected zones specifically for archaeological sites[15] (Article 8(2)) (Strati, 1995). This may be because party States have not attempted to list archaeological sites as SPAMI thus far and also that the aims of the *Regional Activity Centre for Specially Protected Areas* seem to be more orientated towards issues related with marine ecology, biodiversity, and climate change (ibid). To what extent it is actually possible to list archaeological sites as SPAMI, therefore, remains debatable, although it would appear to be possible under the Protocol as it currently stands.

[3.4.4.2].'Protocol for the Protection of the Mediterranean Sea against Pollution resulting from exploration and exploitation of the Continental Shelf and the Seabed and its Subsoil'

With respect to oil and gas activities, the 'Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from the Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil' of 'The Barcelona Convention' makes reference to a fundamental ethical issue. Article 21(b) of the Specially Protected Areas states that offshore companies should intensify the exchange of information 'among operators, the competent authorities,

[15] For more information about the established SPAMI sites, so far, refer to *Regional Activity Centre for Specially Protected Areas* website, http://rac-spa.org/ [accessed 04-09-2019].

parties and the Organization regarding matters which may affect such areas' (United Nations Environmental Program Mediterranean Action Plan, 2005, 120). This is crucial as it grants party States the right to request, gather, reassess, and store datasets generated during the course of oil and gas operations for the purpose of safeguarding, protecting and preserving sites of environmental, ecological, biological importance and of 'scientific, aesthetic, cultural or educational value' (ibid, 80). As it will be argued below and presented in **Chapter 6**, this means that any discovery of deep sea UCH should be reported in EIA and ESHIA assessments, effectively allowing further investigation and academic examination, archiving and collecting of datasets by the responsible national [heritage] agencies. This has been achieved through this thesis, which is possible because of the support of the Cypriot government and the responsible heritage agency, namely the Department of Antiquities of Cyprus (DoAC). The archaeological results of this data gathering exercises are presented in **Chapter 4**, and pertain to the oil and gas wreck discoveries of 'Eratosthene-Eni', 'Aphrodite-Noble' and 'Calypso Appraised – ENI&TOTAL' and the amphorae alley of 'Alley I-block 8'.

[3.4.5].International Law Association Draft Convention on the Protection of Underwater Cultural Heritage ('The ILA Draft Convention')

In 1988, the International Law Association (ILA) formed a Committee on Cultural Heritage Law whose main priority was to develop an international convention for the protection of UCH (Xianglan and Quiang, 2006). The ILA attempted to address the gaps left by the UNCLOS regarding the protection of archaeological remains beyond the TS through 'The ILA Draft Convention'. In this respect, the ILA Committee via Article 1(3) proposed that party States should be given the right to establish 'Cultural Heritage Zones' (CHZ) for sites 'beyond the TS of the State up to the outer limit of its CS as defined in accordance with relevant rules and principles of international law' (Nafziger, 1997). As it has been evaluated above, this concept was not new or even popular. For instance, the idea of a CPZ was initially raised in

'Recommendation 848 (1978)' on the UCH but subsequently rejected. In any case, 'The ILA Draft Convention' was submitted to the UNESCO Committee for consideration where the idea of a CHZ was subsequently rejected on an international level for the third time, thus underlining the necessity to establish a broader framework for the protection of UCH (Xianglan and Quiang, 2006). In 1996 and 1998 UNESCO unanimously decided that it was essential to draft a specific convention for the protection of UCH, which after three years of discussions and drafting, developed into what is now known as the '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage'.

[3.4.6].The '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage' ('2001 UNESCO Convention')

The numerous attempts of International and European Committees to codify and progressively develop rules relating to the protection and preservation of UCH in conformity with international law and practice, in particular those of UNCLOS, led to the development of the '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage' ('2001 UNESCO Convention'). According to Dromgoole, at the heart of this 'treaty are the provisions with respect to the Exclusive Economic Zone and the Continental Shelf' (Dromgoole, 2013, 62). For instance, Articles 9 to 10 are in principle concerned with the jurisdictional regime governing the safeguarding of UCH and deal specifically with the issue of deep-sea under-threat cultural heritage in the maritime zone between 12 nm and 200 nm. In fact, one of the main arguments for drafting the '2001 UNESCO Convention' was that UCH can be located in increasingly greater depths due to radical advancements in the field of deep seabed explorations and NRS. In this respect, concerns were raised about treasure hunting activity taking place at depths beyond the reach of recreation and technical diving (>150), which according to reports

of that time was considered an emerging threat because of the gradual reduction in the price of deep-sea exploration equipment. (ibid., 52; O'Keefe and Nafziger, 1994).

The '2001 UNESCO Convention' probably for the first time asserted a more inclusive mechanism for the safeguarding of UCH found in the area of the EEZ and on the CS. This was laid out in Articles 9 and 10 in which a reporting and notification procedure was established ensuring the safeguarding of UCH with party States acting alone and in concert (Dromgoole, 2013). More specifically, Article 9 states that contractors/subcontractors engaged in any operations in the EEZ and on the CS, regardless of whether the primary purpose of the operation is the detection or discovery of UCH, they are obligated to 'report such discovery or activity' to the State party, to other State parties and UNESCO (Article 9.1(a)) (UNESCO, 2001, 6). The underpinning principle of the '2001 UNESCO Convention' is that all party States should cooperate for the protection of UCH in the EEZ and on the CS and the aim of that is to establish a global information scheme where party States report and circulate information on UCH discoveries among themselves and the Director-General of UNESCO (see Article 9.1.b(i) and (ii), Article 9.3, Article 9.4, Article 10.3.(a) and (b) and Article 10.4) (UNESCO, 2001; Bautista, 2005).

In the interest of ensuring the safeguarding of deep-sea UCH in the EEZ and the CS from treasure hunting activities, Article 10(2) of Convention asserts the right of party States to authorise or prohibit any activities directed at UCH. According to Bautista, 'this clause can be interpreted liberally, to include jurisdiction over Marine Scientific Research, preservation of the marine environment in the EEZ, and activities undertaken for the purpose of exploring and exploiting natural resources in the EEZ and on the CS (such as pipeline and cable-laying, drilling and in the near future deep sea)' (Bautista, 2005, 77). Paragraph 4 of the same Article makes further clarifications in regard to the protection of UCH and argues that the duty of party

States is to 'take all practicable measure in accordance with international law to prevent immediate danger to UCH' (UNESCO 2001, 7). The only limitation to that is that party States are not allowed to interfere with the right of freedom of navigation, right of innocent passage, the laying of submarine cables and pipelines, overflight, and other internationally lawful uses of the sea related to these freedoms (Article 58(1)[16] of the UNCLOS). The provision attributes the duty to party States to protect UCH in the EEZ and on the CS from anthropogenic impacts and in a sense it ensures the effective protection of cultural relics and sites older than 100 years found in the concerned areas (O'Keefe and Nafziger, 1994; Rau, 2002). Of course, to what extent it is actually possible to ensure the protection of UCH in the areas between 12 nm and 200 nm from anthropogenic activities is debatable.

For instance, Rau regards the rights asserted in Articles 9 and 10 'as giving flesh to the bones of the clumsy wording of Article 303(i)[17] of UNCLOS, which concerns the protection of maritime cultural property in the EEZ and on the CS' (Rau, 2002, 407; Bautista, 2005, 77; Dromgoole, 2013). Bautista interprets these Articles as an innovative expansion of the rights of the coastal State, since Articles 9 and 10 are theoretically asserting the right of party States to oversee activities which may be harmful to the *in situ* preservation of UCH, regardless of whether those are concerned directly or indirectly with the discovery of UCH. In this respect party States of the Convention are given the right to authorise or prohibit potentially harmful activities, specifically those led by the offshore energy industry (such as drilling) and commercial deep-sea trawling, on the basis of safeguarding UCH (UNESCO, 2019). Of course, to what extent a State will prioritise the protection of UCH over enormous economic benefits is a matter of State agenda. In my opinion it seems unlikely that any State will suspend the

[16] See footnote 6, page 66.
[17] See footnote 4, page 65.

activities of an offshore oil and gas project because archaeology was discovered, which renders Article 10(4)[18] a highly aspirational and directorial and its implementation seems largely unfeasible.

In the scenario that such activities accidentally [or even intentionally] lead to the discovery of UCH, licenced contractors/subcontractors operating in the EEZ and on the CS of the party State are obligated to follow the technical guidelines listed in the Annex of the Convention (Carducci, 2002). The Annex of the '2001 UNESCO Convention', entitled 'Rules Concerning Activities Directed at Underwater Cultural Heritage', includes practical guidelines for the documentation of UCH, but these were not developed to exclusively apply to the recording of dee-sea UCH. In fact, when one reads the Annex Rules it is clear that UNESCO has developed a set of recording and preservation standards only for projects directed by archaeologists/maritime archaeologists and largely neglects the commercial arena. The 36 Rules set out guidelines for the responsible management of UCH, located in the sea, rivers or dams, and presents a directly applicable operational scheme for the discovery or excavation of UCH by archaeologists, not the industry (Maarleveld, Guérin, and Egger, 2013), leaving the issue of UCH in the deeper waters of the EEZ and on the CS largely unspecified (ibid., 15). This is unfortunate as the '2001 UNESCO Convention' should have set out the regulations for the responsible management of UCH in the maritime zones beyond 12 nm, yet the reality of the situation is that the Annex Rules of the Convention have left the issue of the effective management, safeguarding and preservation by record of deep water UCH largely unaddressed.

[18] **Article 10(4)**: 'Without prejudice to the duty of all States parties to protect underwater cultural heritage by way of all practicable measures taken in accordance with international law to prevent immediate danger to the underwater cultural heritage, including looting, the Coordinating State may take all practicable measures, and/or issue any necessary authorizations in conformity with this Convention and, if necessary prior to consultations, to prevent any immediate danger to the underwater cultural heritage, whether arising from human activities or any other cause, including looting. In taking such measures assistance may be requested from other States parties' (UNESCO, 2001, 7).

In fact, out of the 36 Rules few refer to the mechanisms applicable to the surveying and thereby effective preservation by record of deep-sea UCH assets discovered with commercial machineries such as Remotely Operated Vehicles (ROV) video-photography and Autonomous Underwater Vehicles (AUV) geophysics; And most certainly none of the Annex Rules are compatible with the overall operational framework of the oil and gas industry, which has deep sea UCH asset being discovered and thereby surveyed accidentally as by-product of NRS activities.

Rule 1 reiterates the principle of *in situ* preservation as the foremost option, with Rule 4 furthering this by stating that UCH should be surveyed via non-destructive/intrusive machinery and should 'contribute to the preservation of remains, knowledge or enhancement of UCH' (ibid., 15). According to the *Manual for Activities directed at Underwater Cultural Heritage* composed by UNESCO in 2013, the results of such activities should be presented in the context of a report as laid out in Rule 10[19] and that the documentation 'shall include, at a *minimum*, a comprehensive record of the site, including the provenance of underwater cultural heritage moved or removed in the course of the activities directed at UCH, field notes, plans, drawings, sections, and photographs or recording in other media' (Rule 27) (UNESCO, 2001, 19; Maarleveld, Guérin, and Egger, 2013).

These three Rules lay out the fundamental protocol for the surveying of deep-water UCH. Due to the largely underspecified nature of the '2001 UNESCO Convention' Annex,

[19] **Rule 10**: **'**The project design shall include: (a) an evaluation of previous or preliminary studies; (b) the project statement and objectives; (c) the methodology to be used and the techniques to be employed; (d) the anticipated funding; (e) an expected timetable for completion of the project; (f) the composition of the team and the qualifications, responsibilities and experience of each team member; (g) plans for post-fieldwork analysis and other activities; (h) a conservation programme for artefacts and the site in close cooperation with the competent authorities; (i) a site management and maintenance policy for the whole duration of the project; (j) a documentation programme; (k) a safety policy; (l) an environmental policy; (m) arrangements for collaboration with museums and other institutions, in particular scientific institutions; (n) report preparation; (o) deposition of archives, including underwater cultural heritage removed; and (p) a programme for publication' (UNESCO, 2001, 17-18).

which was also adopted in the 'regulatory administrative acts of 2016' of the 'Antiquities Law of Cyprus', essential guidance on the *minimum* technical standards necessary for good archaeological practice, which are crucial for the preservation by record of deep-sea UCH discoveries made during oil and gas operation, remain unaddressed. A possible explanation for this is that the Annex Rules are at a high directorial level, rather than being involved in the details of implementation. This will obviously change as technology develops, which in the field of deep-water surveying may be very quickly. Nevertheless, through the case study of 'Eratosthene-Eni' and 'Aphrodite-Noble', detailed in **Chapter 4**, and the subsequent data analysis of different ROV video-photography and geophysical datasets generated as part of oil and gas operations, seen in **Chapter 5**, I intent to argue for the necessity of greater technical and methodological specifications for surveying deep-water UCH assets discovered accidentally as part of NRS. These specifications are seen in **Chapter 6** where the minimum professional Survey, Data Submission and Reporting guidelines are presented, with them being based on different national and international guidelines, archaeological survey by-standards and geophysical and geotechnical specifications. These by-standards were worked to specify the *minimum* requirements for different levels of surveying and are tailored specifically to the operational framework of deep-water oil and gas explorations, and derive from the data outputs of fourteen offshore hydrocarbon projects that took place in the EEZ of Cyprus (see **Chapter 5**). These recognise that any such guidance or specifications should be both fair and proportional and not be onerous and place a heavy time and financial burden on the companies. The levels of surveying and the subsequent minimum professional Survey, Data Submission, and Reporting by-standards presented therein are not meant to set or alter the planning and delivery of NRS and will be subject to change in order to accommodate new developments in technology or practice within the industry, in the future.

3.UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

[3.5].Overview of different National Legislations concerned with the protection of UCH on the Continental Shelf and in the Exclusive Economic Zone, in the European Economic Area and elsewhere

Most national frameworks foresee the protection of UCH to the limits of the Territorial Sea (TS) or the Contiguous Zone (figure 2, page 62), with currently only a few States extending their jurisdiction over UCH in the maritime zones of the EEZ and on the CS. This practice has been described by Frost as an example of States 'testing' the boundaries of international law, based on the uncertainties surrounding the formation of customary international law[20] (Frost, 2004). Therefore, this means that different nations can choose what constitutes archaeology underwater, how and in which maritime zones it should be managed, and from what activities it should be protected. As a result of this, scholars argue that there is a lack of uniformity among different national laws concerning the protection of UCH in the EEZ and on the CS, with potentially harmful activities, such as offshore drilling, cable and pipeline projects, and in the future deep-sea mining, being regulated under different sets of standards (Frost, 2004; Kwiatkowska 1991). This is of particular importance for countries that have not ratified the '2001 UNESCO Convention' (ibid), such as Cyprus, with 'States adapting their domestic legislation according to their interpretation of the relevant treaties and their national interest' (Lin, 2019, 170)

The following section aims to provide an overview of the national laws of different countries of the European Economic Area (EEA) and elsewhere, such as the UK, the USA and Australia, and attempt to evaluate under which frameworks other countries have asserted control over UCH assets in the EEZ and on the CS; what are the prerequisites that offshore contractors must meet for the effective discovery, survey, reporting, and *in situ* preservation and preservation by record of UCH assets discovered accidentally during the course offshore

[20] For the definition of 'customary international law' refer to Footnote 1, page 58

development projects; and who are the responsible custodian agencies in addition to heritage departments enforcing the protection of UCH in deep waters. This pertains to establishing precedents for the survey levels and subsequent policy recommendations that will be set out in **Chapter 6** and identifying if there are any areas of consistency in national policy practices with respect to how countries assert, protect, preserve, and manage cultural resources found in the EEZ and on the CS.

A review into the different national legislations undertaken by the author, reveals that Ireland, Cyprus, Denmark and Spain are the only countries from the EEA to have made use of heritage law to assert a protective status over UCH in the areas of the CS and the EEZ. For instance, Section 3(1) of Ireland's 'National Monuments (Amendment) Act' of 1987, asserts that archaeological/historical assets found 'on, in or under the sea bed of the territorial waters of the State or on, in or under the sea bed to which section 2 (1) 'Continental Shelf Act' 1968, applies or on or in land covered by water that […]' (National Monuments (Amendment) Act, 1987; Kirwan, 2010). This is very similar to Article 18A of '2014 (amended) Antiquities Law of Cyprus' that grants a protected status to 'any archaeology on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on' (The Antiquities (amended) Law Cyprus, 2014, 1120); and it is also almost indistinguishable from Section 28 of the 2001 'Museum Act' of Denmark that states that wrecks of airplanes, shipwrecks, shipload and parts of such located in creeks, lakes, in the Territorial waters or on the Continental Shelf are State property and anyone who becomes aware of them must notify the Heritage Agency (Tamm and Ostrup, 2010). Along the same lines, Article 40 of the 'Spanish Historical Heritage' law of 1985 asserts 'the protection of moveable and immovable property of historical nature that can be studied using archaeological methods, regardless of whether it is found on the surface of the ground or underground, in the Territorial

sea or Continental Shelf' with the relevant public authority being responsible to promote and safeguard access to such sites (Ministerio De Cultura y Deporte, 2021; Spanish Historical Heritage Law, 1985).

The aforementioned frameworks appear to be very much uniform in principle and content, suggesting that progress has been achieved since 1978 when Lyndel Prott and Patrick O'Keefe published the *Final Report on Legal Protection of the Underwater Cultural Heritage,* stating that 'individual [heritage] laws also vary greatly in content; from the very complex and complete to the simple and rudimentary' (Roper, 1978, 49). By virtue of these principles, it is clear that UCH —regardless of definition— found in the waters of the CS and EEZ, falls under the coastal sovereignty of States and for this reason any actions that may affect directly or indirectly the *in situ* state of UCH requires the prior consent of the responsible heritage agencies. Equally, the implementation of these legal frameworks sits explicitly with the national heritage agencies, and, as they currently stand, they assert complete control and legislative competence over archaeological/historic assets situated in the EEZ and on the CS (Dromgoole, 2013).

The development of UCH policies has seen major changes during the last few decades. Based on the principle of 'protective interventions and scientific researcher', UCH assets are also protected through obligating 'the licensees of mineral exploration or exploitation projects' to respect the cultural assets of the country they operate in (Strati, 1995, 261; Johnson, 2000, 8). According to Strati, the 'undertaking of protective measures in the exercise of their resources-related rights' is legally permissible under Article 303(i)[21] of the UNCLOS (Strati, 1995, 261). This is because coastal States can choose how to regulate the exploration and exploitation of natural resources in the zones of the EEZ and on the CS, and act on the intention

[21] See footnote 4, page 65.

to protect ‘objects of an archaeological and historical nature found at sea and shall cooperate for this purpose’ (UNCLOS, 1982, 138; Dromgoole, 2013, 267).

Australia, for instance, first asserted the safeguarding of historic shipwrecks and any relics or artefacts more than 75 years old in the ‘waters adjacent to the coast of the State’ (Department of Agriculture, Water and the Environment, 2021; Jeffrey, 2006). The phrasing of ‘waters adjacent to the coast of a State’ seen in ‘Australian Historic Shipwrecks Act’ of 1976, was further clarified under the ‘Petroleum (Submerged Lands) Act’ of 1967 where a protective status was asserted to archaeological/historical wrecks in the waters extending to the edge of the CS (Jeffrey, 2006). The success of ‘Australian Historic Shipwrecks Act’ of 1976 was replaced by the amended ‘Underwater Cultural Heritage Act’ of 2018, ‘that made further proclamations over the control UCH asserting full jurisdictional control over UCH asserts to the outer limit of Australia’s Continental Shelf’(Australian Government, 2018).

From the EEA, Norway added a paragraph in the 1978 ‘Cultural Heritage Act’ declaring the protection of cultural heritage in deep waters, ‘by including in oil exploration permits over parts of its CS a condition requiring the licensee to report objects of cultural, historic or archaeological importance discovered during the course of the exploration’ (Roper, 1978, 56). The latter was further reinforced via the ‘Petroleum Act’ of 1996, in which it was a prerequisite for all planned commercial activities to avoid damaging UCH and for this purpose licensees were required to cooperate with the agency responsible for Cultural Heritage Management to achieve this (Ministry of Climate and Environment, 1978; Kvalø and Marstrander, 2006, 223). The combination of these frameworks has set the precondition for an archaeological clearance to be issued prior to any planed offshore development project. In fact, this is evident through cases studies of the Haltenbanken, the Ormen Lange, and Trondheim Harbor projects evaluated in **Chapter 2** (pages 39 -41), which demonstrated that offshore developers in Norwegian waters

were occasionally required to conduct additional maritime archaeology reconnaissance surveys and even additional sampling or even conduct excavations on sites, so as to ensure that 'cultural remains on land and under water are protected in the same way' (Søreide, 2011, 167).

Through regulating oil and gas activities, both the Australian and Norwegian heritage and petroleum acts established cultural protection clauses and provided an important precedent encouraging other states to do the same. Since then, a growing number of States such as Greece and Netherlands, have followed by extending their jurisdiction over archaeological objects and sites throughout the entirety of the EEZ, by requesting from offshore contractors to ensure the *in situ* protection of UCH from planned offshore development projects (Strati, 1995; 2006). For example, the 2002 'Greek Heritage law, on the Protection of Antiquities and Cultural Heritage in General', Article 1(2), states that 'the cultural heritage of the country consists of cultural objects found within the boundaries of Greek territory, including territorial waters and other maritime zones over which Greece exercises relevant jurisdiction in accordance with international law' (Hellenic Ministry of Culture and Sports, 2002, 2). The terminology used of 'other maritime zones' is further defined through the 'Prospecting, Exploration and Exploration of Petroleum (Hydrocarbons) and the Settlement of Related Matters' of 1976, and the subsequent amended framework of the 1995 'Prospecting Exploration and Exploitation of Hydrocarbons and Other Provisions', Article 16(6) by stating that 'carrying out work of prospecting, exploration and exploitation, the contactor/subcontractor must observe the laws and regulations in force including the regulations referred to in Article 39 hereof relating to cultural property, archaeological sites and monuments in general' (Hellenic Hydrocarbon Resources Management, 1995; Strati, 2006). This is an approach that is similar to the Norwegian and Australian examples, where the effective protection of UCH, regardless of in which maritime zone is found, is achieved through the petroleum/hydrocarbon acts in

combination with heritage law. This is by stating that exploration and exploitation 'activities must take all possible precautions to avoid damaging the cultural remains found on the sea floor of the CS and in the EEZ' (Kvalø and Marstrander, 2006, 223).

Similarly, in 2000, after asserting an EEZ and a CS, Dutch heritage law —the Wet op de Archeologische Monumentenzorg— saw an extension of jurisdiction, with permitholders of offshore explorations and exploitations operating in the North Sea being required to abide to the *in situ* protection of cultural heritage by 'all means' and in 'all maritime zones' (Maarleveld, 2006). According to Strati and Maarleveld, Dutch and Greek heritage law provided the basic principles for a blanket protection system with the *in situ* protection of UCH in the EEZ and on the CS being officially implemented through petroleum acts (Maarleveld, 2006, 171; Strati, 1995). With regard to the case study of the Netherlands, this refers to the 'Mining Act' of 2003, Article 141a.4(e), 'the area of development, in which drilling or cable and pipeline is planned to take place, should not wholly or partly overlap with an area in which cultural and natural heritage of the world is found' (Ministry of Economic Affairs and Climate, 2003, 64). The terminology of 'other' or 'all maritime zones' seen in both Greek and Dutch heritage laws enables the protection of UCH in the maritime zones beyond the Territorial waters, where through additional laws (i.e., the aforementioned petroleum acts/hydrocarbon rules and regulations), both countries have effectively asserted the protection of UCH throughout the entire 200 nm. As a result of this, the protection of UCH in the deep water of the EEZ and on the CS falls under the responsibility of the local hydrocarbon agencies, in addition to the national heritage agency. As it currently stands the Dutch Ministry of Economic Affairs and Climate is responsible for the implementation of Article 141a.4(e) of the 'Mining Act' of 2003; and the Hellenic Hydrocarbon Resources Management agency is responsible for the assertion

of the Article 16(6), of the 1995 amended 'Prospecting Exploration and Exploitation of Hydrocarbons and Other Provisions'.

In the USA, the jurisdictional control for the protection of UCH in the EEZ and on the CS falls under the Minerals Management Services (MMS) Department of the Interior, USA and its successor Bureau of Ocean Energy Management (BOEM). This was initially introduced in 1955 via the 'Outer Continental Shelf Land Act' and further defined in 1969 under the 'National Environmental Policy Act' (NEPA), through which certain rules, regulations and lease stipulations asserted the prerequisites that offshore development contractors must meet for ensuring that potentially adverse effects on any historic property, and the environment more broadly, are taken into account prior to the issuing of any license or permits (Varmer, 2006). In this respect, BOEM considers the potential effects that may occur from planned development projects and essentially requires offshore contractors to 'conduct surveys of the seafloor using remote-sensing instruments before they undertake any bottom disturbing activities' (BOEM, 2021c). To ensure that this is achieved, BOEM has laid out the prerequisites that offshore contractors must meet in the 'Pre-Seabed Disturbance Survey Mitigation' policy. This umbrella document includes additional archaeological, geophysical and geotechnical survey guidelines, providing a consistent and systematic approach to acquiring information and data on 'how to proceed when directed by a condition of an application approval to perform an archaeological assessment' prior to commencing with development and bottom-disturbing activities (BOEM, 2011, 1). These guidelines will be evaluated in **Chapter 6**, and inform the survey levels and the output by-standards of the study, based on how the USA assess the potential impacts of offshore oil and gas operations on cultural resources and ensures the *in situ* and by record protection of UCH assets.

3.UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

'There is no doubt that States have the power to exercise control over the Underwater Cultural Heritage within their territory' (Roper, 1978, 55). Although 'no State has protested the extension of jurisdiction', a small group of States such as Ireland, Cyprus, Spain, and Denmark, have asserted the protection of UCH to the full extent of the EEZ and on the CS, by making clear use of national heritage law. According to Dromgoole and Strati, this remains a 'unilateral practice', that has yet to be approved by the International Court of Justice, with the review demonstrating that other States such as Greece, the USA, the Netherlands, Australia and Norway, have avowed their intention to protect deep-sea UCH by implementing protective measures through regulating the exploration and exploitation of natural resources in 'all maritime zones' (Strati, 2006; Dromgoole, 2003; Varmer, 2006; Maarleveld, 2006; Kvalø, and Marstrander, 2006; Jeffrey, 2006). The review has revealed that petroleum and/or hydrocarbon acts, rules and regulations, in addition to heritage law, foresee that planned offshore development projects taking place in the EEZ and on the CS should not jeopardise or harm cultural resources that have been identified or are believed to exist in an area in which companies are operating. The analysis has demonstrated that in this case the *in situ* protection of archaeological/historic assets in the open waters of the EEZ and on the CS, is an issue of concern for more than one Ministry and Departments in addition to the local heritage agency.

For other Sates of the EEA, such Poland and Bulgaria, and other countries with extensive deep-water oil and gas activities, such as the UK, it seems that the legal interest has focused too much on regulating ownership and protection of UCH found in the TS, but has yet to provide any effective legal mechanism for the protection of UCH in the zones beyond the 24 nm, up to the outer boundaries of EEZ and CS (Martin and Gane, 2020). For Bulgaria, a review of both heritage and petroleum/hydrocarbon laws reveals that the effective management of deep sea UCH [such as the discoveries made as part of the Black Sea M.A.P.], is achieved through

soft laws and department procedures. This is because a protected status for sites in the deep-waters of the EEZ of Bulgaria has yet to be granted. For this matter, avoiding the unintentional destruction of know sites, and informing about the discovery of new sites as well as ensuring the *in situ* protection, reporting and further management of deep water sites is based on 'goodwill' and effective liaising between the Bulgarian authorities and the Bulgaria's Centre for Underwater Archaeology and oil and gas contractors/subcontractors (University of Southampton, 2018).

In Poland, the protection of UCH is regulated under three different areas of law, the 'Maritime Code' and other regulations of maritime law and some provisions of the 'Civil Code'; and the law on the 'Protection of Cultural Property' (Kowalski, 2006, 238). A review of them suggests that the first two frameworks are relatively inapplicable for the protection of UCH as there are mainly concerned with the issue of ownership, the reporting of recovered finds and rewarding their finders (ibid). Further analysis into these frameworks reveals that cultural resources are in fact asserted a protective status only in the zones of 12 nm up-to the 24 nm CZ (ibid), whereas beyond the CZ, no legal rules and obligations for the *in situ* protection of UCH appear to be permissible. This issue is also evident in UK heritage law as the 'Protection of Wrecks Act' of 1973, falls short in 'asserting provision for expenditure upon archaeological investigation and management of designated sites' in the maritime zones beyond the TS. According to English Heritage this is because the act lacks the 'capacity for 'area' designations to protect locations of 'high archaeological potential', the result of which is the absence of restrictions on potentially intrusive activities other than salvage [and by extent any other development] operations in the zones of the EEZ and on the CS (English Heritage, 2004, 18).

3.UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

Restricting jurisdictional control over UCH assets in the areas of the EEZ and on CS over concerns of 'creeping jurisdiction'[22], is a practice undertaken by the majority of States globally with only a few imposing some control over offshore contractors/subcontractors to consider UCH for any planned offshore development activities in the 200 nm zone. Unlike Cyprus, Ireland, Spain, Denmark, Australia, the USA, Greece, the Netherlands, and Norway where UCH assets are officially protected in the entirety of the EEZ and on CS under law, other States such as, the UK, Polland and Bulgaria possess vague, 'hortatory planning policies, [and in some occasions departmental procedures] which although they sometimes refer to a need to consider UCH in any planned marine activity across the 200 nm, do not provide any firm rules by which the UCH should be valued or under which a failure to consider its interests can be enforced' (Martin and Gane, 2020, 82; Dromgoole, 2006). Instead, much of the offshore development taking place in the deep waters of the North and Black Sea, relies upon the principle of 'goodwill' and 'legally non-binding and recommendatory rules (so-called 'soft law'), such as industry protocols and guidelines and other codes of conduct, to uphold the broader public interest in protecting the historic environment' (Martin and Gane, 2020, 82). According to Martin and Gane, 'while such soft laws and [departmental procedures] provide flexibility and better technical interoperability, the lack of legal firmness in the most important rules contained within them also weakens the capacity of any agency or public protector to enforce or implement such protection' (ibid). Code of conducts developed by professional bodies of the UK such as the Chartered institute of Archaeologists (CifA), will be evaluated in

[22] According to Franckx, 'creeping jurisdiction' refers to the extension to unilateral or unattributed actions directed at upsetting a legal framework adhered to by the majority of other States (Franckx, 2005, 136). In this case, by asserting control over UCH in the EEZ and on the CS, coastal States are attempting to exercise greater control than what is permissibly under the *UNLOSC* (Leanza and Caracciolo, 2015).

Chapter 6 and help to inform the development of the minimum professional Reporting by-standards of the study.

As it will be displayed underneath, this is relevant to how countries choose to assert the preservation by record of cultural resources when these are discovered as a by-product of NRS, with a review of different national laws revealing that this is mostly achieved on the basis of advisory and 'soft law' guidelines. This is with the exception of specific management and protection concepts, as different States assert the establishment of 'protection zones' and the submission of datasets under either their national heritage laws or hydrocarbon/petroleum acts. The following review seeks to establish precedents for the survey levels and the associate professional Survey, Data Submission and Reporting by-standards provided in **Chapter 6**, by highlighting the national policies permissible under law that foresee the 'best practical means' at a technical and operational level for the effective detection, survey, *in situ* protection, preservation by record and management of any archaeological/historic assets discovered accidentally within the wider prospect location(s) during NRS activities.

[3.5.1].Common Practices in National Laws for the management and *in situ* protection and preservation by record of cultural heritage resources discovered accidentally during the course of oil and gas explorations

A review of different national laws, suggests that States achieve the protection of confirmed UHC assets by establishing protected zones in which offshore development and any other distractive activities (i.e., fish-trawling, offshore drilling and anchoring) are prohibited (IUCN, 2008). Usually, specifications pertaining to the size and radius of the protected area being assessed on a case-by-case basis and depend on different parameters and State practices. As evaluated above, even though the concept of "Cultural Protection Zones (CPZ)" has been rejected on three different occasions by the international community —at the Council of Europe in 1978, at the Draft European Convention in 1985 and at 'The ILA Draft Convention in

1988'— the information presented below aims to address to what extent different States have adopted this policy on a national level. A review reveals that:

- Cyprus foresees the establishment of 'cultural protection zone' via Article 18C(1)[23] of the '2104 the Antiquities (amended) Law of Cyprus';
- Ireland asserts the implementation of 'restrictive zones' via Article 3(1)(2)(a) of the 1987 'National Monuments (Amendment) Act', 1987;
- Norway automatically protects officially registered monuments or sites by establishing 'security zone' as per Section 6 of the 1978 'Cultural Heritage Act';
- Spain declares 'archaeological areas' for the protection of 'known', 'unknown' and 'presumed' UCH sites (Aznar-Gomez, 2006). This is asserted through Article 43 of the 'Spanish Historical Heritage' law of 1985 (Spanish Historical Heritage law, 1985);
- Greece, can declare 'protection zones' 'around underwater monuments and archaeological sites, […] where any activities shall not be allowed without a prior permit' with this being permissible under Article 15(4) of the 2002 'Greek Heritage law, on the Protection of Antiquities and cultural' (Hellenic Ministry of Culture and Sports, 2002, 4);
- Australia, under Section 21(7) of the 'Underwater Cultural Heritage Act' of 2018 'prohibits (a) the entry of persons or vessels into [protected] areas; (b) the movement of persons or vessels within such areas; (c) trawling or fishing in such areas; (d) conduct underwater activity within such areas; (e) the anchoring or mooring of vessels in such areas; (f) the

[23] **Article 18C(1):** 'The Council of Ministers, following the suggestions of the Director of the Department of Antiquities Cyprus, and by declaring her/his decision through the Cyprus Government Gazette, to declare "Cultural Protected Zones (CPZ)" for Underwater Cultural Heritage sites of archaeological or artistic value, that are either confirmed or suspected to exist at specific or approximate locations within the Exclusive Economic Zone and on the Continental Shelf' (The Antiquities (amended) Law Cyprus, 2014, 1121).

release or deposit of objects or materials within such areas' (Australian Government, 2018, 2018, 22);

- the UK asserts the protection of UCH through the establishment of 'protected places' or 'controlled sites' under Section 2 of the 'Protection of Wrecks Act' of 1973 and the General Provisions 'Protection of Military Remains Act' of 1986. Based on above review this applies only to the limits of the TS, as the UK government has limited jurisdiction in the zones of the EEZ and CS (English Heritage, 2004; Kowalski, 2006);
- the USA asserts the establishment of 'buffer' or 'exclusion zones' around confirmed UCH sites. This is according with national legislation, with clarification provided through different soft laws and other archaeological and geophysical, guidelines that offshore contractors/subcontractors must meet when operating in the deep water of the EEZ and on the CS (MMS 2004; BOEM 2014). For specifications refer to the 'Pre-Seabed Disturbance Survey Mitigation' umbrella policy framework, *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585*, and *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585.*

The analysis presented here, illustrates that the establishment of 'protective zones' appears to be an area of consistent practice among different States as it emerges as the most effective approach for the *in situ* preservation and future management of UCH assets from any kind of activities. According to Farquhar and Santos, prohibiting development in specifically designated areas, of either archaeological, environmental, biological, or ecological value is increasingly popular and is gaining acceptance on an international level so that it may soon become customary international law[24] (Farquhar and Santos, 2019). This statement gains

[24] For the definition of 'customary international law' refer to Footnote 1, page 58

further validity when considering that the 2030 UN Development Agenda of Sustainable Development Goals target 11.4 encourages States to 'strengthen their efforts to protect and safeguard the world's cultural and natural heritage' with the United Nations General Assembly officially recognising the inclusion of archaeological sites in 'marine protected areas' in all maritime zones or as part of marine spatial planning mechanisms (ibid).

Further analysis into national laws reveals that States require 'offshore contractors to present more data from their work' (Søreide, 2013, 1013). From the countries of EEA, and as demonstrated below, under heritage [and other] law(s) Cyprus requires the submission of datasets from offshore oil and gas contractors, with other countries requiring the same primarily under different petroleum and hydrocarbon acts and other soft laws, code of conducts and guidelines. For instance, in Australia under Article 406-408, Section 2, paragraph b(iii) of the 'Offshore Petroleum Amendment (Greenhouse Gas Storage) Act' of 2008 it is stated that any datasets generated during the course of natural resource surveys (NRS) should be 'given to the responsible Commonwealth Minister, or to a person specified in the data management plan' (Department of Industry, Science, Energy and Resource 2008, 372). Similarly, the UK, the Netherlands, Denmark, Greece, and the USA require from contractors to 'regularly exchange knowledge, data, and experience', as part of their offshore hydrocarbons requirements. In Norway, Section 6 of the 'Regulations to Act Relation to Petroleum activities' of 2020 foresees that oil and gas contractors 'shall no later than five weeks prior to the commencement of activities according to a survey licence, submit the following information to the Norwegian Petroleum Directorate, the Directorate of Fisheries and the Ministry of Defence' (Norwegian Petroleum Directory, 2020). This should include reports and datasets generated as part of geohazard, geotechnical and environmental baseline surveys and other environmental impact assessments prior to development (ibid). In effect, the submission of data generated as part of

NRSs and other offshore development projects appears to be a prerequisite for most countries evaluated here, with this to be clarified under different national laws and regulations. This legal mandate appears to be part of a broader data review analysis strategy, usually undertaken by the relevant environmental, hydrocarbon [and perhaps heritage] custodial agencies.

Furthermore, analysis into the national laws, regulations and soft laws of the States evaluated above reveals that in fact only a very few countries have further defined the operational by-standards that offshore oil and gas contractors must meet for the effective discovery, survey, reporting and preservation by-record of UCH assets that are discovered accidentally during the course of NRS in the deep water of the EEZ and on the CS. As it will be discussed in **Chapter 6** this is because archaeological by-standards are largely absent on an international level with some examples set only nationally. A review of these by-standards in **Chapter 6** focuses on primarily on the USA [and other State such as Australia and the UK] and presents an overview of BOEM's *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585*, and *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585*. These guidelines along with other European soft laws and guidelines and international and national archaeological lease stipulations, geophysical/geotechnical and upstream operational guidelines will inform the output levels of survey and the associate archaeological by-standards of the study that are seen **Chapter 6** of the study.

From the analysis of different national laws, regulations and soft laws, it has been argued that there are indeed some areas of common practice among States. The review of twelve different national laws from the EEA and elsewhere, such as Australia, the UK, and the USA, revealed that States assert control over UCH assets to the full extent of the EEZ and on the CS either through heritage law or by requiring offshore development contractors to respect the

cultural assets of the country they operate in. The latter is achieved through asserting cultural protection clauses in petroleum and/or hydrocarbon acts, rules and regulations, that usually refer to heritage law and set the provisions for avoiding damaging the cultural remains found on the seafloor of the CS and in the EEZ. Further analysis into different heritage national laws, revealed that the effective management and *in situ* protection of UCH from NRS activities in the deep water of the EEZ, is achieved through the assertion of 'protected zones' around sites. From the twelve countries analysed here, seven foresee the establishment of some sort of no-development/or buffer zone in the EEZ and on the CS, with the same States also requiring the submission of data and reports for reassessment purposes. However, it is fair to assume the reassessment of data is mostly relevant to environmental and hydrocarbon purposes and largely excludes issues related to cultural heritage resource reasons. This relates to the assumption that has States unlikely to suspend offshore oil and gas activities because archaeology was discovered, inadequacy surveyed or destroyed all together. For the EEA countries, only Cyprus foresees the submission of datasets under heritage law with other States asserting this but under different petroleum and hydrocarbon acts and other soft laws and guidelines. In addition, the review has revealed that from the States analysed here only the USA and to some extent Australia have set the specific archaeological survey prerequisites that oil and gas contractors must fulfil for the effective protection by-record of UCH found in the deep-wates of the EEZ and on the CS. This is in respect to what information appears to be currently publicly available with the possibility of other countries enforcing additional departmental procedures that unfortunately appear to be outside public domain. The common practices identified here (i.e., establishment of no-development zones, and the submission of data and reporting) as well as other prerequisites seen in different soft laws, geophysical, geotechnical, and geohazard guidelines, will be analysed in **Chapter 6** so as to establish precedent for the output levels of

survey and the minimum professional Survey, Data Submission and Reporting by-standards of Cyprus that oil and gas contractors must meet preceding the drilling of well(s).

[3.6].The National Legislation of Cyprus and its Safeguarding of the Underwater Cultural Heritage of the Island

The protection of UCH in the EEZ and on the CS is of great concern for the Department of Antiquities Cyprus (DoAC). This becomes apparent via the '2014 (amended) Antiquities Law of Cyprus', which refers to the protection of UCH in all maritime zones. Article 18A grants a protected status to: 'Any archaeology[25] on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on' (The Antiquities (amended) Law Cyprus, 2014, 1120). In the interest of ensuring the protection of UCH in all maritime zones from commercial activities, Article 18B-(1) asserts the right to the DoAC to monitor activities of 'licenced agencies, contractors or individuals operating in the Exclusive Economic Zone and on the Continental Shelf of Cyprus' (ibid). If discoveries of UCH are made, licenced contractors (such as those related to offshore oil and gas activities) 'are required to report to the Director of the Department of Antiquities Cyprus the discovery of UCH sites, regardless if such were made intentionally or not, and for this manner contractors operating should thereby submit geographical coordinates and additional information' (ibid).

The '2014 (amended) Antiquities Law of Cyprus', lays out a legal framework that enables the effective involvement of DoAC in the affairs of the EEZ and on the CS. Due to the

[25] Under the '2014 (amended) Antiquities Law of Cyprus' archaeology is defined as: any object, whether movable or part of immovable property and is considered to be a work of architecture, sculpture, graphic art, painting, or generally any form of art which has through human effort been produced, sculptured, inscribed or painted in Cyprus or abroad. The aforementioned should be 100 years old, or older, produced in any manner whatsoever and from any material, and were found, discovered or excavated or recovered in Cypriot territory both on land or at sea. This includes any such object(s) or part thereof which has at a later date been added, reconstructed, readjusted or replaced subsequently (The Antiquities Law Cyprus, 2014, 1120).

largely unspecified nature of the framework and in particular that of Article 18B-(1), that omits to clarify exactly what datasets should be submitted, the DoAC has the right to monitor any activities that are both concerned with the discovery of UCH directly or indirectly. This applies to NRS and any other kind of commercial activities, such as those related with the laying of pipelines, cables and in the near future deep-sea mining. Further clarifications regarding the protection of UCH in the context of NRS activities are included in the main authorisation requirements of the 'The Hydrocarbons (Prospection, Exploration and Exploitation) Law of 2007' by which contractors are agreeing to the 'protection of biological and mineral resources and of national treasures possessing artistic, historic or archaeological value' (Article 13(1).h) (The Hydrocarbons (Prospection, Exploration and Exploitation) Law, 2007, 13). If UCH discoveries are made, Article 23(1) of 'The Hydrocarbons (Prospection, Exploration and Exploitation) Regulations, of 2007 and 2009)' further states —and by extent clarifies Article 18B-(1) of the '2014 (amended) Antiquities Law of Cyprus'— that 'the holders of an authorization are bound to inform the Minister of all major developments in relation to the course of hydrocarbons operations' (The Hydrocarbons (Prospection, Exploration and Exploitation) Regulations, 2007 and 2009, 25). To this end, 'copies of all geological, geophysical and other technical reports, well logs, maps, diagrams, magnetic tapes, electronic and other stored data, in any form, reports and interpretation which have been prepared by or for the holder of an authorization', according to Article 23(2).(a).(i) of the same framework, should be submitted to the Ministry, concerned Departments and other stakeholders (ibid). As it was evaluated above, this appears to be an area of common practice between different States involved in oil and gas exploration activities, with them asserting the submission of datasets and the protection of UCH in their specific hydrocarbons rules and regulations through different rules, articles and soft laws.

3.UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

In terms of physically ensuring the safeguarding of UCH in the entirety of Cypriot waters, Article 18C(1) asserts the right to 'the Council of Ministers, following the suggestions of the Director of the Department of Antiquities Cyprus, and by declaring her/his decision through the Cyprus Government Gazette, to declare "Cultural Protected Zones (CPZ)" for Underwater Cultural Heritage sites of archaeological or artistic value, that are either confirmed or suspected to exist at specific or approximate locations within the Exclusive Economic Zone and on the Continental Shelf' (The Antiquities (amended) Law Cyprus, 2014, 1121). Article 18C(2) clarifies this further by stating that within this CPZs actions such as: 'a) installations of artificial island and structures, b) anchoring of vessels, c) fishing activities both commercial or not, d) diving, e) drilling, the usage of explosions or placing of explosions in the marine environment, and f) in general any activities directed at UCH regardless they threatening the *in situ* state of UCH or not' are strictly prohibited (ibid).

The protected status granted to UCH in the maritime zones of the EEZ and on the CS Cyprus by the DoAC is also recognised in the Environmental law of Cyprus. For instance, 'the Assessment of Impact on the Environment of Certain Plans and Programs' of 2005, under the General Provisions (Part II) provides the technical conditions to assess the impacts to the environment from the implementation of certain projects, including offshore oil and gas operations, and it sets the conditions for granting the related environmental permission or approval. Among those it asserts that a final EIA or ESHIA should be composed prior to the drilling of offshore wells but after the completion of the Environmental Baseline Survey (EBS) and Geohazard Investigations [or other types of Supplementary Hydrographic Surveys] , and should describe and evaluate the effects that hydrocarbon explorations and exploitation activities may have on the seabed around the drilling site(s). More specifically, both the EIA or ESHIA reports should elaborate upon the activities taking place in the prospect study area(s)

and present the characterisation of the physical, chemical, biological, and socio-economic baseline conditions of the region. In principal, these reports should also include the results of the both offshore and onshore EBS and evaluate the impacts of both routine and unplanned activities and incidents of the proposed drilling program, and recommend the specific measures and mitigation strategies for the protection of marine mammals, ecological sites, marine organisms and according to Article 3(2).a.(iv), 'archaeological sites' (ENI Cyprus LTD, 2017). This analysis of impacts is subject to the national law of Cyprus and the international regulations followed by the country in the zones of the EEZ and on the CS and has resulted in the reporting of discoveries of UCH found as a result of NRS (ENI Cyprus LTD, 2017). This is mentioned here but expanded on in detail in **Chapter 6**, which evaluates the unspecified Scope of Work (SoW) set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus,* which stipulates that Desk Based Assessments should address 'specific concerns (archaeological artefacts, marine protected areas, fishery restricted areas, cables, pipelines, *et cetera*)'(Ministry of Agriculture, Rural Development and Environment, with the input of the Departments of Environment and Fisheries and Marine Research, Cyprus, 2017, 5). This is of significance as it proves that Cypriot national legislation foresees the reporting of accidental discoveries of UCH made during the course of NRS and creates the possibility for researchers to conduct further academic research on datasets pertaining to deep sea UCH discoveries. In order to do so, however, this requires the support of heritage agencies as well as national or international frameworks being in place that grant a protected status to deep sea UCH found in the EEZ and on the CS. The data collected as part of this thesis demonstrates that in Cyprus this works effectively. As analysed above, this also seems to be also the case with international frameworks, thereby suggesting that through this thesis, Cyprus, can be viewed as a pioneering case study in effectively promoting research on

oil and gas datasets. As per the abovementioned analysis of different national laws, I believe that similar studies can also be conducted in other in country that are involved in NRS activities. This is in because certain rules and regulations, articles or soft laws foresee the submission of datasets developed by the offshore oil and gas industry, and after awareness is raised, scholars in collaboration with heritage agencies simply need to start utilising such datasets as part of future interdisciplinary academic studies.

[3.7].Discussing the National Legislation of Cyprus

The issue of jurisdiction over UCH in the areas of the EEZ and on the CS has been recognised by various international Conventions, but it still remains a grey area (Lin, 2019). For instance, the UNCLOS contains only two articles related to the protection of UCH, neither of which are applicable for the protection of UCH in the entirety of the EEZ and on the CS (Scovazzi, 2014). To this end, the legal vacuum left by UNCLOS in the areas of 12 nm to 200 nm, was seen by international organisations and individual States as an opportunity to elaborate upon.

As an attempt to provide a solution to the issue of safeguarding UCH in the EEZ and on the CS, policy makers and maritime archaeologists drafted the 'Recommendation 848 (1978)', where for the first time it was argued that UCH should be protected in the entirety of the EEZ and on the CS, under the so called CPZ. According to 'Recommendation 848 (1978)', the CPZ concept asserted the right of coastal States to declare specific areas of interest protected by establishing a buffer zone around archaeological sites and prohibiting any activities that may be potentially harmful to UCH. Even though the concept of the CPZ has been rejected in two occasions, both by European and International Committees, mainly due to concerns of 'creeping jurisdiction',[26] it seems that other international frameworks have proposed similar strategies for the broader protection of the marine environment. For instance, the 'Protocol Concerning

[26] See footnote 22, page 94

Specially Protected Areas and Biological Diversity in the Mediterranean' proposed the establishment of 'Specially Protected Areas of Mediterranean Importance', where party States can safeguard sites of biological, ecological and archaeological value (Dux, 2011, 333).

Thus far, archaeological sites have not been included in the SPAMI list, however, listing them would appear to be possible under the Protocol. Cypriot legislation as it currently stands suggests that the safeguarding of UCH is permissible via CPZ, as it is mentioned in Article 18C(1)[27] of the '2014 (amended) Antiquities Law of Cyprus'. Even though Article 18C(1) awaits implementation, the safeguarding of sites discovered in the EEZ and on the CS of Cyprus, such as those mentioned in **Chapter 4**, is adequately achieved via the establishment of buffer zones and mitigation agreements with the industry, guaranteeing that drilling will not take place in the buffer zone itself, nor for a further 300 to 1,5000 metres further from the proposed drilling area. In the cases of 'Eratosthene-Eni' and 'Calypso Appraised – ENI&TOTAL' drilling was agreed to take place 300 to 500 meters away, in addition to the established buffer zones with 300 metres radius set around the UCH sites. Therefore, part of the latter strategies of this project is to advocate for the implement of the relevant Article and assert the establishment of CPZs[28] for the six shipwreck sites detailed in **Chapter 4**.

Despite the controversy around the CPZ regime, it is the decision of the State parties of 'The Valletta Convention' to assert the extent to which they enforce the protection of UCH on a national level (Blake, 1996; Dromgoole, 2013; Strati, 1995b; Willems, 2007). Evidently, the protection of UCH for the DoAC is of foremost interest as Article 18A of the '2014 (amended) Antiquities Law of Cyprus' grants a protected status to any 'sites of archaeological or artistic value' in the entirety of Cypriot waters (The Antiquities (amended) Law Cyprus, 2014, 1120).

[27] See footnote 23, page 96
[28] See footnote 22, page 94

In consideration of that, however, no legal framework is perfect and indeed as it has been argued above both Cypriot domestic legislation and other national and international frameworks lack specifications regarding to how UCH should be surveyed, and thereby preserved by recorded, when it is accidentally discovered during the course of NRS. A possible explanation for why this occurs is that there has been too little oversight of exactly how the oil and gas industry treats accidental discoveries of UCH and thus specific frameworks, Articles or Annex Rules (i.e. such as those ones of the '2001 UNESCO Convention') in regard to this issue, at least for the Mediterranean Sea, are absent. From my experience in analysing such datasets this is a crucial aspect missing from both national and the aforementioned international policies and indeed as it will be argued in the following chapter via the examples of 'Eratosthene-Eni', 'Aphrodite-Noble' and other ROV video-photography and geophysical datasets, examined in **Chapters 4** and **5**, deep-sea UCH is inadequately surveyed and therefore the archaeological record of discoveries made during the course of NRS in Cypriot deep waters demonstrates significant limitations. In my opinion, this can be rectified if the survey levels and the output minimum professional by-standards seen in **Chapter 6** are implemented in the 'regulatory administrative acts of 2022' of the 'Antiquities Law of Cyprus'. These guidelines are worked to specify the *minimum* requirements for different levels of surveying and are tailored specifically to the operational framework of the oil and gas industry and derive from the suggestions made by other national custodian agencies such as the Australian Government, BOEM , the Chartered institute of Archaeologists (CifA), and other international regulatory agencies, such the European Union, the International Association of Oil & Gas Producers (IOGP), and the International Petroleum Industry Environmental Conservation Association (IPIECA) (see **Chapter 6**).

3.UNDERWATER CULTURAL HERITAGE IN THE EXCLUSIVE ECONOMIC ZONE: LEGAL REVIEW

Nevertheless, international and national frameworks, protocols or even specific Articles concerned with issues related to UCH discoveries during the course of offshore commercial activities have developed considerably since 'Recommendation 848 (1978)'. For instance, 'Recommendation 848 (1978)' identified that the reporting and safeguarding of UCH should be based on mutual cooperation and 'goodwill' between heritage agencies and oil and gas contractors/subcontractors (Roper, 1978). This remains an integral factor for developing partnerships between the industry and heritage agencies, yet frameworks since 'Recommendation 848 (1978)' have displayed a more proactive approach towards asserting control over offshore commercial activities taking place in the deep waters. This is evident in Articles 9 and 10 of the '2001 UNESCO Convention' where party States are given the right to authorise or prohibit any activities directed at UCH. From the perspective of national law, different States have made use of heritage, petroleum/hydrocarbon acts and require the protection of UCH in the deep water of the EEZ and on the CS, and further assert the establishment of protective zones and the submission of dataset through different soft laws, rules and regulations. In the case where UCH discoveries are made, contractors/subcontractors engaging in any operations in the EEZ and on the CS, regardless if the detection or discovery of UCH is the primary purpose of the operation or not, are obligated to 'report such discovery or activity' to the State party, and to other State parties and UNESCO (UNESCO, 2001, 6).

For the case study of Cyprus, the only applicable protocol which ensures the effective protection of UCH in all maritime zones is the 'Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf with and the Seabed and its Subsoil', of 'The Barcelona Convention', as it is the only international Protocol signed and ratified in 2006 and implemented in 2011. The Protocol goes a step further than that and expects that offshore companies should intensify the exchange of information

'among operators, the competent authorities, parties and the Organization regarding matters which may' affect possible UCH sites, as it is stated in Article 21(b) (United Nations Environmental Program Mediterranean Action Plan, 2005, 120). According to this Protocol, legally contractors/subcontractors are obliged to submit information and data to the DoAC and also other Cypriot government agencies. This supplements the unspecified Article 18B-(1) of the '2014 (amended) Antiquities Law of Cyprus' and Article 23(1) of 'The Hydrocarbons (Prospection, Exploration and Exploitation Law, 2007 and 2009)'. These frameworks (both national and international) have made this thesis project legally viable and at the same time the project, with the help of Dr Despina Pilides of the DoAC and the academic supervision of Dr Damian Robinson, University of Oxford, has effectively contributed towards achieving the implementation of the national legislation of Cyprus '2014 (amended) Antiquities Law of Cyprus' Articles 18A[29] and 18B-(1)[30]. This is possible because gathering, re-analysing, storing, and requesting following-up on datasets for the purpose of this study allows the DoAC to assert control over contractors operating in the EEZ and on the CS of Cyprus, by ensuring the effective protection and management of any accidental discoveries of UCH made during the course of NRS.

[3.8].Conclusion

To conclude, the safeguarding of UCH in the deep waters of the EEZ and on the CS of Cyprus is granted a protected status both under national and international frameworks. Because of these

[29] **Article 18A**: Any archaeology on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on (The Antiquities (amended) Law Cyprus, 2014, 1120).

[30] **Article 18B-(1)**: Licenced agencies, contractors or individuals operating in the Exclusive Economic Zone and on the Continental Shelf of Cyprus, are required to report to the Director of the Department of Antiquities Cyprus the discovery of any UCH sites and objects regardless of such discoveries were made intentionally or not, and for this manner they should submit geographical coordinates and additional information (ibid).

laws, this thesis has provided a template for communication between the DoAC and the offshore oil and gas industry that has proven to be mutually beneficial for the implementation of the Articles 18A and 18B-(1) of the '2014 (amended) Antiquities Law of Cyprus'. UCH is not only now routinely being discovered, but it is also being documented and reported, with the relevant geophysical and ROV video-photography datasets being submitted to the DoAC.

The analysis of different national laws has revealed that there is indeed an area of common practice between different States of the EEA and elsewhere for the protection of UCH discoveries made during offshore development projects taking places in the deep-waters of the EEZ and on the CS. This protection appears to be legally permissible under heritage or other petroleum or hydrocarbon acts, rules and regulations and may soon be regarded as a general practice accepted under 'customary international law'[31]. The analysis has revealed that important areas of common practice between different States for the *in situ* protection and management of UCH assets exists, and this is via the establishment of 'protected zones' and the submission of datasets being a legal prerequisite. In consideration of this, however, Cypriot domestic legislation, international frameworks and other national laws, regulations and soft laws lack the specifications regarding exactly how UCH should be surveyed, preserved by recorded and reported when UCH is accidentally discovered during the course of NRS in the deep-waters of the EEZ and on the CS. This, I believe, creates a loophole, which acts for the benefit of the industry, mostly because there are no legal rules and obligations that a contractors/subcontractors must meet when conducting NRS and accidentally discover UCH. In fact, it can be further argued that there is a difference between high level laws that are aspirational and general and the practical issues of their implementation. This is particularly relevant in the field of deep-water surveys, which changes rapidly in terms of technology and

[31] For the definition of 'customary international law' refer to Footnote 1, page 58

dataset production, and as such, specific guidelines need to be more rapidly updated than the principles of international law. Consequently, I believe that UCH in the EEZ, when discovered during NRS, is usually inadequately surveyed. **Chapter 5** will present examples of this issue, based on ROV video-photography and other geophysical datasets generated during the course of oil and gas operations, arguing that this can be rectified if the survey levels and the associate minimum professional by-standards of the study are implemented. To this end, **Chapter 6** will put forward the Survey, Data Submission and Reporting by-standards for the effective discovery, survey, reporting, data-submission, archiving, and *in situ* preservation and preservation by record of archaeological/historical assets found in the wider prospect area(s), in the EEZ of Cyprus (and the eastern Mediterranean more broadly). These are based on data observations made in **Chapter 5** and are aligned with other archaeological geophysical, geotechnical, and upstream operational guidelines, composed by both national and international regulatory agencies, such as the European Union, IOGP, CifA, and IPIECA, the Australian Government and BEOM.

In this respect, **Chapter 5** will present a rare insight into how the oil and gas industry operates and produces geophysical and ROV video-photography datasets, arguing that deep UCH when discovered during the course of NRS can be effectively preserved by record only via the enactment and implementation of the output survey levels and the minimum professional by-standards of the study in the 'regulatory administrative acts of 2022' of the 'Antiquities Law of Cyprus' or by further determining the vague SoW set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus*. To this end, the following chapter —**Chapter 4**— seeks to evaluate both new and past deep sea UCH discoveries made in the EEZ of Cyprus, as an attempt to postulate that when it comes to analysing shipwrecks and their extant cargo from ROV video-photography datasets generated

as part of oil and gas operations, the emerging archaeological interpretations present ambiguities limiting what can be stated with confidence.

4.UNDERWATER CULTURAL HERITAGE DISCOVERIES IN THE EXCLUSIVE ECONOMIC ZONE OF CYPRUS

[4.1].Introduction

The potential to conduct deep water archaeological research using Remotely Operated Vehicles (ROV) video-photography datasets generated from oil and gas operations is an exciting one that offers insights into new deep water Underwater Cultural Heritage (UCH) discoveries. To demonstrate the potential of this approach, accidental finds from oil and gas companies operating in the Exclusive Economic Zone (EEZ) of Cyprus since 2011 have revealed three new shipwreck sites and one amphorae alley. These wreck-sites along with the additional alley, will be examined in this chapter where a detailed analysis of the observable cargo is undertaken to propose an approximate date for the wrecking of the ships. The composition of the cargo also provides information pertaining to the ship's original route and possible destination. In addition to the oil and gas data, exploration cruises by the Ocean Exploration Trust (OET) in 2010 and 2012 have also revealed an additional three shipwreck sites, and a staggering 300 scatters of materials in the deep seas of Cyprus (cf. Ballard, et al, 2017). Some of these were examined superficially and not in the context of a holistic study. These data are evaluated here, particularly to address the typology of deep sea wrecks and also to investigate further the issue of scatters of material and what they offer for interpreting deep water UCH. The spatial analysis undertaken here seeks to interpret them as nothing more than they simple are: evidence of 'marine littering' of ancient mariners who discarded the amphorae after they consumed their content whilst sailing the sea-lanes of the eastern Mediterranean. The results of this analysis postulate that more complicated theories, such as scatter amphorae terminating at wreck sites or to areas of 'high archaeological potential', may stand, if future surveys are conducted within the suggested areas presented in Figures 12 and 13, pages 127 and 131, respectively. Debris trails from multiple vessels have never been studied in this detail before. Finally, a discussion section will draw upon both shipwrecks and scattered materials in an attempt to examine if this evidence fit the prevailing theories of the economic development of the eastern Mediterranean.

4.UNDERWATER CULTURAL HERITAGE DISCOVERIES IN THE EXCLUSIVE ECONOMIC ZONE OF CYPRUS

[4.2].The Underwater Cultural Heritage Discoveries of the Ocean Exploration Trust in the Exclusive Economic Zone of Cyprus

The first visual evidence demonstrating the potential for deep water archaeology in the EEZ of Cyprus were generated in 2010 by the OET, whose founder and president is Robert Ballard. Funded by the National Oceanographic and Atmospheric Association (NOAA) and supervised by the Department of Geology Cyprus (DoGC), the OET 2010 and 2012 surveys were primarily intended to add information regarding the biological and geological nature of the Eratosthenes Seamount[1]. However, given the number of amphorae and sites discovered accidentally in 2010, the 2012 survey agenda was expanded to encompass the recording of UCH (Ballard, et al, 2017). Thus, the 2012 OET expedition marked the first, and thus far only, deep sea survey within the EEZ of Cyprus where archaeological documentation was officially part of a project's agenda (ibid). The ROV photographs from both expeditions were submitted to the DoGC and latterly, in 2018, transferred to the Department of Antiquities Cyprus (DoAC). The generated data from both of the expeditions were submitted to the author as part of this project and are included in an ArcGIS (geo)database of UCH finds in Cypriot deep waters created by the author on behalf of the DoAC. The datasets submitted from the 2010 and 2012 OET survey cruises are 750 GB in size and include primarily photographs on: A) Three shipwreck-sites; B) Environmental, geological and biological data displaying the diverse nature of the Eratosthenes Seamount (such as: deep sea corals, rare fish and marine litter); and C) 300 scatters of materials mainly amphorae. This section will present the archaeological materials from the 2010 and 2012 OET survey-cruises.

[1] The Eratosthenes Seamount is situated in the Exclusive Economic Zone of Cyprus, approximately 92 km south of the coast of the island, and 340 km northeast of Egypt. It is an elevated submerged elliptical plateau which rises about 1300 meters above its surroundings, enclosed by a deep natural moat and the abyssal plain of 2000 plus meters depth (Kempler, 1998, 709). The top of the Seamount resembles a table-like surface, and lies roughly at 700 meters below sea-level, with the overall shape of the structure tilting northwards, sliced by a series of normal faults.

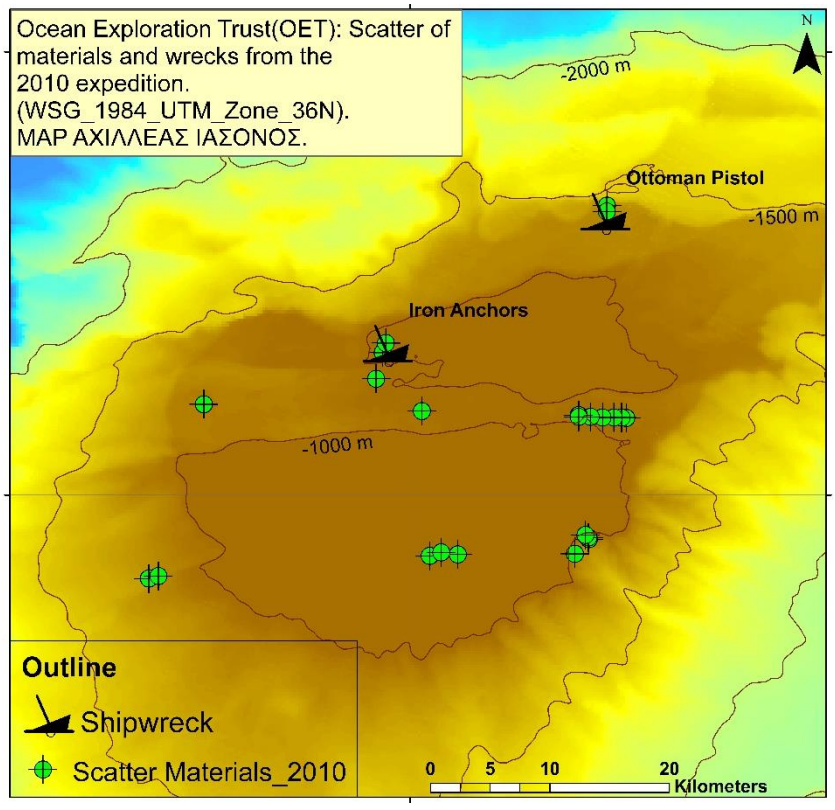
[4.2.1].The 2010 Ocean Exploration Trust Survey

For a period of six days, from the 22nd to the 28th August 2010, the research team of OET surveyed the Eratosthenes Seamount in two phases. Phase one entailed the use of side-scan-sonar (SSS) atop the Seamount in order to identify potential anomalies of high scientific value (i.e. deep sea corals and geological features), followed by phase two, where the most promising targets were visually examined via ROV video-photography (Wachsmann, et al, 2011). The 2010 survey revealed a wider collection of biological, ecological, and geological features, as well as 70 isolated amphorae dating from the Cypro-Geometric (11th to 8th centuries BC) to the Late Roman/Byzantine periods (4th to 7th centuries AD), and two 'relatively recent shipwreck sites' (ibid., 30; Ballard, et al, 2017).

[4.2.1.1].Scatter of Materials noted from the 2010 Ocean Exploration Trust Expedition

The ROV photographs from the 2010 OET expedition presented in the **Appendix, Section 1**, pages 336-343, illustrate an array of scatter amphorae predominately dating to the Late Roman/Early Byzantine period (4th to 7th centuries AD), with a few dating to the Hellenistic period (4th to 1st centuries BC), and three examples of Phoenician amphora dating from the Cypro-Geometric to Cypro-Archaic periods (11th to 5th centuries BC) (**Appendix, Table 1,** figures ID 3, 48, and 54, pages 344, 354 and 355) (Wachsmann, et al, 2011). In addition, thee cooking pots in an exceptional state of preservation were discovered dating to the Hellenistic period (4th to 1st centuries BC) (**Appendix, Table 1,** figures ID 13, 27 and 44, pages 346, 350 and 353), four juglets, and one pilgrim flask (ibid) (**Appendix, Table 1,** figures ID 50, 61, 63, 64 and 65, pages 355 and 357). The artefacts were primarily recorded on top of the Eratosthenes Seamount's plateau at depths roughly of 800 to 1500 metres, with a substantial concentration of materials surveyed at the north foot, south-east end and the centre of the seamount (Figure 5, page 116). The following analysis reviewed all photographic data of scattered amphorae submitted to the DoAC from the 2010 OET survey cruise. The results of this study are presented

in the **Appendix, Table 1**, pages 344-358, and is based on the photographic data shown in the **Appendix, Section 1**, pages 336-343. The analysis of scatter artefacts derives from Opaiţ's initial study *Deep-water Archaeological Discoveries on Eratosthenes Seamount* (Ballard, et al, 2017), but is developed further based on the author's observations from previously unstudied photographs. The purpose of this is to provide additional information where possible on the type, chronology, and origin of each amphora. Besides the three cooking ware, four juglets and one flask, this work identified 32 amphorae: one was dated to the Cypro-Geometric (11th to 8th centuries BC); two to the Cypro-Archaic period (8th to 5th centuries BC); three to the Hellenistic period (4th to 1st centuries BC); seven to the Roman period (1st century BC to 4th century AD); sixteen to the Late Roman/Byzantine period (4th to 7th centuries AD); and two to the Ottoman (16th to 19th centuries AD). These amphorae are grouped according to their type, spatially analysed and discussed latter on in the chapter (see Discussion Section of the 2010 and 2012 Ocean Exploration Trust Scatter of Materials, pages 126-131).





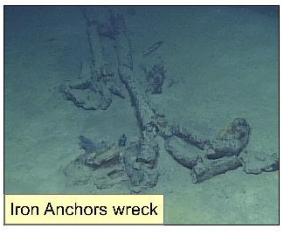


Figure 5: The exact location of the 2010 OET noted scatter materials and the two shipwreck sites. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[4.2.1.2].Shipwrecks noted from the 2010 Ocean Exploration Trust Expedition

In addition to the scatter materials, the 2010 survey revealed also 'two fairly recent shipwrecks', one of which according to Wachsmann carried a pair of iron grapnel anchors (the 'Iron Anchors' wreck), with the other carrying an admiralty anchor attached to a chain (the 'Ottoman Pistol' wreck) (Figure 5) (Wachsmann, et al, 2011). While both wrecks have important scientific value, they have unfortunately received little detailed academic interest thus far. Nevertheless, both sites are briefly introduced in Wachsmann's article *Archaeological Discoveries on Eratosthenes Seamount* where he effectively dates the 'Ottoman Pistol' wreck, based on the argument that anchor chains and muskets were introduced in the 19th century. Similarly, the 'Iron Anchors' wreck was also dated to the same century, 'based on the presence of iron grapnel anchors' (ibid., 30). This was a relatively cursory analysis and there was sufficient additional evidence in the digital archive with which to provide further insights into the construction, chronology, typology, usage, cargo, and sinking of both vessels.



figure 6: All three iron grapnel anchors of the 'Iron Anchors' wreck recorded by the OET in the 2010 expedition. Source: image © DoAC

[4.2.1.2.1].The 'Iron Anchors' wreck

The 'Iron Anchors' wreck was discovered at roughly 1000 metres of depth on the central part of the Seamount's plateau (Figure 5). It is scattered throughout an area of roughly 100 m^2, with three iron grapnel anchors instead of only a pair as initially stated in Wachsmann's publication (Wachsmann, et al, 2011, 30). This is seen in figure 6 where a pair, and one individual anchor,

can be seen just a few metres a part (squared in red and yellow) (ibid., 30). Two anchors seem very similar, roughly 2 metres in length, consisting of four flukes of which three are exposed, with the fourth embedded in the seabed, and heavily corroded, possibly appearing to be of rectangular shape (Ono, et al, 2016). The shank of the anchors appears to be circular for all three and was probably linked to a rope, since no evidence of iron chains were noted at the site. Similarly, the small iron anchor found on its own, in the middle of the image (figure 6, squared in yellow), appears to share the same characteristics with the other three. It seems to have an overall size of less than a metre, consisting of four rectangular flukes, of which two of them are exposed and preserved in good condition (ibid). According to Votruba, 'the earliest iron grapnels as primary anchors may have been specifically those assigned to Late/Post Byzantine Mediterranean galleys' with the earliest evidence for such deriving from a Venetian manuscript (Votruba, 2013, 248). He further argues that iron grapnel anchors were first used in the Mediterranean Sea as a result of influence from Easterners engaging in maritime trade. Grapnels were first recorded archaeologically from the 14th or 15th centuries AD Mercury shipwreck from the Red Sea (Vosmer, 1999) and their use continued up to the 19th century AD. Within this chronological margin of six centuries, anchor chains were introduced in the 19th century, which in this case are absent. This suggests that the 'Iron Anchors' wreck probably pre-dates the 19th century AD but dates no later than the 14th century AD (Curryer, 1999).

Additional information pertaining to a narrower chronology can be deduced through the analysis of photographic data exhibiting the hull and artefacts found in the debris field. For instance, figure 7 shows the interior of the 'Iron Anchors' hull, consisting of two wooden floor-timbers, one of which preserves evidence of mortises and tenons. The tenon (squared in red) is made of iron and was perhaps used to link the floor timber with the first futtock and latterly secured with iron rivets (squared in yellow). The hull-planks were most probably running parallel to the frames, fastened together with the so-called carvel technique and were secured

onto the frames by iron spikes, covered by iron-sheathing which seems to have been laid and fastened on the hull's interior (squared in orange). According to Young, the practice of protecting the submerged portions of the ship's hull with iron-sheathing can be traced in historic documents from naval dockyards, dating roughly around the 16th century AD. This process, however, was subsequently abandoned early on in the 17th century AD, due to the limited durability of the material (Young, 1867). This information is vital for further clarifying the chronology of the 'Iron Anchors' wreck, but is nevertheless treated with caution as Young does not make it entirely clear if iron-sheathing was applied on ship's with wooden or metal hulls.

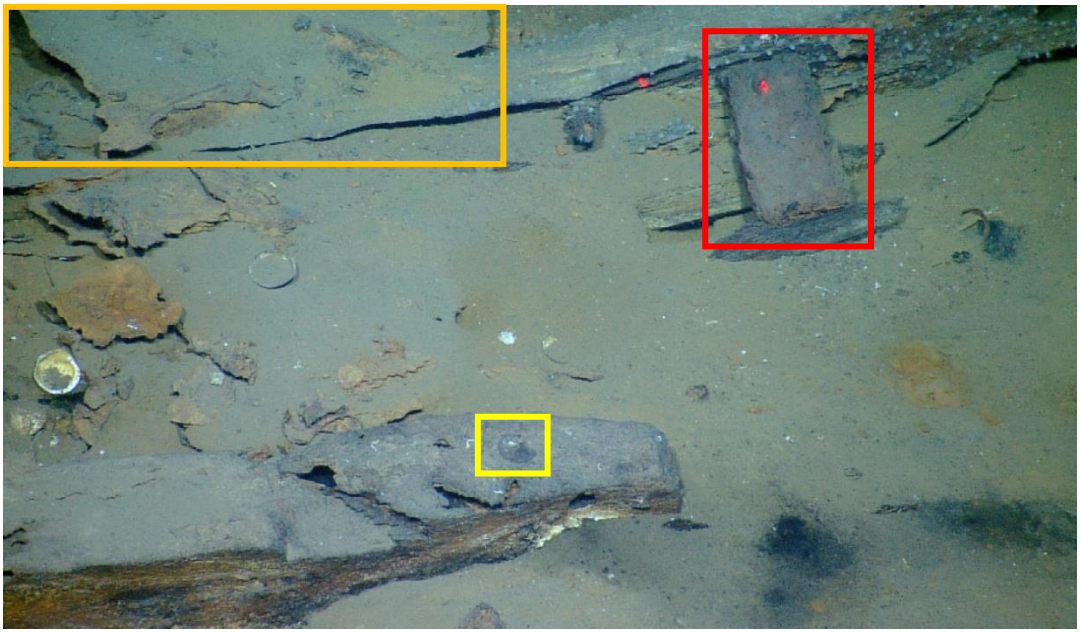


figure 7: Part of the preserved hull of the 'Iron Anchors' wreck. Source: image © DoAC.

In the debris field of the 'Iron Anchors' wreck, two artefacts were noted, which due to their poor state of preservation are difficult to identify (**Appendix, Section 1**, figures 65 and 67, page 343). Adjacent to them a rim of a cooper or bronze cauldron barely protrudes from the sediment, which was probably used to cook the crew's meals (**Appendix, Section 1**, figure 62, page 342). Furthermore, the remains of two detached iron tubes can be seen (figure 8), linked by bands of iron (Dana, 1911). These pieces can perhaps be identified as the remains of a

breech-loading iron swivel gun which according to the catalogue of cannons of *The Armouries of the Tower of London* dates to the first half of the 16th century AD (Blackmore, 1976). This type of firearm became widely used in the 17th century AD and was known as a 'Portugal base' or a 'sling' and 'would have been used for the firing of small bullets in the fashion of the later ships' musketoons (ibid., 20).



figure 8: The iron canon recorded *in situ* at the site of 'Iron Anchors' wreck. Source: image © DoAC

The data suggest that the hull of the 'Iron Anchors' wreck presents similarities with the 16th century AD Venetian merchant ship Sveti Pavao, excavated off the coast of Croatia (Beltrame, et al, 2014). Therefore, this tentatively infers to a ship constructed roughly around that period, with further evidence such as the presence of a breech-loading iron swivel gun, to further reinforce the site's possible chronology roughly around the 16th and 17th centuries AD and not the 19th century AD as initially proposed by Wachsmann (Wachsmann, et al, 2011). This seems to be also compatible with Young's statement which has the introduction of iron-sheathing made around this time also.

The absence of a 'ship-like' outline, as well as the scant evidence of any crew belongings, renders it difficult to evaluate why this ship sunk. The fragmented preservation of the wreck's hull does not give a real indication of what the size of ship was, however, the presence of two large anchors perhaps suggests a hybrid boat that was not as big as a galley but

big enough to carry large anchors. With this in mind, and the established chronology deriving from the remains of the iron swivel gun, it can be postulated that perhaps the 'Iron Anchors' site infers to the remains of a Mediterranean ship type used both for war and trading, known as the Xebec (or Zebec). Drawing an absolute conclusion, however, is simply not possible from the documentation of the remains as they stand. Hypothesizing on the *in situ* remains, Votruba suggests a model for calculating the relative size of ships —in metric tons— based on the size and weight of the iron anchors. Votruba suggests that three iron anchors of the 17th century AD are indicatives of a ship of a total size ranging between 60 to 130 metric tons, depending on the anchors weight (Votruba, 2013, 618).

Nevertheless, in the absence of substantial evidence one could postulate a scenario where it could be suggested that the 'Iron Anchors' site represents the remains of perhaps an Ottoman (16th to 17th century AD) boat attached to a larger ship (perhaps a Xebec), from which both the lifeboat and the two large anchors were discarded. This was likely a desperate attempt to make the ship lighter and more buoyant, if it were foundering during a storm or fleeing another warship or combat. The scenario could indeed explain the third small anchor being associated with the ship's lifeboat as well as the limited evidence of crew belongings and the absence of a 'ship-like' outline. Another explanation could simply be that what we are looking at the remains of a larger ship that broke up and that it is buried under differing amounts of sediment. This theory is consistent with the discovery of the bronze cauldron barely since often they have been recovered from the remains of galleys.

[4.2.1.2.2].The 'Ottoman Pistol' wreck

In addition to the 'Iron Anchors' wreck, the 2010 OET expedition noted the remains of another largely destroyed shipwreck with an intact admiralty anchor attached to a chain (figure 9). The site was recorded roughly at 1100 metres at the north-end slope of the Eratosthenes Seamount

(Figure 5, page 116) and was named by the OET team the 'Ottoman Pistol'[2] wreck, due to the presence of a flintlock musket pistol (figure 9, yellow square). The site seems to cover an area of less than 25 x 25 metres and comprise of fragments of a largely destroyed wooden vessel (figure 9). The lower parts of the hull seem to be buried in the sediment with three of its frames partly intact. Given the paucity of the evidence, as well as the lack of preserved wooden planking, drawing any further interpretations about the construction of the vessel seems to be unfeasible. For this reason, the preliminary analysis of the wreck site, undertaken by Wachsmann, suggested a chronology based on the presence of the flintlock musket pistol and anchor chain, dating the wreck to the early 19th century AD (Wachsmann, et al, 2011). Yet, scholars such as Reid, argue that weapons similar to this one, date roughly between the 17th to 18th centuries AD (Reid, 2016). Additionally, artefacts such as a copper or bronze cauldron, three bottles of what I assume used to contain wine or other alcohol

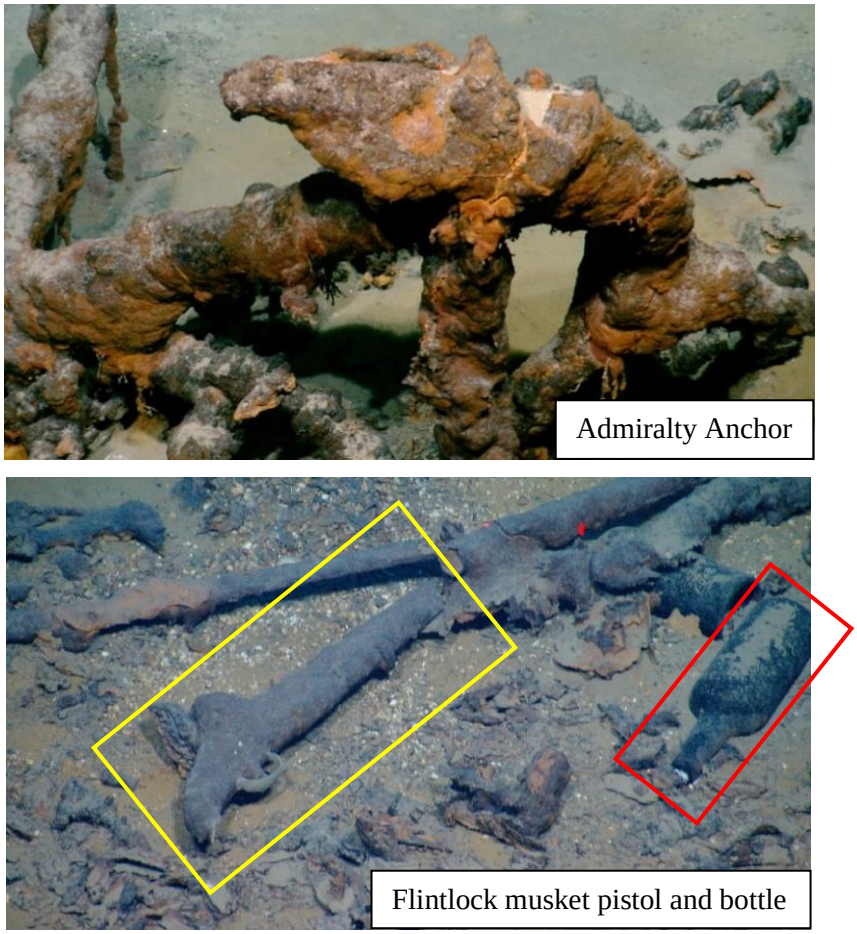


figure 9: The 'Ottoman Pistol' wreck with the top image exhibiting the intact admiralty anchor and the attached chain; and the bottom image exhibiting a flintlock musket pistol and a bottle (squared in yellow and red, respectively). Source: image © DoAC

[2] For the video link of the 2012h, E/V Nautilus, *Mediterranean Shipwreck: Ottoman Pistol | Nautilus Live* follow the link, https://www.youtube.com/watch?v=p1pzlOKM8nE [accessed 10/04/2019].

and a porcelain mug were also recorded providing insights into life on board (figure 9, red square). Further analysis of the three bottles, based on sample bottle typologies dating between 1650-1800 from Marx's *The Underwater Dig*, refers to a typology dating approximately around 1770 to 1800 (Marx, 1975, 25) (figure 10). Unfortunately, there is little further that can be said about the 'Ottoman Pistol' wreck. The site reflects the remains of a relatively small boat sailed by a few mariners carrying very few personal belongings, dating probably around the beginning of the 18th to the early 19th centuries AD (Ottoman period) (ibid).

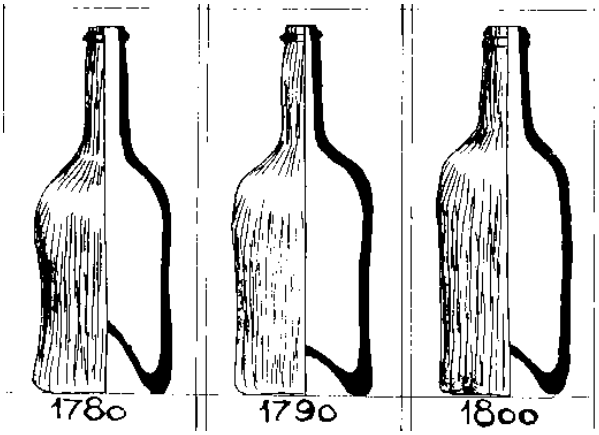
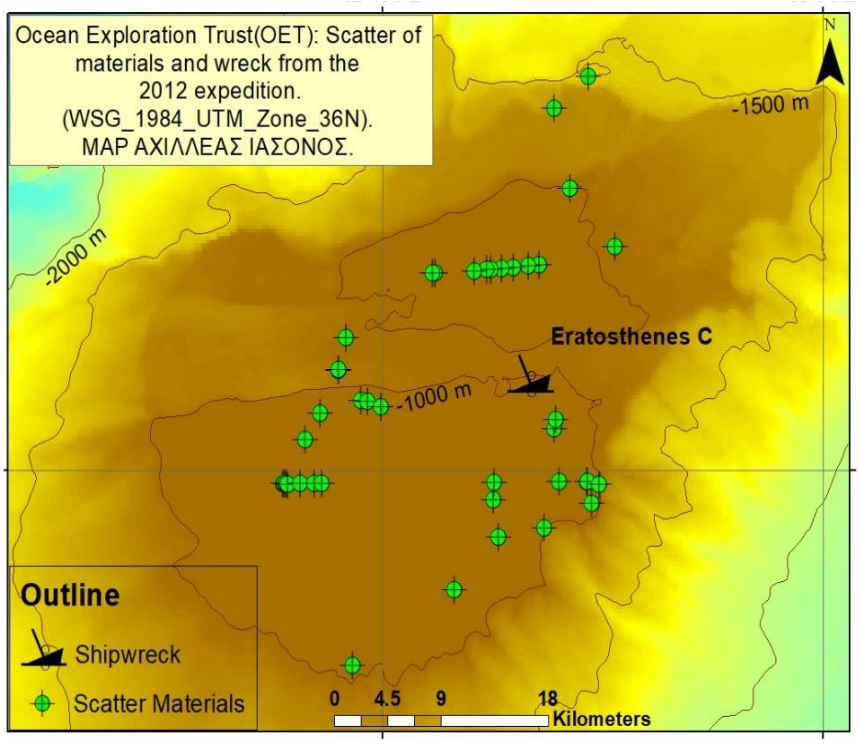


figure 10: The possible bottle types found at the 'Ottoman Pistol' wreck. Source: image from Marx, F. R. (1975). *The Underwater Dig.* New York: Pisces Books. 25.

[4.2.2].The 2012 Ocean Exploration Trust Survey

Following the successful discovery of two archaeological sites and the abundant presence of scattered materials (mainly amphorae), in 2012 the OET conducted a more systematic survey of the Eratosthene Seamount plateau. For nine days, from the 14th and the 25th of August, the OET surveyed with a deep-tow long-range SSS with the most promising targets visually examined via ROV video-photography. As a result, a staggering 106 isolated amphorae were revealed (Cornwell, et al, 2013), along with a Hellenistic shipwreck of roughly 100 visible artefacts, dating to the late 4th century BC (330 BC) (ibid., 43) (Figure 11). Overall, approximately 18% of the Seamount was explored over the two seasons, revealing a total of roughly 300 scatters of materials and three shipwrecks (Ballard, et al, 2017). The results of both expeditions highlight that the Eratosthenes Seamount not only offered ideal conditions for the preservation of UCH, but also confirmed it as an area of 'high archaeological importance'.

4.UNDERWATER CULTURAL HERITAGE DISCOVERIES IN THE EXCLUSIVE ECONOMIC ZONE OF CYPRUS



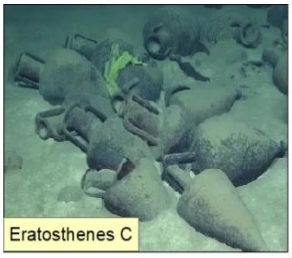


Figure 11: The exact location of the 2012 OET noted scatter materials and the shipwreck of 'Eratosthenes C'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[4.2.2.1].Scatters of Materials noted from the 2012 Ocean Exploration Trust Expedition

The ROV photographs from the 2012 OET expedition presents information on 106 newly discovered amphorae, with this work effectively identifying 59; of which two amphorae were dated to the Late Bronze period (17th to 11th centuries BC), one to the Cypro-Archaic (8th to 5th centuries BC), fourteen to the Hellenistic (4th to 1st centuries BC), twelve to the Roman (1st BC to 400 centuries AD), and 29 to the Late Roman/Early Byzantine period (4th to 7th centuries AD) and one to the Frankish period (12th to 5th centuries AD) (**Appendix, Section 2**, pages 359-370) (Wachsmann, et al, 2011; Cornwell, et al, 2013; Ballard, et al, 2017). In addition to these finds, four cooking pots were confirmed (Appendix, **Table 2**, Figures ID 19, 72, 80 and 87, pages 375, 385, 387 and 388). The remaining 43 could not be identified mainly because the amphorae were badly preserved, or the photographic record was ambiguous. The scattered materials were primarily recorded on top of the Eratosthenes Seamount's plateau at depths roughly of 800 to 1400 metres, with a substantial concentration of artefacts surveyed at the south and south-east ends as well as at the centre of the Seamount's plateau (Figure 11). As part of this study, all of the photographic data of the scattered amphorae submitted to the DoAC

from the 2012 OET survey were reanalysed with the results presented in the **Appendix**, **Table 2**, pages 371-392. Similar to the 2010 analysis of scattered materials, this study was based on the *Deep-water Archaeological Discoveries on Eratosthenes Seamount* article but developed further based on the author's observations from additional unstudied photographs. Both the 2010 and 2012 OET scatters of materials will be returned to in the discussion section underneath, where they will be grouped based on their amphorae type and spatially analysed to reveal possible information about areas of 'high archaeological importance' of additional scatters of amphorae or even debris trails associated with uncharted shipwrecks (see Discussion Section of the 2010 and 2012 Ocean Exploration Trust Scatter of Materials, pages 126-131).

[4.2.2.2].'Eratosthenes C' wreck

The 2012 survey produced 1,238 images of the 'Eratosthenes C' wreck. According to Ballard a high-definition photo-mosaic was produced along with video data, which were not submitted to the DoAC. This is an issue that requires further investigation and discussion, as at present OET would appear not to have fully complied with Cypriot law.

'Eratosthenes C' was discovered on top of the Eratosthenes Seamount's plateau at roughly 1000 metres of depth, in two main concentrations approximately 25 metres apart with roughly 100 complete visible amphorae and two large pithoi (Figure 11, page 124) (Ballard, et al, 2017). The scatter seems to be spread throughout an area of approximately 25 x 25 metres, with the wreck's cargo concentrated in high density at the fore and aft, lying *in situ* protecting the hull. The low-density of artefacts at the centre of the site, imply that 'Eratosthenes C' may have also carried other organic materials and containers and foodstuff that will have deteriorated over time. Further analysis of the wreck's cargo by Andrei Opaiţ suggested that the ship carried largely amphorae from the 'SE Aegean: Rhodes, Peraea, Knidos, Samos (mushroom rim types), and Chios. The next most represented group is north Aegean amphorae: for Mende, Peparethos, Pella, Thasos, and perhaps other small northern centres (Akanthos,

Samothrace). Isolated amphorae originating from Corinth/Corfu, Sinope and a Phoenician centre can be added to the above groups' (ibid., 4). In addition, at least fourteen amphorae belong to unknown types, either because they were discovered in a fragmentary state or were largely covered under sediment. Drinking and kitchen ware, such as krateriskoi, large and medium krateres and kantharou, represent a substantial number of the finds along with numerous narrow-necked jugs, pots and casseroles. Finally, a single lamp and a wooden box were documented protruding from the sediment.

Based on the exposed cargo, the shipwreck 'Eratosthenes C' was tentatively dated to the later 4th century BC, possibly around 330 BC, and was interpreted as a merchant ship carrying a combination of cargo and personal belongings, transporting them perhaps from the Aegean to the Near East. Through the reanalysis of the 'Eratosthenes C' data it became apparent that little more could be added to that already published on this wreck (Ballard, et al, 2017). For photographic data refer to the YouTube video, *Mediterranean Shipwreck: Eratosthenes C | Nautilus Live.*[3]

[4.3].Discussion Section of the 2010 and 2012 Ocean Exploration Trust Scatter of Materials

The following analysis seeks to map the results of these cruises in relation to the expedition's survey line paths according to typology. This approach aims to investigate the potential spatial patterns of scatters of materials in relation to line surveys and deduce information pertaining to debris-trails from vessels in trouble. This technique of back-tracing scatters of materials and modern debris trails to detect wrecks has been proven to be effective and has been successful

[3] For the video of the 2012g, E/V Nautilus, *Mediterranean Shipwreck: Eratosthenes C | Nautilus Live* follow the link, https://www.youtube.com/watch?v=0w2EfTuxFVc&t=11s [accessed 25-07-2020].

applied in the discovery of wreck sites such as the RMS *Titanic*, Bismark, and the Skerki bank ancient wrecks (cf. Foley and Ballard, 2004).

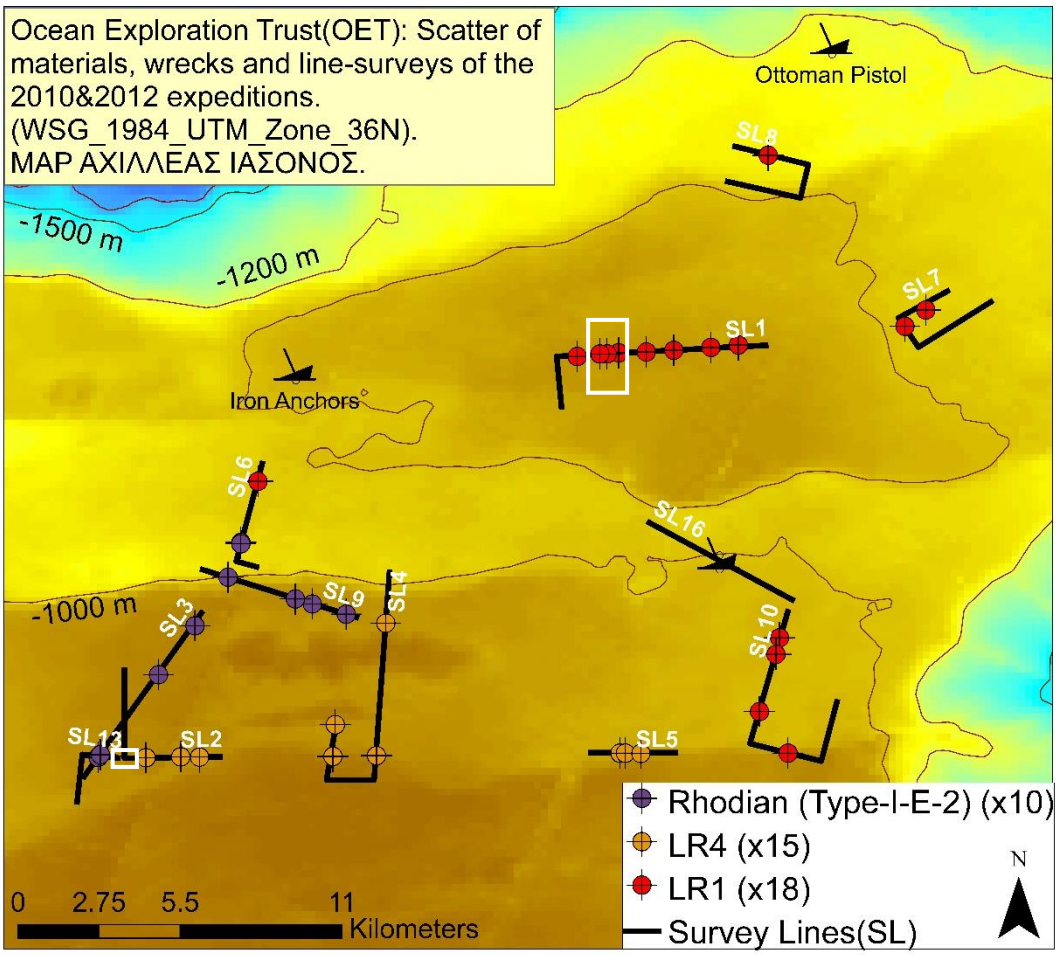


Figure 12: The analysis suggests two possible areas of 'high archaeological potential' (squared in white), and its' based on the classification of three main groups of amphorae. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Figure 12 illustrates the three main groups of amphorae recorded during the 2010 and 2012 OET expedition found in quantities of more than ten, mapped in relation to the vessel's navigation path and investigated as potential amphora alleys. The three main amphorae groups correlate to eighteen Late Roman 1 (LR1), fifteen Late Roman 4 (LR4) and ten Rhodian Type I-E-2 types. The map reveals the distribution of a total of 40 amphorae in relation to twelve survey-lines, with the distribution of the recorded amphorae suggesting two possible areas of 'high archaeological potential' (Figure 12, white squares). Even though, the likelihood of these amphorae trails terminating in shipwrecks is low, supplementary surveying in the near future

may shed light at the marked locations suggesting if these amphorae alleys 'have been the effects of emergency jettisoning of cargo' or 'evidence of a debris trails leading to wrecks that might lie beyond the boarders' of the 2010 and 2012 OET survey cruises (ibid., 184). In addition to this, it must also be considered whether these actions could also represent the jettisoning of transport containers from ships after their contents were consumed by ancient mariners whilst sailing. This would resemble modern actions similar to those of discarding ocean trash, with this analysis regarding them as evidence of sea-routes of passing sailors.

Figure 12, Survey Line 1 (SL1) reveals the distribution of nine LR1 along a straight west-south navigation path of 8 km, followed by a 4 km turn to the south. The first four amphorae are found at a distance of approximately 400 metres apart, leading to a 'cluster area' with four amphorae found 100 metres away from each other, and the last amphorae recorded roughly 200 metres further from the 'cluster area'. The discovery of nine identical LR1 amphorae, along a single survey line, rules out the possibility of them being an accidental find, and could perhaps correlate to the emergency jettison of a stricken vessel. To prove if this theory stands, it is essential to understand better the distribution of the LR1 amphorae especially around the 'cluster area'. For this reason it is proposed to survey further. Figure 12, suggests a 2 x 2 km grid where within this area a detail ROV video-photography survey should be conducted and provide a 100% area coverage. The results of this detail survey may allow a better understanding as to what these finds represent, and if the 'cluster area' leads to more un-surveyed scatter finds that may be part of a broader homogenous debris trail of LR1 amphorae associated with a nearby wreck (Figure 12).

Of particular interest seems to also be the area around Survey Lines 2, 3, 13 where a total of seven Rhodian Type-I-E-2 and ten LR4 amphorae were discovered. Survey Line 3 (SL3) was laid out on a straight south-west axis and led to the discovery of five Rhodian Type-I-E-2 amphorae; at the south-western end of the survey line two amphorae were recorded just

20 metres apart. Further surveys at the south-west end of SL3, where Survey Line 13 (SL13) crosses SL3, an addition of two Rhodian Type-I-E-2 amphorae were found situated 100 m apart, along 1,5 km straight north axis followed by a sharp 180° turn, following a 1 km eastwards direction, resembling a 'Γ' shape survey path. Additional surveys roughly 1 km opposite where SL13 ended, revealed the scattering of another ten LR4 amphorae on a 6 km straight path on a westerly axis, just before Survey Line 2 (SL2) focused on a northerly path of 4 km. The area between SL2 and SL13 seems to be a crucial one and based on the evidence presented in Figure 13 underneath, it seems that SL13 revealed a substantial concentration of an addition of eight Roman and Late/Early Byzantine amphorae. Some of these amphorae were discovered within the proposed grid of 810, 000 m^2 (marked in white in Figure 12) indicating its potential: only 200, 000 m^2 of this area was surveyed by OET (Figure 12). The quantity of evidence illustrated in Figures 12 and 13, and found along SL2 and SL13, postulate an area of perhaps steep geomorphology, with the discarded amphorae perhaps rolling down the slope settling on a flatter seafloor zone. To prove or disprove whether this hypothesis stands or not, a solution would be to generate high resolution bathymetric datasets, accompanied by further ROV video-photography for further surveying the gap area between SL2 and SL13. To conclude, the discovered evidence arise a great deal of uncertainty whether these amphorae are representatives of a single event, such as debris trails terminating at a shipwreck, however, further investigation in the proposed area may provide the necessary data for reaching an accurate conclusion. It is my position that by conducting the suggested surveys in the proposed grid, illustrated in Figure 12, new data can potentially allow the discovery of additional scatter amphorae or shed light as to what these finds represented and if the large concentration of these scatters is related to the seafloor geomorphology of the surveyed area between SL2 and SL13.

Another spatial mapping approach of the scatters materials is illustrated in Figure 13 where all identified amphorae were mapped according to their typology. The mapping of each

amphorae type reveals the concentration of primarily two main areas, squared in red and purple, with sizes of 15 km x 12 km and 20 km x 12 km respectively (Figure 13, page 131), in which a substantial concentration of roughly a total of 72 identified scatter amphorae have been noted. The area squared in red presents evidence of 27 amphorae, of which twelve were dated to the Hellenistic period and the remaining six and nine to the Roman and Late Roman/Byzantine periods respectively: no shipwreck was found within this area. Similarly, the area squared in purple presents evidence of roughly two Hellenistic, eleven Roman and 32 Late Roman/Byzantine amphorae, alongside an additional roughly 100 amphorae associated with wreck discovery of 'Eratosthene C'. A remaining array of roughly 26 artefacts, consisting of a mixture of juglets, Hellenistic cooking wares and other amphorae dating from the Late Roman/Byzantine to the Ottoman periods can been seen outside these areas of 'high archaeological potential' at Survey Lines of 7, 8, 12, 15, 17, 19, and 21.

From the distribution of artefacts along Survey Lines 5, 10, 11, 14, 16, 20 and 22 marked within the marked area of Figure 13 (in purple), it is not possible to link this evidence with the actions of mariners discarding cargo from ships in trouble seeking to lighten their loads or with trails terminated at shipwrecks. In the words of Foley and Ballard, amphorae alleys 'tell the story of the sailors' last few frantic moments' only if an amphorae trail is homogenous, linear and dense (Foley and Ballard, 2004, 194). In this instance, however, because the amphorae are not consistent and represent a wider mixture of different amphora types, a simpler explanation is needed. With this in mind, I would advocate that these finds can be interpret as indicators of ocean 'littering', relevant to the theory which has amphorae containing food for the crew's voyage being routinely cast overboard when emptied (ibid). For this reason, the analysis undertake in Figure 13 advocates that scatter amphorae should not be treated solely with regards to their linear distribution, but also grouped and spatially analysed in regards to their type. This analysis takes into consideration the fact that they are linear because the line-path survey of the

ROV was linear, and thus the amphorae were surveyed along the ROV's flight-path rather than along a possible route or trail. In this instance, the interpretation of these finds does not postulate anything beyond what they simply are: transport containers, discarded along the sea-lanes of the eastern Mediterranean. The examination of these finds, suggests that different hypothesis may arise if future surveys are conducted in the suggested areas marked in Figures 12 and 13.

The spatial analysis undertaken in Figures 12 and 13 has provided insights pertaining to four possible areas of 'high archaeological potential' that may perhaps lead to the discovery of additional scatters of amphorae or even debris trails associated with uncharted shipwrecks (Figure 12, white squares and Figure 13, red and purple squares). Although, it seems unfeasible to suggest that shipwrecks will be situated within these suggested areas, nevertheless, the possibility of locating at least a Late Roman/Byzantine wreck in the area remains at large (Figure 13, marked in purple).

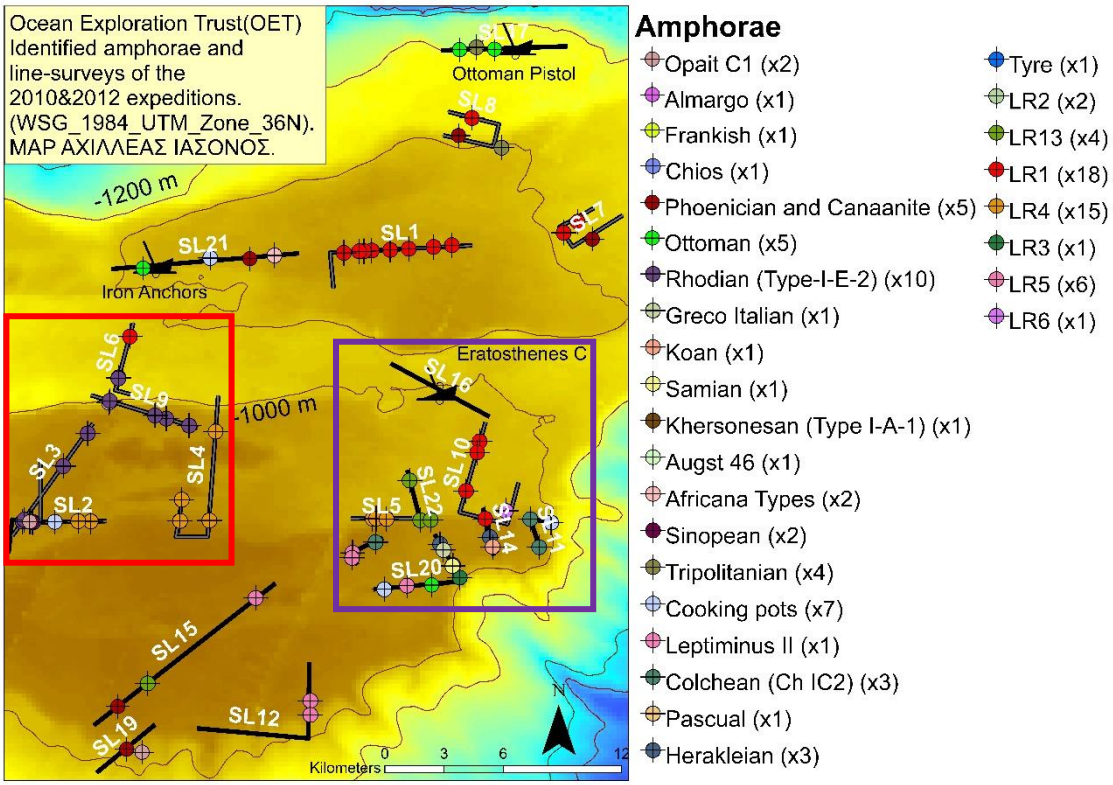


Figure 13: The map reveals the distribution of a total of roughly 100 identified amphorae, grouped according to amphorae type, in relation to 22 survey lines, with the distribution of them suggesting two broader areas of 'high archaeological potential' (squared in red and purple). Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

4.UNDERWATER CULTURAL HERITAGE DISCOVERIES IN THE EXCLUSIVE ECONOMIC ZONE OF CYPRUS

[4.4.].*Oil and Gas Archaeology* and Underwater Cultural Heritage Discoveries made in the context of Natural Resource Surveys

The development of Autonomous Underwater Vehicles (AUVs) and ROVs have launched a revolution in oceanographic and hydrographic sciences, enabling new scientific methods for mapping, sampling, monitoring, and video/photography-recording of the deep seabed (>100) (Roman and Mather, 2010). These technological advancements utilised in the context of projects led by pioneering deep sea explorers such as Willard Bascom, Robert Ballard, and more recently Jon Adams, have contributed in demonstrating that survey and even excavation of archaeological remains in deep waters 'is a technologically enabled field' (ibid., 327). Yet, datasets exhibiting deep water wrecks are rarely seen in academia and are even more scarcely produced in the context of surveys targeting the detection of deep water UCH sites exclusively. In fact, the reality of the situation is that deep water discoveries of UCH sites are mostly made accidentally and in the context of commercially funded projects for purposes other than the discovery of UCH, such as oil and gas explorations (ENI Cyprus LTD, 2017; Noble Energy International Ltd, 2011; Søreide, 2011, 27; Ford, et al, 2010; Warren, et al, 2007; BOEM, 2008), hydrographic and military surveys[4] (Søreide, 2011), cable and pipeline projects (Warren, et al, 2007), and deep sea filming missions[5]. The result of this is that information from commercial surveys about any accidental UCH are rarely examined in the scope of academic studies, thus limiting considerably the researcher scope of the sub-discipline of maritime archaeology to the shallow waters of TS (**Chapter 2**). In the case of this thesis, however, because commercial datasets are examined in the context of an academic study in the following section I analyse the

[4] For examples of hydrographic surveys for environmental and geological purposes that have revealed deep sea UCH refer to the Schmidt Ocean Institute website, https://schmidtocean.org/ [accessed 10/04/2020].

[5] Examples of deep sea filming missions, relevant but not explicit to the discovery of UCH, can be seen at the Ocean Exploration Trust website, https://www.oceanexplorationtrust.org/ [accessed 10/04/2020]; R/V Petrel website, https://www.rvpetrel.com/ [accessed 21-05-2019] and Rebikoff-Niggeler Foundation website, https://www.rebikoff.org/ [accessed 10/04/2020].

hitherto unpublished *Oil and Gas Archaeology*[6] discoveries made by the offshore oil and gas industry in the EEZ of Cyprus from 2011 up to 2020.

[4.4.1].The shipwreck site of 'Aphrodite-Noble'

Block 12 of the EEZ of Cyprus is approximately 160 km from shore and is adjacent to the maritime borders of Israel, Lebanon and Egypt. The Block was awarded to Noble Energy International Ltd, Delek Drilling Limited Partnership and BG Cyprus Limited, following the 1st Hydrocarbons Licencing Round of the Republic of Cyprus in 2008 and proceeded with the drilling of two well sites in 2011, and the subsequent discovery of the Aphrodite deposit (Cyprus Hydrocarbons Company, 2019) (Figure 14).

Preceding the drilling, a Geohazard Investigation survey took place at the eastern boundary of Block 12 covering an area of roughly 24 km x 11.9 km at approximately 1,700 metres of depth. The Geohazard survey was outsourced to Williamson & Associates[7] and the analysis of generated SSS, sub-bottom-profiler (SBP) and ROV seabed video-recording data were entrusted to Gardline Surveys, Inc[8] to carry out the relevant Geohazard assessment. The assessment of the datasets determined that the seabed of the Aphrodite prospect site 'is incised by an active, north-south oriented drainage channel located in the northeast portion of the study area, with the SSS data showing a channel of approximately 20 to 40 metres deep and 380 metres across in the north' (Noble Energy International Ltd, 2011, 50). Adjacent to that feature, an anomaly approximately 20 metres long and 3.5 metres wide was discovered and sequentially visually assessed by ROV and confirmed as an ancient shipwreck. The site was named by the DoAC 'Aphrodite-Noble' and represents the first ever UCH discovery made during the course of natural resource surveys (NRS) in the EEZ of Cyprus. The site was reported by Noble Energy

[6] For the definition of the term *Oil and Gas Archaeology*, refer to **Chapter 1**, page 7, footnote 4.
[7] For more information about Williamson & Associates follow the link, https://www.wassoc.com/ [accessed 03-01-2020].
[8] For Gardline Surveys Inc follow the link, https://www.gardline.com/ [accessed 03-01-2020].

in 2011 at 1714 metres with the exact coordinates of the site been withheld in this thesis due to confidentiality agreements signed between the author and the DoAC (Figure 14).

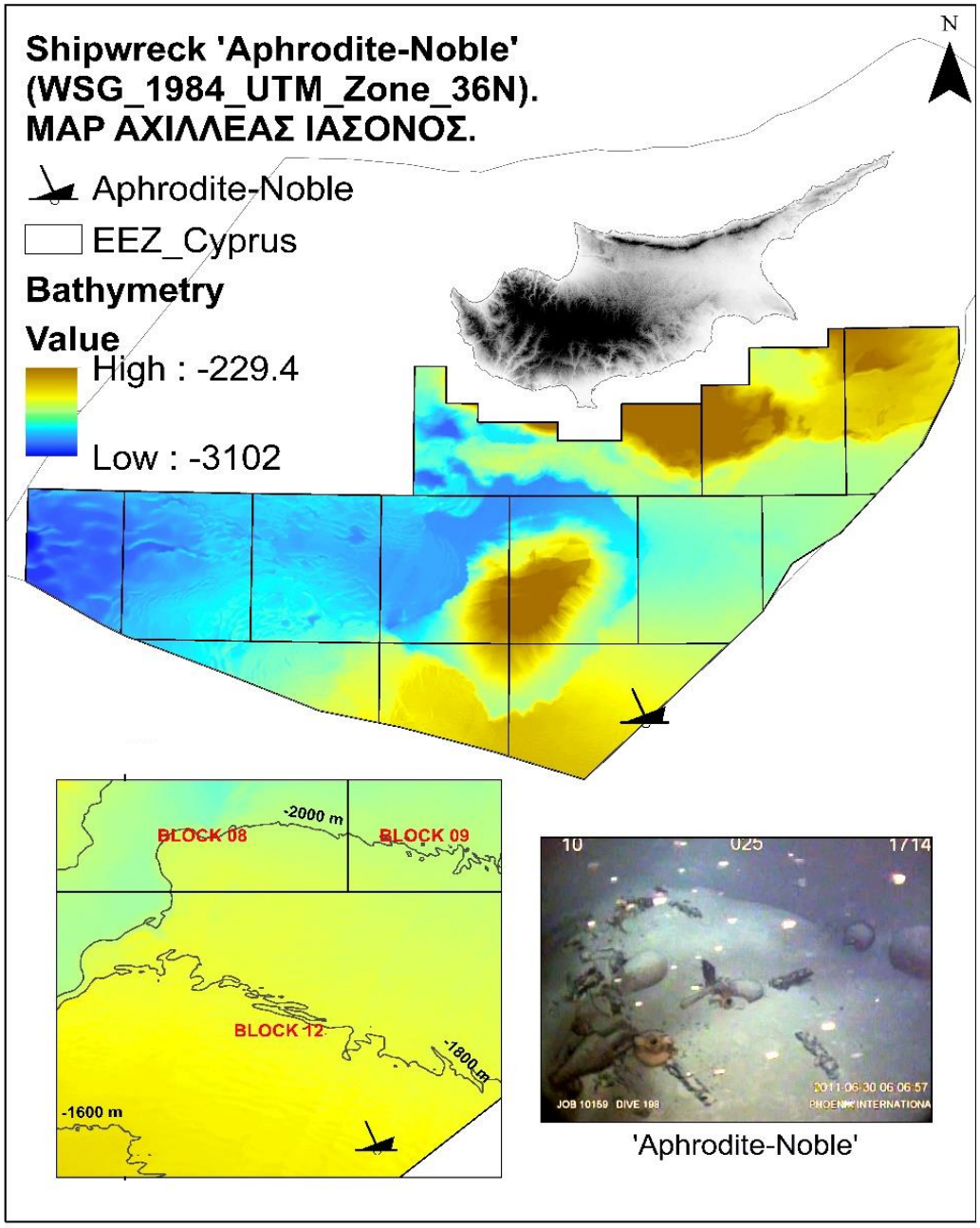


Figure 14: The exact location of the 2011 Noble Energy shipwreck discovery 'Aphrodite-Noble'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[4.4.1.1].ROV Video-Photography data and the site

The ROV video provides a glimpse of a submerged shipwreck site with intact amphorae of a non-homogeneous cargo. The site appears to be covered by sediment, resembling a mound-like

structure, where the protruding materials (mainly amphorae) can provide a tentative chronology for the ship. From a closer angle (figure 15), the upper exposed part of the mound presents the distribution of various amphorae, and probably the partly exposed outline of the ship's hull, covering an overall area of not more than 15 x 15 metres. In total, the ROV video indicates at least twenty amphorae that can be classified in to three wider groups. There is also a concentration of various other scattered materials that are at present unidentified. Most of the material culture appears to have spilled outside the wreck during its decomposition on the seabed and is distributed at both the port and starboard ends of the vessel, with a few protruding artefacts also appearing amidships. From additional images, it is fair to assume that alongside substantially more amphorae, elements of the hull and perhaps its rigging, as well as the ship's equipment, and crew objects still lie preserved *in situ.*



figure 15: The shipwreck site, cargo and hull-outline of 'Aphrodite-Noble'. Source: image © DoAC.

The preliminary analysis of the wreck was prepared by an anonymous maritime archaeologist and submitted to the General and Operations Managers of EDT Marine Construction[9] on the 23rd of August 2011. The report was later forwarded to the DoAC as Noble Energy International Ltd's (2011) *Archaeological Assessment of a Deep-water Shipwreck Site*

[9] For additional information about EDT Offshore refer to, http://www.edtoffshore.com/en/solutions-services/marine-construction [access 09-12-2019].

in Cyprus Economic Zone. It provides a preliminary analysis of 'Aphrodite-Noble' and gives account to the archaeological and cultural content of the site and contains a discussion of the ship's hypothetical trajectory, origin, and wrecking circumstances. It was based on 'three images taken by the ROV, concluding that 'Aphrodite-Noble' 'sank during the Late Roman period' (Noble Energy International Ltd, 2011, 3). The argument of the initial report acts as a starting point for the following study, which is based on the analysis of the entire ROV video of the site, the result of which is a more thorough identification of the amphorae types.

Prior to analysis of the ROV data, it is essential to note that the ROV video lacks resolution and detail, and that its duration is approximately three minutes. The lack of any detailed archaeologically appropriate survey of the site is due to it not being a necessary outcome of this survey, which was simply aimed at ground truthing the anomaly. Once it was clear that this was an ancient wreck, not endangering the drilling of the well, no further time, or money, needed to be spent on the site. As the aim was simply to investigate not to archaeologically record, the survey used out-dated video equipment with insufficient lighting and framed it poorly making interpretations extremely difficult. For example, thorough analysis of the datasets suggested that little effort was made to scientifically record the protruding amphorae or indeed any of the artefacts or the remains of the ship that could have provided vital information about the wreck. This technical and methodological observations are discussed in **Chapter 5**.

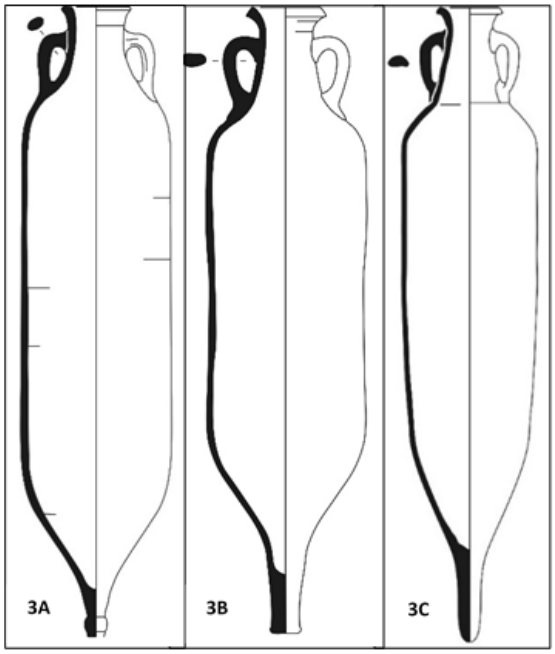
[4.4.1.2].The identification of amphorae of 'Aphrodite-Noble'

The following analysis creates a typology of amphorae from the wreck, based on image characteristics and description. Three specific amphorae types are represented in the ROV video and are presented in the Tables 2-4 underneath, which is supplemented in the following section by evidence related to how these conclusions were reached as well as additional information pertaining to the origins, distribution and exact chronology of each amphorae type.

Table 2: Observable features of **Amphorae Type 1** as seen in the ROV video dataset of 'Aphrodite-Noble' (see figure 16, page 139)		
Body-type:	Globular	
Base-type:	Rounded basalt point	
Neck-type:	Conical	
Handles in profile:	Bowed	
Rim-profile:	Everted	
Handles in section:	This feature is not observable	
Shoulder-type:	Bended	
Image source:	Archaeology Data Service. (2005). *Archives: Amphora: Late Roman Amphora 2.* https://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/details.cfm?id=239 [accessed 18/03/2019].	

Table 3: Observable features of **Amphorae Type 2** as seen in the ROV video dataset of 'Aphrodite-Noble' (see figure 17, page 141)		
Body-type:	Tapered	
Base-type:	Long hollow	
Neck-type:	Conical	
Handles in profile:	Arched	
Rim-profile:	Rounded	
Handles in section:	This feature is not observable	
Shoulder-type:	Rounded	
Image source:	Archaeology Data Service. (2005b). *Archives: Amphora: Kapitän 2: specimen.* https://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/zoom.cfm?id=154&img=307A0023 [accessed 18/03/2019].	

Table 4: Observable features of **Amphorae Type 3** as seen in the ROV video dataset of 'Aphrodite-Noble' (see figure 18, page 143)

Body-type:	Cylindrical	
Base-type:	Spike but also possibly tapered	
Neck-type:	This feature is not observable	
Handles in profile:	This feature is not observable	
Rim-profile:	This feature is not observable	
Handles in section:	This feature is not observable	
Shoulder-type:	Carinated	
Image source:	For image 3A: Archaeology Data Service. (2005c). *Archives: Amphora: Africana 3A: drawings*. https://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/drawings.cfm?id=208 [accessed 18/03/2019]. For image 3B: Archaeology Data Service. (2005d). *Archives: Amphora: Africana 3B: drawings.* https://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/details.cfm?id=309 [accessed 18/03/2019]. For image 3C: Archaeology Data Service. (2005e). *Archives: Amphora: Africana 3C: drawings*. https://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/details.cfm?id=310 [accessed 18/03/2019].	

[4.4.1.3].Amphora Type 1 Analysis

Amphora Type 1 (Table 2, figure 16) is distinguished by its plain rounded body shape (globular) and rounded-basal foot. The body appears to be decorated with horizontal straight lines. From additional images it was observed that the amphora has a short neck of conical shape gently linking with the shoulder (figure 16). The handles appear to have an irregular bowed profile, seemingly attached to the upper part of the amphora's neck just below the rim, connecting the handles with the shoulder. It has a short everted form of rim.

4.UNDERWATER CULTURAL HERITAGE DISCOVERIES IN THE EXCLUSIVE ECONOMIC ZONE OF CYPRUS

This description closely resembles the Late Roman 2 type amphora (LR2[10]) group (Opaiţ, 2004). According to Keay, the LR2 amphorae type dates from the 4th to the 7th centuries AD (Keay, 1984, 354). In this instance it is not possible to further narrow down the exact date of Amphora Type 1 as the subdivision of the LR2 type is primarily based on details such as the riling style, the rim, and the foot (Opaiţ, 2004). Unfortunately, these features are obscure on this amphora type from the video-record of 'Aphrodite Noble'.

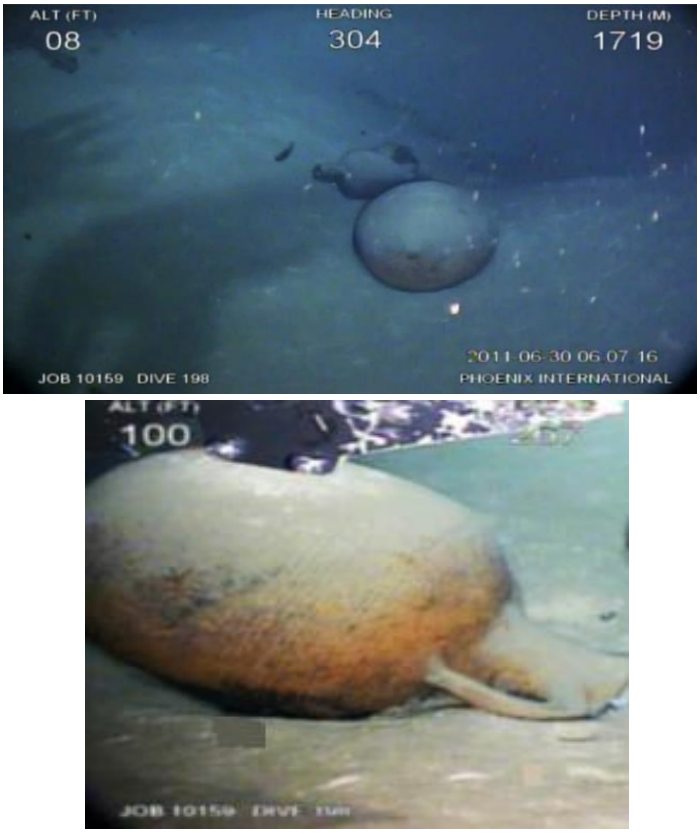


figure 16: Amphora Type 1. Source: image © DoAC.

[4.4.1.4].Additional information about Amphora Type 1

The origins of the LR2 type are known from workshops in the Aegean such as Chios, Cnidos, and Kounoupi in the Argolid (Munn, 1985; Swan, 2004). Given the bulk of evidence around the LR2 type, other production centres are possible, but are yet to be discovered (Munn, 1985). In addition, a lack of publications from the northern Balkans obscures our knowledge about additional potential workshop centres in this area. Nevertheless, a wider distribution network has been hypothesised for the LR2 type with scholars such as Dyczek giving an account of a network ranging from Asia Minor, Syria, and Britain, with additional significant concentrations

[10] It is worth recognising that the LR2 term is the most popular one today, and will be used for the purpose of this study, as it also encompasses additional amphorae classes identified by specialists in the field in the past such: Class 43 (Peacock and Williams, 1986) / Keay LXV (Keay, 1984, 354) / Benghazi Late Roman Amphora 2 / British B1 / Kuzmanov 19 / Scorpan 7A (Archaeology Data Service, 2005).

in Spain, Egypt, the Middle East, Greece, Tunisia, and Turkey (Dyczek, 2001). Adding to the literature, Olga Karagiorgou suggests that the LR2 type was equally present in the north Balkans as in the Aegean or elsewhere in the Mediterranean Region (Karagiorgou, 2001).

Even though the distribution of the LR2 type seems to be quite broad, shipwreck sites with predominantly LR2 amphorae cargo are few. For instance, there is a substantial presence of LR2 amphorae in wreck sites, such as the much-discussed Yassiada shipwreck (Carlson, et al, 2015) and other less-known sites such as the 2008 Chios project (Theodoulou, et al, 2015) and the Joni wreck off the Albanian coast (Stratton, 2014). Unfortunately, the limited maritime evidence belies the widespread terrestrial distribution of LR2. With regards to their usage, analysis from these sites have concluded that LR2 amphorae contained both olive oil and wine, although this excludes the possibility of them being used to transport foodstuff such as picked olives (Opaiţ, 2004).

Given the discussion above, it is likely that Amphora Type 1 dates roughly from the 4th to 7th centuries AD and is an example of an LR2 amphora (Table 2 and figure 16). This takes into consideration clearly observable characteristic features including the general globular outline of the vessel, the rounded basal point, and the horizontal riling. Based on this, the chronological scope of the wrecking event can now be narrowed from a general Late Roman/Early Byzantine date to between the 4th to the 7th centuries AD.

[4.4.1.5].Amphora Type 2 Analysis

Amphora Type 2 (Table 3, figure 17) presents distinct characteristics with regards to its body-outline and shoulder-area, whereas features such as base-type, neck, and handle profile are more difficult to discern. From figure 17, it can be argued that Amphora Type 2 has a tapered body shape, resembling that of a reverse cone. The profile of the amphora narrows towards the bottom, tapering gently into a long hollow foot. The outline of the amphora is defined at the

shoulder where it creates a rounded collar. The neck of the vessel appears to be conical and the handles emerge as long/vertical, resembling an arch.



figure 17: Amphora Type 2. Source: image © DoAC.

It can consequently be suggested that Amphora Type 2 presents characteristics similar to the Kapitän 2[11]. Chronologically, the Kapitän 2 class of amphora have been suggested by Paczynska and Naumenk to occur throughout the 2nd and 4th centuries AD (Paczynska and Naumenk, 2004, 298); however, its size and distribution shrinks by the mid-3rd century AD, peaking again at the beginning of the 4th to mid-4th century AD, with the latest known example of Kapitän 2 dating to the early 5th century AD from the Athenian Agora (Dyczek, 2001).

[4.4.1.6].Additional information about Amphora Type 2

The nature of the clay inclusions in the Kapitän 2 class suggests manufacturing centres in the Aegean, perhaps on the islands of Samos and Kos, without excluding the possibility of an additional workshop on the island of Rhodes (ibid). In terms of distribution, Kapitän 2 has been recorded all over the Roman Empire, with a significant concentration in the Mediterranean, in

[11] It is worth recognising that the Kapitän 2 term is the most popular one today, and will be used for the purpose of this study, as it also refers to additional amphorae classes identified by specialists in the field in the past such: Benghazi Mid Roman Amphora 7 / Hollow Foot Amphora / Kuzmanov 7 / Niederbieber 77 / Ostia 6 / Peacock & Williams 47 / Zeest 79 (Archaeology Data Service, 2005b).

Sicily, Ostia, Thebes, Athens, Corinth, and Knossos, as well as Palestine and Iraq (ibid). This implies that this amphora class occurs more frequently in the Aegean and the eastern Mediterranean but less so in the west (Negru, et al, 2003). When looking at the record of shipwreck sites containing Kapitän 2, however, this is not necessarily the case. Only eight shipwreck sites are listed in the database of shipwrecks available from the *Oxford Roman Economy Project* (Strauss, 2013), representing mainly the central and western Mediterranean Seas and the Aegean. Furthermore, studies on amphorae from Roman Dacia (modern eastern and south-eastern Transylvania) revealed additional evidence for Kapitän 2 along the Roman 'river-roads' of the Danube (ibid), hence suggesting that this amphora type was subject to transportation both by sea and river. The presence of examples of Kapitän 2 in Dacia at Roman military camp sites (ibid), suggests that it was mostly used to transport wine or other foodstuff along the Roman *limes* (Oleson, et al, 1994).

It can be suggested that Amphora Type 2 from 'Aphrodite Noble' are Kapitän 2. Importantly, it coexisted with LR2 amphora (Amphora Type 1) for a period of at least a century, approximately around the 4th century AD. Based on this, it is feasible to suggest a narrower chronological scope for the wreck of 'Aphrodite-Noble' to approximately the mid-4th century AD. The presence of Kapitän 2 in the open seas of the eastern Mediterranean, marks the wreck as a find of ample archaeological importance as it introduces new evidence in understanding the transportation and distribution patterns of the Kapitän 2 class in the Levant in the contexts of both trade and possibly military supply.

[4.4.1.7].Amphora Type 3 Analysis

With a chronological framework for the wrecking event set roughly around mid-4th century AD, it is now feasible to move into more hypothetical territory and attempt to identify an amphora which demonstrates fewer observable characteristics. Amphora Type 3 (Table 4, figure 18) has only three observable features, the body-type, shoulder-type, and the base-type, which make

the task of identification rather daunting. Nevertheless, it is possible to note that Amphora Type 3 has a cylindrical body with a distinct elongate spike/tapered toe. The shoulder area appears to form possibly a carination, but it is only vaguely distinguishable, mainly because other objects and sediment obscure the view (figure 18).

The observable features of Amphora Type 3, notably the substantial spike/tapered foot and the cylindrical body-shape, point towards a single but broad amphora class, the Africana 'contenitori cilindrici della tarda età imperiale' (cylindrical containers of the Late Imperial period), also known as Keay Type 25. This is a typological group that, according to Keay, coexisted with the 'Africana Grande' series, but predates the larger cylindrical African amphorae of the later 5th and 6th centuries AD, and dates to the 3rd to 4th centuries AD. Keay identified 30 sub-variants of this type (Keay, 1984), gathering the



figure 18: Amphora Type 3. Source: image © DoAC.

most common variants into three main groups, Africana types 3A[12], 3B[13] and 3C[14] (Table 3, and figure 17). Unfortunately, due to the poor quality of the imagery, identifying the exact group and variant for Amphora Type 3 is impossible as the example from the wreck is buried in sediment around the shoulder and the foot does not seem to present any additional detailed characteristics. Additional variables enhancing the issue emerge from the fact that the typologies of Africana 3A, 3B and 3C are considered very much compatible in their general outline, with only minor differentiations at the foot, rim, handles, and neck areas. Consequently, it is sufficient here to simply suggest that Amphora Type 3 is likely that of the Keay 25 general category/type.

[4.4.1.8].Additional information about Amphora Type 3

Identifying the origins of Africana 3A, 3B, and 3C is not yet possible, mainly because the archaeological record gives a sparse account of stamp data on these types, while at the same time no kiln-sites have been reported. On the other hand, the general literature identifies the Africana class 3A, 3B, and 3C as originating from Tunisia, with Bonifay suggesting coastal production centres at Nabeul and Carthage. Additional evidence based on the survey work of Bonifay suggest that additional workshop areas might be seen at Byzacena (modern central Tunisia) (Bonifay, 2004) and Algeria (Royal, 2012). In broader terms, the distributions of these types varies greatly, occurring in larger quantities in the western Mediterranean, including the south-eastern and northern Spain and western Italy. Adding to the archaeological record, evidence of Africana 3A, 3B, and 3C were also noted in southern France at Marseilles and Arles

[12] It is worth recognising that the Africana types 3A term is the most popular one today, and will be used for the purpose of this study, as it also refers to additional amphorae classes identified by specialists in the field in the past as Keay 25.1 (Archaeology Data Service, 2005c).
[13] It is worth recognising that the Africana types 3A term is the most popular one today, and will be used for the purpose of this study, as it also refers to additional amphorae classes identified by specialists in the field in the past as Keay 25.3 (Archaeology Data Service, 2005d).
[14] It is worth recognising that the Africana types 3A term is the most popular one today, and will be used for the purpose of this study, as it also refers to additional amphorae classes identified by specialists in the field in the past as Keay 25.2 (Archaeology Data Service, 2005e).

(ibid). With regards to their usage, unfortunately, there are no consistent data on the principal contents of Africana 3A, 3B and 3C types with them being used as wine transporters and also for other liquid-goods such as garum (Archaeology Data Service, 2005c; Archaeology Data Service, 2005d; Archaeology Data Service, 2005e).

In the context of shipwreck-sites, the Africana classes 3A, 3B, and 3C were reported from the Eloro A wreck off the southeast coasts of Sicily, and the Pain di Spille wreck off the Tuscan coast of Italy, as well as the Joni wreck off Albania and the Yassiada wreck off Turkey (Carlson, et al, 2015). Further data from the *Oxford Roman Economy Project* accounts for an additional twenty examples of shipwrecks containing Keay 25 amphorae; eleven are off the coast of France (such as Dramont, Heliopolis and Pampelonne), four are off the coast of Italy (such as Capo Colonna and Punta dell Arcena) and five were found between Sicily, Sardinia, and Tunisia at the Skerki bank reef (Strauss, 2020b; 2020c; 2020d). It has been suggested that Amphora Type 3 is a Keay 25, but that the subcategory cannot be identified due to the obscure visual representation of the amphora in the ROV data. Nevertheless, the presence of an example of this type on the 'Aphrodite Noble' represents one of the few, if not the only, example discovered so far in the open seas of the eastern Mediterranean. If this is the case, this may be a rare scenario where 'Aphrodite-Noble' has the potential to further develop our understanding about the distribution patterns of the Africana classes in the Levant Sea.

[4.4.1.9].Other unidentified artefacts

The ROV video provides views of additional artefacts, which unfortunately cannot be identified. For instance, there is another amphora type which seems to demonstrate distinctly different features from the rest of the analysed cargo. Despite its intact state, drawing interpretations with regards to its structural characteristics or even promoting a hypothetical classification seems a rather optimistic task. This is because Amphora Type 4, (figure 19) does not reveal any distinct characteristics, or any outstanding features that could point towards a

general typological group. Unfortunately, the ROV video only provides a very fragmentary image of an amphora that might have a rounded basal-point, spike-tapered, or knobbed foot; features which appear to be equally possible 'candidates'. The profile of the rim appears to be everted, but that might also be an optical illusion, or the potential over interpretation of the author. Other features such as the shoulder area and handles are completely obscure. Thus, identifying a type for Amphora Type 4 is not possible with the state of current data.



figure 19: Amphora Type 4. Source: image © DoAC.

An additional unidentified artefact includes a wheel-ridged storage jar of cylindrical shape, consisting of a short neck and a pointed toe, without handles. Potentially this could be a relatively small pithos jar (figure 20). This speculative scenario gains validity when considering that other nearby deep sea shipwreck sites from the EEZ of Cyprus were carrying such ceramic vessels (i.e. section 'Eratosthenes C' wreck, pages 125-126) (Ballard, et al, 2017).



figure 20: A storage jar probably small pithos. Source: image © DoAC.

4.UNDERWATER CULTURAL HERITAGE DISCOVERIES IN THE EXCLUSIVE ECONOMIC ZONE OF CYPRUS



figure 21: Two roof tiles, potentially reflecting the remains of an on-board structure and other additional unidentified artefacts. Source: image © DoAC.

Due to the deep sea nature of the site, there is a good possibility of structural preservation, especially when it is considered that 'Aphrodite-Noble' is situated in an area which is far from commercial fishing activities. Therefore, this reinforces what is already generally known in the sub-discipline of maritime archaeology: the inaccessible nature of deep sea wrecks contributes towards creating ideal preservation conditions. This statement can be demonstrated when looking at figure 21, where two roofing tiles of substantial size appear to still lie *in situ.* The presence of them reinforces the chronology of the wrecking event (around the 4th century AD) posited here, as this kind of material was more regularly shipped during the Late Roman/Early Byzantine period (Carlson, et al, 2015; Rieth, 2015). Furthermore, the rooftiles arouse speculations about potential structural elements of the vessel since it is known that roof tiles were used for covering small cabin structures (ibid). If this is the case, it is fair to assume that the shipwreck site of 'Aphrodite-Noble' maintained its structural integrity while sinking. This suggests that evidence of on-board structures might be preserved in a relatively intact state under the sediment.

[4.4.1.10].Conclusion: 'Aphrodite-Noble'

The ROV video provides a rare but fragmentary glimpse of a Late Roman/Early Byzantine (4th to 7th centuries AD) eastern Mediterranean sea-going ship. It is important to acknowledge, however, that the ROV survey does not 'live-up' to academic standards. This is mainly due to the use of outdated equipment, and the overall problematic recording, which created difficulties

in identifying the amphora type that make up the cargo of the vessel. In addition, the absence of a proper survey methodology means that the ROV data are unusable beyond their raw formatting. For example, the flight tracks and video recordings were not undertaken in a systematic and overlapping way that would have allowed the creation of an orthomosaic/photomosaic model(s), thereby limiting our overall potential to fully understand the shipwreck site. For information pertaining to the technical and methodological analysis of the ROV video-photography dataset of 'Aphrodite-Noble' refer to **Chapter 5**, section: Insights into ROV Video-Photography data generated during oil and gas activities, pages 191-200.

According to the cargo analysis, it is possible to suggest that the wrecking event of 'Aphrodite-Noble' took place at some point during the Late Roman/Early Byzantine period around the mid-4th century AD, perhaps slightly later. The location of the site (Figure 14, page 134) and the non-homogeneous cargo implies that the vessel undertook a long-distance voyage stopping at various places of the Mediterranean Sea along the Levant, Cyprus, and the Tunisian coasts (Figure 22). This is possible only if one accepts that each of the identified amphora types was loaded on the wreck from the relevant place of origin. Alternatively, it can be speculated that amphorae were laded from three wider distribution areas: the Aegean, Algerian, or Tunisian coasts at a single location such as an *emporium* most likely in the eastern Mediterranean. The presence of Kapitän 2 and Keay 25 amphorae on 'Aphrodite-Noble' adds new information regarding the distribution patterns of these Late Roman amphora types, whilst at the same time providing an account of a hypothetical explanation regarding the character of the shipwreck site. For instance, the presence of Kapitän 2 on the shipwreck with its links to Roman military supply (Dyczek, 2001; Negru, et al, 2003; Oleson, et al, 1994) could suggest that 'Aphrodite-Noble' was transporting goods such as wine, olive oil, and garum for the Roman *limes* of the middle east (*Limes Arabicus*).

4.UNDERWATER CULTURAL HERITAGE DISCOVERIES IN THE EXCLUSIVE ECONOMIC ZONE OF CYPRUS

From this preliminary evaluation of the site, it is clear that it has the potential to be of great archaeological and scientific value: the whole ship potentially sank in a relatively short time, and most of the cargo and the non-floating artefacts still lie *in-situ*, 'protecting' the ship's hull, thus reinforcing the general perception that 'deeper lying wrecks are in better condition' (O'Keefe, 2002, 2). This is largely because immense depths provide protection from commercial fishing activities, and prohibit diving, while environmental parameters such as low temperatures, mild chemical reactions, and the absence of currents, recreate an ideal environment for *in situ* preservation (ibid; Oxman, 1988; UNESCO, 2019).

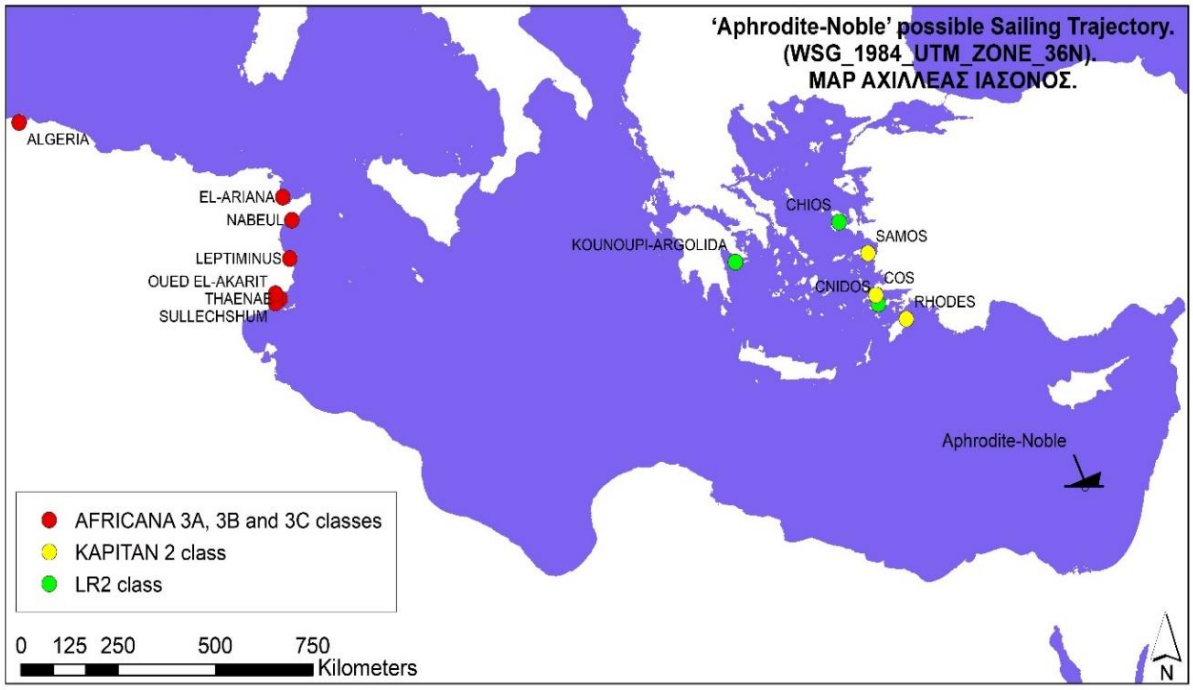


Figure 22: The origins of the identified amphora in relation to the shipwreck site of 'Aphrodite-Noble'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[4.4.2].The shipwreck site of 'Eratosthene-Eni'

In 2016, the Government of the Republic of Cyprus announced the 3rd Hydrocarbons Licencing Round, awarding Block 8 to ENI and as part of this agreement wells were expected to be drilled between 2017-2019 (Cyprus Hydrocarbons Company, 2019). The 'Eratosthenes South' prospect area was determined and an Environmental Baseline Survey (EBS) took place at the south-eastern part of Block 8, some 10 km from the foothills of the Eratosthenes Seamount covering an overall surface of approximate 45 km^2 at a minimum distance from the coastline of approximately 105 km (ENI Cyprus LTD, 2017). This surveys were outsourced to Lighthouse S.p.A.[15] and data of MBES without backscatter-data, SSS, SBP and ROV seabed video-recording datasets were produced (Woods Hole Coastal and Marine Science Centre, 2019; Burguera and Oliver, 2016; Woods Hole Oceanographic Institute, 2019). The bathymetry of the area ranges from 1,817 to 2,250 metres and is characterised by the presence of a series of elongated ridges and steep slopes (>13°) of clayey-sandy silt and silty-sandy clay (ENI Cyprus LTD, 2017). The analysis of SSS data revealed a mount-anomaly of approximately 20 metres in length and 3 metres width. The anomaly was visually assessed by an ROV and was reported by ENI in 2017 to be an ancient shipwreck site at roughly 1,909 metres of depth (Figure 23). The shipwreck site was named by the DoAC 'Eratosthene-Eni' and represents the second ancient shipwreck discovery made during the course of NRS in the EEZ of Cyprus.

[4.4.2.1].ROV Video-Photography data and the site

The ROV video of the site of 'Eratosthene-Eni' shows at least 60 intact, partially exposed amphorae of a largely homogenous cargo of what appears to be an ancient merchant vessel. The dataset shows the two top stacks of amphorae, positing that additional rows of amphorae and possibly the wreck's hull is still preserved *in situ* buried under the sediment and cargo.

[15] For more information about Lighthouse S.p.A. visit the website, https://www.lighthouse-geo.com/ [access 09-12-2019].

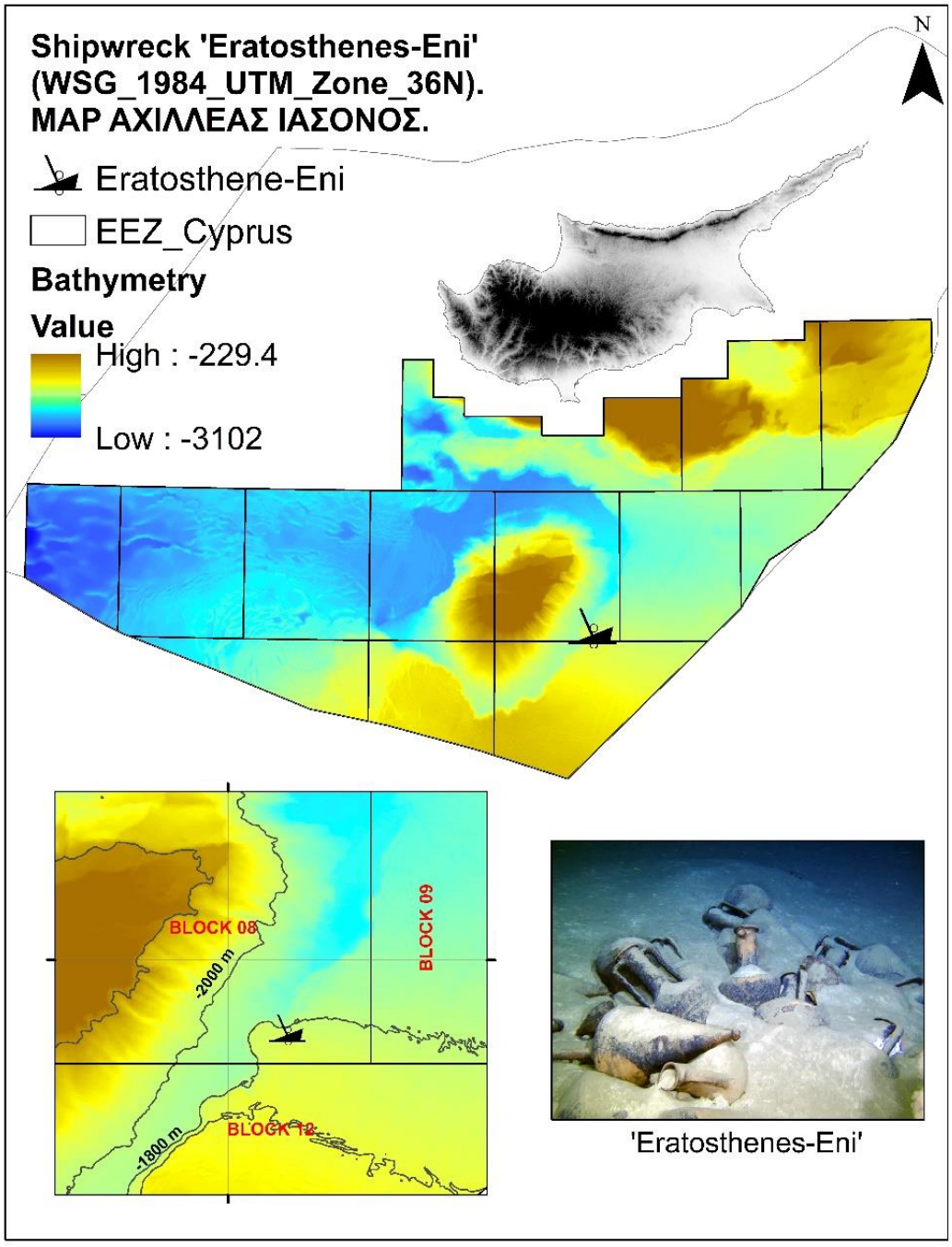


Figure 23: The exact location of the 2017 ENI shipwreck discovery 'Eratosthenes-Eni'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

The amphorae are shown in the ROV video from various angles, with two types being observable (figure 24). The dimensions of the site that was visually assessed with the ROV appears to cover an area of approximately of 7 x 2 metres, with an overall elevation of approximately 1.5 metres from the seabed. The wreck's cargo is predominately composed of

Amphorae of Type 1 (Table 5, page 153) with the exception of one amphora with different characteristics (Table 6, page 154).

Based on preliminary discussions at the DoAC deriving from the analysis of the ROV video of ‘Eratosthene-Eni’, it was suggested that the cargo of the wreck probably dates to the early Hellenistic period. In the absence of information/data regarding amphorae stamps, it was agreed that the best possible way to identify more precisely the amphorae cargo of the wreck would be to follow amphorae classification schemes based solely on the amphorae shape and form (ENI Cyprus LTD, 2017).



figure 24: The wreck site of ‘Eratosthene-Eni’ as recoded by ENI’s subcontractor company Lighthouse S.p.A., with the image displaying two sets of different amphorae types. Source: image © DoAC.

As a general note, the ROV video of the wreck is problematic as it was clearly undertaken in haste without a methodological approach to the survey of the site itself and the debris field. This is because the visual inspection of the wreck-site was not carried out with archaeological intentions in mind, but rather to fulfil the commercial obligations and identify

the survey anomaly as a wreck site. As a result of any by-standards to define an archaeologically appropriate survey strategy, the site was not entirely documented and only surveyed for 30 seconds. Consequently, valuable archaeological information is missing, which unfortunately diminishes our chances to fully understand this rare shipwreck site that engaged into long-distance trade. The ROV video-photography datasets of 'Eratosthene-Eni' are discussed and future examined in **Chapter 5**, with an orthomosaic model of the site presented at Figure 38, page 197.

[4.4.2.2].The identification of amphorae of 'Eratosthene-Eni'

The following analysis seeks to identify the types of amphorae recorded from the wreck of 'Eratosthene-Eni'. The analysis of the ROV video suggested two amphorae types are present and are shown in Tables 5 and 6. These are followed by a discussion of how these conclusions were reached as well as additional information pertaining to the origins, distribution and exact chronology of each amphorae type.

Table 5: Observable features of **Amphora Type 1** of 'Eratosthene-Eni' as seen in the ROV video dataset (figure 24, page 152)

Body-type:	Tapered	
Base-type:	Hollow Button-shape foot also knowns as "dunce-capped" toe	
Neck-type:	Long Cylindrical	
Handles in profile:	Long and Vertical	
Rim-profile:	Mushroom-rim	
Handles in section:	This feature is not observable	
Shoulder-type:	Carination	
Image source:	Palamida, Ch., Seroglou, F. K., Lawall, L. M., and Yiannikouri, A. (2016). The Emergence of Hellenistic Transport Amphoras: The example of Rhodes. In Japp, E., and Kogler, P. (eds.) *Traditions and innovations: Tracking the development of pottery from the later Classical to the Early Imperial periods. Proceeding of the 1st Conference of IARPotHP Berlin, November 2013, 7th-10th*. 135-150. Österreich: Wien.	

Table 6: Observable features **Amphora Type 2** of 'Eratosthene-Eni' as seen in the ROV video dataset (figure 24, red square, page 152)		
Body-type:	Tapered. Overall, the amphora seems to be substantially smaller than Amphorae Type 1	
Base-type:	This feature is not observable	
Neck-type:	Relatively long Cylindrical (shorter than Amphorae Type 1)	
Handles in profile:	Short-topped and broad	
Rim-profile:	Mushroom rim	
Handles in section:	This feature is not observable	
Shoulder-type:	Carination	
Image source:	Grace, V. (1971). Samian amphoras. *Hesperia* 40:1, 52-95.	

[4.4.2.3].Amphora Type 1 Analysis

Amphora Type 1 is seen in the ROV video from various angles revealing all of its diagnostic features: a mushroom-shaped rim and an elegant long cylinder-shaped neck of what appears to be a vessel of substantial height and size. The conical outline of the amphora is defined at the shoulder area, where it appears to form a distinct carination, giving a sense of an amphora type of a 'reverse cone shape', tapering gently into a stemless, hollow button-shaped foot (Monachov, 1995) (figure 24 and Table 5). Handles, when they appear in profile in the video are long and vertical, seemingly attached just below the rim area, connecting the handles with the upper part of the shoulder.

The description of Amphora Type 1 is that of a proto-Rhodian amphora type, first identified by Virginia Grace in her article *Notes on the Amphoras from the Koroni Peninsula* as proto-Rhodian type 5 (Grace, 1963, 323). According to Grace, this type of amphora belongs to the 'period before a single style of the later Rhodian amphora had been settled upon' and most probably dates from the end of the 4th century BC, finishing roughly in the third quarter

of the 3rd century BC (ibid., 322; Monachov, 1995). Rhodian amphorae were produced throughout the Late Classical and Hellenistic periods and in the absence of information or data on stamps, they were further classified based on their form and shape. For instance, Monachov in his article *Rhodian Amphoras: Developments in Form and Measurements*, classified proto-Rhodian amphorae 'as long-necked (type 1) and short-necked (type 2)' and argued that they were subject to constant modifications and experimentation and 'best adaptation', of which the rejected ideas were replaced by the 'winning model'. Based on this, he revaluated Grace's classification scheme and established a more secure chronology for the proto-Rhodian amphorae group, positing that VARIANT I-A (equal to the Grace's proto-Rhodian type 5 amphora) dates to the 300 – 280 BC (Monachov, 1995, 72; Palamida, et al, 2016, 135).

[4.4.2.4].Additional information about Amphora Type 1

The proto-Rhodian type 5/Rhodian VARIANT I-A amphorae are primarily associated with the Kyrenia wreck (Figure 25) since it is the single largest, partially intact, almost-homogenous deposit of this amphora type so-far discovered. Furthermore, amphorae of the same type were also recorded in 1987 from the wreck site of the El Sec Mallorca in Spain. Parker in his shipwreck catalogue *Ancient Shipwrecks of the Mediterranean and the Roman Provinces*, mentions an additional 21 shipwreck sites containing Rhodian amphora (Parker, 1992, 17). These discoveries, alongside new scientific



Figure 25: The proto-Rhodian type 5/VARIANT I-A amphorae, found at the Kyrenia shipwreck. Image taken at the Kyrenia museum storage room. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

studies on the content of these amphorae using residue analysis have revealed that proto-Rhodian type 5/Rhodian VARIANT I-A amphorae were used predominantly as wine transport containers, with the possibility of them also being used for the transport of foodstuff and other liquids such as olive oil (Katzev, 1969). Moreover, analysis of amphora stamps carried out in the second half of the 20th century, in which names and initials on amphorae were interpreted to signify the eponyms of the producer and the associated manufacturing centre(s), suggested that proto-Rhodian type 5/Rhodian VARIANT I-A amphorae were linked explicitly with the island of Rhodes (Cankardeş-Şenol, 2015).

[4.4.2.5].Amphora Type 2 Analysis

Amphora Type 2 (Table 6, figure 24, red square) is only partially visible in the ROV data, although there is sufficient evidence to illustrate characteristics different to those of Amphora Type 1. For instance, Amphora Type 2 seems to be substantially smaller in size and most probably has a broader body and short neck with broad handles. Features such as the mushroom shape rim, and the relatively elegant long cylinder-shaped neck stand out, revealing features similar to the Samian amphorae type such as those found at the Kyrenia wreck. The main body of the amphora is buried in the sediment, however, it appears to form a distinct carination at the shoulder area giving the sense of an amphora of globular shape. Given the limitations in the dataset, the exact identity of this amphora type can only be speculated upon.

Amphora Type 2 possesses characteristics similar to those mentioned in Grace's article on *Samian Amphoras* where they are said to consist of a 'mushroom rim, handles that were short-topped and broad in proportion (rather than roundish in section), neck and handles much shorter than on the accompanying early Rhodian jars, and the neck tapering slightly to the shoulder (whereas on the Rhodian the neck spreads to the shoulder)' (Grace, 1971, 78-79). The toe of the Samian amphorae presents characteristics that are mostly consistent and has been described by Grace as a bevelled knob.

Samian amphorae have a profile quite different from the proto-Rhodian amphorae, but nevertheless, according to Grace both types share some similarities in their production and general assortment of shapes (Grace, 1963). In this respect, she argued that these two amphora types date roughly to the third quarter of the 4th century BC (300 – 275 BC) and were produced approximately during the same period with proto-Rhodian type 5/Rhodian VARIANT I-A amphorae (Grace, 1971; Monachov and Rohov, 1990). More recent archaeological data resulted in the proposal of a more secure chronology for Samian amphorae, with Monachov and Rohov arguing that Samian, or as they called them Type Solokha I amphorae (which can be equated with Amphora Type 2 found in 'Eratosthene-Eni') 'do not go beyond the limits of the mid-third quarter of the 4th century BC' (Monachov and Rohov, 1990, 140).

[4.4.2.6].Additional information about Amphora Type 2

Further explanations as to why both proto-Rhodian type 5/Rhodian VARIANT I-A amphora and Samian/Type Solokha I date to the same period were proposed by Monachov and Rohov, who argued that these two types are uniform in their origin and that 'part of them may be considered to be a product of Rhodes and part of Samos' (Monachov and Rohov, 1990, 139-140). This, however, does not exclude the possibility of them been produced on Naxos and Paros also (ibid). According to Demesticha and Whitbread this ambiguity regarding the origins of Samian/Type Solokha I is due to the absence of specific kiln sites, thus leaving the production centres for a considerable proportion of these containers so far undetermined (Demesticha, 2010; Whitbread, 1995; Carlson, 2006). Parker mentions that Samian amphorae were reported from twenty shipwreck sites from the Aegean islands (i.e. Chios and Thasos), North Africa (Tunisia), and the Italian coast (Parker, 1992). More specifically, in Cyprus Samian/Type Solokha I amphorae were recorded on the Mazotos and the Kyrenia wrecks and are attributed primarily to the island of Samos, although this should not exclude the possibility of links with the island of Paros and Asia Minor more broadly (Demesticha, 2010; Harpster, 2012).

Interpretations regarding their usage were mentioned on Harpster's website *The Kyrenia Shipwreck Collection Restoration Program*, where he states that Samian amphorae from the Kyrenia wreck contained foodstuffs with Grace arguing that 'the contents of the Samian shipping container were not wine but oil' (Harpster, 2012; Grace, 1971, 79).

[4.4.2.7].Conclusion: 'Eratosthene-Eni'

The analysis presented here gives account to the archaeological information deduced from the ROV video of 'Eratosthene-Eni' and reflects the input of amphorae specialists from the DoAC, at the University of Oxford and the author. The chronology of the wreck derives solely from the analysis of the wreck's amphorae cargo and suggests that 'Eratosthene-Eni' sank during the third quarter of the 4th century BC (300 – 275 BC) or slightly later. The evidence from the ROV video suggests that the visible portion of the cargo is largely homogenous containing predominantly proto-Rhodian type 5/Rhodian VARIANT I-A amphorae and one Samian/Type Solokha I amphora. The presence of both amphorae types reinforces a possible scenario in which 'Eratosthene-Eni' may have carried a similar cargo along a similar trajectory to the Kyrenia ship. By examining the cargo of 'Eratosthene-Eni', it can be suggested that Rhodes [or possibly Samos] was the home port of the vessel, if we accept that the amphorae were loaded at the relevant place of origin (Figure 26). While the cargo of the wreck may have been loaded from anywhere in the eastern Mediterranean or the Aegean Seas, Rhodes was a major *emporium*

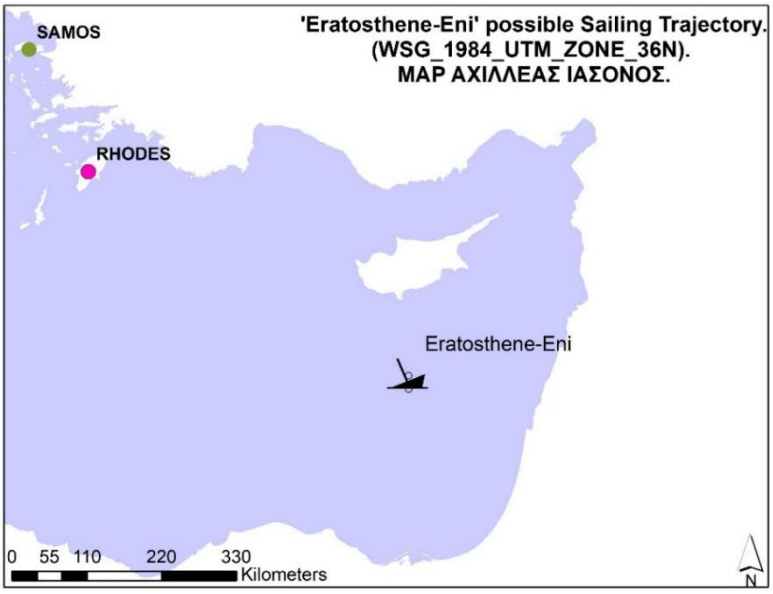


Figure 26: The hypothetical sailing route of 'Eratosthenes-Eni'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

and maritime power at this time, and it is probable that the ship was laded there. Based on the analysis of the wreck's cargo it can also be stated that 'Eratosthene-Eni' was most probably transporting wine, olive oil and perhaps other foodstuffs. From its location almost half-way between Cyprus and Egypt, it is also possible to suggest that the ultimate location for the vessel would have been the rapidly developing port of Alexandria at this time. This close relationship is clearly seen in the large numbers of Rhodian amphora found there, with perhaps 'Eratosthene-Eni' being situated along this important ancient sea route (Arnaud, 2005b; Şenol, 2018). This statement is discussed underneath: Discussing the Deep Sea archaeology of Cyprus, pages 172-180.

4.UNDERWATER CULTURAL HERITAGE DISCOVERIES IN THE EXCLUSIVE ECONOMIC ZONE OF CYPRUS

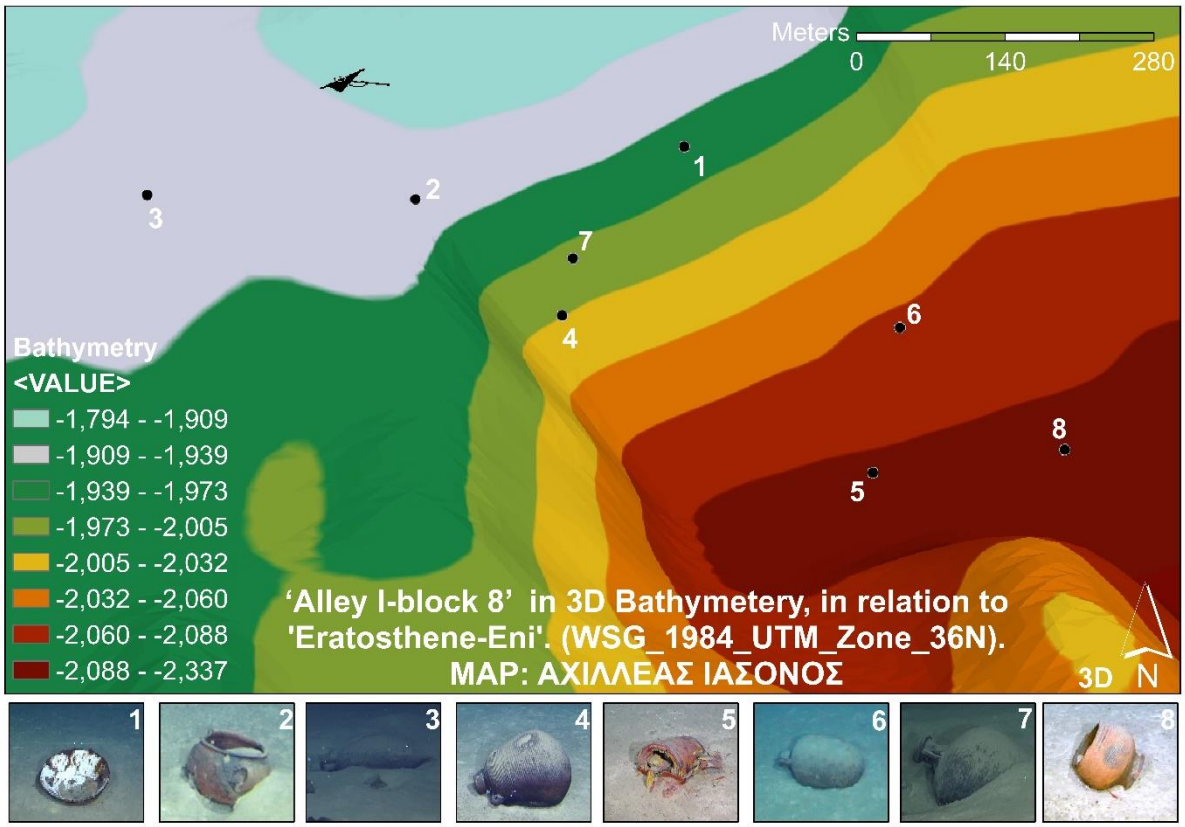


Figure 27: The linear trail of 'Alley I-block 8' of eight scatter materials, extending approximately 1.6 km. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[4.4.3].The Amphorae 'Alley I-block 8' site

Alongside the shipwreck discovery of 'Eratosthene-Eni', the 2017 EBS survey of Lighthouse S.p.A., revealed a linear scatter of approximately eight archaeological objects, including amphorae, cooking pots and other unidentified materials (Figure 27). The artefacts were surveyed in an area of less than 2 km from the shipwreck site of 'Eratosthene-Eni', at depths varying from 1909 to 2377 metres and were noted along a southeast axis (Figure 27). The trail of scatter materials is roughly 1.6 km long, with each artefact roughly 150 to 300 metres from each other. The following analysis seeks to provide a detailed assessment of all the noted scatter materials of 'Alley I-block 8' to provide interpretations about this group of artefacts and their relationship to the shipwreck site of 'Eratosthene-Eni'. It is worth mentioned that the presented area of Figure 27 was visual assessed in its' entirety, with Lighthouse S.p.A. stating that the ROV survey was conducted on a predetermined line-path. This means that the linear

distribution of scatter materials is not the result of the ROV's line path but rather how these finds were surveyed *in situ*.

From a total of eight scattered artefacts, three remain unidentified either because their diagnostic features are covered by sediment or they are preserved in a fragmentary state. Figure 28 illustrates all noted unidentified materials, which correlates to objects 5, 7, and 8 in Figure 27. Figure 28-A is a poorly preserved ceramic artefact. Figure 28-B, seems to represent a partly preserved amphora, or a cooking pot chipped around the rim area. Figure 28-C shows an intact amphora with an ovoid outline, consisting of a rounded rim and short vertical handles. The neck of the amphora appears to be disproportionately short and narrow in relation to its overall size, possibly displaying similarities to a Late Roman 6 (LR6) type. Drawing an absolute conclusion, however, in this instance is not possible, mainly because the foot area is covered by sediment and also due to the angle from which the artefact was recorded.

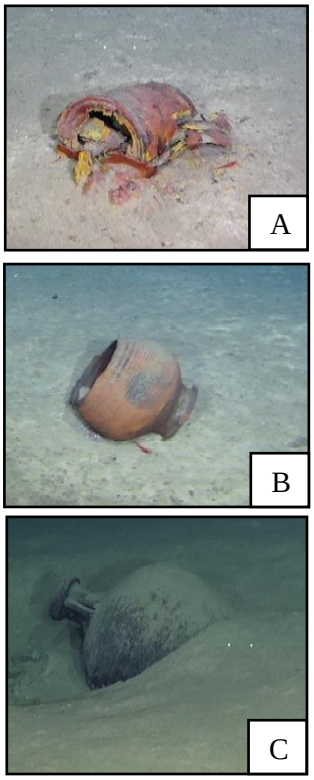


figure 28: The three unidentified artefacts recorded as part of ENI's 2017 survey. Source: image © DoAC.

Adding to the catalogue of discoveries, figure 29 presents evidence of two cooking wares found approximately 30 metres apart (Figure 27, findspots 1 and 2). Figure, 29-A is a cooking pot of spherical design, with either a flat or round base and two vertical strap handles seemingly attached to the upper body of the pot, just under the rim. The rim appears to form an overhang. This is similar to cooking

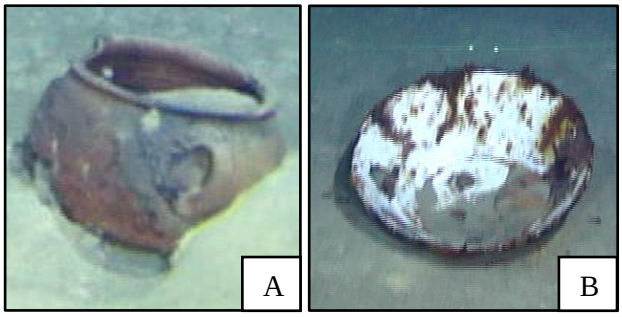


figure 29: Cooking wares, recorded as part of ENI's 2017 survey. Source: image © DoAC.

pots recorded by the 2012 OET expedition, which have been identified by Opaiţ to have originated from Egypt, dating most probably to the Hellenistic period (1st to 4th centuries BC) (**Appendix, Section 2**, figures 80 and 87, pages 367-368, and **Appendix**, **Table 2**, figures ID, 80 and 87, pages 387-388) (Ballard, et al, 2017). Figure 29-B illustrates a dish or bowl, with a possible white slipped or glazed interior. The base of the dish/bowl appears to be flat and it was probably used for food consumption and serving. Evidence of organic growth can be seen around the object's rim, suggesting the clay composition of the artefact.

In addition, 'Alley I-block 8' encompasses three amphorae (Figure 27, findspots 3, 4 and 6) dating to the Late Roman/Early Byzantine period (4th to 7th centuries AD). Figure 30-A presents the diagnostic features of an amphora with short vertical handless, a cylindrical neck and an overall ovoid body-outline, tapering to a solid spike pointed foot. The shoulder area appears to form a possible carination. It resembles most probably an Africana series amphora dating to the 2nd to 5th centuries AD (Keay, 1984, 185). Figure 30-B is an LR2 amphora, the identification of which was possible due to its distinct globular outline, consisting of a short conical neck and the everted rim. Its handles appear short and bowed, connecting the upper part of the amphora's neck, just below the rim, with the upper part of the shoulder. The literature suggests that the LR2 amphora type was used for a period of at least three-hundred years most probably maintaining its general form and function (Opaiţ, 2004). Minor morphological variations for this type were

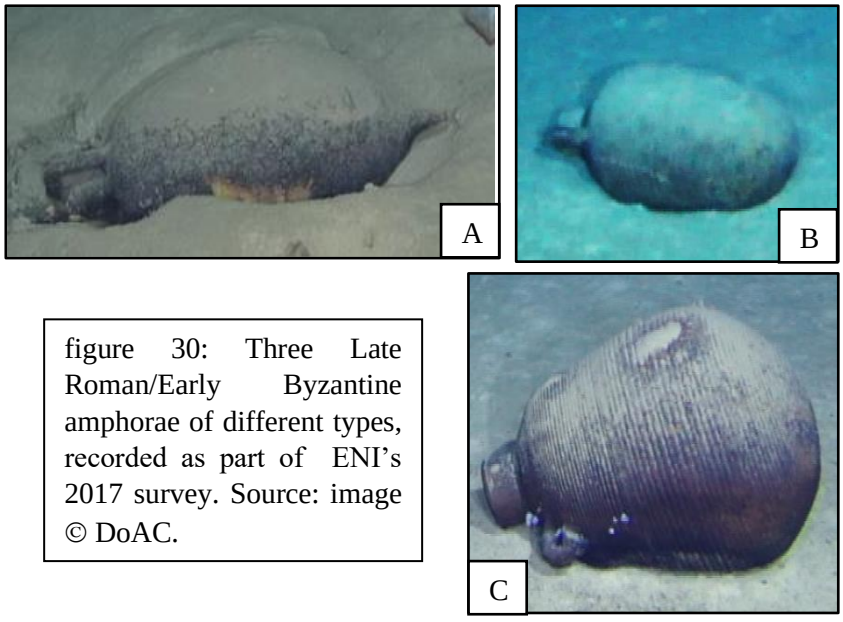


figure 30: Three Late Roman/Early Byzantine amphorae of different types, recorded as part of ENI's 2017 survey. Source: image © DoAC.

reported to occur during the mid-4th to early-6th century AD, mainly in the foot area where the basal knob appears to have shrunken to a mere basal wort. This basal wort is distinctively observable in this instance, and hence suggests that figure 30-B most probably resembles a 4th or 6th century LR2 type (Karagiorgou, 2001). Figure 30-C is of an amphora of sagging globular (or bag-shaped) outline, with ring handles and a round smooth base (Figure 27, findspot 4). The neck area is short and vertical consisting of some sort of collar rim (probably with an overhang). In this instance, Late Roman type 5 (LR5) seems to be the most appropriate type for this amphora and has been associated with production centres mainly from Palestine and northern Egypt dating from the late 4th century AD onwards (Reynolds, 2005, 570).

[4.4.3.1].Archaeological and topographical interpretations emerging from Figure 27

'Alley I-block 8' presents a linear trail of artefacts predominately dating to the Late Roman/Early Byzantine period, probably around the 4th to 5th century AD, and noted in close proximity to the Hellenistic wreck of 'Eratosthene-Eni' (Figure 27). Inevitably, this begs the questions of: what is the archaeological significance of the wider area of Figure 27; and what kind of hypothesis can derive from 'Alley I-block 8'? By viewing the wreck site in the context of its immediate surrounding underwater environment and in relation to the scatter of materials, it could be argued that:

A. The archaeological evidence of 'Alley I-Block 8' may postulate a scenario in which the Hellenistic site of 'Eratosthene-Eni' may not be the only shipwreck site situated in the wider area of Figure 27. If the artefacts represent a debris trail, there may also be an indicative of the debris trail of a Late Roman/Early Byzantine period wreck situated nearby;
B. If the artefacts simply represent dumping overboard from passing ships, it can be assumed that the 'sea-lane' represented by 'Alley I-block 8' demonstrates continuity in terms of its usage from the Hellenistic period to the Late Roman/Early Byzantine period,

a timespan of at least 1000 years. From this, it can thus be argued that the wider Eratosthenes Seamount area was a known sea-highway/lane for long-distance sailing;

C. From a topographical angle, 'Alley I-block 8' is situated on an 11-24% slope, which fluctuates from 2337 to 1939 metres. Unfortunately, this is not an ideal environment for *in situ* preservation, considering that additional scatters of materials are possibly part of 'Alley I-block 8' and might have tumbled down the slope and broke. The homogeneous nature of the materials seems to reflect a rather more meaningful pattern instead of a random collection of artefacts, with perhaps more Late Roman/Early Byzantine amphorae, part of this alley to continue in the adjacent un-surveyed area at the bottom of the slope.

[4.4.3.2].Conclusion: 'Alley I-block 8'

To conclude, 'Alley I-block 8' consists of amphorae dating primarily to the Late Roman/Early Byzantine period (4th to 7th centuries AD). The analysis above demonstrates that we are potentially looking at signs of a single event, that probably took place around the 4th or early 5th centuries AD, arguably reinforcing Ballard's and Foley's observations: 'Amphora alleys are indicators of emergency jettisoning of cargo, for stricken vessels' (Foley and Ballard, 2004, 184). This suggests that ancient mariners discarded portions of the cargo, during rough or unexpected weather conditions, as an attempt to avoid sinking, by making the ship lighter and thus, more buoyant. According to the 'Rhodian Law of Jettison' and the latter Book XIV, Title II of the *Digests of Justinian*, in case 'merchandise is thrown overboard for the purpose of lightening a ship, what has been lost for the benefit of all must be made up by the contribution of all' (Dugaime, 2020). The remains of 'Alley I-block 8' is perhaps evident of such an action where ancient mariners discarded part of the cargo as an attempt to avoid sinking. This explanation is consistent to how the ROV video-survey was conducted, postulating that the scattering of the artefacts is not the result of the survey but rather how they were found *in situ*.

Alternatively, ‘Alley I-block 8’ may also be interpreted as a debris trail, an indicator of a nearby shipwreck site. According to Ballard this is a fair assumption, when considering that modern ‘debris trails are evident with deep water wrecks, such as the RMC *Titanic* and Bismark’ (ibid., 184). It can also be argued that the specific ‘sea-lane’ in this area represented by all of the finds demonstrates continuity in seafaring for at least 1000 years, dating roughly from the Hellenistic to the Late Roman/Early Byzantine periods. The location of the finds corelates to the trade route that terminated to Alexandria, that was enormously important and from the 5th century BC up-to the Ottoman period (16th to 19th centuries AD). This statement is discussed underneath: Discussing the Deep Sea archaeology of Cyprus, pages 172-180.

[4.4.4].The shipwreck site 'Calypso Appraised – ENI&TOTAL'

Block 7 has an overall surface area of approximately 4560 km^2 and is located at a minimum distance from the coastline of roughly 54 km with a bathymetry fluctuating from 786 to 2703 metres. The Block was licenced to ENI Cyprus Limited and TOTAL E&P Cyprus BV join venture and was granted an exploration licence in September 2019 (Cyprus Hydrocarbons Company, 2019). Analysis of the seismic data revealed a potent area of trapped hydrocarbons, with the EBS of 2019 covering an overall surface of approximate 35 km^2 at a minimum distance of approximately 30 km from the southwestern foothills of the Eratosthenes Seamount (TOTAL and ENI Cyprus Ltd , 2019). The EBS survey was entrusted to Lighthouse S.p.A.[16] with MBES with backscatter-data, SSS, SBP and ROV seabed video-recording datasets produced for the wider 'Calypso Appraised' prospect site. The ROV visual inspection enabled the identification of 30 amphorae, 25 of which were found scattered within a radius of approximately 230 metres (ibid). In Lighthouse S.p.A. Filed Memo, the site was initially identified as 'an area with intense scatter materials', possibly reflecting the remains of a scattered shipwreck (ibid). The site 'Calypso Appraised – ENI&TOTAL' was reported by ENI, in 2019 and declared by the DoAC a scattered shipwreck. The site is situated on a slopping ledge, consisting of 25 scattered amphorae following a trail 10 metres apart at depths varying from 2,157 to 2,200 metres (Figure 31). The following analysis seeks to map and provide information pertaining to the chronology of 'Calypso Appraised – ENI&TOTAL', which represents the third ancient shipwreck discovery made in the EEZ of Cyprus during the course of NRS.

[4.4.4.1].Data and interpretation

At the time of writing (July 2021) the ROV videos have not been submitted to the DoAC, and the information presented here was extracted from a Feld Memo report (TOTAL and ENI, Cyprus Ltd, 2019). This was submitted with images of 30 amphorae, 24 of which seem to be

[16] See footnote 15, page 150.

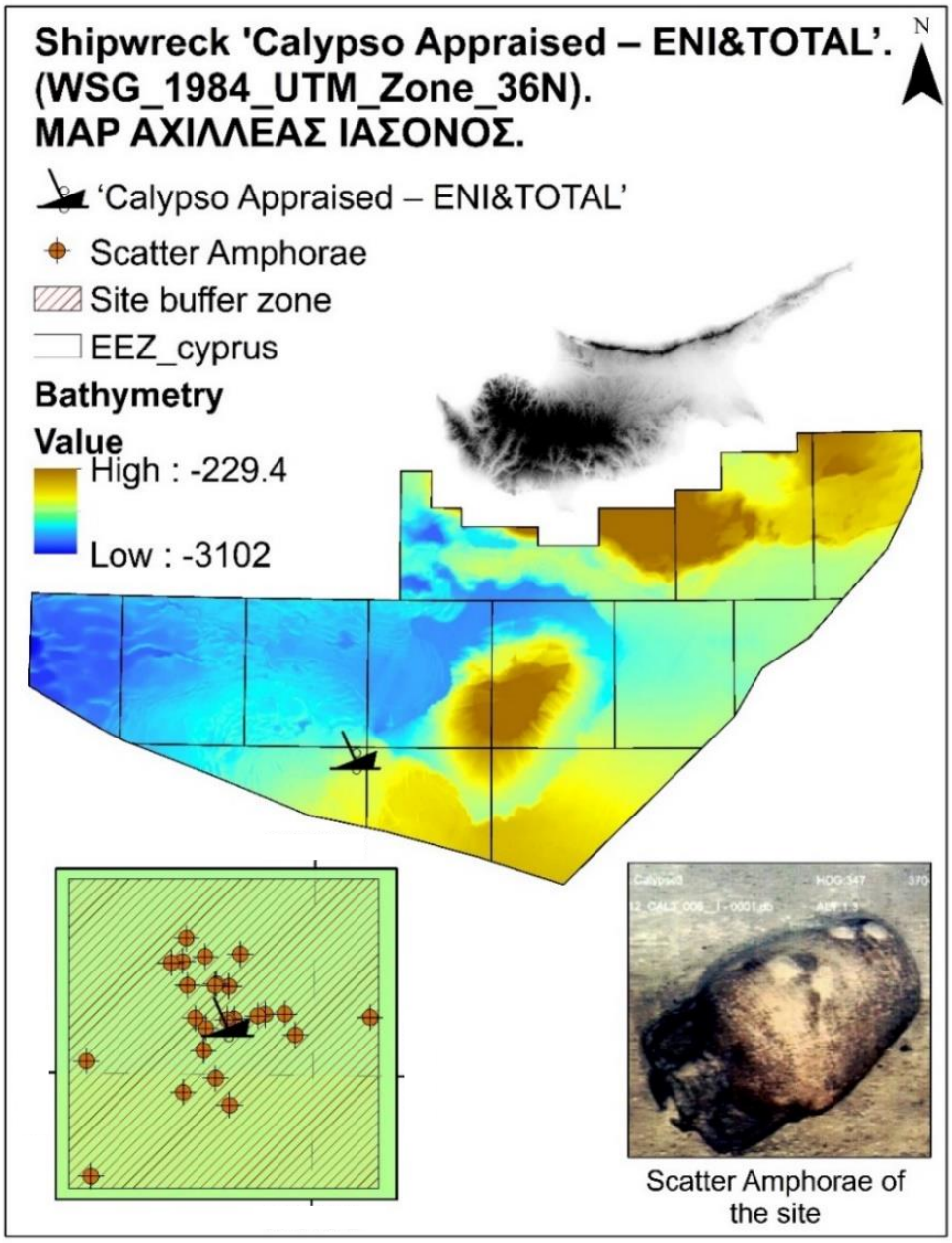


Figure 31: The exact location of the 2019 ENI/TOTAL shipwreck discovery 'Calypso Appraised – ENI&TOTAL'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ

concentrated in an area of 230 x 130 metres (Figure 31). Based on preliminary discussions, mapping and reviewing of the datasets at the DoAC, it was suggested that the site potentially reflects the remains of a merchant ship which sank spilling much of its homogenous cargo. Analysis of the photographic data attached to the report suggest that the 'Calypso Appraised – ENI&TOTAL' consists of a single amphora group dating roughly from the Late Roman/Early

Byzantine period (4th to 7th centuries AD). In addition, the presence of one large pithos (figure 33, page 171) jar seems to reinforce this interpretation as it seems highly unlikely that ancient mariners would have been able to discard this part of the wreck's cargo due to its weight of pithoi, especially when containing grain. The information discussed at the DoAC will be the subject of analysis pertaining to the identification of the recorded amphorae group for the purpose of tentatively dating the sites of 'Calypso Appraised – ENI&TOTAL'. The remaining six amphora were found at substantial distance from the main site and are believed to be scatter materials. These will not be the subject of detail analysis here, largely because they were preserved in a fragmented state or were noted buried mostly under sediment making their identification virtually impossible.

[4.4.4.2].The identification of amphorae of 'Calypso Appraised – ENI&TOTAL'

The following analysis seeks to ascribe the most suitable typology to the amphorae documented in the Field Memo, based on image characteristics and descriptions. The results presented in Table 7 pertain to the 24 homogenous amphorae and are supplemented in the following section by evidence relating to how this conclusion was reached and additional information pertaining to the origins, distribution and exact chronology of this amphora type.

Table 7: The identity of the 'Calypso Appraised – ENI&TOTAL' amphorae cargo, as seen in Field Memo report (figure 32)

Body-type:	Cylindrical (also described as semi-barrel-shaped form)	
Base-type:	Rounded paling base	
Neck-type:	Wide Cylindrical	
Handles in profile:	Large curved	
Rim-profile:	Rounded but uneven	
Handles in section:	Round	
Shoulder-type:	Rounded	
Chronology	5th to 7th centuries AD	
Image source:	Archaeology Data Service. (2005f). *Archives: Amphora: Late Roman Amphora 1.* https://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/details.cfm?id=236 [accessed 18/03/2019].	

[4.4.4.3].Amphora Type 1 Analysis

Amphora Type 1 is presented in the submitted images from various angles revealing all diagnostic features, illustrating an amphora with a cylindrical body gradually narrowing at the shoulder area and base to a rounded, small nimble base. It consists of a narrow neck with a small folded band rim consisting of gently cupped mouth, linked to a tronoconical neck which broadens at the shoulder area (Swan, 2004). Its handles appear thick and stumpy consisting of a double concave moulding with grooves. Overall, part of the body of the amphorae appears to be decorated with horizontal riling of straight lines, engraved on relatively thin walls of light-yellowish colour (figure 32).



figure 32: The homogenous amphora cargo of the wreck site of 'Calypso Appraised – ENI&TOTAL'. The image was taken by the Field Memo report. Source: image © DoAC.

From the emerging description and the image shown in figure 32 it can be argued that this is a Late Roman 1 (LR1[17]) amphora. In particular, due to the broad arch-shaped handles, the semi-barrel-outline of the amphora, and the slightly externally dished rim, it can be suggested that Amphora Type 1 presents similarities to what Swan suggests to be a sub-variation of the LR1 dating to 476 to 480 AD (ibid).

[4.4.4.4].Additional information about Amphora Type 1

Late 5th century LR1 amphora have been mostly documented as coming from Eastern Cilicia, Cyprus and Palestine (Peacock and Williams, 1986; Swan 2004). Early Petrography[18] studies

[17] It is worth recognising that the LR1 term is the most popular one today, and will be used for the purpose of this study, as it also refers to additional amphorae classes identified by specialists in the field in the past such: Ballana 6 / Benghazi Late Roman Amphora 1 / British B2 / Carthage Late Roman Amphora 1 / Keay 53 / Kuzmanov 13 / Peacock & Williams 44 / Scorpan 8B (Archaeology Data Service, 2005f)

[18] Additional studies on the origins of the LR1 type, suggest possible workshops in Cilicia, Antioch, and Ko (Opaiţ, 2010). However, further investigation at the time of writing was not possible, due to limited library access as a result of COVID-19.

rejected the origins of LR1 being from Egypt with further analysis suggesting that LR1 amphorae most probably originated from Cyprus 'due to intense peridotite inclusions' (Peacock and Williams, 1986, 185). They have been predominantly associated with the transport of olive oil, with additional evidence from the port of Marseille highlighting the possibility of them being used as containers for wine (ibid). The LR1 has been described as 'the most common eastern Mediterranean amphora import on most Mediterranean sites' as they were recorded in substantial numbers also in Egypt, Beirut and Turkey (Archaeology Data Service, 2005f). The archaeological record also suggests evidence for LR1 distribution from Dichin (modern day Bulgaria), at the Nicopolis ad' Istrum, and elsewhere on the Lower Danube *limes*, the Aegean, Asia Minor, Tunisia, southwest Britain and in the Black Sea region (Peacock and Williams, 1986; Swan 2004). With regard to shipwrecks, LR1 amphora have been recorded at four sites along the Cypriot coast, at Avidmou bay, Ayios Stephanos, Cape Andreas and Cape Zevgari as well as at numerous other sites throughout the entire Mediterranean Sea, including the Yassiada wreck off the coast of Bodrum, Turkey (Strauss, 2020e; Leidwanger, 2007).

[4.4.4.5].Conclusion: 'Calypso Appraised – ENI&TOTAL'

The chronology of the scattered wreck derives solely from the study of the amphorae, which suggest that 'Calypso Appraised – ENI&TOTAL' sank at some point between 476 to 480 AD or perhaps slightly after. 'Calypso Appraised – ENI&TOTAL' represents the remains of a scattered shipwreck site, that sank spilling much of its cargo, with perhaps the wreck itself being located further up the slope. It may be that with additional analysis of the ROV video and the SSS and SBP data in the future the location of the wreck site itself will be revealed. The report generated by S.p.A. Lighthouse on behalf of ENI Cyprus Limited and TOTAL E&P Cyprus BV join venture, in 2019, indicates a singular homogenous deposit of LR1 amphorae and a large intact pithos (figure 33). The analysis of the amphorae cargo suggests that 'Calypso

Appraised – ENI&TOTAL' most likely sailed from Cyprus and sank around the fourth quarter of the 5th century AD, dating the site to the Late Roman/Early Byzantine period.



figure 33: The pithos of the 'Calypso Appraised – ENI&TOTAL' wreck. The image was taken by the Field Memo report. Source: image © DoAC.

Although it is only a cluster of amphorae, it is clear that the site of 'Calypso Appraised – ENI&TOTAL' is of archaeological importance. This is largely due to the scattered nature of the site, covering an area of 230 x 130 metres. It is not a traditional wreck with an amphorae mound at its core (Figure 31, page 167), such as 'Eratosthene-Eni' and 'Aphrodite-Noble', but instead is likely to be indicative of such a mound nearby. Consequently, it is suggested that a further systematic resurvey of the broader area and further analysis of the ROV video, SSS and SBP datasets is required. This may potentially shed light on the actual density of the scattered amphorae, as well as on possible evidence of the hull and core remains of the site that remained un-surveyed in the area.

[4.5].Discussing the Deep Sea Archaeology of Cyprus

Scatter materials, amphorae alleys and shipwreck sites in the open seas of Cyprus portray the Mediterranean Sea as a web of interacting but frequently changing networks of interconnected routes of travel, where maritime connections 'can and should be looked at through the entanglement of people and things' (Mills, 2018, 241; Horden and Purcell, 2000; Broodbank, 2013; Kowalzig, 2018). It is this through these open water finds and the academic notion which has them being 'symptoms of movement' that we can trace patterns of seaborne connectivity and long-distance trade among communities and regions throughout the centuries (Leidwanger and Knappett, 2018, 1). Since 2010, deep water surveys have revealed an abundant presence of archaeological sites and this chapter has presented for the first time an holistic evaluation of all six shipwreck sites, one amphorae alley and approximately 100 identified additional scatters of archaeological materials found in the EEZ of Cyprus. Although these discoveries are not substantial enough to augment the maritime archaeology framework of the island, their contribution to this can be discussed. The following analysis aims to review the traditional picture of maritime archaeology of the island and place these new deep sea discoveries in it to see how well it fits with prevailing theories of the economic development of the region.

The discovery of two Canaanite jars in the open waters of Cyprus represents the earliest material evidence, indicating that long-distance sailing was taking place from, to, or around the island since Late Bronze Age (17th to 11th centuries BC) (**Appendix, Table 2,** figures ID 12 and 54, pages 373 and 380). According to Hulin and German, mentions of this were first portrayed in the ancient documents of the 14th century BC, suggesting that long-distance 'trade in the Late Bronze Age eastern Mediterranean grew at an unprecedented scale' (Hulin and German, 2018, 359; Wachsmann, 1986). According to Garcia, one of the reasons explaining why trading flourished during this period was the diplomatic contacts between the king of Alasiya (Cyprus) and the Egyptian pharaoh, who often exchanged goods and prestige gifts

(Garcia, 2016). This contributed to the development of a 'materialistic world of purely commercial exchanges' that gradually shifted from being a privilege enjoyed only by the palatial elite, to latterly being intensified through the exchange of humbler goods, such as foodstuffs transported in amphora containers (ibid; Sherratt, 2003). This resulted in merchants using the trade networks established by the institutions for their own projects, trading with their own goods, enabling the hypothesis that private trade developed from repeated opportunistic movements and shared experiences among seafarers to a more sustainable and systematic model of trading (Reden, 2011; Leidwanger and Knappett, 2018). This new notion of maritime trade becomes evident during the Cypro-Geometric period (11th to 8th centuries BC), where the discovery of three Phoenician amphorae (**Appendix, Table 1,** figures ID 3, 48, and 54, pages 344, 354 and 355) from the open seas of Cyprus correlate well with the general pattern that has the extensive discovery of more than 250 imported Phoenician amphorae in the island, at different settlement and rural sites such as at Kition and Idalion, the necropolis at Kition, the anchorage at Kioni, and Panayia Ematousa (Christodoulou, 2019).

The end of the Cypro-Archaic period (around 8th to 5th centuries BC), and the beginning of Cypro-Classical period (5th to 4th centuries BC) saw a decline of trade activities since material culture from the open seas of Cyprus seems to be largely absence. This, however, changes with the expansion of trade in the Hellenistic period, with 25 scatter amphorae and five cooking pots (**Appendix**, **Table 1,** figures ID 13, 27, and 44, pages 346, 350 and 353 as well as **Appendix**, **Table 2,** figures ID 70 and 80, pages 385 and 387) and 2 shipwrecks (namely 'Eratosthene-Eni' and 'Eratosthenes C') suggesting that long-distance trade and interconnectivity was the driving force of economic change in the Hellenistic period (4th to 1st centuries BC) (Manning, 2018). In effect, this increase in trade refers to how consumption turned into demand, which eventually contributed to the gradual development of a market-oriented economy (Reden, 2011). Inevitably this led to the establishment of retail trading on a commercial level with independent

merchants of the Hellenistic period sailing as far as India, streamlining the transport, exchange, distribution and storage of goods (ibid; Peters, 2019). These routes, commonly referred to as the Maritime Silk Route, connected the ports and cities of the Mediterranean Sea, with Mesopotamia and the eastern Mediterranean, with the Red Sea to the Indian Ocean (Peters, 2019). The amphorae recorded in the open waters of Cyprus represented possible evidence of this route(s), since they can be viewed as indicators of passing ships, sailing the blue water of the eastern Mediterranean Sea. Furthermore, with almost half of the scatter amphorae and one wreck site ('Eratosthene-Eni') originating from Rhodes, it can be further argued that that Rhodian wine was among 'the most important foodstuffs traded in the Aegean and eastern Mediterranean in the Hellenistic period' (Lund, 2018, 280).

The discovery of 'Eratosthene-Eni' in the open seas puts, retrospectively, into perspective a more specific scenario that has Greeks sailing to the commercial centre of Naukratis in Egypt from the Aegean, to provide mercenary services to the Pharaohs or trade merchant goods (Malouta, 2015). The sinking of 'Eratosthene-Eni' roughly around 300-275 BC, fits well with what 'Herodotus's describes Naucratis being a Greek settlement and *emporion'*, that later on according to Strabo gradually developed to a Greek *apoikia* (ibid., 7). The location of the site and the wreck's cargo as well as the famous *Hellenion* sanctuary in Naukratis that was co-founded by the city-state of Rhodes, infer to 'Eratosthene-Eni' as merchant ship, transporting Rhodian wine, that engaged actively in long-distance trade with perhaps end or start destination being Egypt (Kramer, 2016). This of course does not exclude the possibility of 'Eratosthene-Eni' sailing to other important trade centres in the area such as the port of Thonis-Heracleion, where intensive excavations in the area highlighted that 'imported ceramics during that period confirm extensive contacts' between the Aegean and the eastern Mediterranean (Goddio and Fabre, 2013, 70; Robinson and Goddio, 2019).

Nevertheless, the origin of an amphora is hardly the same as understanding the origins, sailing trajectory or end destination of a vessel, yet amphorae are still seen as strong indicators of maritime connectivity and are viewed as proxies for studying networks, economy, interconnectivity, long-distance trade, and movement (Leidwanger and Knappett, 2018). While different approaches invoke certain network concepts, distilling the full scale of trade and interconnectivity can be deconstructed when looking at quantifiable data from assemblages of cargo goods of shipwrecks and scatter materials of the same period (Green, 2018). For instance, the scatter of materials from the deep seas of Cyprus reflect this 'dynamic, active process of connectedness in the Mediterranean', with amphorae of the Hellenistic period postulating an economic network of mobility and connectivity with other city-states other than Rhodes, such as Kos, Chios, Thasos, Knidos and Crete who most probably also exported goods to the eastern Mediterranean (Hodos, 2009).

Further evidence supplementing the Hellenistic framework of interconnectivity and maritime trading and how this was conducted can be deconstructed via the 'Eratosthene C' wreck. Unlike the largely homogenous cargo of 'Eratosthene-Eni', which infers most probably trade between two centres, the 2012 OET wreck discovery of 'Eratosthene C' brings to light a rather new academic debate which has maritime trade and shipping in the Hellenistic period being undertaken by means of cabotage (Wilson, 2010; Mazurek, 2016). The non-homogenous cargo of the wreck with amphorae from the various centres from the South and North Aegean fit the general norm of cabotage being a 'speculative coastal tramping from port to port, selling a bit of cargo here and there, and picking up other wares to sell on further down the line' (Wilson, 2010, 53). The location of the site far from the coast in the open seas arguably challenges this concept. It reinforces how Wilson interprets non-homogenous cargos as evidence of passing ships picking up cargo at a single *emporium* 'and being traded either to another distant major port, or being redistributed to lesser ports in the coastal foreland of an

emporium' (ibid., 54). This theory gains further validity when considering that the shipwreck 'Aphrodite-Noble', would have travelled roughly 1,600 to 2,500 km just to be laded from the three wider distribution areas: the Aegean, Algeria, or Tunisia coasts, only to sail to the eastern Mediterranean Sea (Figure 22, page 149). This scenario seems to be unrealistic, when 'considering the levels of investment in port infrastructure, and evidence of resident trading communities in ports, all combine to show that commerce in the Hellenistic and Roman periods was emphatically not solely a matter of coastal tramping' (ibid., 54). It is only logical to assume that the end or start destination of 'Eratosthene C' and 'Aphrodite-Noble' would have perhaps been a single *emporium* most likely somewhere in the eastern Mediterranean or the Aegean.

Even so, from the data presented here, Mediterranean trade increased during the Hellenistic period and peaked under the Roman and Late Roman/Early Byzantine periods (1st century BC to 7th century AD) (Wilson and Bowman, 2018). According to Wilson and Bowman, this was due to institutional factors, technological innovations in ship technology and increasing demand in goods which 'began to encourage the mass production of certain goods' and artefacts (Wilson and Bowman, 2018, 6; Wilson, 2008). For instance, moulds are believed to be used for standardising the process of large-scale ceramic production as early as the 6th century BC, with this to gradually expand to the commercial production and firing of other wares such as amphorae (Wilson, 2008). This argument becomes apparent from the scatter amphorae from the deep seas of Cyprus as approximately three times more Roman and Late Roman/Early Byzantine amphorae have been found than Hellenistic amphorae. In fact, the archaeology gives account to 64 scattered amphorae, 19 Roman and 45 Late Roman/Early Byzantine were discovered between Egypt and Cyprus, suggesting that the organisation of trade was expanded, intensified and standardized, especially 'between Egypt and other eastern provinces of Rome' (Adams, 2018, 184).

From the 64 amphorae, 19 of them date to the early 1st century AD (Roman period) referring to what Adams's argues to be evidence of military supplies, transported over considerable distance throughout the year (ibid). The remaining 45 amphorae date to Late Roman/Early Byzantine period (4th to 7th centuries AD) with 18 of them being of the LR1 type. A possible explanation as to why so many LR1 amphorae were found in the open seas of Cyprus might be related to the establishment of Constantinople and the new markets this created (Reynolds, 2018). According to Reynolds, this led to extensive usage of LR1 amphorae transporting agricultural products which were circulated primarily in the eastern Mediterranean. This theory gains further validity when considering that both the Hellenistic site of 'Eratosthene C' and also the Late Roman wreck of 'Calypso Appraised – ENI&TOTAL', were transporting two and one large pithoi respectably, that perhaps contained grain. Even though stating what was the start or end destination of both wrecks is impossible, the wreck site of 'Calypso Appraised – ENI&TOTAL', which contained a largely homogenous cargo of LR1 Cypriot amphorae presents a reasonable assumption that it originated from Cyprus. If this is the case then, the 'Calypso Appraised – ENI&TOTAL' reinforces a notion which has Cyprus playing a bigger role in the regional distribution supply network of the broader Byzantine Empire, since it played an important role as an island stop and/or exported of grain to the wider eastern Mediterranean and Middle east region (ibid).

On a similar note, the presence of six LR5 amphorae, and one amphorae alley (namely, 'Alley I-block 8'), and at least another fifteen scatter materials dating roughly to the same period, put into context the scenario which has trade routes running from Alexandria and Caesarea, with Cyprus being part of 'eastern exploitation of the western Mediterranean market' (ibid., 384). In effect, long-distance networks from the late 4th to mid-5th century AD, suggest that interconnectivity occurred on a broader scale between the eastern Mediterranean and the west. This evidence in conjunction to the shipwreck site of 'Aphrodite-Noble' postulate that

interregional/international trade between different *emporiums* was conducted alongside with localise maritime trade (Tartaron, 2018, 75). Yet, moving beyond the safe and familiar 'small words' to the open-seas, was in the hands of few specialist merchants and sailors who possessed 'knowledge of sea routes, navigation in a range of conditions, open-sea and coastwise sailing, winds, currents, storms, landing sites en route and at the final destination, and personal relationships with people along the way' (ibid., 75).

The scatter materials and shipwrecks from the deep seas of Cyprus suggest that interregional/international trade was not conduct on the same scale as localise trade, but most certainly contributed to the acme of 'the economy as an evolving complex system' (ibid). An economic system that was firmly established by the Roman period, and latterly developed in the Late Roman/Early Byzantine period, leading to an increase of population, intensification of land use, economic and political integration, and urbanization (Flohr, 2014; McCormick, 2012). According to Wilson this led to a collapse of intensive long-distance trade, with this to be perhaps related with the establishment of the Arab world, and the creation of separate Byzantine and Islamic trading networks. In fact, this is evident in the deep seas of Cyprus, as only very few scatter amphorae and no shipwrecks were discovered dating in the Late Byzantine to Venetian periods (8th to 16th centuries AD). Subsequently, the evidence postulate that coastal cabotage tramping superseded interregional/international trade, thus leaving long-distance trade and blue water sailing to the hands of very few opportunist or specialist merchants and sailors. According to McCormick, this is evident due to the 'overwhelmingly dominant pattern of coastal voyaging, in relatively small ships, in strong contrast to the maritime world of the Hellenistic and Roman periods' (Wilson, 2010, 54; McCormick, 2012).

The brief pertains to the interpretation of shipwrecks, the amphorae 'Alley I-block 8' and scatter materials found in the open water of Cyprus and using them as evidence of long-distance trade and interconnectivity. The analysis has highlighted the maritime role of the island

since the Late Bronze Age with a nuanced picture of established trade networks emerging in the Hellenistic and Roman and Late Roman/Early Byzantine periods. The evidence from the deep seas of Cyprus thus far, seems to suggest an increasingly organised system of trade that first emerged in the Hellenistic period and peaked during the Late Roman/Early Byzantine era. The archaeological record of the deep seas of Cyprus reveals that most probably long distance trade was conducted from one *emporium* to another, with ships carrying both homogenous and non-homogenous cargoes (Wilson, 2010, 54). This is in support of the model which has interregional/international trade conducted alongside localise maritime trade (cf. Tartaron, 2018). Cyprus' role in this seems to be more related to an island stop or as an exporter of grain, with evidence from two shipwrecks sites, one Hellenistic ('Eratosthenes C') and one Late Roman/Early Byzantine ('Calypso Appraised – ENI&TOTAL') demonstrating this. The location of these shipwrecks seems to fit well with the sailing routes described by ancient geographers and mapped by Arnaud in his book *Les Routes de la Navigation Antique. Itineraires en Mediterranee*, with 'Aphrodite Noble' situated between the trade route that run between Ascalon and Curias; and 'Eratosthene C', 'Eratosthene-Eni' and 'Calypso Appraised – ENI&TOTAL' between Curias and Pelusium (figure 34). The absence of archaeological evidence during the Byzantine period, from the deep seas of Cyprus is according to McCormick and Wilson of no surprise as trade in the 7th to 9th centuries shifted from open water sailing to cabotage tramping, due to the formation of the Arab world (ibid). This does not account for the introduction of other more perishable packings and the replacement of archaeologically visible evidence, such as amphorae, but nevertheless seems to correlated well with the archaeological record of the deep seas of Cyprus, which has long distance trading resuming with the establishment of the Ottoman Empire roughly around the 16th century and onwards with this been evident from both the 'Iron Anchors' (16th to 17th century AD) and 'Ottoman Pistol'

(beginning of the 18th to the early 19th centuries AD) wrecks. The growth and success of the Ottoman Empire subsequently, led to the establishment of interregional/international trade on a broader and more organised scale, with the recently discovered, and partly excavated 17th century AD [Enigma] Ottoman wreck, found in the EEZ of Lebanon, to reflect this (**Chapter 2**, Deep Sea Archaeology in the eastern Mediterranean and the Exclusive Economic Zone of Cyprus, page 45-51).

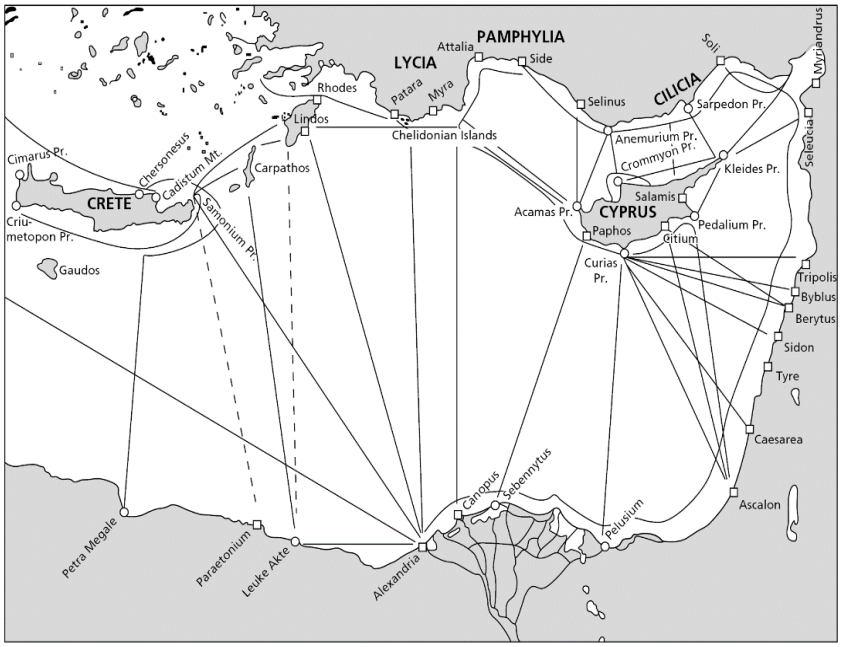


figure 34: The trade routes of the eastern Mediterranean as described by ancient cartographers and mapped by Arnaud. Source: image from Arnaud, P. (2005). *Les routes de la navigation antique. Itineraires en Mediterranee.* Errance: Archéologie. 212.

[4.6].Conclusion

This chapter has evaluated seven archaeological sites and has undertaken the spatial analysis of another 100 identified scatter of materials, all of which were found in the deep seas of Cyprus. From these sites three shipwrecks and one amphorae alley were discovered during the course of oil and gas explorations and are first published here. These are the sites of 'Aphrodite-Noble', 'Eratosthene-Eni' and 'Calypso Appraised – ENI&TOTAL', and the amphorae alley of 'Alley I-block 8'. The remaining three wreck sites were discovered during the 2010 and 2012 OET exploration surveys, of which two of them, namely, the 'Iron Anchors' and 'Ottoman Pistol' wrecks were reassessed to provide more nuanced insights into the construction, chronology, typology, usage, cargo, and sinking of these vessels. The information presented here represents

the first holistic analysis of all deep water archaeological sites of Cyprus, for the period of 2010 to 2021, with the discussion revealing that this evidence fits the prevailing theories of the economic development of the region. These results do not augment the existing maritime framework of the island, but it is clear that a broader study of deep sea UCH discoveries in the eastern Mediterranean region, based on the concept of *Oil and Gas Archaeology*, can shed additional light on to our developing understanding of long-distance trade, economic development and interconnectivity in the region. This is evaluated and discussed in the conclusion, **Chapter 7**. From a methodological perspective, the analysis has shown that ROV video-photography datasets generated during the course of oil and gas explorations present deficiencies, especially when compared to ROV video-photography datasets generated during the 2010 and 2012 OET explorations surveys. Unfortunately, this limits how much archaeological information can be deduced, with the output archaeological interpretations of oil and gas discoveries presented here, being somewhat ambitious. As it will be demonstrated in the following chapter, this is due to the absence of *minimum* technical and methodological survey parameters for offshore oil and gas contractors. Through the analysis of ROV video-photography and geophysical datasets, **Chapter 5** will shed light on these deficiencies, whilst also provide the solutions necessary for adapting commercial surveys and their data outputs to best discovery, survey and thereby preserve by record deep sea UCH assets discovered accidentally during the course of oil and gas operations.

5.GEOHPYSICAL AND VIDEO-PHOTOGRAPHY DATASETS AND THE STUDY (Analysis and Observations)

[5.1].Introduction

This chapter aims to evaluate specific oil and gas datasets submitted to the Department of Antiquities Cyprus (DoAC) for the period between 2017 to 2021 and to first present a detailed account of the data and information gathered as part of this thesis. The second section of this chapter aims to use the data to provide insights into how the oil and gas industry conducts visual inspections of archaeological/historic sites discovered accidentally during the course of natural resource surveys (NRS). The chapter will also address the technical and methodological parameters for best conducting visual inspections via Remotely Operated Vehicles (ROV). The last section aims to examine the results of side-scan-sonar (SSS) and multibeam-bathymetry-echosounder (MBES) and backscatter datasets as an attempt to develop an 'Atlas of SSS and MBES and backscatter sonographs' and illustrate how different acoustic responses of geological features are manifested in the submitted datasets. The end objective of this is to address what geological, and by extension archaeological information can be deduced from the analysis of geophysical datasets generated during the course of oil and gas operations, the aim being to clarify the appropriate frequency for generating SSS and MBES and backscatter data for best detecting potential shipwrecks and debris scatters. The results from this chapter will be used in **Chapter 6** to help develop the survey levels and the associate minimum professional Data Submission and Survey by-standards for offshore oil and gas contractors operating in the Exclusive Economic Zone (EEZ) and on the Continental Shelf (CS) of Cyprus.

[5.2].Data and the study

This study was developed as an attempt to contribute to the implementation of Article 18A[1] of the '2014 (amended) Antiquities Law of Cyprus', with this being achieved by granting access

[1] **Article 18A:** 'Any archaeology on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on' (The Antiquities (amended) Law Cyprus, 2014, 1120).

to the author, under confidentiality restrictions, to archaeological and geophysical datasets generated during the course of NRS. The purpose of this was to initially investigate how the oil and gas industry operates; how deep sea Underwater Cultural Heritage (UCH) is preserved by record when accidentally discovered and thereby visually surveyed during NRS; and what information can be deduced from the analysis of geophysical datasets.

From 2017 up to 2021, the study has developed a database containing 1.7 TB of data and a (geo)database that includes 6 GB of data and the site coordinates of eight shipwreck sites, 300 scatter materials and one amphorae alley (Figure 35, page 190, underneath). Two wrecks were excluded from this synopsis, as they were found situated in the EEZs of Lebanon and Egypt (Figure 35). Alongside the eight confirmed archaeological sites, this thesis has also gathered information, mapped and archived, coordinates for 22 SSS targets of 'high archaeological potential'. This information derives primarily from two military expeditions, that took place in 1986 and 1999 in search of the lost Israeli submarine, the Dakar. The unpublished reports and coordinates were disclosed to the author and present evidence of seventeen potential shipwreck anomalies in the Territorial Sea (TS) and the EEZ of Egypt (Supervisor of Salvage U.S. Navy, 1986; Jourdan, 2018, pers com). In addition, SSS data generated in 2011 as part of a cabling laying project connecting Cyprus and Israel revealed four targets of 'high archaeological potential' in the TS of Israel, and one in the TS of Cyprus (Wright, 2018, email communicate with author) (Figure 35).

The database includes a total of 245 GB of ROV seabed videos representing over 10 hours of footage, covering a total of approximately 150 km. These data were generated explicitly from oil and gas operations, with ENI and TOTAL providing 103 GB from six NRS and ExxonMobil submitting 141 GB from four projects. The remaining 1 GB comes from the early 2011 Noble Energy project and only concerns the shipwreck site of 'Aphrodite-Noble'.

5. GEOHPYSICAL AND VIDEO-PHOTOGRAPHY DATASETS AND THE STUDY (Analysis and Observations)

From a total of fourteen different projects that have taken place in the EEZ of Cyprus since 2011, three are still to submit ROV footage. Six projects have submitted the complete RAW uncut ROV dataset, with the remaining five contractors selectively providing only the ROV data showing archaeological artefacts. Table 8, pages 187-189, summarises the data submissions of each company. Unrelated to oil and gas but also included in the database are the 2010 and 2012 Ocean Exploration Trust (OET) surveys that have thus far provided a total of 750 GB of ROV photographic data, with the remaining RAW videos still to be submitted to the DoAC.

The remaining 700 GB of data consists of geophysical datasets with ten out of fourteen projects having submitted at least one output dataset of the requested SSS, MBES and backscatter, and SBP. More specifically, the database includes MBES data with backscatter from five projects, three projects provided only MBES data and no associated backscatter, and the remaining six did not provide anything (Table 8). With regards to SSS data, five projects provided the RAW dataset in (.XTF) format, two submitted an output stitched mosaic but not the individual line-paths of the SSS dataset. Seven projects are still to submit any SSS data. Furthermore, Table 8 reveals that only one project, ExxonMobil for the 2018 'Delphine-1' prospect project, submitted all of the requested datasets. Ten projects are still to submit SBP data, and on two occasions PDF files were submitted instead of the RAW data. RAW SBP data were submitted in SEGY format in only two occasions.

Table 8 indicates that there are different behaviour patterns in data submission. This is due to the absence of specifications in Article 18B-(1)[2] of the '2014 (amended) Antiquities Law

[2] **Article 18B-(1):** 'Licenced agencies, contractors or individuals operating in the Exclusive Economic Zone and on the Continental Shelf of Cyprus, are required to report to the Director of the Department of Antiquities Cyprus the discovery of any UCH sites and objects regardless of such discoveries were made intentionally or not, and for this manner they should submit geographical coordinates and additional information' (ibid).

of Cyprus' and in the Scope of Work (SoW) of the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus*. For example, when this project started in 2017, attempts were made to collect data retrospectively for the early 2011 Noble Energy and the 2017 ENI projects. From the analysis of the results of the initial collection it was possible to refine our requests for data in the second year of the study, particularly with regards to the formats that were required. An example of this derives from the 2017 ENI datasets; we initially requested 'ROV videos', which resulted in ENI submitting specific videos showing the archaeology only. Even though this was regarded as adequate at the time, discussions with the DoAC in 2018 resulted in the agreement that in future it would be better to specifically request 'RAW uncut ROV video data' to address any concerns about any possible undetected UCH sites. This was implemented quite effectively with more of the required data being submitted from 2018 onwards (Table 8).

Nevertheless, from the results seen in Table 8 it is my position that this project has provided a framework for communication between the DoAC and offshore oil and gas contractors/subcontractors. This was possible due to the commitment of Dr. Despina Pilides of the DoAC, who has been liaising with offshore oil and gas contractors throughout this period ensuring that the best interested of the DoAC in protecting UCH in all maritime zones, as well as the aims and objects of this study were met. Nevertheless, only seven out of fourteen projects have submitted the final Environmental Social Impact Health Assessment (ESHIA) and Environmental Impact Assessment (EIA), whereas for the case of the 'Calypso Appraised' prospect site, Block 7, only an archaeological Filed Memo has been provided thus far (Table 8). This indicates that the process of submitting and thereby archiving datasets and reports from all oil and gas companies operating in the EEZ of Cyprus at the DoAC is still a work in progress. In the absence of archaeological regulations and specifications regarding what and when exactly

they need to submit, and how geophysical and ROV video-photography dataset are to be generated so as to incorporate components of maritime archaeology surveying, contractors/subcontractors seem to selectively choose datasets, formats, and resolution/frequencies. This resulted in the creation of the data Survey and Data Submission by-standards set out in **Chapter 6**, with the aim of clarifying and simplifying the process of data development and submission. Ideally, by implementing these minimum professional by-standards [and by extent the survey level in which these are associated with], either in the 'regulatory administrative acts of 2022' of the 'Antiquities Law of Cyprus', or by determining the unspecified SoW set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus,* contractors/subcontractors who fail to meet the *minimum* technical and submission prerequisites can be held liable for breaching government regulations and guidelines. According to the Article 15(4) of the 'Hydrocarbons (Prospection, Exploration and Exploitation) Regulations law of 2007 and 2009', failing to comply with national law/regulations and international industry standards allows the 'Minister of Energy to suspend the authorization until the holder of an authorization [i.e. of the oil and gas contractor/subcontractor] has taken the necessary corrective measures' (Hydrocarbons (Prospection, Exploration and Exploitation) Regulations, 2007 and 2009, 16).

The following analysis pertains to how the oil and gas industry conducts ROV visual inspections of archaeological sites made in the context of NRS. It then examines how the industry produces geophysical datasets as well as what information can be deduced from them. For further information regarding in which block each company is operating refer to Figure 1, **Chapter 2,** page 56.

Table 8: A summary of data generated from oil and gas explorations, collected and [partly] evaluated in the context of this thesis for the period of 2017 to 2021.

Contractors operating in the EEZ of Cyprus	RAW uncut ROV video-photography data	MBES with Backscatter data	Side-Scan-Sonar (SSS)	Sub-Bottom Profiler (SBP)	ESHIA or EIA Reports
NOBLE ENERGY 2011 (Block 12) 'Aphrodite'	**Submitted. Video only showing the archaeological discovery of 'Aphrodite-Noble'**	**Not Submitted**	**Not Submitted**	**Not Submitted**	**Submitted**
TOTAL and ENI 2017 (Block 11) 'Onisiforos'	**Not Submitted**	**Not Submitted**	**Not Submitted**	**Not Submitted**	**Not Submitted**
ENI 2017 (Block 3) 'Cuttlefish'	**Submitted. RAW uncut data Pending**	**Submitted. No Backscatter. RAW data Pending**	**Not Submitted**	**Not Submitted**	**Submitted**
ENI 2017 (Block 6) 'Calypso'	**Submitted. RAW uncut data Pending**	**Submitted. No Backscatter. RAW data Pending**	**Not Submitted**	**Not Submitted**	**Submitted**
ENI 2017 (Block 8) 'Eratosthenes South'	**Submitted. RAW uncut data Pending**	**Submitted. No Backscatter. RAW data Pending**	**Not Submitted**	**Not Submitted**	**Submitted**

Contractors operating in the EEZ of Cyprus	RAW uncut ROV video-photography data	MBES with Backscatter data	Side-Scan-Sonar (SSS)	Sub-Bottom Profiler (SBP)	ESHIA and EIA Reports
ExxonMobil 2018 (Block 10) 'Anthea-1' ExxonMobil	**Not Submitted**	**Submitted**	**Submitted**	**Submitted**	**Submitted**
ExxonMobil 2018 (Block 10) 'Glaucus-1' ExxonMobil	**Submitted**	**Submitted**	**Submitted**	**Not Submitted**	**Submitted**
ExxonMobil 2018 (Block 10) 'Delphine-1' ExxonMobil	**Submitted**	**Submitted**	**Submitted**	**Submitted**	**Submitted**
ExxonMobil 2019 (Block 10) 'Pegasus' ExxonMobil	**Submitted**	**Submitted**	**Submitted Mosaic. RAW data Pending**	**Submitted in PDF format. RAW data Pending**	**Not Submitted**
ExxonMobil 2019 (Block 10) 'Pegasus' extension' ExxonMobil	**Submitted**	**Submitted**	**Submitted Mosaic. RAW data Pending**	**Submitted in PDF format. RAW data Pending**	**Not Submitted**
ENI and TOTAL 2019 (Block 6) 'Cronos' TOTAL Eni	**Submitted**	**Not Submitted**	**Submitted**	**Not Submitted**	**Not Submitted**

Contractors operating in the EEZ of Cyprus	RAW uncut ROV video-photography data	MBES with Backscatter data	Side-Scan-Sonar (SSS)	Sub-Bottom Profiler (SBP)	ESHIA and EIA Reports
ENI and TOTAL 2019 (Block 8) 'Eratosthenes Main'	Submitted	Not Submitted	Submitted	Not Submitted	Not Submitted
ENI and TOTAL 2019 (Block 7) 'Calypso Appraised'	Not Submitted	Not Submitted	Not Submitted	Not Submitted	Not Submitted. Only Archaeological Field Memo
TOTAL 2019 (Block 11) 'Alphee'	Submitted. RAW uncut data Pending	Not Submitted	Not Submitted	Not Submitted	Not Submitted

Index	
Not Submitted	
Submitted	
Partly Submitted	

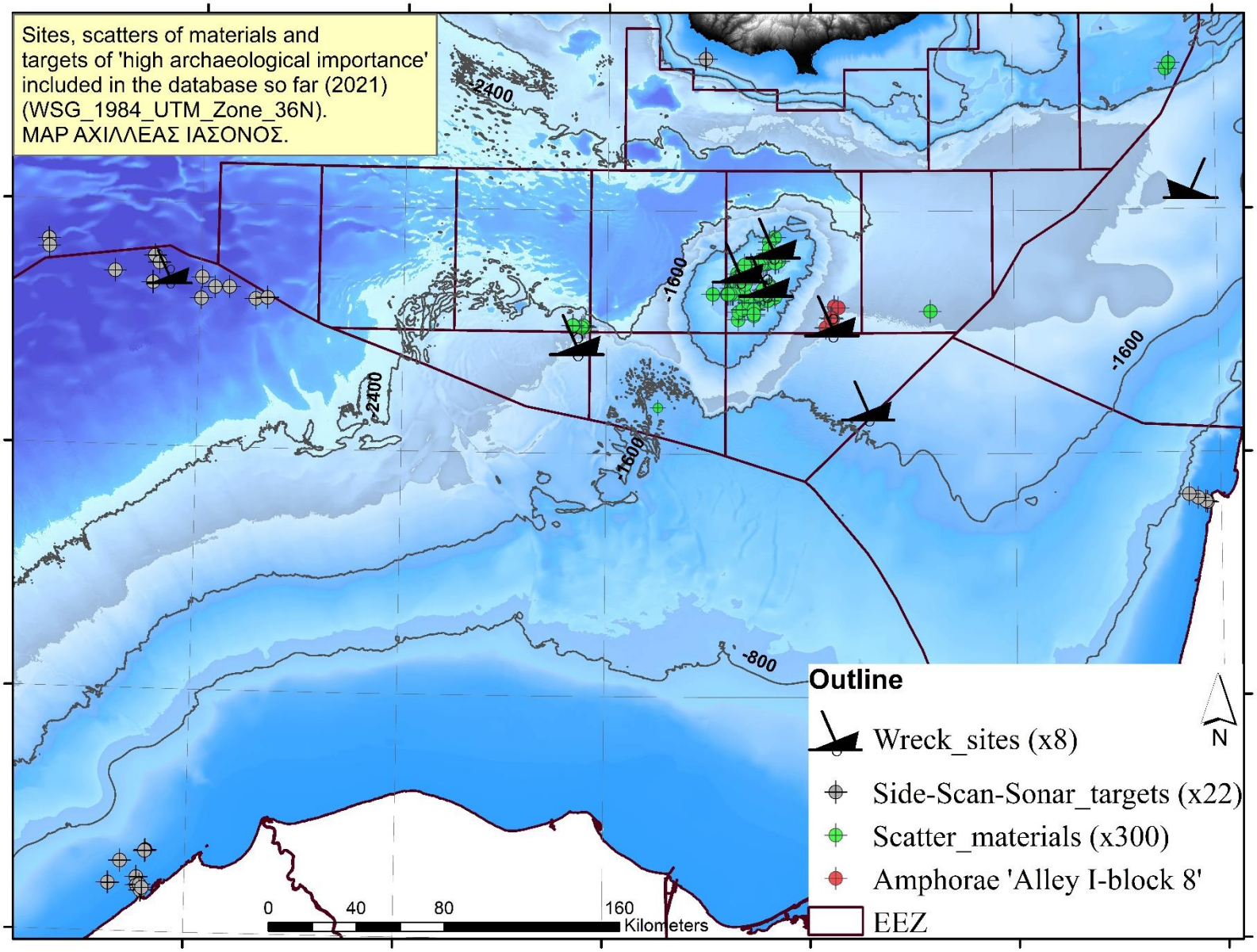


Figure 35: The results of the project's (geo)database and the locations of eight wreck sites, 300 scatters of materials, one amphorae alley and 22 SSS targets. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[5.2.1].Insights into ROV Video-Photography data generated during oil and gas activities

ROVs play a crucial role in the investigation of deep seafloor (Macreadie, et al, 2018). They have been described as the 'eyes, and hands of scientists in the sea' and indeed it is through ROV footage that maritime archaeologists can now analyse in detail shipwrecks and their extant cargo (ibid., 1). In effect, ROV video-photography has enabled archaeologists to scientifically study shipwrecks in the deep seas, rendering deep sea maritime archaeology a scientifically and technologically enabled field. From an industry perspective, ROV footage allows contractors/subcontractors to provide visual insights into the character and nature of discovered geophysical anomalies and thus report to stakeholders and the responsible heritage agencies — through ESHIAs, EIAs, Environmental Baselines Surveys (EBS) and Geohazard Investigation reports— whether sites of UCH were discovered or not.

For ROV visual data produced during the Geohazard Investigation or EBS, preceding the drilling of wells (see **Chapter 6**), they do not produce the same results as an archaeological survey, as they are conceived and undertaken with different objectives in mind. This statement received emphasis, initially in **Chapter 4**, through the archaeological analysis of the oil and gas shipwreck discoveries of 'Aphrodite-Noble', and 'Eratosthene-

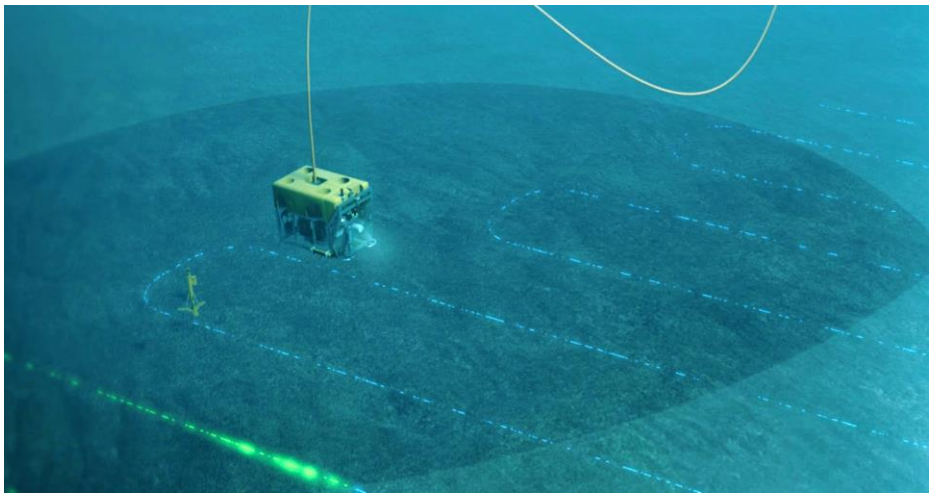


figure 36: An illustration of a commercial ROV operating in a pre-programmed line-path-survey. Source: image by Kongsberg. (2020). *HiPAP: High Precision Acoustic Positioning.* 1.

Eni', postulating that the quality of the ROV video-photography record creates ambiguities when interpreting ancient shipwrecks and their extent cargoes. This initial observation is furthered here, with the analysis below investigating this as an attempt to supplement the unfortunate lacuna left in the academic literature: there are no insights of exactly how UCH is visually inspected by oil and gas contractors/subcontractors when discovered accidentally during the course of NRS. This is problematic as it may lead to the assumption that commercially driven projects survey UCH in a similar fashion to projects with archaeological driven objectives, such as the Black Sea Maritime Archaeology Project (M.A.P.) (Pacheco-Ruiz, et al, 2019). The reality of the situation is that this is not the case as the ROV video-photography datasets collected in this study have revealed two main issues of concern. First, commercially driven projects when accidentally lead to the discovery of UCH lack a cohesive methodology regarding how to survey and thus preserve by record archaeological assets. This is because ROVs usually operate on pre-programmed line-path-surveys and are stopped momentary to visually assess any sites of potential UCH importance or other prenoted geohazards (figure 36). This survey methodology yields problematic results that considerably limit how much archaeological information can be deduced (**Chapter 4**).

From a technical point of view contractors/subcontractors seem to utilise different ROV camera and light systems. This is an important parameter for video-recording at depths where there is absolutely no natural light. This is an issue relevant to the basic principles of photography in general, but is amplified in the deep seas, as the use of appropriate light systems is a decisive matter between good deep video-photography record and bad. This is because images captured with insufficient lighting have exposure issues (i.e. the image appears too dark) and can appear largely unclear and distorted (Shutterstock, 2014). In effect, this relates to issues

of them not being adequate for creating photomosaics, orthomosaics and photogrammetric models or requiring more time in being postprocessed.

Figure 37, page 195 presents information pertaining to the resolution of four different ROV camera systems utilised in four different NRS projects by three different contractors. It illustrates most obviously that image resolution of underwater camera systems has improved immensely since 2011. This can be attributed to the introduction of deep water commercial Hight Definition (HD) camera systems around 2015, followed by the introduction of Ultra High Definition (UHD) around 2018. Figure 37 illustrates this progression by providing an overview of the ROV video-photography systems utilised in the deep seas of Cyprus, with figure 37 image A showing the usage of a Standard Definition (SD) camera system in 2011, the integration of a HD in 2017 (figure 37 image B), and the latest upgraded to a UHD camera system in 2018 and onwards (figures 37 images C and D). The following evaluation seeks to present the development of ROV video-photography to address the issue of what the image resolution and lighting power is necessary to collect data of sufficient quality to accurately and consistently characterise UCH. While, obviously, imaging and lighting technology will continue to develop, for the purposes of setting the minimum professional by-standards for future data capture (**Chapter 6**), what is presented here should be regarded as the *minimum* that would be acceptable. This is one aspect for effectively achieving the adequate surveying of deep sea UCH. There is also a requirement for the correct methodological parameters for the systematic collection of data to effectively record and thereby preserve by record any accidental deep sea UCH assets. These methodological parameters are developed below.

According to the EIA of Noble Energy International Ltd, the shipwreck discovered in 2011 was surveyed with a SD Simrad 1367 colour CCD video camera and 4 lights of 250 watts

each (figure 37 image A, page 195) (Noble Energy International Ltd, 2011b). The resultant video has a resolution of 1920 x 1080 pixels shot at 25 frames per second and was exposed by 7,000 lumens of light (ibid). The quality of the video is lacking in resolution, due to the standard of the camera system. The duration of the video is approximately 4 minutes and 30 seconds in total and mainly comprises of a simple fly over of the site lasting for approximately 3 minutes, which seems to have provided the information necessary for the contractor/subcontractor. This was shot at eye level with occasional high angles at a distance of roughly 2 to 4 metres from the target. The survey was not conducted with an archaeological objective in mind and instead the shipwreck was treated as another geohazard anomaly that was subject to ground truthing. Unfortunately, this resulted in crucial scientific information pertaining to the cargo of the vessel and the wooden hull being largely unrecorded.

In order to reconstruct how the survey was conducted, further post-processing of the video dataset of the 'Aphrodite-Noble' wreck was undertaken in *Agisoft Metashape* and *Autodesk ReCap Pro* 2019. The aim of this was to utilise the mathematical modelling behind the basic principles of photogrammetry to enable further investigation into the navigation path of the ROV survey. For this reason, the video was first converted to still images, using *Free Video to JPG Convertor*, with the most promising images demonstrating significant overlap selected. The post-processing of the selected images was unsuccessful as both pieces of photogrammetry software were unable to generate a model. This was due to the following factors: first, the mediocre quality of the images did not allow the tracing of precise points of common interest with a point cloud being unable to be generated; and second, the orientation angle of the ROV's camera was not set at a fixed position. Inevitably, this suggests that the angle of recording, and the specifications of the camera and lighting systems, did not result in

the necessary level of data to adequately document the shipwreck. While the datasets were sufficient for a preliminary identification and analysis, they were simply insufficient for full documentation and effective preservation by record. This observation was the starting point for the recognition of the importance of developing the survey levels and the associate minimum professional by-standards seen in **Chapter 6** (see: General prerequisites and survey levels 2 and 3 sections, pages 266-269, 274-277 and 277-280 respectively).

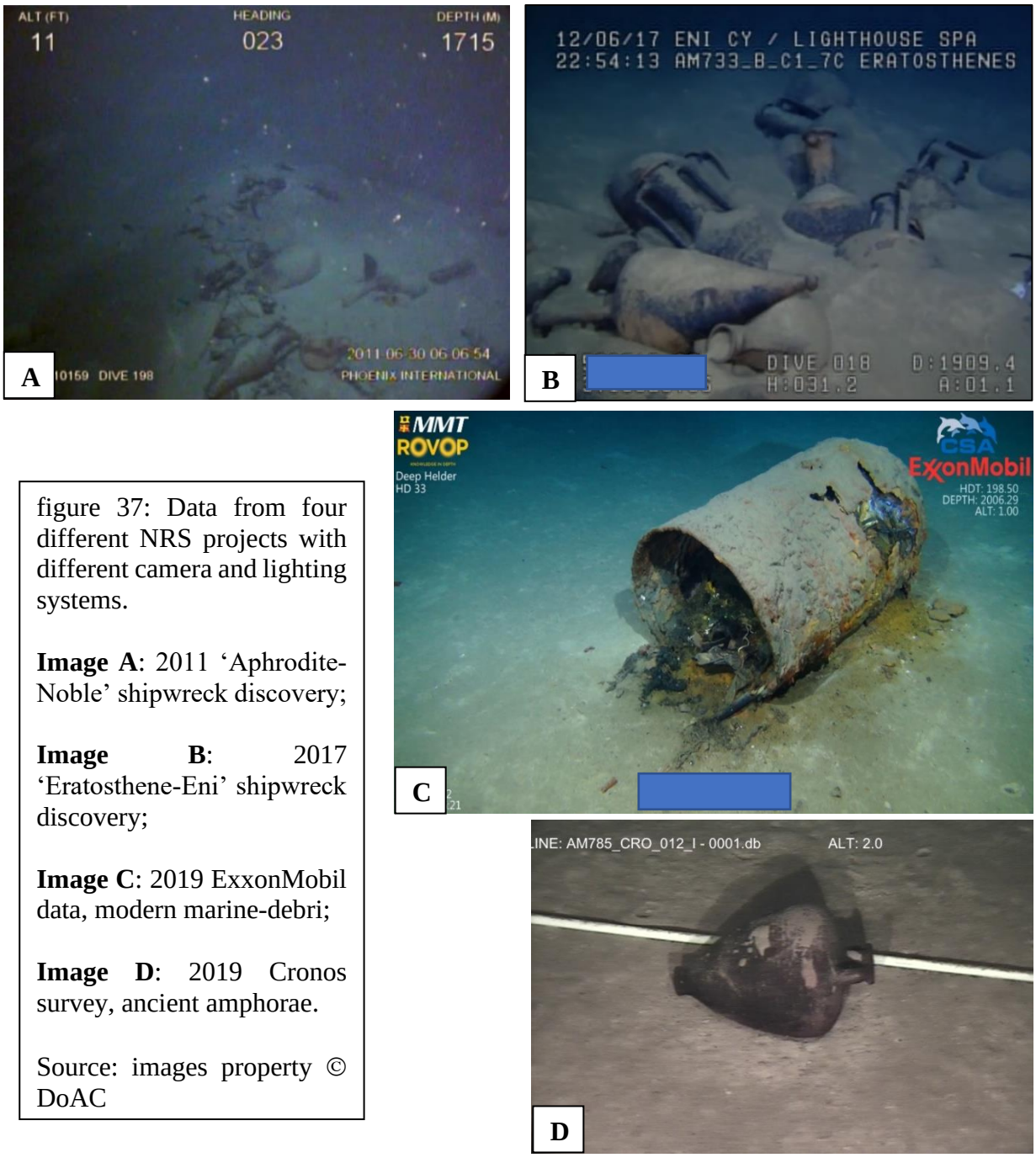


figure 37: Data from four different NRS projects with different camera and lighting systems.

Image A: 2011 'Aphrodite-Noble' shipwreck discovery;

Image B: 2017 'Eratosthene-Eni' shipwreck discovery;

Image C: 2019 ExxonMobil data, modern marine-debri;

Image D: 2019 Cronos survey, ancient amphorae.

Source: images property © DoAC

Another early example highlighting how the industry surveyed shipwreck sites, is presented in figure 37 image B. According to the subcontractor, Lighthouse S.p.A., the 2017 shipwreck discovery of 'Eratosthene-Eni' was surveyed with a Teledyne HD camera mounted on Quasar's MkII Work Class ROV, with the seabed being illuminated by roughly 9,000 lumens (Lighthouse S.p.A., 2017). The result of this, show a substantial improvement in image quality compared to 'Aphrodite-Noble' that can be attributed to the use of a HD camera and the use of a lighting-rig with at least 2,000 more lumens. The video submitted to the DoAC of the 'Eratosthene-Eni' survey, has a resolution of 720 x 488 pixels per frame and 29.97 frames per millisecond. It has a total length of five minutes, however, the shipwreck itself was only documented for 36 seconds.

Post-processing the 36 seconds of the shipwreck was undertaken in *Free Video to JPG Convertor*, from which 97 still photographs were extracted and processed in *Agisoft Metashape* to develop an orthomosaic model. From these 97 images, 58 were aligned successfully, creating a model of 1,742 tie points and 335,169 individual points of a single cloud. For the purpose of maximising the potential of generating a model of higher resolution, reconstruction parameters were set to ultra-high quality and depth filtering was set to aggressive. This created a model with 179,999 faces and 90,566 vertices. The tiled model parameters of the dense cloud was set to 8192, creating an orthomosaic model of 859 x 521-pixel analysis (Figure 38).

The orthomosaic of 'Eratosthene-Eni' presented in Figure 38 is presented from three different angles. For instance, Figure 38, angles A and B shows a model of relatively good quality, revealing the principal orientation in which the site was recorded. This, however, seems to change when shifting the model 180°, with Figure 38 angle C revealing a distorted model that is blurred with pixel gaps. These observations confirm that 'Eratosthene-Eni' was not

surveyed beyond a simple fly-by (Figure 38 angles A and B) suggesting that the shipwreck happened to be situated in the ROV's line-path with the pilot pausing the flight of the machine momentarily. Consequentially, the shipwreck was not surveyed in its entirety, thus, diminishing our chances to fully understand this rare find. This is problematic for obvious scientific reasons and the only way to add further information is to revisit the site.

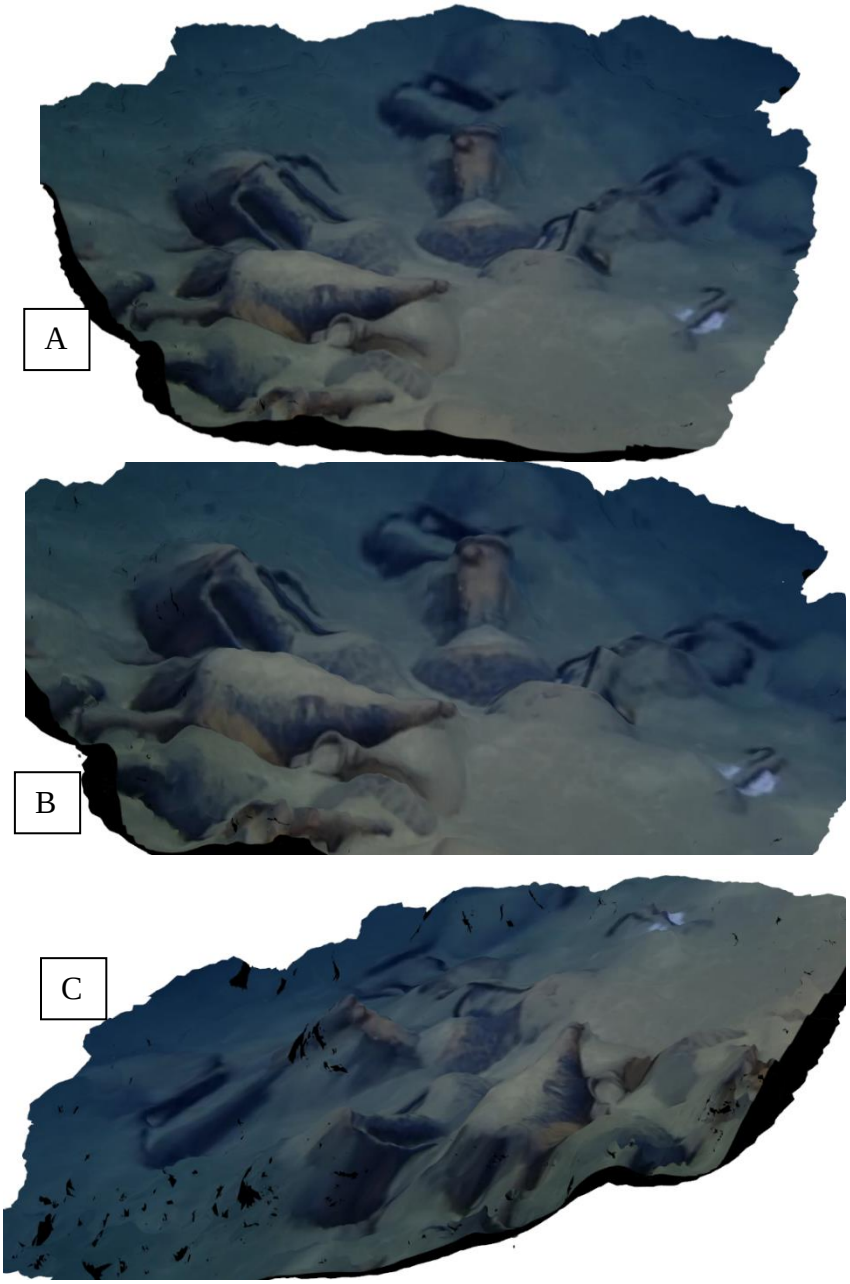


Figure 38: The results of the orthomosaic model of 'Eratosthene-Eni' displayed from three different angles (A, B and C) Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

The latest 2019 ROV data submitted by ExxonMobil and ENI/TOTAL (figure 37 images C and D, page 195) reveals that even in the absence of specific archaeological survey strategies, the use of up-to-date equipment can improve data capture and therefore its scholarly utility. Figures 37 images C and D presents a significant improvement in data capture since both companies employed UHD camera systems, with figure 37 image D showing an amphora exposed to 8,000 lumens and a barrel exposed to 10,000 lumens. Both datasets are of good quality, indicating that the use of UHD systems provides the best data for the study of the deep-seabed and for modelling any accidental discoveries of shipwrecks. Even though there is some difference in exposure and colour balance, both datasets enable zooming clearly in the images whilst maintaining an acceptable level of clarity. This helps when it comes to the analysis and interpretation of UCH sites [and in particular amphorae wrecks], allowing researchers to best study materials *in situ.* Inevitably, this renders the use of up-to-date commercial camera systems such as UHD necessary.

From the analysis above, it can be stated that the DoAC should set as a precondition that offshore oil and gas contractors/subcontractors operating in the EEZ of Cyprus and on the CS undertaking NRS must utilise commercial ROVs *as a minimum* equipped with: UHD or in the near future 4K camera systems with a lighting rig comprising of LED systems capable of exposing the deep seabed of the bathypelagic zone between 1000 to 3000 metres at approximately 10,000 to 14,000 lumens. Ideally, contractors should use the latest camera technology available at the time and light systems powerful enough to expose with clarity and clear colour balance any UCH discoveries. This is vaguely set as a precondition for work in a European Union standards document (cf. Hitchin, R., Turner, J. A., and Verling, E, 2015) with

further clarifications pertaining to the usage of specific lumens and ROV camera systems presented here.

In terms of conducting visual inspections for preserving by record accidental UCH discoveries, surveys should be at least 10 to 20 minutes long, depending on the size of the shipwreck. Obviously for isolated scatter sites significantly less time needs to be spent recording the UCH. The time on site should be utilised for the systematic collection of data that will enable accurate interpretations, as well as increasing the probability of post-processing the datasets more effectively. For this reason, the methodology for recording an UCH site (i.e. shipwrecks) should combine both still-photography and video recording and should ideally follow the basic principles of photogrammetry and Structure from Motion (SfM). This has been effectively addressed in the 2019 article of *Deep sea Archaeological Survey in the Black Sea – Robotic Documentation of 2,500 years of Human Seafaring* where John Adams and his team give account to the best 'optic and acoustic survey techniques to accurately record and create 3D and pseudo 4D models of the shipwrecks' (Pacheco-Ruiz, et al, 2019). In effect, this article postulates that the application of still-photography will allow a more thorough inspection of



figure 39: A jug discovered by ExxonMobil in 2018, and surveyed in a circular manner, capturing the artefact in all angles. This survey results can be effectively postprocessed into a 3D model. Source: image property © DoAC.

the wreck, allowing emphasis to be placed on specific diagnostic features of the shipwreck itself and its extant cargo. According to the results from the Black Sea M.A.P., the overall survey should be carried out based in a spiral or circular taking with video-recording carried out first, followed by the application of photography (Pacheco-Ruiz, et al, 2019; Nornes, et al, 2015; Akal, et al, 2004; Ballard, et al, 2000). A good example of this is illustrated in figure 39, which shows the general expectation of how individual finds [and by extension UCH sites] should be surveyed and thereby preserved by record. The basic concept of this recording methods seeks to allow the application of the Structure from Motion (SfM) technique, which 'operates under the same basic tenets as photogrammetry and stereoscopic photogrammetry, namely that 3D structures can be resolved from a series of overlapping, offset images' (Westoby, et al, 2012, 301; Pacheco-Ruiz, et al, 2019; Prado, et al, 2019; Micheletti, Chandler and Lane, 2015). In effect, the idea is that objects and sites should be recorded in their entirety from all possible angles, so as to be able to post-process the video results into photomosaic/orthomosaic models. The video and photographs should be taken from three different angles, bird's-eye view, high angle, and eye level, with the closest angle to be set 1 metre from the site and the furthest 5 metre (Pacheco-Ruiz, et al, 2019). The camera system should be fixed and not moved when surveying and should be changed only after completing spiral or circular flyovers of the site. The data generated during this process should be able to be processed and developed into detailed orthomosaic/or photomosaic models based on the SfM technique. The suggestions made here are an extension of current practices/knowledge, primarily applied in the context of educational/explorational survey project, such as the Black Sea M.A.P. or in the EEZ of Cyprus such as the 2010 and 2012 OET survey project, which should be adopted and implemented by the oil and gas industry, when deep sea UCH is accidentally discovered as a by-product of NRS.

[5.3].Geophysical datasets

In the light of work on the ROV camera and lighting systems it became clear that the most modern equipment invariably produced the best results. Such an observation was similarly apparent in an initial viewing of the geophysical data in consultation with specialists in the field. This suggested that it would be most beneficial to base any proposed *minimum* standards on the best current practice, which in the case of the submitted datasets is that from the 2018 ExxonMobil datasets (Table 8, pages 187-189). These datasets were generated at considerably higher frequency and resolution than seen in previous submitted surveys and presented significantly better results. Consequently, the following analysis focuses on the evaluation of datasets generated as part of the 'Anthea-1', 'Glaucus' and 'Pegasus' prospection projects (Figure 40, page 202), with the SSS data being generated with an EdgeTech 2200-M Full Spectrum Chirp Dual Frequency system, at frequencies between 369 - 451 kilohertz (kHz), mounted on an Autonomous Underwater Vehicle (AUV) operating between 30 to 40 metres from the seabed; and the MBES and backscatter data generated with a EM2040 Multibeam Kongsberg system, at frequencies between 200 and 400 kHz, also mounted on an AUV and operated between 30 to 40 metres from the seabed and at an output resolution of 1 point at every 3 metres. This section will analyse the SSS and MBES and backscatter datasets to investigate what geomorphological and perhaps archaeological information can be deduced from them.

The following analysis briefly introduces each dataset and is then followed by presenting the results of how specific geomorphological and man-made features (i.e. archaeology) are manifested in the datasets. This includes a discussion of the appropriate data frequency to generate SSS and MBES and backscatter data for best detecting potential shipwrecks and debris scatters. The discussions are supplemented with ROV images, where possible, to better illustrate the points being made. This section seeks to reinforce one of the

overarching arguments of the thesis, which is that geophysical datasets generated in the context of a NRS, should be purpose-driven beyond addressing specific operational objectives related to drilling (such as: seabed characterisation, topographical analysis and geohazard investigation) and should be undertaken so that any accidental discoveries of deep sea UCH can be identified. This is clearly evident in the analysis below which suggests that deducing insights relevant to the discovery of UCH assets (i.e. shipwreck sites and scatter of materials) from MBES and backscatter, and SSS datasets is not straightforward. This is because geophysical datasets generated in the context of oil and gas operations are produced at resolution and frequencies that unfortunately do not allow the analyst to clearly distinguish between shipwreck sites [with amphorae cargo] and geological features, or archaeological materials from modern debris.

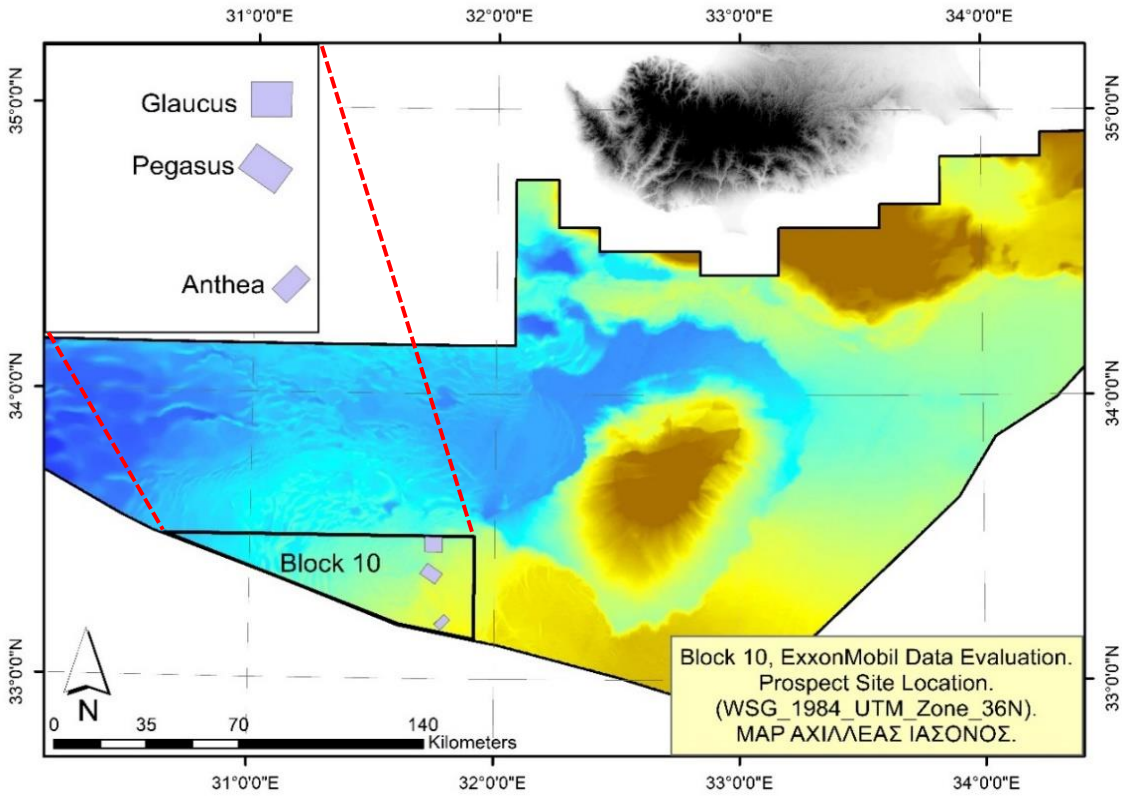


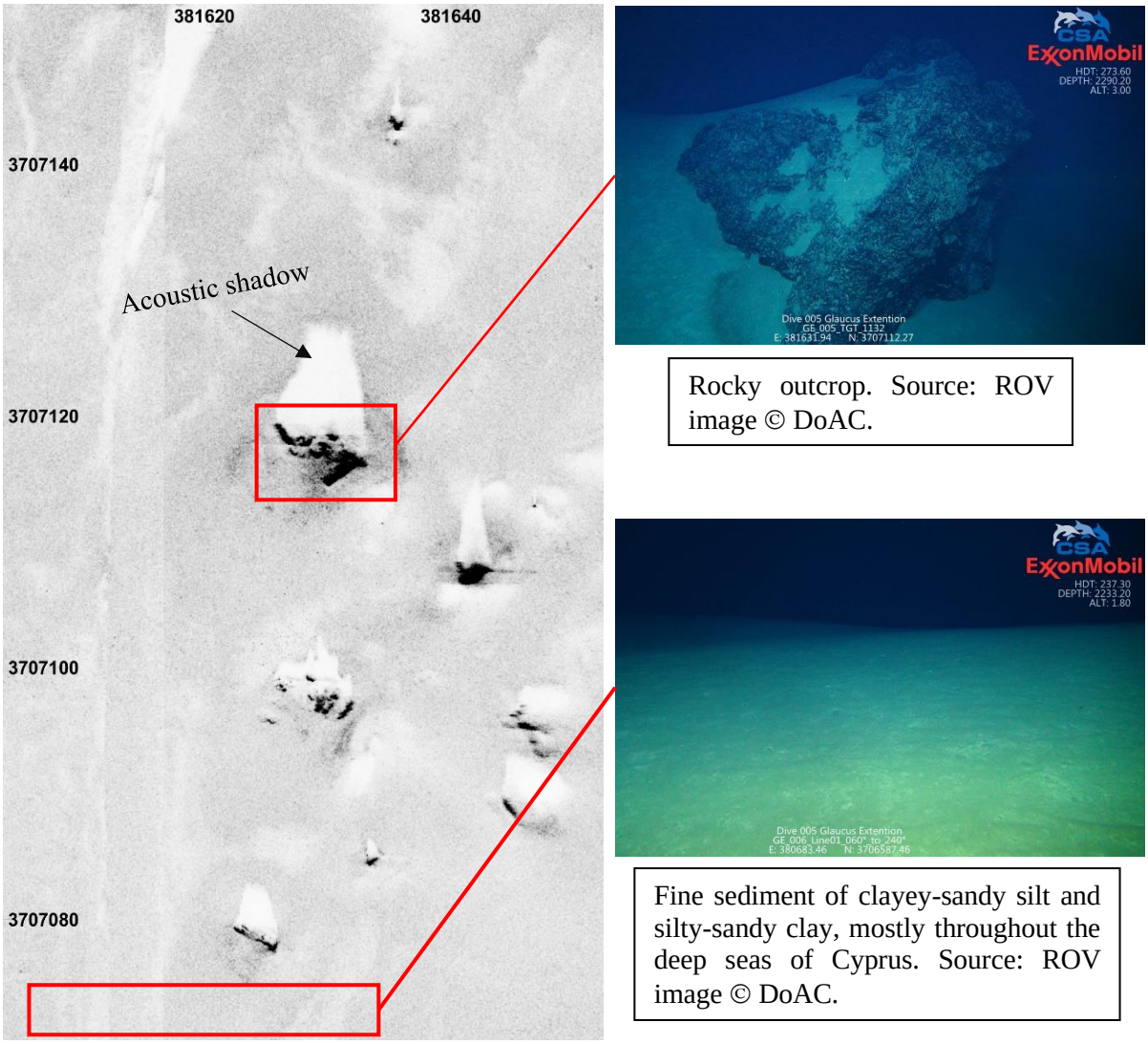
Figure 40: The location of the 'Anthea', 'Glaucus' and 'Pegasus' prospection projects. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[5.3.1].Side-Scan-Sonar

A side-scan-sonar (SSS) transducer emits high-frequency fan-shaped acoustic pulses that are bounced off the seafloor and sent back to the system to efficiently create a sonogram or an image of the seabed's morphology. The output data can show the seabed's texture/characteristics and marine sediments such as sand waves, slopes, pockmarks, large boulders (Bai and Bai, 2019). Importantly, SSS can also detect man-made seafloor targets such as shipwrecks, modern debris, and cables, as well as natural features like coral reefs and Posidonia meadows (Geoscience Australia, 2018). A simplified explanation of how the SSS system operates is that the transducer computes the time and distance of the returning sound waves emitted downwards to the seafloor, with the output sonar data –the sonograph– displaying the intensity of the return. This is based on the interaction of the sound pulses with the seafloor with soft, muddy, silt sand, fine sand, silty clay, seafloors absorbing most of the energy, which in this instance, are shown in the output image in different shades of light grey. Rough, hard or dense surfaces, such as a rocky seafloor, rock outcrops, or small-scale boulders on a sandy seafloor, deflect most of the emitted sound-waves, with these high-intensity returns showing as solid black in the output image (Savini, 2011). Weak returns (low backscatter) or cast shadows (no returns) are usually manifested in the data as blank (white) areas or variations of light grey depending on the intensity of the return. Black spots in the data (white) occur when an obstacle is projecting for the seabed, such as a steep hill, rocky outcrops or shipwrecks and marine debris, blocking the transmitted acoustic pulses from reaching the seafloor (United States Naval Academy, 2018). This is referred to as an acoustic shadow and can be used to determine the size of the associated feature. Examples from the study dataset are presented below.

[5.3.1.1].Side-Scan-Sonar geological features and seabed geomorphology

The following section presents the results of a developing 'Atlas of SSS sonographs', which illustrates how different acoustic responses of geological features are manifested in the SSS data. The purpose of this is to demonstrate the characteristics of the natural seabed in the deep waters of Cyprus' EEZ and how such geological features can be differentiated from anomalies associated with UCH. For instance, figure 41 presents evidence of a mostly a homogeneous seafloor characterised by low acoustic reflectivity (light grey throughout), corresponding to fine sediments. This is a typical characteristic of the entire deep seafloor of Cyprus (Lighthouse S.p.A., 2017).



Rocky outcrop. Source: ROV image © DoAC.

Fine sediment of clayey-sandy silt and silty-sandy clay, mostly throughout the deep seas of Cyprus. Source: ROV image © DoAC.

figure 41: SSS data accompanied by ROV images illustrating the geomorphology of the deep seabed of Block 10, with evidence of rocky outcrops. Source: SSS and ROV images © DoAC.

Figure 41 presents the shallow lithology of what appears to be a soft but consolidated clayey-sandy silt and silty-sandy clay, of yellow-brown colour. The even surface shows evidence of protruding rocky outcrops that cast acoustic shadows (marked in white) onto the seabed with these features varying in size. Measurements deriving from the acoustic shadows, which corelate to the height of the protruding rocky outcrops, suggest that they are elevated from the seabed between 1 - 4 metres. According to ExxonMobil's unpublished Environmental Baseline report, and other reports composed by the industry, rocky outcrops have been recorded occurring quite frequently throughout the eastern Mediterranean Sea, probably due to the active tectonics of the area. They are perceived by the industry as a major geohazard for drilling operations (ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018).

Rocky outcrops have been defined as the visible exposure of bedrock and have been occasionally recorded occurring in the deep seas protruding from the seafloor in clusters (ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018b). For instance, figure 42 presents an area of 10,327 m^2 covered by a solid rocky outcrop, the origins of which are suggested to be the result of plate collisions and paleo/or neo tectonic activity. These rocky outcrops can be understood as evidence of on-going tectonic uplift and compression associated with the incipient collision between the Eurasia and African-Arabian plates (Stern and Johnson, 2010; Lighthouse S.p.A., 2017). From a marine biology perspective these geological features are of significance as they can facilitate the growth of biological assemblages and thus provide shelter to different marine species and other organisms (Karl, 2020). Although, in the example shown in figure 42, the EBS data generated by ExxonMobil and the associate ROV video data do not show any living organisms in the area, other than occasional species of crabs and fish: Sampling in the near future could perhaps reveal additional information related to the

mineralogical attributes of this particular rocky outcrop (Cuyvers, et al, 2018). Additional information deriving from the area of figure 42 marked in purple demonstrate the exposed bare bedrock exhibiting a rough and irregular surface, consisting of flat lying massive slabs. Boulders are widespread across the bedrock surface, with some being of well-rounded shape sitting on-top of the hard surface (Fader, 2005). In this instance, the boulders appear to occur in clusters, especially underneath the overhanging rocky outcrop and at the foothills of the

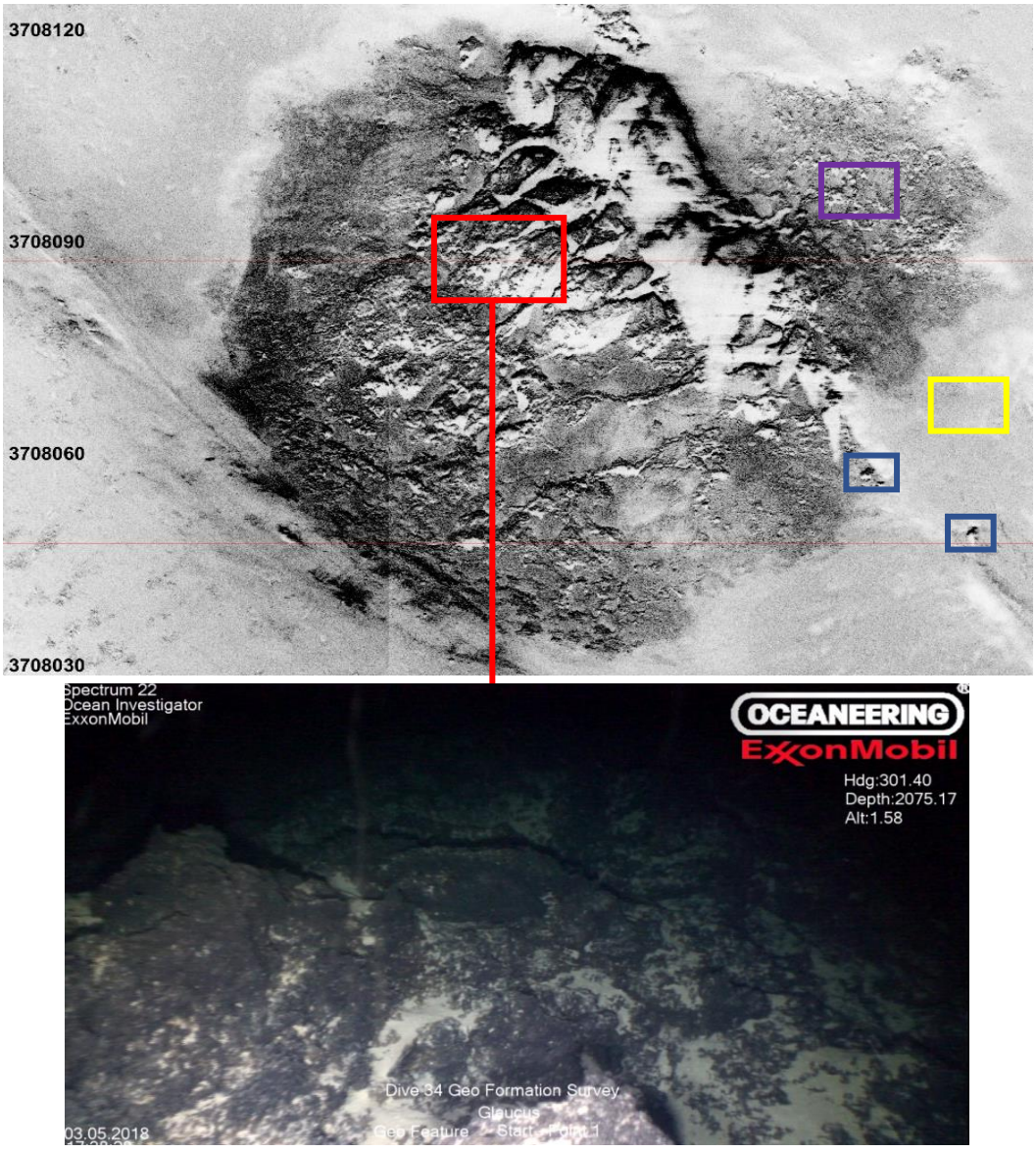


figure 42: A rocky outcrop found in Block 10, at the prospect site of ‘Glaucus’. Source: SSS and ROV images © DoAC.

outcrop (marked in blue on figure 42), with them perhaps being eroded from the projecting rocky outcrop. The adjacent sand covering the area, (marked in yellow on figure 42) is similar to that described in figure 41 and is generally representative of the deep seafloor of the region.

Additional evidence from the SSS data demonstrates the presence of an area characterised by high acoustic reflectivity, with figure 43 illustrating the seabed in a variation of shades of grey, which is in contrast to the monochrome shade seen in figure 41. This is due to the sediment being predominantly composed of small gravel/pebble sized rocks and less sand. The overall geomorphology seen in figure 43 presents evidence of an uneven terrain with small slopes and mild ripples (or creases). These are seen most clearly on the left-hand side of the image (Green, 1986). Furthermore, a steep slope in the sediment can be seen on the right-hand side of the image,

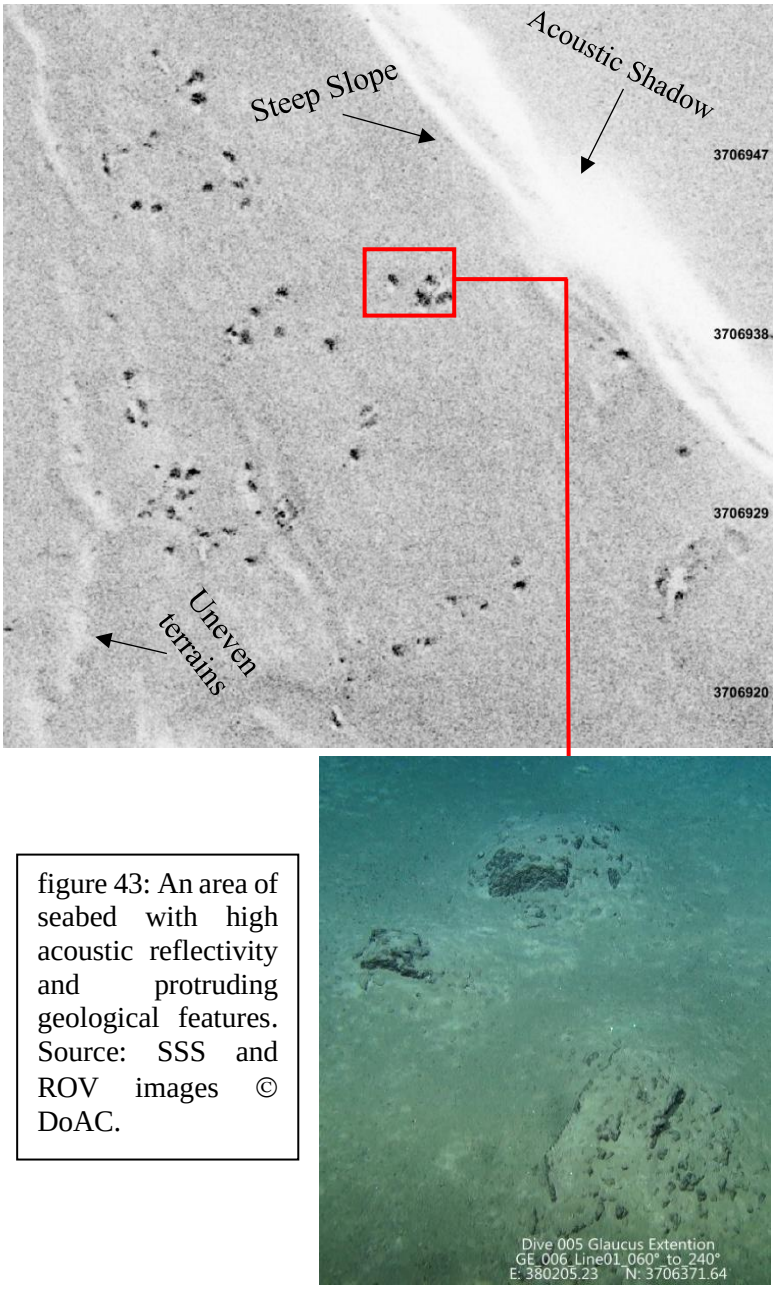


figure 43: An area of seabed with high acoustic reflectivity and protruding geological features. Source: SSS and ROV images © DoAC.

which appears to be sufficient to obscure the acoustic pulses from reaching the seafloor. The acoustic shadow of this anomaly is 3-5 metres, which correlates to the overall average up-lift of the ridge. Finally, strong backscatter returns (seen in black), with a maximum size of 2 metres in diameter demonstrate the abundant presence of small outcropping rocks and scatters of boulders (Bai and Bai, 2019).

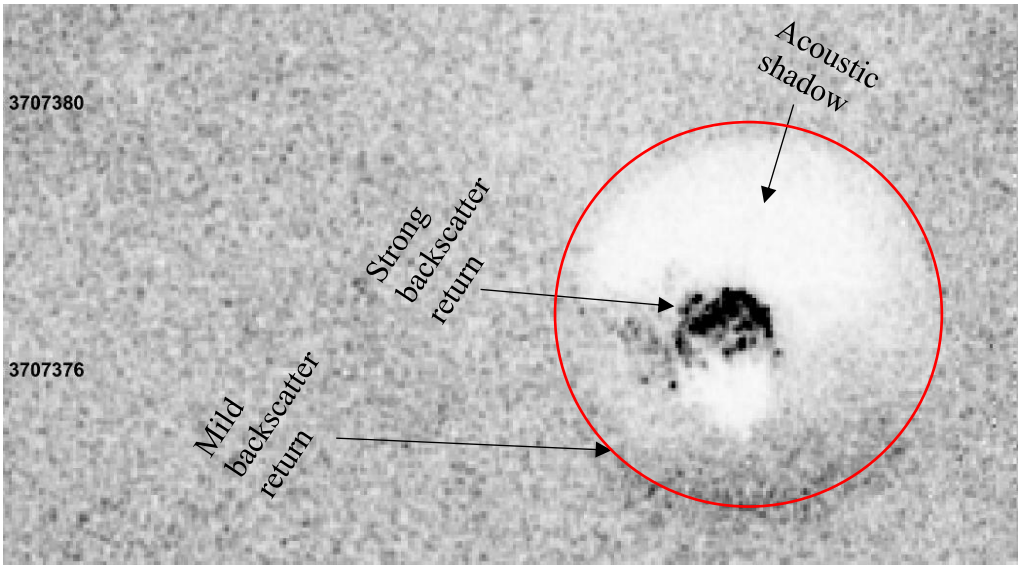


figure 44: An 'eye' pockmark. Source: SSS image © DoAC.

Another feature that systematically appears in the SSS data and occurs in significant density, covering extensive areas of the deep seabed of Cyprus, are pockmarks. As seen in figure 44, pockmarks are usually presented in the dataset as minor fluctuations in seabed topography, similar to rocky outcrops. Instead of peaks of high backscatter return, such as those presented in figure 44, this kind of feature usually appears resembling a cone-like-shape, forming a crater-like depression into the seabed. These can vary in size, being between a few centimetres to a few metres wide and usually appear in silty and muddy seafloors (Josenhans, King and Fader, 1978). On some occasions, pockmarks present evidence of a strong backscatter return (i.e. a darker colour), which in this instance is seen in the middle of the concave crater-

like depression called the ‘eye’. Half of this depression shows a mild intensity return and the other half an acoustic shadow (white) (Wheeler, et al, 2001). In figure 44, the boundary of the pockmark is outlined in red, suggesting a feature with a total diameter of 5 metres and crater area of roughly 1 metre. Such an ‘eyed’ pockmark is the result of escaping fluid and hydrocarbon gases, with them being usually recorded in large concentrations and perceived by the industry as good indicators of ‘trapped’ hydrocarbons (Hoffmann, et al, 2020; Hovland, Gardner, Judd, 2002).

Scientific studies since the 1970s have revealed that pockmarks may also occur in different sizes, shapes and outlines (Josenhans, King and Fader, 1978). For instance, figure 45 illustrates a different type of pockmark, consisting of an irregular hollow of U-shaped outline with two projecting rims of high backscatter return (black) and a low backscatter return (white colour) in the middle. These features vary in size but have been consistently recorded in clusters throughout the deep seas of Cyprus. They have an overall size up to 5 metres in length and are less than a

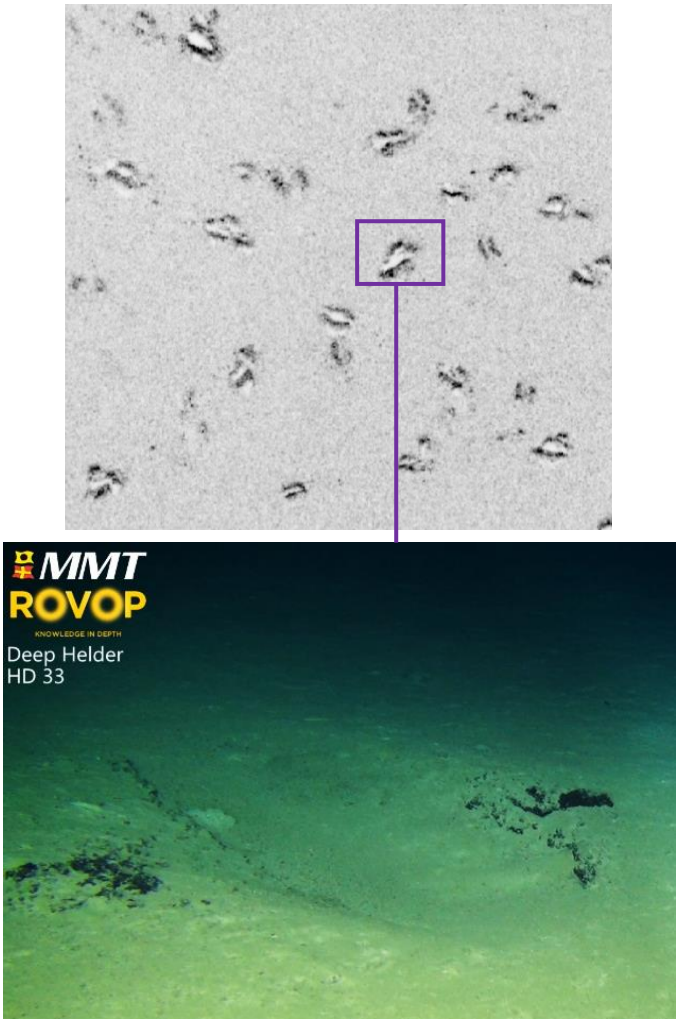


figure 45: Microdepressions (also called ‘intrapockmarks’) found throughout the deep seas floor of Block 10, recorded at the prospect site of ‘Anthea-1’. Source: SSS and ROV images © DoAC.

metre in depth (figure 45). These features are termed 'intrapockmarks' and according to reports composed by the oil and gas industry pockmarks such as those presented in figures 44 and 45, 'pose threats to the mechanical integrity of the subsea facilities and offshore operations' and for this reason are marked by the contractors/subcontractors as geohazards and avoided (Chuku, et al, 2018, 5; Chand, et al, 2009).

Occasionally, the SSS data presents evidence of slumping/sliding phenomena (figure 46 image A). This is the result of processes related to neotectonic activity, the effect of which is the slumping or sliding of sediments (Ramprasad, et al, 2011). These features are usually manifested in the SSS data as linear creases that leave slump scars, and intermittently present strong backscatter returns (i.e. black colour) following the general direction of slope gradients over 2° (figure 46 image A) (Cifici, Dondurur and Ergun, 2002). The strong backscatter return pertains to the accumulation of sediment components, such as pebbles and piece of broken shells, composing an overall harder surface with an evident mild elevation marked by an acoustic shadow. The industry perceives these slump scars as evidence of weakened seafloor and loose sediments, that may potentially affect drilling operations (ibid., 1).

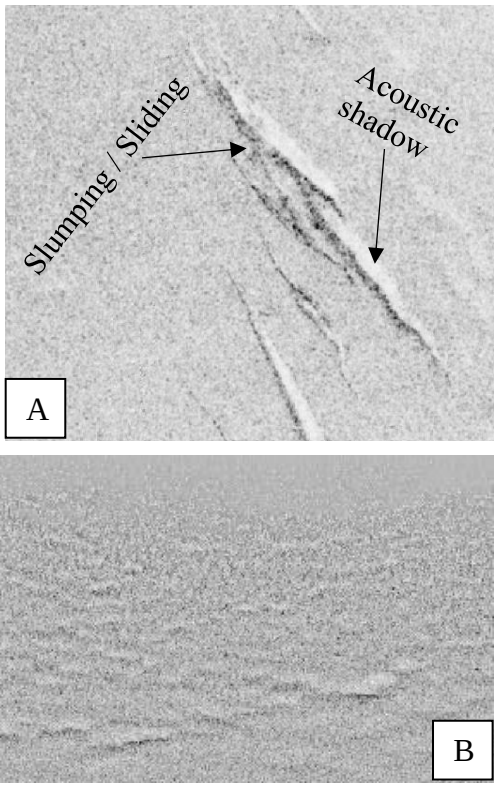


figure 46: Different soil effects manifested in the SSS data, with image A: exhibiting slumping/sliding effect; and image B: presenting evidence of soil creeping effect. Source: SSS image © DoAC.

Soil creeping effects, which are similar to slumping/sliding phenomena although milder processes, are also observed in the deep seas of Cyprus (figure 46 image B). Sedimentologists and hydrographers argue that unlike slump scars caused by neotectonics, soil creeping effects are the result of current activity and subsurface movements and subsequent releases of trapped fluid/gas (ibid., 3). The result of these processes is the mild creeping of the seafloor, which is usually manifested in extensive areas resembling small but consistent seabed fluctuations. Soil creeping effects are seen in the dataset as mild acoustic returns, similar to small cut-marks, following the general orientation of the sloping seabed (Huvenne, Blondel and Henriet, 2002). Both slumping/sliding and soil creeping effects presented in figure 46 were recorded in close proximity to a rocky outcrop mount. Figure 47 presents the rocky outcrop area seen here as a high backscatter return (dark), casting its' acoustic shadow (shown in white) onto a relatively less elevated area abutting a second rocky outcrop mount. In the upper part of figure 47 (marked in yellow) are lines, which Savini calls peculiarities in the sonograph resulting from lowering, raising or readjusting of the AUV machine —onto which the SSS was mounted— while surveying the deep seabed (Savini, 2011).

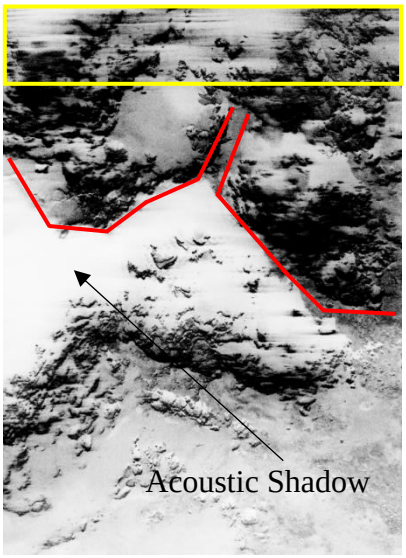


figure 47: A rocky outcrop mount casting an acoustic shadow abutting a second rocky outcrop mount. Peculiarities in the sonograph are marked in yellow. Source: SSS image © DoAC.

Additional features are illustrated in figure 48, which are observed in areas of steep or sloping geomorphology with a relatively smooth surface. Sub-cropping of hard sediments are manifested in the dataset as high acoustic reflection patch, covering an area of approximately 5

m^2, composed of a mixture of different sediment properties, such as gravels and gravelly sand and other outcropping rocks (Wheeler and Sutton, 2001). These resemble an anomaly with a relatively high backscatter with occasional stronger backscatter returns (seen in black) that represent the rocky outcrops and no acoustic shadow. The overall feature seen in figure 48 seems to follow a down slope orientation, creating flat linear marks on the seafloor, with a high acoustic reflection and rough texture. Sub-cropping of hard sediments are not particularly elevated from the overall seabed, thus no acoustic shadows are usually associated with this kind of features. These geological features are distinct and the pattern of anomalies can be confused with those produced by shipwrecks, especially when the SSS data are produced in low frequencies (cf. figure 49, underneath).

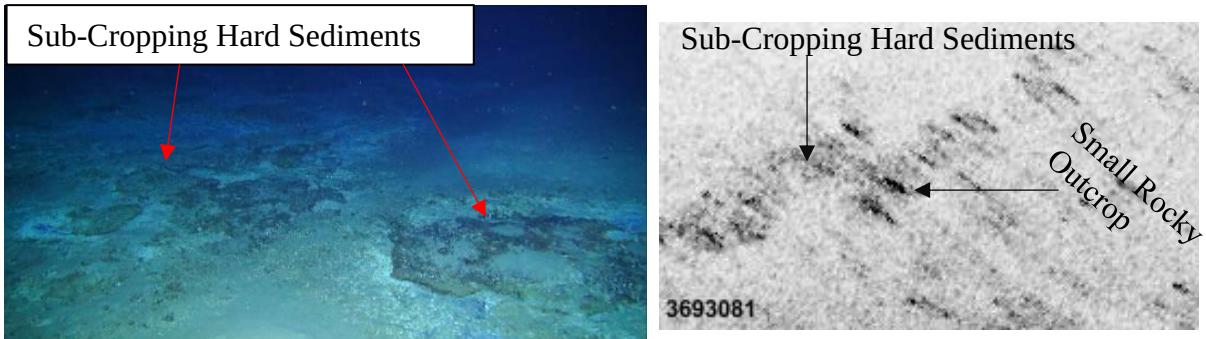


figure 48: The sub-cropping of hard sediments. Source: SSS and ROV images © DoAC.

[5.3.1.2].Shipwrecks with amphorae cargoes and geological features

Figure 49 shows the ancient wreck of 'Eratosthenes-Eni' (**Chapter 4**, The shipwreck site of 'Eratosthene-Eni', pages: 150-159) as initially manifested in the produced SSS sonograph. The image of the site was taken from Lighthouse S.p.A., 2017 Environmental Baseline report as the SSS dataset from the specific prospect site, at the time of the writing of this chapter, was still pending submission (Table 8, ENI 2017 (Block 8) 'Eratosthenes South', page 187). Even though the SSS data of figure 49 was generated at different resolution, lower frequency and with different machinery than from the 2018 ExxonMobil dataset, it reinforces Ferentinos et al argument that 'detecting ancient shipwrecks among other seafloor features using SSS, is not a straightforward procedure' (Ferentinos, et al, 2020, 1). This is because geological anomalies, such as rocky outcrops partially covered by sediment are almost indistinguishable from shipwreck with amphorae cargo. An example of this can be seen in figure 50 that was deemed by the subcontractor company of ExxonMobil, ROVOP Ltd[3], being of 'high archaeological potential'. It is worth mentioning that at the time of writing, the relevant ROV video-photography datasets have not been submitted to the DoAC (Table 8, ExxonMobil 2018 (Block 10) 'Anthea-1', page 188) and as result we can only speculate about the nature of the anomaly. What, however, remains crucial is that both figures 49 and 50 present similar

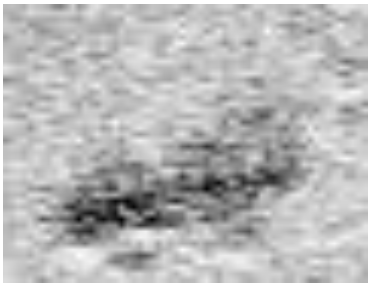


figure 49: The site of 'Eratosthene-Eni' as seen in the SSS data. Source: image from Lighthouse S.p.A. (2017). *Environmental Baseline Survey: Eratosthenes South (Block 8); Cuttlefish (Block 3); Calypso (Block 6)*. 30. [Unpublished]

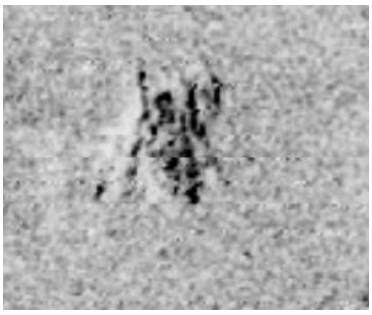


figure 50: A rocky outcrop partially covered by sediment. Source: SSS image © DoAC.

[3] For the ROVOP Ltd survey company refer to: https://www.rovop.com/ [accessed 15-04-2020].

characteristics, relevant to what Ferentinos et al defines shipwreck anomalies with amphora cargo being 'more or less of an oval shape, that is slight elevated from the seafloor, with high texture and high acoustic reflection' (Ferentinos et al, 2020, 8). Yet, according to Ferentinos et al, in order to be able 'to maximize the separation of potential shipwreck targets from other seafloor features', SSS data need to be produced at the highest possible frequencies, roughly 'around 900 kHz' (Ferentinos, et al, 2020, 8; Savini, 2011). In this instance, however, because the datasets produced in the context of EBS and Geohazard Investigation surveys, are generated at frequencies much lower than the aforementioned —roughly between 200 and 400 kHz— it seems rather unlikely that the industry will choose to develop SSS data at such high frequencies that require considerably more time to be produced (Ferentinos, et al, 2020). This is because in order to obtain the highest operational frequencies, the survey vessel needs to move slowly (ibid), which obviously has a cost implication in terms of the time taken to complete the survey. Inevitably, this means that the discovery of UCH relies upon ground truthing inspections, rendering visual inspection of all noted shipwreck-like anomalies or features of 'hight archaeological potential' necessary.

[5.3.1.3].Ancient and modern anthropogenic debris

The analysis below presents some of the anthropogenic debris discovered in the deep seas. These are included to show how modern and ancient debris are manifested in the SSS data. It is hoped that this can be the start of a visual atlas —'Atlas of SSS sonographs'— of such anomalies for the deep waters of Cyprus that can later be used by analysts working for the DoAC and also commercial companies who are responsible for interpreting SSS datasets. Clearly one of the key principals of this analysis from an archaeological perspective is how to distinguish between ancient and modern material in the SSS data. The following results reflect

a methodological process based on corelating the coordinates of a SSS anomaly with the coordinates seen on the accompanying ROV video. This aims to minimise any margin for error and provide a positive identification of each SSS anomaly. It does not contain entire shipwrecks as these have been studied above, whereas individual pieces of debris have not received the same attention in the academic literature before.

[5.3.1.3.1].Ancient pots, cooking vessels, and amphorae

This section presents an array of ancient scatter artefacts such as pots (Table 9), cooking vessels (Table 10) and both intact and broken amphorae (Table 11-14). This will give a full overview of how the most commonly discovered ancient ceramics are manifested in the SSS data. Together these encompass the full range of forms, conditions and orientations seen in the data presenting a full overview of such jettisoned material.

Table 9: Ancient pot as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

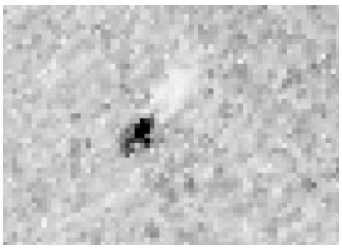
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): less than 0.5 metre Acoustic shadow (marked in white): less than 1 metre Additional information: This pot presents evidence of a high backscatter return (black) and exaggerated acoustic shadow. Due to the relatively small size of the pot, the given anomaly has a generic, largely unspecified outline, rendering it largely indistinguishable from any other geomorphological features. The exaggerated acoustic shadow is evidence of the emitted swath at perhaps a certain angle, or the ancient pot was situated on a slope.

Table 10: Ancient cooking pot as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

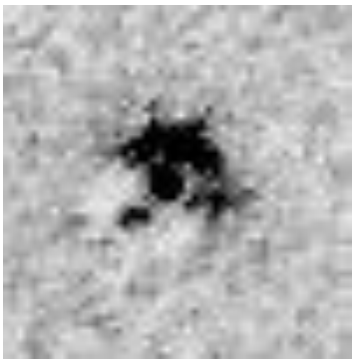
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): less than 0.5 metre Acoustic shadow (marked in white): less than 0.5 metre Additional information: The position of this cooking pot, sitting upright and intact on the deep seabed, is captured quite successfully in the dataset, presenting a high backscatter return (black) in the middle perhaps due to solid sediments accumulated inside of it. The high backscatter return of the pot recreates quite accurately the overall circular shape, and other features such as the rim area and handles.

Table 11: Intact amphora as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

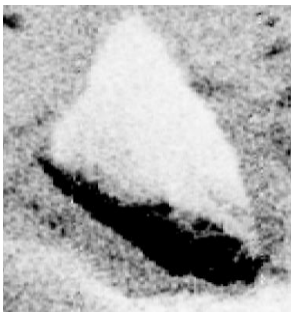
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): slightly larger than 1 metre Acoustic shadow (marked in white): approximately 2 metres Additional information: From this example it is reasonable to argue that when an amphora is surveyed sitting intact and completely exposed on a relatively flat seabed, it can potentially be manifested in the output SSS data in detail. The acoustic shadow seems to be exaggerated due to the diagonal orientation of the amphorae relative to the emitted SSS swath.

Table 12: Broken amphora as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

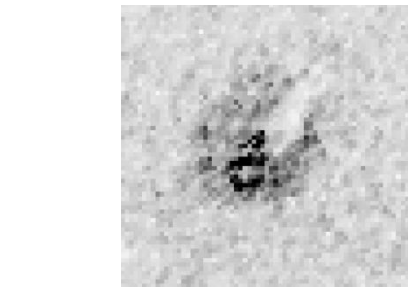
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): less than 0.4 metre Acoustic shadow (marked in white): less than 0.5 metre Additional information: These two pieces are perhaps parts of a single broken amphora. It appears that the majority of the body of the amphora is buried in the sediment with the neck and handle section broken off and displaced to the side. These pieces are clearly seen in the dataset, manifested in the shape of a circular and a tringle-like shape of high backscatter returns (black). The sediment around the two main acoustic shadows seems to present a stronger backscatter return (mild grey) pertaining perhaps to broken pieces of the amphorae mixed with the sediment.

Table 13: Intact amphorae as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

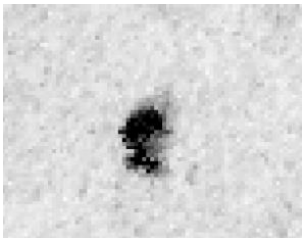
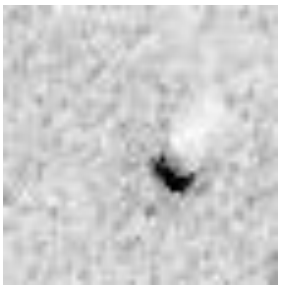
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): less than 1 metre Acoustic shadow (marked in white): none Additional information: From this example it is reasonable to argue that the amphorae presents a strong backscatter return throughout its entirety and no acoustic shadow, with this to be perhaps attributed to the direction of emitted acoustic pulses. This kind of insight pertains to the specific dataset analysed here, and specific orientation of the amphorae in relation to the emitted acoustic swath, noted to be situated on what appears to be a flat seafloor.

Table 14: Intact amphorae as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): less than 1 metre Acoustic shadow (marked in white): slightly larger than 1 metre Additional information: Similar to Table 11 the exposed amphorae is manifested in clear detail in the output SSS data. The amphorae presents a strong backscatter return recreating its overall circular shape. Additional detail, such as the neck and handless, are not clearly distinguishable in the datasets, perhaps because the AUV was flown at considerable distance from the target. The acoustic shadow seems to be exaggerated due to the diagonal orientation of the amphorae in relation to the emitted swath of the SSS machinery and its position on a slope.

[5.3.1.3.2].Modern debris and marine refuse

This section presents an overview of the most common modern debris and marine refuse discovered in the deep seas of Cyprus, and how these are manifested in the SSS data. The following pertain to an iron cable (Table 15), a barrel (Table 16), an iron barrel lid (Table 17), perhaps a discarded military equipment (Table 18), part of a fibre optic cable (Table 19) and a rubbish bag (Table 20), demonstrating how some of these objects are practically indistinguishable from ancient ceramic artefacts when not visually assessed.

Table 15: Iron cable as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

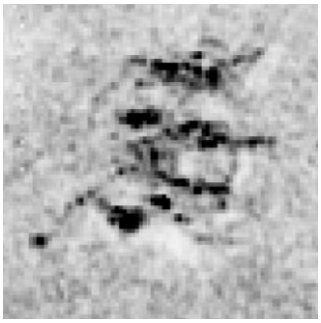
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): roughly covering an area of approximately 9,5 m^2 Acoustic shadow (marked in white): none Additional information: The iron cable presents linear high acoustic returns mostly when protruding from the deep seabed. When buried the iron cable is manifested in the datasets in the form of low-acoustic returns (in grey colour) of cable-like-outline.

Table 16: Barrel as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

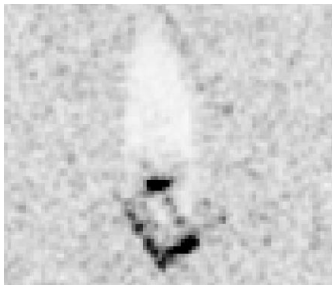
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): approximately than 1 metre Acoustic shadow (marked in white): approximately than 2 metres Additional information: The high backscatter return (black) clearly recreates the outline of the barrel. The acoustic shadow seems to be exaggerated due to the diagonal orientation of the barrel relative to the direction of the emitted swath of the SSS. This object presents similarities with the complete amphorae, displayed in Table 14, page 218.

Table 17: Iron barrel lid as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

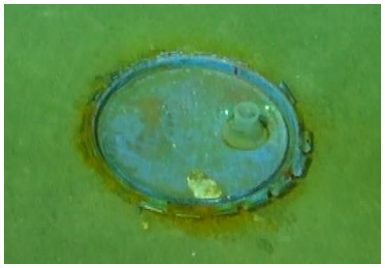
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): less than 1 meter Acoustic shadow (marked in white): none Additional information: The iron lid presents a high backscatter return (black) recreating its circular outline and a softer return in the middle. This object resembles similarities with the broken amphorae, displayed in Table 12, page 217.

Table 18: Perhaps military equipment with iron wire as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

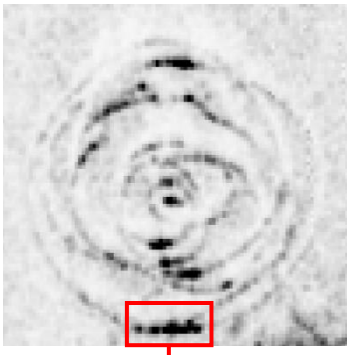
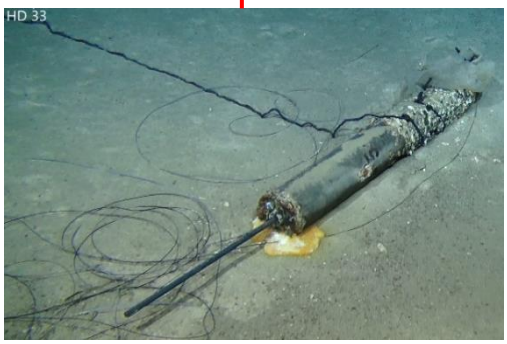
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): roughly covering an area of approximately 10 m^2 Acoustic shadow (marked in white): none Additional information: The iron cable attached to this military object presents a relatively strong acoustic return, when exposed, and leaves a cable-like mark in the form of a mild-acoustic return when buried (light grey, occasionally black). The iron object, that can perhaps be identified as an ammunition shell, it is manifested in the datasets in the form of a strong acoustic return with an overall rectangular shape.

Table 19: Fibre optic cable as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

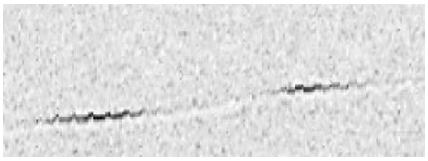
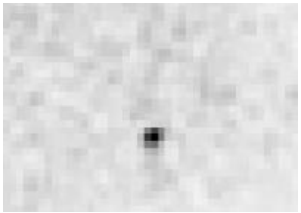
Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): roughly 3 metres Acoustic shadow (marked in white): none Additional information: Fibre optic cables present a mild acoustic return mostly when exposed on the surface, resembling a liner feature. When buried, they present low-acoustic returns (manifested in lighter grey sections in the SSS sonograph). Together, the exposed and buried sections of cable leave a linear mark on the seabed.

Table 20: Rubbish bag as seen in the SSS data, supplemented with ROV image. Source: SSS and ROV images © DoAC.

Images (SSS and ROV photograph)	Description
 	Size of the anomaly (marked in black): less than 0.5 m Acoustic shadow (marked in white): none Additional information: This high acoustic return does not present any distinct characteristics other than its circular shape, which unfortunately renders it similar to a variety of geological feature and archaeological objects. The high acoustic return of the rubbish bag may be perhaps attributed to its content of perhaps iron and aluminium litter. This object presents similarities with the intact pot, seen in Table 9, page 215.

[5.3.2].Side-Scan-Sonar concluding remarks

The analysis above has demonstrated that distinguishing geological anomalies from shipwrecks, as well as modern debris from ancient artefacts, is an issue that has no definitive answer. This is because data interpretation for each SSS survey are unique and largely depend on parameters related to data frequencies, the orientation of the emitted swath[4], and at what distances the AUV on which the SSS machinery was mounted, and flown from the deep seabed. In the examples above, the SSS data were acquired at high frequency between 369 - 451 kHz with the AUV flown between 30 to 40 meters from the deep seabed (ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018). The results evaluated here present adequate insights to the geomorphology of the area, but do not seem to portray a clear image of how shipwreck sites with amphorae cargoes can be distinguished from geological features, and how archaeological materials can be differentiated from modern debris. This is with the exception of metal objects and cables. Nevertheless, the discussion here makes it clear that the aforementioned 'Atlas of SSS sonographs' is necessary as it can provide the necessary insights for speeding up the process of anomaly characterisation, and in effect allow heritage resources to be more securely identified prior to ground truthing investigations using ROV video-photography.

From the specific dataset utilised here it can be suggested that SSS data generated in the future should be operating at data frequencies slightly higher than those seen in the case studies above. Ideally these should be in the range between 400 to 600 KHz, with the AUV operating between 20 and 30 meters from the deep seabed. This would produce better data clarity,

[4] Information pertaining to angle of the emitted swath of the SSS are not mentioned in the submitted ESHIA, EIA or EBS reports. It is my intention to address these factor in the near future, perhaps in the context of a postdoctoral study, by liaising with the contractor/subcontractor company, and the specific personnel who was responsible in generated the SSS data for the 2018 Anthea-1', 'Glaucus' and 'Pegasus' prospection projects.

rendering the process of distinguishing between modern and ancient debris, as well as shipwreck sites and geological features, perhaps being less ambiguous. This suggestion is compatible with BOEM's (2015) *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585* (BOEM, 2015, 8). However, this raises the question as to how additional much time will be needed to operate the SSS machinery at such frequencies and hence if doing so, will this add significantly to the overall costs of the surveying company? In my opinion, because these suggestions were made by BOEM, which has set the most effective industry by-standards for the protection archaeological/historic assets by oil and gas operations (**Chapter 6**, Review of Archaeological by-standards and offshore oil and gas operations, pages 249-258) and is also outlined in the general guidelines of NOAA's, 2017, *Hydrographic Surveys Specifications and Deliverables*, it is suggested that while generating SSS data at frequencies between 400 to 600 KHz will add some time to the survey, and hence cost, it is an overall fair and reasonable mitigation strategy for the adequate survey, discovery and thereby preservation by record deep sea UCH. It is also one that is accepted practice for contractors working in waters overseen by BOEM and as such could similarly be implemented in Cypriot waters.

[5.3.3].Multibeam-Bathymetry and Backscatter data

A multibeam-bathymetry echosounder system (MBES) emits swaths of acoustic sound pulses onto the seafloor and calculates the speed and travel time of the returning sound pulses (echo) back to the MBES system (Zakariya, et al, 2018). From each swath of acoustic pulses, bathymetry and backscatter measurements are collected concurrently, where 'the delay between sending the signal from the transmit arrays and receiving the acoustic returns provides a measurement of ocean depth, or bathymetry data' and by extent provides a relief image of the

sea floor'; whilst the strength of the returning signal –the backscatter[5]– provides an indication of how hard the seafloor is (Geoscience Australia, 2018). The data output of the MBES systems produces images of the relief of the seafloor, where bathymetry presents information relevant to the seafloor topography and geological environment; and backscatter provides insights to seafloor characterisation relevant to the roughness and textural parameters (i.e. rock, mud, sand) (Parnum and Gavrilov, 2011; Dartnell and Gardner, 2004). When produced at the appropriate frequencies, these datasets can also provide information relevant to anthropogenic features (i.e. shipwrecks) and environmental characterisations (i.e. coral reefs) (Sen, et al, 2016; Chakraborty and Fernandes, 2012). This, however, depends on parameters such as data frequencies, and data resolution and analysis, where the output MBES data are generated and latterly manifested in the formatting of individual points, also known as pings, by which the spacing between each ping composes the general resolution of the relief (Sen, et al, 2016). The closer the points are to each other, and by extent the greater quantity of them, the better the resolution is. Each ping contains X, Y, Z data, where X and Y stands for the exact geographical coordinate and Z to the measured bathymetric value. Other parameters such as the beam width of the system, the associated footprint on the seafloor, the pulse repetition rate, and vessel speed over ground, are equally important factors for determining that data are collected at the best resolution achievable by the system. These are complicated factors that require technical expertise and depend on project specification. Unfortunately, at the time of writing information pertaining to these parameters were not provided in any of the associate EIA and ESHIA reports and as a result will not be addressed here. The following analysis aims to present the MBES and

[5] For more information pertain to how backscatter returns are manifested in the datasets, refer to the Side-Scan-Sonar (page 203) and Side-Scan-Sonar geological features and seabed geomorphology (pages 204-212) sections above.

backscatter data of the 'Anthea-1' prospect area (Figure 51, page 226) generated by ExxonMobil in 2018. This was done with an EM2040 Multibeam Kongsberg system, mounted on an AUV, at frequencies between 200 and 400 kHz with a data resolution of 1 point at every 3 metres. Similar to the SSS data, the AUV was flown at a distance between 30 to 40 metres from the deep seafloor. This particular dataset was selected primarily because it presents an overall dynamic geomorphology with different geological features, composed by both rough and soft sediments, and backscatter anomalies with characteristics of 'high archaeological potential'. As will be demonstrated underneath, the MBES and backscatter data of the prospect site of 'Anthea-1' corelate also to specific geological and topographical features examined in the previous section on SSS data. This I believe adds to the overall results evaluated in previous sections of the chapter as specific features (such as: creeping soil effects, eyed or 'intrapockmarks', and rocky outcrops) are viewed in the context of both SSS and MBES and backscatter datasets. The analysis below seeks to present the dataset in 2D first, followed by a map export composed of backscatter data superimposed on the MBES (Figures 51 and 54, pages 226 and 233, respectively). The analysis seeks to deliver insights into seafloor geomorphology, topography and seabed characterisation and aims to clarify whether the evaluated data were generated at the appropriate frequency to identify possible shipwreck sites.

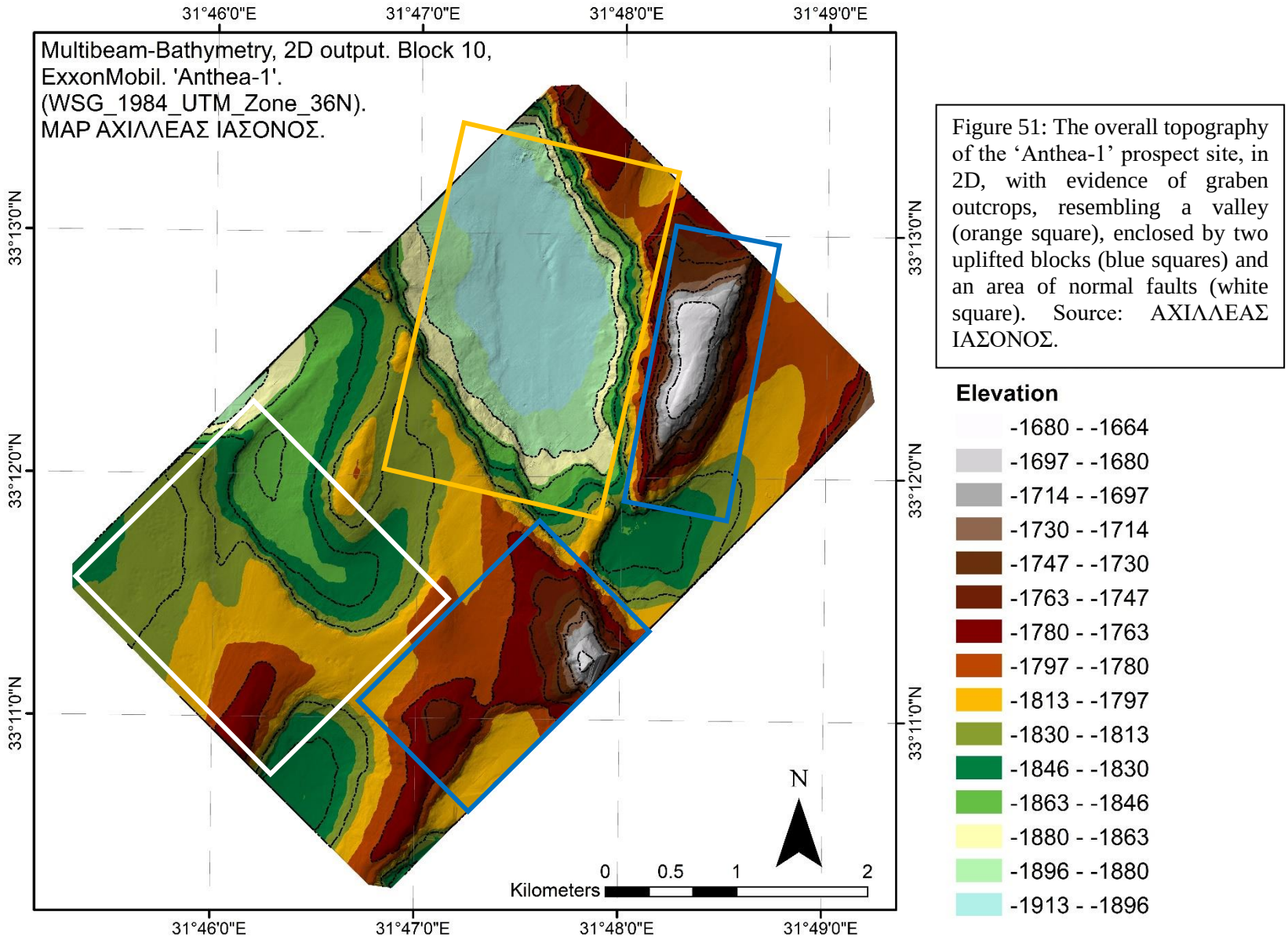


Figure 51: The overall topography of the 'Anthea-1' prospect site, in 2D, with evidence of graben outcrops, resembling a valley (orange square), enclosed by two uplifted blocks (blue squares) and an area of normal faults (white square). Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[5.3.3.1]. 'Anthea-1' prospect site

Figure 51 presents the 2D results of a Triangulated Irregular Network (TIN) model processed in ArcGIS and provides information relevant to the surface topography and morphology of the wider prospect area of 'Anthea-1' (Figure 40, page 202) (Marks, et al, 2017). The analysis shows an area of fluctuating bathymetry from approximately 1,600 to 2,000 metres below mean sea level, with a seafloor slope roughly less than 3° dipping west to northwest. The overall topography of the block illustrates a relatively gentle westward slope at water depths ranging between approximately 1,700 and 2,550 metres, enabling speculations that the adjacent area, currently not surveyed, may be of flat and even topography (ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018). Slopes greater than 15° are present approximately 300 metres to the east where the western flank follows a north to northwest direction. In the northeastern section of the dataset evidence of trending graben outcrops are observable (marked in orange and blue, Figure 51), resembling characteristics of a valley, enclosed by two uplifted blocks referred to as horsts (i.e. escarpments, or cliffs, marked in blue in Figure 51). This geological phenomenon is the result of tectonic plates being pulled apart, the outcome of which is the creation of tension cracks on the seabed resulting in the development of normal faults. This leads to blocks of the Earth's crust dropping down (Figure 51, squared in orange), thus forming valleys or grabens, whereas the uplifted blocks form linear mountain ranges, or horsts (Figure 51, squared in blue) (Nelson, 2015). The area delineated in white on Figure 51 presents a geologically more stable seafloor, with an amplitude varying

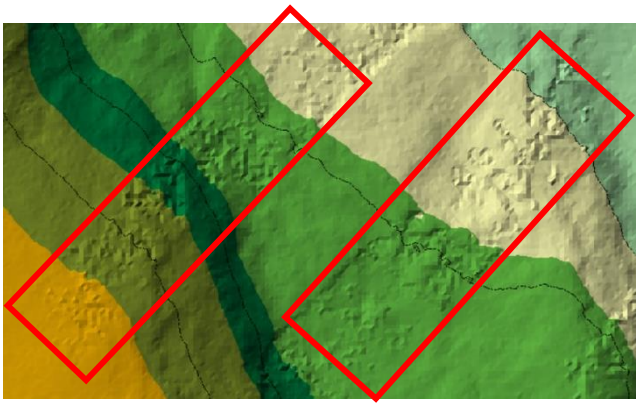


figure 52: Evidence of landslides (red squares) following the direction of the seabed's slope. Screenshot taken from Figure 51: The overall topography of the 'Anthea-1' in MBES.

from -1747 to -1846 metres and evidence of normal faults (ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018c). The term ‘normal fault’ describes a rupture in the earth’s crust, the result of which is the creation of fluctuating topography of occasional slopes, that quite frequently present evidence of landslides or creeping soil effects composed of a mixture of soft and harder sediments, occasionally consisting of eroded boulders (Figure 52, squared in red) (USGS, 2020).

A closer look into the dataset presents evidence of at least three different areas, covering roughly between 40 m² to 55 m², with groups of circular micro-depression features. These micro-depressions vary in diameter between 30-40 metres and can be seen primarily in the southwest area of the prospect site (figure 53 screenshot A). In addition, at the eastern end of the dataset, there is evidence of small-mount-like-structures with an approximate diameter ranging between 15 to 22 metres (figure 53 screenshot B). Zooming in, these features appear as if they have a concave crater-like depression in the middle, characteristics of eyed pockmarks (figure 44, page 208). Finally, at the northeast end of the dataset, figure 53 screenshot C displays features of what seems to be rocky outcrops projecting from the flat seabed creating an uneven surface of fluctuating bathymetry. This covers roughly 670 m² with these features projecting roughly between 10 to 17 metres from the seabed.

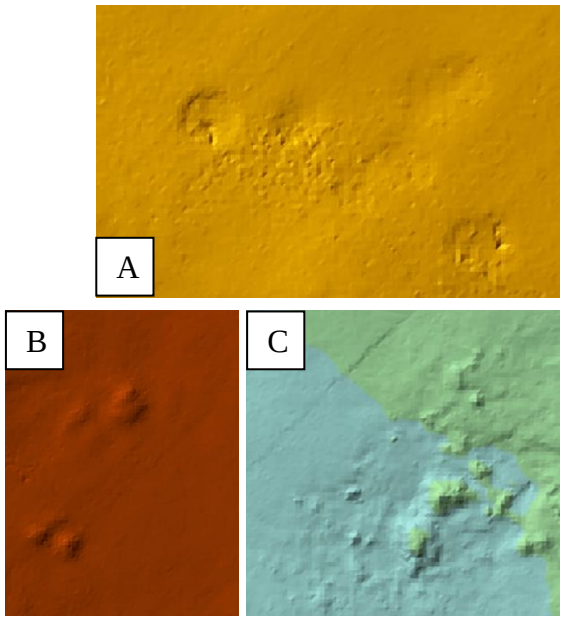


figure 53: Screenshots A, B and C presents the main anomalies seen in Figure 51: The overall topography of the ‘Anthea-1’ in MBES data.

Figure 54 (at the end of the section) presents further analysis into the wider topography of the ‘Anthea-1’ prospect site, illustrating backscatter data superimposed onto MBES the TIN model, with the transparency set at around 30%. The purpose of this is to reveal insights into

the character of the broader seafloor, and the already noted anomalies, supplemented by bathymetric information, for verifying or adding information about possible features of 'high archaeological potential'. The results from this analysis suggest that the sediments of the displayed prospect site are composed of similar amounts of sand, silt and clay with them being evident from the weak acoustic return (low backscatter, mid-grey) covering the majority of the entire area. This is with the exception of the two main protruding horst blocks and the two areas of normal faults squared in red on Figure 54, page 233. These features are seen in the backscatter data showing strong returns (i.e. are black in colour) of evidence of rocky outcrops and protruding cliff edges. On top of the southeast protruding horst, the dataset appears to show evidence of a plateau-like surface composed of hard surface textured sediments, such as a mixture of silt/sand, gravel and shell fragments. This is apparent from the high acoustic return seen in the dataset (ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018c; Jongmin, et al, 2020). Additionally, the west and southwest section of Figure 54 marked in yellow and blue, reveals evidence of soil creeping effects covering an area of 400 m^2 and 410 m^2 respectively. This feature is manifested in the dataset as a low-acoustic return presenting mild fluctuations in the bathymetry of the area. This casts a mild acoustic shadow, resembling a notable scar on the deep seafloor. The features illustrated in Figure 54 reveal that the micro-depressions of figure 53 screenshot A are primarily composed of soft sediments, with this being also the case for the small-mount-like-structures shown in figure 53 screenshot B. When comparing this with figure 53 screenshot C the backscatter data presents evidence of a much harder seafloor, verifying that indeed these features are protruding rocky outcrops.

A closer view into Figure 54 reveals evidence of one area of high acoustic return, seen in the northeast section of the dataset. A zoomed in view of this is presented in figure 55 image A. The acoustic anomaly noted in this figure presents evidence of what appears to be a rocky

outcrop covering an area of roughly 700 m², with the bathymetry suggesting that these features are protruding from the seafloor between 2 to 5 metres. Of notable interest, however, is the feature square in purple (figure 55 image A). This is zoomed in figure 55 image B and was suggested as a possible shipwreck target with an amphora cargo by the subcontractor survey company. In the absence of ROV video-photography data (Table 8, ExxonMobil 2018 (Block 10) 'Anthea-1', page 188), the analysis presented here suggests that figure 55 image B possesses characteristics compatible with those that Ferentinos et al and Savini recognise as a 'shipwreck-like' anomaly (Savini, 201; Ferentinos et al, 2020). For instance, the overall oval shape, the high texture and acoustic reflection, and the general size of this anomaly, as well as its overall size (15 metres long and roughly 4 metres wide and roughly 1 to 2 metres elevated from the seafloor) are parameters that suggest that the anomaly is compatible with most of the characteristics of a shipwreck site with an amphora cargo. Adding to the potential identification of this feature as a shipwreck is the acoustic shadow, outlined in red in figure 55 image B, which is the result of the reflection and/or absorption 'of the sound on the amphorae (clay) surfaces that are apparently stacked in layers and from the voids between them' (Ferentinos, et al, 2020, 6). Even though the data do not show the anomaly in absolute clarity, the analysis has shown that this target can be suggested with some confidence as being of 'high archaeological importance'.

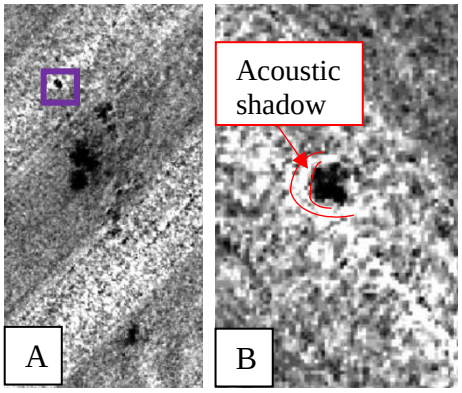


Figure 55: Images A and B present evidence of a rocky outcrop area with: Image B zooming into a high acoustic anomaly of a possible target of 'high archaeological potential' (marked in purple). Screenshot taken from Figure 54: The overall topography of the 'Anthea-1' in MBES data with backscatter data superimposed.

This section has revealed that MBES and backscatter survey undertaken in the context of oil and gas operations are developed to address industry concerns primarily related to

drilling. For this reason, the output data are best suited for characterising the seafloor at quite a large scale. From the MBES in particular and the associated backscatter data, the analysis has shown that it is also possible to also note targets of 'high archaeological importance', yet this depends on whether the contractors/subcontractors are prepared to investigate the particular dataset in sufficient depth. Ideally, this can be achieved through the Survey by-standards set in **Chapter 6**, and the mandatory development and submission of an Archaeological Impact Assessment (AIA). The purpose of this AIA study is to ensure that SSS, MBES and backscatter dataset are studied in detail (and from a maritime archaeological perspective) so as to demonstrate whether UCH assets were discovered or not. To successfully address this, however, the data analysis undertaken here indicates that SSS, MBES and backscatter dataset should be generated at considerably higher frequencies and resolution than is commonly the case in oil and gas surveys. If this is not possible, another solution to this could be that national heritage agencies should request from contractors/subcontractors to employ specialists with experience in successfully discovering archaeological/historic assets from geophysical datasets to undertake the writing of the AIA. The best, albeit the most expensive solution would see a visual inspection of every geophysical anomaly seen in both SSS and MBES and backscatter datasets and deemed of 'high archaeological importance' (survey level 1, by-standard 09, pages 273-274).

[5.3.4].Multibeam-Bathymetry and Backscatter data concluding remarks

The data from the 'Anthea-1' prospect site illustrated in Figures 51 and 54, as well as the specific features presented in Figures 52, 53 and 55, suggest that both the MBES and backscatter data were generated at frequencies and resolution compatible with the identification of anomalies with an overall size greater than 3 metres. This suggests that the 2018 ExxonMobil datasets, which were generated with an EM2040 Multibeam Kongsberg system, mounted on an AUV operating between 30 to 40 metres from the seabed, at frequencies

between 200 and 400 kHz and with an output resolution of 1 point at every 3 metres can be used as a *minimum* standard for contractors/subcontractors in the future. As argued above, the resolution and frequency of the dataset is adequate for the purposes of seafloor characterisation, topographical identification, and geohazard investigation. Yet, for the purpose of effectively discovering archaeological/historic sites, the analysis has shown that this is quite difficult as there is a level of ambiguity between distinguishing whether an anomaly is of archaeological or geological character. In my opinion, the most practical and perhaps cost-effective solution to this should be the mandatory ground truthing investigation of any noted geophysical anomaly deemed of 'high archaeological importance' or 'shipwreck-like' character and this is set as a precondition in survey level 1 by-standard 09 of **Chapter 6**, pages 273-274. Such a mitigation strategy would remove any concerns over the unintentional destruction of possible sites of archaeological/historical interest, as well as those of environmental or geological importance, by offshore drillings.

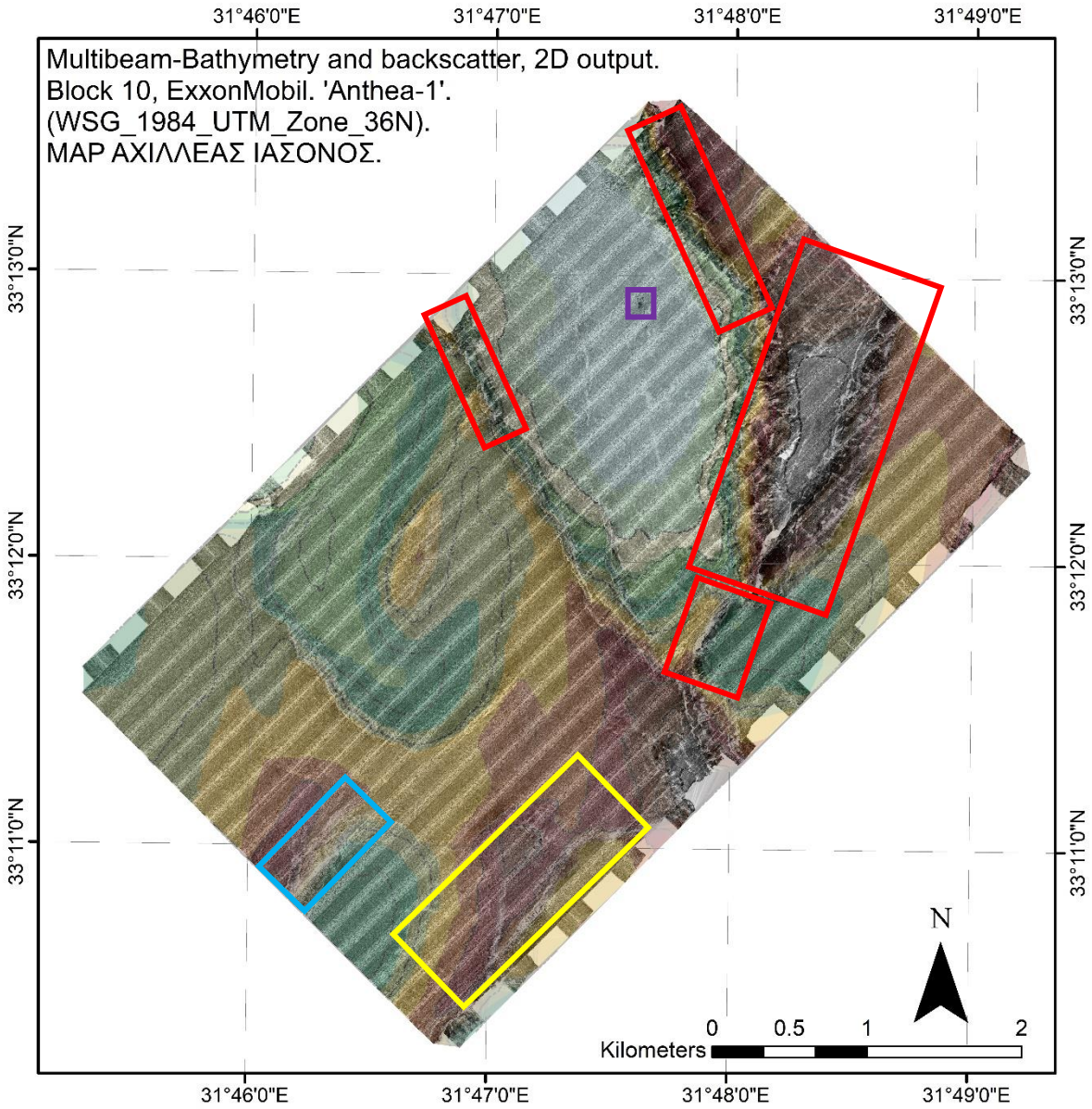


Figure 54: The wider topography of the 'Anthea-1' prospect site, with the backscatter data being superimposed onto MBES data. This analysis reveals insights into the broader character of the seafloor and on features of 'high archaeological potential'. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

Elevation

- -1680 - -1664
- -1697 - -1680
- -1714 - -1697
- -1730 - -1714
- -1747 - -1730
- -1763 - -1747
- -1780 - -1763
- -1797 - -1780
- -1813 - -1797
- -1830 - -1813
- -1846 - -1830
- -1863 - -1846
- -1880 - -1863
- -1896 - -1880
- -1913 - -1896

[5.4].Conclusion

This section has provided a unique insight into how the oil and gas industry generates geophysical and ROV video-photography datasets and has argued that such datasets should be purpose-driven beyond simple seabed characterization and geohazard investigation. More specifically, the analysis of ROV video-photography dataset has shown serious inconsistences both in terms of the survey parameters and machinery used, revealing that in the absence of any specifications contractors/subcontractors operating in the EEZ of Cyprus are free to choose how, in what ways, and with what kind of camera and lighting system to conduct visual inspections of UCH. This yields problematic results that considerably limit how much archaeological information can be deduced from any UCH sites discovered accidentally during the course of offshore oil and gas operations.

With regards to geophysical datasets, this chapter has shown that SSS data generated at high frequency between 369 - 451 kHz with the AUV operating between 30 to 40 meters from the deep seabed are of adequate resolution to produce a detailed image relief of the seabed and reveal geological and geohazard anomalies, modern and ancient debris as well as man-made and shipwreck-like features. According to Ferentinos et al and Savini, however, in order to be able to distinguish clearly potential shipwreck targets from other seafloor features, SSS data need to be produced at the highest possible frequencies, roughly ‘around 900 kHz’ (Ferentinos, et al, 2020; Savini, 2011). Unfortunately, generating data at such frequencies is unfeasible in NRS activities, as these high frequencies take time to generate, which is likely to affect the strict operational framework of the industry. For this reason, the analysis suggested that SSS data should ideally be generated at data frequencies between 400 and 600 KHz. This is in accordance with how the industry currently operates at best, with the AUV flying roughly between 20 and 30 metres above the deep seabed. This would give better data clarity, rendering the process of distinguishing between modern and ancient debris, as well as shipwreck sites

and geological features, less ambiguous. This suggestion is in compliance with BOEM's (2015) *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585* (BOEM, 2015, 8) and NOAA's (2017) *Hydrographic Surveys Specifications and Deliverables.*

Finally, the analysis of MBES and backscatter data has shown that dataset generated with an EM2040 Multibeam Kongsberg system, at frequencies between 200 and 400 kHz and a data resolution of 1 point at every 3 metres, with the AUV flying at a distance between 30 to 40 metres from the seabed is ideal for the purpose of seafloor characterisation and topographical identification, and for geohazard investigation but less suitable for the effective characterisation of archaeological/historic assets. This has been demonstrated in this chapter, with ExxonMobil's 2018 dataset outlining the *minimum* technical[6] requirements for generating datasets in the near future, with this being relevant to the operational frequencies of the machinery, output resolution of data and flying distance of the AUV from the seafloor. In order to improve the results of this study and generate MBES and backscatter data that can effectively reveal deep sea UCH, the study concludes that it may be best to produces this dataset at operational frequencies ranging from 250 to 550 KHz with a resolution of 1 point every 2 or 3 metres, if not better. This is in accordance with the International Hydrographic Organization, (IHO) *Standards for Hydrographic Surveys* 6th Edition, 2020, publication, Order 1a Survey Standards and NOAA's (2017) *Hydrographic Surveys Specifications and Deliverables* document and BOEM, (2015) *Guidelines for Providing Geophysical, Geotechnical, and*

[6] The analysis of the MBES and backscatter does not account for other more complicated factors, such as the range and angle of the swath (for generating MBES data) and the angular dependence of the backscatter strength. Addressing these factors requires more research and liaising further with the contractor/subcontractor companies, and the specific personnel who were responsible for the MBES and backscatter survey, as information pertaining to these are not mentioned in the submitted ESHIA, EIA or EBS reports. It is my intention to address these factors in the near future, perhaps in the context of a postdoctoral study.

Geohazard Information Pursuant to 30 CFR Part 585. As a general suggestion, the results from this section postulate that the development and thereby analysis of MBES datasets should be always accompanied with backscatter data. This pertains to detecting features/anomalies of 'high archaeological potential' or 'shipwreck-like character' with improved clarity, and distinguishing between modern and ancient debris, shipwreck sites and geological features, as well as characterising the seafloor morphology and geology, and sediment distribution with less ambiguity. The suggestions deriving from this section inform the survey levels and the associate minimum professional by-standards seen at **Chapter 6** and should be viewed as a work in progress.

6.POLICY RECOMMENDATIONS(Survey Levels and Minimum Professional by-standards)

"Because industrial applications underwater are still in their infancy, the extensive rules and regulations for comparable onshore work is still mostly lacking. […] One must therefore take care and introduce sound and defensible standards, similar to those imposed on land to be proud of—rather than fear future judgments on the industrial use of the ocean"
(Fredrik Søreide, 2013, 1014).

[6.1].Introduction

In the absence of minimum professional survey by-standards for oil and gas operations in the national waters of Cyprus, **Chapter 5** demonstrated that geophysical datasets generated by different contractors/subcontractors during the course of oil and gas activities have different sets of standards regarding the production and submission of datasets to the national heritage authority. Similarly, the submitted data from visual inspections of archaeology/historic assets discovered during natural resource surveys (NRS) demonstrated that deep sea Underwater Cultural Heritage (UCH) is inadequately surveyed. In the light of these observations, it is necessary to develop and implement specifications to promote a standardised methodology for regulating how offshore oil and gas contractors/subcontractors, produce, submit and interpret geophysical datasets from the perspective of maritime archaeology, and also how ROV inspections should be conducted in order to *maximise* the potential for discovering, adequately surveying and thereby preserving by record and *in situ* archaeological/historic assets.

In order to deliver such specifications, however, it is essential to first understand how offshore oil and gas companies operate and when exactly heritage agencies, environmental consulting companies or maritime archaeological consultants can become involved and oversee the operational activities that may lead to the unintentional discovery of archaeological/historic assets. This will be evaluated first, followed by a review of how offshore operations (i.e. drilling, or pipeline laying) constitute a threat to the *in-situ* preservation of deep sea UCH. To see how this issue is addressed, a review of pre-existing

archaeological by-standards, geophysical/geotechnical and upstream operational guidelines[1] will be undertaken, the aiming being to deduce information and insights pertaining to the end objective of the chapter, that is the development of the survey levels and the associate minimum professional Survey, Data Submission and Reporting archaeological by-standards that oil and gas contractors must meet preceding the drilling of well(s).

The purpose of developing such guidelines is to provide an operational framework that is likely to benefit the discovery, survey, reporting, and *in situ* preservation and preservation by record of archaeological/historical assets found in the wider prospect area(s), with limited additional field survey cost. Thus, the following by-standards were developed according to different levels of surveys and provide the technical and methodological specifications necessary for *maximising* the potentials of discovering UCH in the wider prospect area(s); and set the preconditions necessary as to how UCH assets should be surveyed and thereby preserved by recorded when discovered as a by-product of NRS activities. It is suggested that the adoption of the following survey levels and by-standards enclosed therein will ensure that historical/archaeological preservation issues or concerns are taken into consideration at an early stage of offshore oil and gas projects, thus safeguarding the interest of the stakeholder heritage agency, namely, the Department of Antiquities Cyprus (DoAC) (BOEM, 2017). Ideally after the completion of the study, these should be implemented in the 'regulatory administrative acts of 2022' of the 'Antiquities Law of Cyprus' or will help to further define the generic Scope of Work (SoW) set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus,* which stipulates that Desk

[1] The term upstream operational guidelines, here, refers to 'good practices' documents for conducting geophysical and hydrographic surveys during the course of oil and gas operations. The term also encompasses geotechnical specification relevant to survey procedures prior to the drilling of wells (i.e. *Development* phase), and other operational guidelines relevant to the installation of pipelines or the installation of the anchors of the drilling ship/rig for the *Production* phase (Figure 56).

Based Assessments should address 'specific concerns (archaeological artefacts, marine protected areas, fishery restricted areas, cables, pipelines, *et cetera*)'.

The final part of this chapter will give account to issues and challenges related to archiving submitted data and some of the future directions for the Cypriot heritage agency to consider for ensuring the effective management of both the database and (geo)databases produced in this project. The objective is to put forward a strategic model for the sustainable management of the project's databases ensuring that these rare and expensively acquired datasets are appropriately archived through which they will be effectively preserved into the foreseeable future.

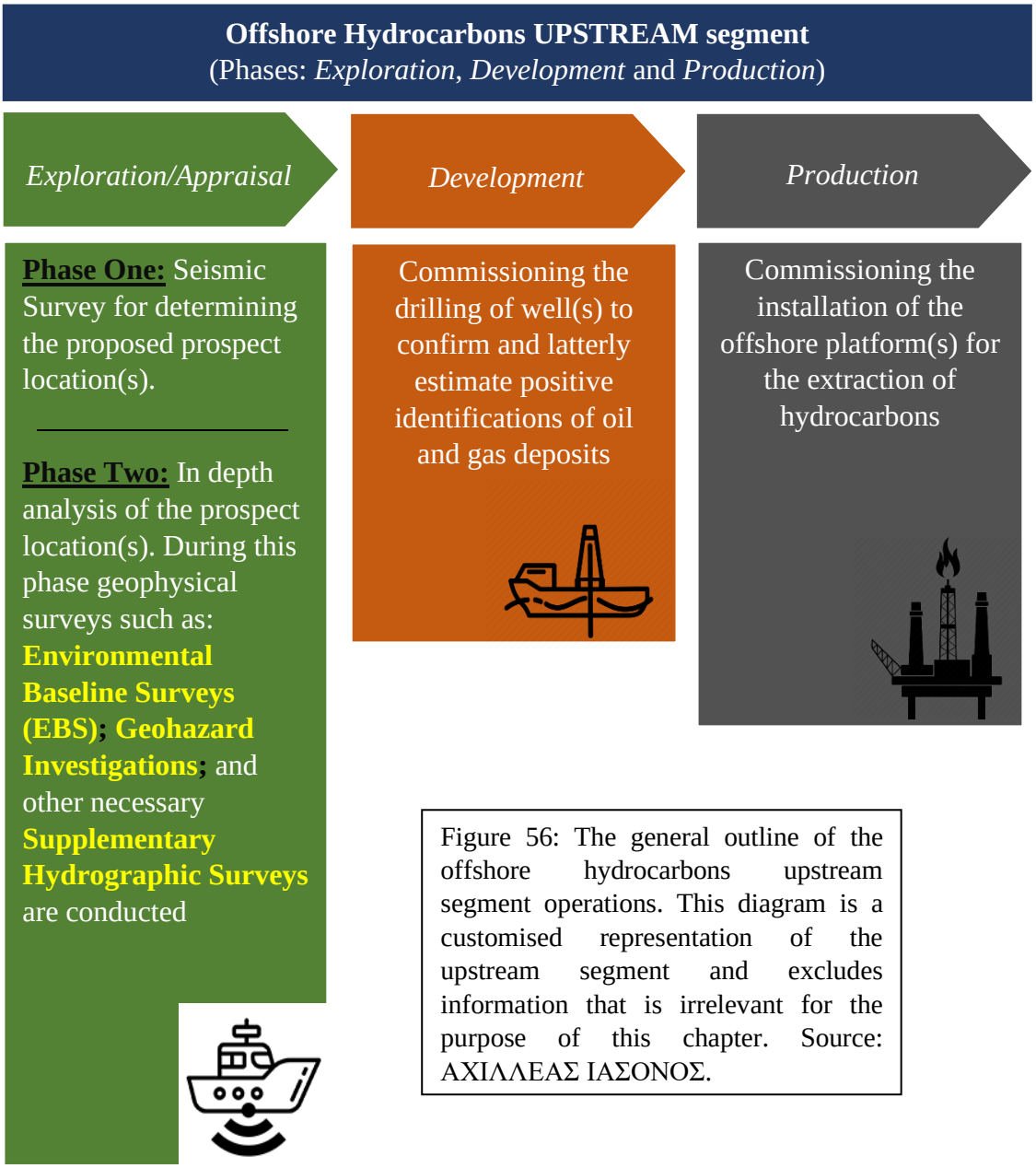


Figure 56: The general outline of the offshore hydrocarbons upstream segment operations. This diagram is a customised representation of the upstream segment and excludes information that is irrelevant for the purpose of this chapter. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

[6.2].The operational framework of upstream hydrocarbons and the discovery of archaeological/historic assets

The operational framework of the offshore oil and gas industry is highly technical and sophisticated, and involves different contractors/subcontractors, stakeholders, agencies, consultants, and specialists. It is divided into three broad segments —upstream, midstream, and downstream— in which different substages of operational functions occur (Niven and McLeod, 2009). This chapter will examine the upstream segment, with the aim of providing information specifying at which phase UCH assets may be accidentally identified and surveyed (Figure 56, *Exploration/Appraisal* phase). This information is relevant to national heritage agencies, environmental consulting companies, and maritime heritage consultants, who wish to implement the survey levels and the associate by-standards and thereby abide to the best archaeological practices that are explicitly applicable to the operational framework of oil and gas operations and aim to ensure the adequate discovery, survey, reporting, data submission and *in situ* preservation and preservation by record of any UCH assets found accidentally during the process of NRS. These specifications are presented at the end of the chapter.

Figure 56 presents the operational framework of the upstream segment of offshore hydrocarbons as evaluated in the European Commission's, 2019 document on *Best Available Techniques, Guidance Documents on Upstream Hydrocarbon Explorations and Production.* It shows the overview of the upstream segment divided into three major phases, *Exploration/Appraisal*, *Development* and *Production*, and is supplemented by information pertaining to the main operational tasks taking place during each phase. The diagram above is a customised representation of the upstream segment and excludes information that is irrelevant to the purpose of this chapter (European Commission, 2019).

6. POLICY RECOMMENDATIONS (Survey Levels and Minimum Professional by-standards)

The *Exploration/Appraisal* phase of the upstream segment has two main phases to its workflow. Phase 1 (*Exploration*) entails a seismic survey (or seismic data interpretation) which aims to narrow down specific locations where prospection drilling will take place. In the case of Cyprus, seismic data were acquired by Petroleum Geo-Services (PGS Marine) both in 2D and 3D formats (and more recently in 4D) 'in which their full rights returned to the Republic of Cyprus upon a contractual termination, or relinquishment of a licensed area' (Cyprus Hydrocarbons Company, 2020b). The seismic data can be purchased 'by existing licensees within active license areas' and are analysed to determine the most promising location(s) of 'trapped' hydrocarbons (ibid) (Figure 56).

For specific prospect locations, a second *Appraisal* phase of Environmental Baseline Survey (EBS) and Geohazard Investigations [or other types of Supplementary Hydrographic Surveys] is usually subcontracted to marine survey company(ies) who undertake geophysical surveys via different techniques. These include surveys using Remotely Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV), mounted with geophysical equipment such as: multibeam-bathymetry-echosounder (MBES) and backscatter-data, side-scan-sonar (SSS), and sub-bottom profiler (SBP) (Woods Hole Coastal and Marine Science Centre, 2019; Burguera and Oliver, 2016). With the completion of these geophysical surveys, further ground truthing investigations take place via ROV video-photography. If potentially viable reservoirs are confirmed, further activities during *Development*, such as the drilling of wells and sampling follows, seeking to better estimate the size of the hydrocarbons field (European Commission, 2019). The data generated during the *Exploration/Appraisal* phase are studied and developed in Geohazard Investigation and Environmental Baseline reports, and latterly integrated in the final Environmental Social Impact Health Assessments (ESHIA) or Environmental Impact Assessments (EIA) reports, primarily for the purpose of determining the most suitable location(s) for drilling and minimising any risks to the environment.

6.POLICY RECOMMENDATIONS(Survey Levels and Minimum Professional by-standards)

The purpose of these localised-hydrographic-surveys (i.e. EBS and Geohazard Investigations) varies greatly, as different kinds of survey machinery are utilised to meet the distinct aims and objectives of each (Sutton, Mine, and Canovas, 2004). An EBS usually combines a review of the available literature, conference proceedings, data synthesis efforts and grey literature, and also includes the results of field data collection techniques such as sampling (ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018). The bulk of the data usually derives from videos and photographs illustrating the deep seabed, where a ROV is usually utilised to conduct predetermined survey-line paths adjacent to the well area(s) (Figure 36, **Chapter 5**, page 191). These seek to add information pertaining specifically to the marine biodiversity and ecosystem adjacent to the well site(s) (Carmichael, Blackmore and Nunan, 2009). Additional sampling methods include, marine mammal observations, acoustic monitoring and collection of sediment, and water column and sediment sampling (ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018b). The emerging EBS report aims to comprehensively determine the character of the prospect area(s) and register all known environmental conditions that affect or could be affected by drilling (Horizon Geosciences, 2020). It seeks to address the physical, chemical and biological baseline environmental conditions and, based on the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus*, it should also evaluate information pertaining to archaeological/historic assets (European Commission, 2019; ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018b; Ministry of Agriculture, Rural Development and Environment, with the input of the Departments of Environment and Fisheries and Marine Research, Cyprus, 2017, 5). The results of an EBS play a fundamental role in developing the final EIA or EHSIA reports. Here an assessment is made of the environmental impacts arising from a proposed development, as well as other related socio-economic parameters related to the operational framework, the end outcome

being the proposition of a set of solutions to reduce the project's impact on the environment [and heritage] (ibid).

A Geohazard Investigation survey [and any other Supplementary Hydrographic Surveys] aims to determine the nature and character of the seabed and the subsoil and secondly to note, and hence avoid, any potential nearby geohazards. The purpose of this survey and the report produced is to identify and delineate all potential geohazards that could negatively impact the safety, integrity, and efficiency of the drilling operations. The output report is a site-specific evaluation based on geophysical, geological, ROV video-photography and offset well data is developed in order to 'assess geohazards and to enable the risk posed to drilling operations by the seabed and geological conditions to be managed and reduced' (IOGP, 2017, 30). Furthermore, it seeks to define a wider 'clear zone' that is topographically and geologically suitable for the installation of the anchors of the drilling platform and any succeeding pipeline to connect the oil and gas field to a landfall site (Quinn, 2004). For this purpose, any geohazards noted from the geophysical survey (i.e. during the SSS survey) are occasionally the subject to ground truthing via ROV video-photography, with this process leading to the accidental discovery of archaeological/historical assets (Chiocci, et al, 2011).

Both EBS and Geohazard Investigations can potentially reveal archaeological/historic assets, and hence why is important to implement the survey levels and the associate minimum professional technical and methodological by-standards during the course of both. In the absence of these, **Chapter 5** has shown that different behaviour patterns in data production and submission exist, the result of which is that deep sea UCH is either inadequately surveyed or worst not surveyed at all. Without these specifications, offshore oil and gas contractors/subcontractors cannot be held liable for breaching government regulations and guidelines, rendering the implementation of the following necessary. In this respect, I would suggest that the survey levels and the associate by-standards developed in this chapter should

be factored in from the design phase of oil and gas projects, so as to minimise the likelihood of impacts from drilling operations. By doing so contractors/subcontractors are given the opportunity to best adopt EBS, Geohazard Investigations [or any other form of Supplementary Hydrographic Surveys] preceding the drilling of wells and incorporate elements of maritime archaeology surveying into their operations with practically little additional field survey costs. This is relevant to both how geophysical datasets should be generated for best detecting potential shipwrecks and debris scatters and how UCH should be visually assessed, and thereby preserved by recorded when discovered accidentally discovered during the course of NRS. The following guidelines were developed based on observations deriving from the operational activities of fourteen offshore hydrocarbon projects that took place in the Exclusive Economic Zone (EEZ) of Cyprus and from their data outputs (see **Chapter 5**) and are based on suggestions made by other archaeological, geophysical, geotechnical and upstream operational guidelines, composed by both national and international regulatory agencies, such as such as the Bureau of Ocean Energy Management (BOEM), the Chartered institute of Archaeologists (CifA), the Australian Government, the European Union, the International Association of Oil & Gas Producers (IOGP), and the International Petroleum Industry Environmental Conservation Association (IPIECA). The survey levels and the by-standards enclosed therein recommend the 'best practical means' at a technical and operational level and are concerned with the effective detection, survey, *in situ* protection, preservation by record and reporting of any archaeological/historic assets discovered accidentally within the wider prospect location(s). The following are not meant to set or alter the planning and delivery of the upstream segment, but rather aim to put forward suggestions for ensuring that certain specifications are met (BOEM, 2017) (Figure 56).

[6.3].The risks and impacts of upstream operations on archaeological/historic assets

The 2010 *Deepwater Horizon* BP disaster in the Gulf of Mexico sparked discussions aimed at introducing new strict environmental, safety and health regulations on an international level (Seddiki, 2018). In the aftermath of the spill, the European Committee pledged to undertake the process of revaluating the 'existing divergent and fragmented regulatory framework' of offshore oil and gas operations so as to effectively ensure that risks from accidents are minimised as much as possible, while also promoting certain health and safety requirements, as well as new strict environmental regulations, are met (Health and Safety Executive, 2020).

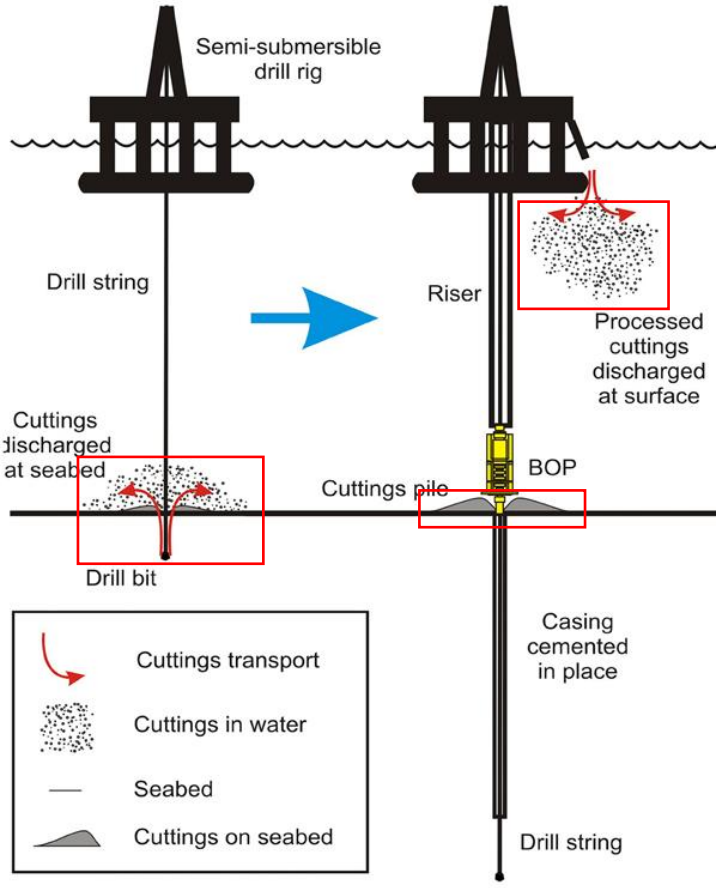


figure 57: The effects of drilling and sediment/rocks resuspension and disposal. Source: image from Cordes et al. (2016). Environmental Impact of the Deep-Water Oil and Gas Industry: A Review to Guide Management Strategies. *Frontiers in Environmental Science* 4:58, 4.

The biggest environmental risks and impacts typically related to accidental events, nevertheless, studies reviewing the operational activities of the upstream sector suggest that there are still a number of dangers resulting from the exploration and production of hydrocarbons (Amec Foster Wheeler Environment & Infrastructure UK LTD, 2016). According to a report produced by Amec Foster Wheeler Environment & Infrastructure UK LTD, on behalf of the European Commission, the risks and impacts associated with

the *Exploration/Appraisal* phase (Figure 56, page 239) are estimated to be relatively low, even though they have yet to be fully understood (Ocean Facts, 2010). For instance, studies suggest that the environmental impact created by noise emitted from seismic surveys, during the *Exploration* phase, can kill fish; disturb spawning fish away from their territory (Fisheries Research Services, 2020); affect migratory patterns leading to whale beaching; (Ocean Facts, 2010); or in general disturb the marine flora (i.e. deep sea corals) (Amec Foster Wheeler Environment & Infrastructure UK LTD, 2016). Nevertheless, the likelihood of noise affecting deep sea UCH seems to be small, yet additional scientific studies addressing this issue have posited that other direct impacts, such as those emerging from drilling, can affect the *in situ* preservation of cultural heritage resources. This received attention in 2011 in an article by Evans on behalf of the United Nations Education, Scientific and Cultural Organization (UNESCO), where he suggested the following:

A. The resuspension and disposal of sediment/rocks over the side of the rig can result in inadvertent damaging or covering any nearby archaeological/historic sites (Evans, 2011; Seagreen Wind Energy Ltd, 2012) (figure 57). In the absence of scientific data specifically addressing the issue, one would expect that the discharging of sediment and rocks from rings can potentially damage sites at a substantial distance. Environmental studies on this suggest that the effects of discarding rocks and sediments on deep sea corals were monitored at distance ‘beyond 2km’ (Cordes, et al, 2016, 1; Join E&P Forum and UNEP Technical Publication, 1997). To what extent this sedimentary ‘fall-out’ can affect the preservation of UCH, and at what distance such effects may occur, depends on parameters related to ‘the size and complexity of the project, the nature and sensitivity of the surrounding environment and the effectiveness of planning, pollution prevention, mitigation and control techniques’

(Join E&P Forum and UNEP Technical Publication, 1997, 11; Corde, et al, 2016; Amec Foster Wheeler Environment & Infrastructure UK LTD, 2016);

B. The discharging or accidental spillage of other water-based and low-toxicity oil-based muds and other contaminating substances can disturb the integrity of a submerged archaeological site, especially when material such as the wooden/iron hulls of shipwrecks are exposed on the deep seafloor (UNESCO, 2018; Hyland, et al, 1994). The scientific effects of this processes on UCH have received little emphasis so far, however, it is fair to assume that the likelihood of causing irreversible damage is high. A report composed by IPIECA in 2020 supports this by suggesting that the effects of discharging or accidental spillage on UCH should be modelled and factored in EIA and ESHIA reports. The IPIECA note that by doing so, this will ensure the effective management and the appropriate response when this scenario occurs (IPIECA, 2020).

C. The installation of infrastructure, such the laying of pipelines or the deployment of anchors, can cause substantial bottom disturbing activities, potentially causing severe damage to any nearby shipwrecks (Evans, 2011; Seagreen Wind Energy Ltd, 2012). The likelihood of such actions permanently destroying UCH is extremely high and indeed this is a known fact within the maritime archaeology community with evidence from shallow water sites supporting this (Corde, et al, 2016, 1; Seddiki, 2018). Such actions can be catastrophic for the *in situ* preservation of UCH, yet the real effects of by-product processes are unpredictable and understudied. For instance, environmental studies suggest that beyond the area of contact when laying a pipeline or installing the anchors of the drilling ship or a rig, sediment resuspension can affect an area within a radius of 100 metres (Corde, et al, 2016). Similarly, underwater vibrations and cutting discharges on the seafloor will also have an impact (Figure 57). Drilling, for example, has been recorded to distort the broader area beyond the well site for up to 200 metres

(ibid). Considering this, one may argue that these actions may be catastrophic for the *in situ* preservation of UCH, yet this remains an understudied topic that requires the appropriate emphasis, so as to implement the correct risk management strategies.

Archaeological/historic assets in proximity to offshore prospect sites are in immediate danger from offshore drilling activities. Even though scientific studies and monitoring schemes have yet to address the actual effects of such processes on UCH, it is only reasonable to assume that the discharging of sediment/rocks both from the drilling well(s) and from rigs, the laying of pipelines and the deployment of anchors, can most definitely affect, damage or even completely destroy UCH (Seagreen Wind Energy Ltd, 2012). Subsequently, the questions that need to be addressed are: what is the appropriate buffer zone radius for the *in situ* protection of UCH; and what is the optimal distance for eliminating the possibility of UCH being affected by the aforementioned processes. Until these questions are addressed and backed-up by scientific reports, the *in situ* safeguarding and the adequate preservation by record of UCH should be recognised as the Corporate Social Responsibility (CSR) of the offshore oil and gas contractors/subcontractors (Koolwal and Khandelwal, 2019). For the case study of Cyprus —and as **Chapter 3** has shown certainly elsewhere— the preservation of UCH in the deep waters of the EEZ and on the Continental Shelf (CS) has been granted a protected status both under national and international frameworks and guidelines, which would render the implementation of the guidelines suggested below necessary. By doing so, licensed contractors would be abiding by the highest heritage standards, guaranteeing that any negative effects on the UCH are taken into consideration at an early stage of the project, reported, studied appropriately, and mitigated (Amec Foster Wheeler Environment & Infrastructure UK LTD, 2016; Anderson and Bieniaszewska, 2005).

[6.4].Review of archaeological by-standards and offshore oil and gas operations

There is a substantial literature drawing upon the basic archaeological guidelines that clarify some of the methods for best identifying, evaluating, and safeguarding archaeological/historical assets discovered accidentally during the course of commercial offshore operations (Zeidler, 1995). A review of these specifications suggests that most were developed either by archaeological/environmental consulting companies (cf. Wessex Archaeology Ltd, 2007; Gribble and Leather, 2011; Faulk, 2014) or by national heritage agencies (cf. Federal Energy Regulatory Commission, 2017; Historic England, 2013; United States Department of Interior Minerals Management Service Gulf of Mexico OCS Region, 2005; Offshore Wind Programme Board, 2015; BOEM, 2015; 2017), and are concerned with offshore commercially driven operations taking place predominately in the Territorial Sea (TS). Inevitably, these refer to offshore projects relating to pipelines and cables, windfarms and harbour expansions (Wessex Archaeology Ltd, 2007; Historic England, 2013; Gribble and Leather, 2011; Offshore Wind Programme Board, 2015) and exclude offshore oil and gas operations taking place in zones where the coastal State has limited jurisdiction, such as those of the Contiguous Zone (CZ), the EEZ, and the CS. This was briefly evaluated in **Chapter 3** and will be expanded further here, arguing that when it comes to the development, and latterly the implementation, of archaeological by-standards for deep water oil and gas operations, the final decision on how and in what ways to effectively ‘protect, preserve, scientifically study, and otherwise manage these cultural resources’, ultimately depends on the government, the relevant Ministry and the responsible national heritage agency (Søreide, 2013, 1010).

‘National legislation regulating offshore oil and gas activities varies greatly’ (Rochette, 2014, 1). Some countries, such as the USA, Australia and Norway, address every stage of the offshore oil and gas industry, from the exploration phase to the dismantling of the

platform, whereas others are limited to the production stage. Some focus on monitoring or predicting the possible environmental impacts of hydrocarbons exploration and exploitation, while others are entirely concerned with facilitating the development of onshore installations (ibid). This is because there are no acceptable operational by-standards developed or implemented on an international level for the upstream segment, the result of which is that hydrocarbon operations have been working for many years under a range of different sets of national regulations, standards, and guidelines (European Commission, 2019). Consequently, offshore oil and gas activities have been developing 'under the sole responsibility of the States involved' (Chabason, 2011, 5) with standards set 'by the governments through the regulatory process' (Extractive Hub, 1). Indeed, this issue pertains to cultural heritage resources that have been discovered during the course of upstream operations also; with **Chapter 5** arguing that different data collection standards are currently in operation, which is an issue largely associated with the absence of offshore hydrocarbon exploration specifications and a lack of explicit guidance and regulations. In the knowledge of this, it is incumbent upon the maritime archaeological community –both heritage managers and researchers– to collaborate with the wider offshore oil and gas industry, the environmental consulting sectors and the responsible heritage agencies and set the specifications necessary.

In recent years oil and gas contractors/subcontractors are required 'to present more data from their offshore survey work' (Søreide, 2013, 1013). One example of this comes from the federal agency of the Bureau of Ocean Energy Management (BOEM) of the Department of the Interior, USA, whose main aim is to oversee projects related to offshore renewables, fossil and mineral resources on the Outer Continental Shelf of the USA[2]. BOEM requires offshore contractors/subcontractors to include in their project planning a site assessment plan

[2] For additional information visit BOEM's website, *Gulf of Mexico Archaeological Information*, https://www.boem.gov/gulf-mexico-archaeological-information [accessed 27-12-2020]

regarding the nature and location of cultural resources that may be affected by the proposed prospection activities. For this BOEM 'has three avenues by which it carries out archaeological research as a part of its mandate', one of which applies specifically to offshore energy and minerals projects (Caporaso, Warren and Gittings, 2018, 210; BOEM, 2017). This is part of the 'environmental review process of permitted industry activities' and the National Historic Preservation Act, where the results of EBS and Geohazard Investigations consider and report the geological, biological, and heritage resources all together (ibid). To effectively achieve this, BOEM's document *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585*, provides the recommendations on the suitable methods to identify UCH, as well as the acceptable formats for generating, reporting and submitting the data outputs for review and archiving (BOEM, 2017). BOEM's regulations governing oil and gas activities and UCH appear to be the first of their kind, tailored specifically to upstream hydrocarbon operations, and have proven to be effective in promoting the survey, reporting, preservation by record, and *in situ* safeguarding of UCH in the deep waters of the Gulf of Mexico (ibid). So far, BOEM has confirmed the discovery of roughly 100 new deep water shipwreck (>100 metres) sites and another '3000 known or potential shipwreck sites in the wider northern Gulf of Mexico area' (Caporaso, Warren and Gittings, 2018, 212). Evidently, archaeological stewardship is integral to BOEM. The new model of integrating archaeological surveys into EBS and Geohazard Investigations, has clearly proven to be a practical and effective one and indeed, for the purpose of this study, BOEM's 'archaeological lease stipulations' will be used as template for the proposed survey levels and the associate minimum professional archaeological by-standards proposed for Cyprus (Evans, 2011, 2). Furthermore, **Chapter 3** has demonstrated that countries such as Australia and the UK have also introduced soft law guidelines pertaining to the archaeological survey prerequisites that offshore contractors/subcontractors must fulfil for the effective protection

by record of UCH. The examples set by these States as well as the legal prerequisites set by other States of the European Economic Area (EEA), as evaluated in **Chapter 3** of the study, help to inform the development of the General prerequisites and the national survey levels and associate by-standards of Cyprus, with these to be designed specifically in respect to NRS operations taking place in the deep-wates of the EEZ and on the CS.

In the absence of archaeological by-standards in the national waters of Cyprus, it is worth investigating what other international bodies foresee when it comes to UCH assets that have been discovered accidentally in the context of commercially driven operations in deep waters. Unfortunately, a review of this reveals that there are no international guidelines outlining how and in what ways the survey, discovery, evaluation, and the preservation by record of cultural heritage resources can be achieved (Lexology, 2019). This also received emphasis in **Chapter 3** and is expanded here, arguing that in the absence of international and national archaeological by-standards, offshore oil and gas contractors/subcontractors, cannot be held liable for breaching government regulations and guidelines, if archaeological/historic assets are inadequately surveyed, not surveyed, or even damaged or destroyed altogether. This loophole acts for the benefit of the industry, mostly because there are no legal rules, guidelines, and obligations, that a company must meet when *Appraisal* surveys for upstream hydrocarbon operations accidentally lead to the discovery of UCH. The result of this is that regardless of how contractors/subcontractors choose to survey and report the discovery of archaeological/historic assets, either in the formatting of a simple Field Memo or a detailed desked-based study, anything they choose to submit to the involved heritage agencies is sufficient. In fact, this is evident from the Archaeological Field Memos that are usually included in the final ESHIA and EIA, written and submitted by the offshore oil and gas contractors/subcontractors operating in the EEZ of Cyprus (i.e. Noble Energy International

Ltd, 2011; Noble Energy International Ltd, 2011b; ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018a; 2018b; 2018c; ENI Cyprus LTD, 2017a; 2017b; 2017c).

The analyses contained in **Chapters 3** and **5** suggested that the discovery, survey, *in situ* preservation, evaluation and preservation by record of deep water archaeological/heritage assets made accidentally during the course of oil and gas operations depends solely on 'good faith' between contractors/subcontractors and the national agency. This statement becomes apparent when looking at the '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage*'* ('2001 UNESCO Convention') Annex Rules, where essential parameters for the *minimum* technical by-standards necessary for best archaeological practices that are crucial for the effective preservation by record and reporting of deep sea UCH are left largely unaddressed (see: **Chapter 3,** The 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage ('2001 UNESCO Convention'), pages 79-84). In fact, UNESCO's aspirational and directorial approach to the survey and thereby preservation by record of UCH discoveries is irrelevant to the operational framework of NRS. This is because the Annex Rules of the '2001 UNESCO Convention' are applicable to projects directed by archaeologists and not to industry led operations, such as those of NRSs. This is somewhat peculiar when considering that the activities that can potentially lead to the discovery of UCH in deep waters are primarily commercially driven. UNESCO has rightfully identified treasure hunting as the main threat to the preservation of UCH but has omitted to take into consideration that projects such those concerned with the exploration of oil and gas, pipeline and cable laying and the extraction of minerals can also reveal, affect or even destroy UCH all together. This is unfortunate as UNESCO has yet to respond to the call of developing the necessary industry by-standards, rendering the organization negligent to set the example of developing the by-standards on an international level that 'often form the basis for national regulations' (Extractive Hub, 5).

6.POLICY RECOMMENDATIONS(Survey Levels and Minimum Professional by-standards)

In the absence of international archaeological by-standards specific to offshore oil and gas operations, this thesis investigates this issue more broadly. A review of other geophysical/geotechnical and upstream operational guidelines has been undertaken as an attempt to evaluate what other international bodies foresee when UCH assets emerge as secondary by-products in NRS. For example, the IOGP, whose work is concerned with identifying and sharing the best practices to implement improvements in safety, health, social responsibility, the environment, security engineering and operations, issued a report in 2017 setting out the good practices for geohazard surveys. The report draws upon all possible constrains and hazards, ranging from natural, geological and man-made features which may affect or be affected by the operational activities of prospection drilling, and suggests the implementation of appropriate operational practices and mitigation strategies required in order to minimise the identified risks (IOGP, 2017). The IOGP, identifies shipwrecks and objects of historical interest among the man-made features and sets as a precondition that 'local regulatory announcements, databases and nautical charts are reviewed beforehand, addressing whether any wrecks, or other site of archaeological importance' are found situated within the proposed prospect area(s) (ibid., 13). According to the IOGP, UCH should be considered integral in the planning process of upstream hydrocarbons and should be formally investigated during geohazard investigation surveys (ibid). The final geohazard report should draw upon the newly acquired data from which rigorous and consistent scientific analysis of them aims to determine whether new UCH assets were discovered or not. The result of this analysis should be 'reported in the text, maps, and other graphics that make up the site survey report', accompanied with all raw and processed data of the survey (ibid., 30).

Similarly, in 2019, the European Commission issued a study on the *Best Available Techniques, Guidance Documents on Upstream Hydrocarbon Explorations and Production,* aiming to identify the best available techniques and mitigation strategies for specific key

environmental issues caused as a result of both onshore and offshore upstream hydrocarbons operations (European Commission, 2019). The purpose of this document is to improve the protection of the environment and, for the first time, the Commission recognised the need to obtain information and data on 'archaeological heritage' during NRS (ibid). Even though, there are no specifications regarding how this data should be obtained, reported, and submitted, the possibility of producing reports for assessing the likelihood of UCH discoveries appears to be a requirement. According to the Commission, information pertaining to UCH should be generated in the context of an EBS and latterly integrated into the final EIA or ESHIA. It is my opinion that this will undoubtedly contribute to the effective implementation and, ultimately, the standardization of desked-based archaeological assessments in the near future.

To conclude, the 'lack of specified standards on an international level leads to uncertainty over the validity and relevance' of archaeology desk-based assessments for NRSs (Polglase, 2015, 1). Nevertheless, this area seems to be increasingly receiving the appropriate emphasis with international bodies acknowledging that it is, in fact, necessary to include surveys with archaeological objectives in Geohazard Investigation and EBS, from which the output of archaeological desk-based assessments should be integrated in to the final EIA and ESHIA reports. According to a report composed by the IPIECA in 2020, this is necessary because the discharging or accidental spillage of water-based and low-toxicity oil-based muds and other contaminating substances can potentially damage or even destroy UCH (IPIECA, 2020). Indeed, there are a number of threats emerging from drilling, rendering the *in situ* safeguarding of cultural resources in close proximity to prospection site(s) the CSR of offshore oil and gas contractors/subcontractors (Koolwal and Khandelwal, 2019). In fact, international bodies such as the IOGP and the European Commission, in their recently issued guidelines have identified this, by suggesting that offshore oil and gas

contractors/subcontractors need to get an ‘archaeological clearance’ preceding the drilling of well(s) (IOGP, 2017; European Commission, 2019). This can be achieved by obtaining geophysical and visual datasets during EBS and Geohazard Investigation that can then be analysed and developed into archaeological/historic desk-based assessments. Even though the international community has yet to clarify how archaeological/historic surveys should be conducted, or what an archaeological desk-based assessment should include, it seems that specifications pertaining to this are becoming available in by-standards developed mostly by national [heritage] agencies and in some cases by international organisations, other than UNESCO. Evidently, the norm which has international regulations and by-standards often forming ‘the basis for national regulations’, is starting to be challenged. BOEM —and to certain extent other countries such as Australia and the UK— seem to be the only few national agencies with explicit and available archaeological by-standards for governing offshore hydrocarbon explorations operations. Yet, it is worth recognising that perhaps other national [heritage] agencies may have developed similar documents but are keeping them outside of the public domains. This remains a possibility and will be investigated further in the future.

Nevertheless, it is possible for national heritage agencies, environmental consulting companies and maritime archaeological consultants to liaise with offshore oil and gas contractors/subcontractors to integrate archaeology surveys in EBS and Geohazard Investigations for the purpose producing the necessary desk-based assessments. In fact, this should be a precondition for oil and gas contractors/subcontractors operating in waters in which States:

A. have either signed or ratified the ‘Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the

Continental Shelf and the Seabed and its Subsoil', of the Barcelona Convention (**Chapter 3**, pages 77-78);

B. have national heritage frameworks in place which foresee the protection of UCH in all maritime zones (i.e., '2014 (amended) Antiquities Law of Cyprus' and other national legislations as per the evaluation of different State legislations) (**Chapter 3**, pages 101-105 and 85-95 respectively);
C. have hydrocarbon laws which foresee the protection of cultural resources from offshore oil and gas operations as per the analysis of different State laws (**Chapter 3**, pages 85-101);
D. have other environmental laws which require EIAs to include the evaluation of archaeological/historic assets prior to any development projects (**Chapter 3**, pages 101-105);
E. or have national Guidelines [and/or other soft laws] related specifically to what EBS for oil and gas exploration activities should include, naming the identification and evaluation of archaeology as a prerequisite (**Chapter 3**, pages 85-101 and 101-105).

Even though, the archaeological by-standards have yet to be developed and implemented on an international level, it is clear that national and international frameworks and guidelines foresee the protection of UCH by upstream hydrocarbon operations (IOGP, 2017; European Commission, 2019; IPIECA, 2020). The likelihood of UCH being affected by drilling operations is likely, and because of this the effective discovery, survey, reporting, *in situ* preservation and preservation by record of UCH discovered during the course of oil and gas operations is the CSR of offshore oil and gas contractors/subcontractors. In order for them to meet this CSR, contractors/subcontractors are encouraged to abide by the following survey levels and the associate minimum professional by-standards, guaranteeing that any negative

effects on the UCH are taken into consideration, studied appropriately and mitigated (Amec Foster Wheeler Environment & Infrastructure UK LTD, 2016; Anderson and Bieniaszewska, 2005). With regards to Cyprus, the *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus* states clearly that from 2017 and onwards oil and gas contractors/subcontractors operating in the EEZ and on the CS of Cyprus should include information about 'specific concerns related to archaeological artefacts' in the final EBS (Ministry of Agriculture, Rural Development and Environment, with the input of the Departments of Environment and Fisheries and Marine Research, Cyprus, 2017, 5). This means that archaeological assessments are part of the operational scope, rendering the development and implementation of the following guidelines necessary.

[6.5].Minimum Professional by-standards for safeguarding deep-sea archaeological/historic assets found in the Exclusive Economic Zone. Guidelines for offshore oil and gas contractors/subcontractors conducting Marine Environmental Baseline Surveys, Geohazard Investigations [or any other Supplementary Hydrographic Surveys], preceding the drilling of wells

The following survey levels and the associate minimum professional by-standards seek to provide the guidelines pertaining to how offshore oil and gas contractors/subcontractors may best adapt marine geophysical surveys, EBS and Geohazard Investigations [and any other Supplementary Hydrographic Surveys] and their data outputs to incorporate elements of maritime archaeological surveying. The following section intends to promote the best practical solutions for the effective discovery, survey, *in situ* and by recorded safeguarding, reporting, data-submission, and archiving, of UCH discoveries and geophysical and ROV video-photography data outputs generated in the EEZ of Cyprus [or the eastern Mediterranean more broadly] during the course of NRS. The survey levels underneath and the associate by-standards provide the technical and methodological specifications necessary as to how UCH assets should be surveyed and thereby preserved by recorded when discovered as a by-product of NRS activities and set the preconditions necessary for *maximising* the potentials of discovering and thereby adequately surveying and preserving by record the accidental discovery of UCH found situated in the wider prospect area(s). It is suggested that the adoption of these guidelines will ensure that historical/archaeological preservation issues or concerns are taken into consideration at an early stage of any offshore commercial project and thereby the necessary specifications are met, thus safeguarding the interest of the stakeholder heritage agency, namely, the Department of Antiquities Cyprus (DoAC) (BOEM, 2017). The guidelines underneath should be perceived as the *minimum* technical and methodological prerequisites that contractors/subcontractors may choose and apply to follow or to exceed to achieve an optimum solution for the benefit of both the UCH and the commercial

organisations involved and these are to be applied in the context of six different phases of surveying:

- **General Prerequisites**
- **Level 1** – Geophysical surveys and the identification of features or anomalies of 'high archaeological potential' and 'shipwreck-like character';
- **Level 2** – Visual inspections of features or anomalies of 'high archaeological potential' and 'shipwreck-like character';
- **Level 3** – *Reconnaissance* surveys of confirmed archaeological sites (only for shipwreck sites);
- **Level 4** – Sampling of artefacts and structural components (If deemed necessary and only in exceptional cases);
- **Level 5** – Excavation (Only if *ex-situ* preservation is the only solution).

[6.5.1].Minimum Professional Survey by-standards

The levels of surveying and the subsequent by-standards presented therein are tailored specifically to the operational framework of deep-water oil and gas explorations and for the majority of cases are not meant to alter the planning and delivery of NRS. This is with the exception of triggering survey levels 4 and 5 and only in the extremely rare scenario when a discovered shipwreck-site is deemed of exception archaeological and scientific interest or outstanding value and more data are required; or if a shipwreck is in immediate danger of been destroyed by planned activities (i.e., drilling) and by-processes (anchoring of the pontoons or pipeline or cable laying installations) and the licence holder company did not express the intention of moving protecting the shipwreck *in situ* (as per General prerequisites by-standard 02). With the exception of the latter two survey levels, survey levels 1, 2 and 3, aim to suggest to the licence holder company and contractors/subcontractors that EBS, Geohazard Investigations, [or any other type of Supplementary Hydrographic Surveys], should be designed and conducted in a manner that is likely to benefit the discovery, documentation and *in situ* preservation and preservation by record of any possible confirmed

archaeological/historic asset(s) found situated in the broader prospect area(s) (BOEM, 2015). The survey levels and the subsequent minimum professional survey by-standards enclosed in each, are developed around specific pre-set conditions and general practices, with these clarifying the overreaching prerequisites that contractors/subcontractors must considered prior to engaging with the succeeding survey levels 1, 2 and 3.

Survey level 1 foresees the development of datasets that are suitable for the effective identification of 'shipwreck-like' anomalies or features of 'high archaeological potential', with the by-standards enclosed therein providing the specifications necessary that contractors/subcontractors must meet in generating geophysical datasets. These represent the *minimum* data collection standards for ensuring that *Appraisal* surveys are designed and conducted in a manner suitable for providing the basic information for wreck site identification and characterisation. This pertains to the production of geophysical datasets such as side-scan-sonar (SSS) and multibeam-bathymetry-echosounder (MBES) and backscatter, the aim of which 'is to improve the consistency and quality of geophysical data acquired for archaeological purpose' (Historic England, 2013, 5). This is relevant to being able to view the seabed with better clarity, rendering the process of distinguishing between modern and ancient debris, as well as shipwreck sites and geological features, with less ambiguity. The by-standards seen in survey level 1, are written in a manner that can be followed by 'archaeologists (with or without previous geophysical knowledge), geophysicists/surveyors (with or without previous archaeological experience), developers and planners, as well as other people working in the industry, the government, academia/research and the heritage sector' (ibid). With the completion of survey level 1, contractors/subcontractors are required to submit a Field Memo presenting the features and anomalies of 'high archaeological potential' or 'shipwreck-like character' that will be subject to ground truthing investigations in the later stage of survey level 2.

Survey level 2 provides additional clarifications as to how ROV visual inspections should be conducted and what prerequisites ROV operators should consider prior to commencing with deep-seabed surveying. More specifically, this is in respect to conducting visual inspections of the deep-seabed around the drilling sites when ROVs are operating on a pre-programmed line-path-survey; and ground truthing investigations on the reported anomalies/features of 'high archaeological importance', noted as part of the output Filed Memo report of survey level 1. The purpose of the these guidelines is to firstly *maximise* the potential of discovering UCH sites and secondly to lessen the chance of endangering any nearby [unconfirmed but awaiting discovery] archaeological sites and assets.

In the scenario of the discovery of UCH assets during the course of level 2 surveying, contractors/subcontractors are required to implement the procedures of survey level 3. Survey level 3 provides the methodological clarifications as to how emphasis should be placed on a discovered UCH site and sets the prerequisites for contractors/subcontractors to apply the basic principles of Structure from Motion (SfM) to generate photogrammetric/orthomosaic models of metric accuracy, high quality and resolution only for shipwrecks discovered during the course of NRS. The aim of the by-standards of survey level 3 is to essentially improve how ROV video-photography data are captured and thus to enable the effective preservation by recorded and thereby future study of deep water discoveries. With the completion of survey level 3, and regardless to whether UCH assets were discovered or not, an Archaeological Impact Assessment (AIA) should be written, with the specifications pertaining to this addressed below (see Minimum Professional Reporting by-standards, pages 286-304).

On the rare occasions that a shipwreck site is discovered, and it is deemed necessary after a thorough review of the output video-photography datasets, photogrammetric/orthomosaic models, the geophysical datasets and the AIA report, the DoAC may ask contractors/subcontractors to engage with further sampling procedures.

Survey level 4 provides the general description of the artefact retrieving process and the machinery requirements and sets the precondition that only artefacts and structural components visible on the surface should be recovered. This pertains to addressing specific questions surrounding the chronology, origin, and cargo of the shipwreck, with the survey level 4 process to be triggered only if a site is deemed of exceptional archaeological and of scientific interest or outstanding value; and only after an agreement has been reached between the involved contractors/subcontractors, the licence holder company, and the DoAC.

Along the same lines, survey level 5 requires the excavation of a shipwreck only if it is situated in the immediate vicinity of a drilling site, approximately less than 300 metres from where wells are planned to be drilled, and the licence holder company has not expressed interest of protecting the site *in situ* through the establishment of a protection zone (as per General prerequisites by-standard 02, page 267) (Corde, et al, 2016). In the unlikely scenario of a shipwreck site being in immediate danger or under threat by drilling or other by-process related to oil and gas operations (such as: anchoring of the pontoon and drilling vessel, pipeline or cable laying installations *et cetera*), then *ex situ* preservation may be required. The implementation of survey level 5, it is expected to result in a considerable delay and economically burden the licence holder company and should be triggered only after all prior survey levels have been implemented and no middle ground solutions for the effective *in situ* protection of the site have been reached between the involved stakeholders.

All survey levels are supplemented by a set of overreaching General prerequisites that illustrate the basic principles and conditions that offshore oil and gas contractors/subcontractors must meet prior to engaging with any form of surveying. These include what has generally been applied in the industry for some time now with further clarification presented here, pertaining to the operational, technological, and methodological parameters that will ensure the adequate discovery, survey, protection, and preservation by

record of any archaeological/historic asset(s). These General prerequisites set the guidelines for best practices and present the mitigation strategies for the effective management of confirmed deep sea UCH sites; set the preconditions necessary for the usage of up-to-date machinery; and further define how mutual cooperation for the effective survey and thereby preservation of confirmed shipwreck sites between heritage agencies and oil and gas contractors/subcontractors can be achieved.

It is proposed that the survey levels and the associate by-standards presented here, should be implemented in the upcoming 'regulatory administrative acts of 2022' of the 'Antiquities Law of Cyprus'. They are intended to ensure that the interest of the DoAC in protecting UCH sites in the EEZ and on the CS is safeguarded, as per Articles 18A[3] and 18B-(1)[4] of the '2014 (amended) Antiquities Law of Cyprus'. To effectively achieve this, in my opinion, the best solution should be that contractors/subcontractors, regardless of whether UCH is discovered or not, should consider producing an Archaeological Impact Assessment (AIA) demonstrating that the likelihood of any heritage assets situated within the broader prospection area(s) have been identified and received the appropriate consideration. Legally, this is in accordance with the undetermined prerequisites SoW set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus*, which stipulates Desk Based Assessments to address 'specific concerns (archaeological artefacts, marine protected areas, fishery restricted areas, cables, pipelines, *et cetera*)' (Ministry of Agriculture, Rural Development and Environment, with the input of the Departments of Environment and Fisheries and Marine Research, Cyprus, 2017, 5). In the

[3]**Article 18A:** 'Any archaeology on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on' (Antiquities Law Cyprus, 2014, 1120).

[4]**Article 18B-(1):** 'Licenced agencies, contractors or individuals operating in the Exclusive Economic Zone and on the Continental Shelf of Cyprus, are required to report to the Director of the Department of Antiquities Cyprus the discovery of any UCH sites and objects regardless of such discoveries were made intentionally or not, and for this manner they should submit geographical coordinates and additional information' (ibid).

absence of specifications relevant to how desk based assessment should be conducted, the following General prerequisites, survey levels and the associate Data submission and Reporting by-standards aim to present the best operational, methodological and technical solutions to ensure the adequate discovery, survey, reporting, data submission and *in situ* preservation and preservation by record of any UCH assets found [and their data outputs] accidentally during the process of NRS.

[6.5.2].Definition of Deep Sea Cultural Heritage (archaeological/historic assets)

For the purposes of the proposed survey levels and the associate minimum professional by-standards, deep sea cultural heritage in the EEZ of Cyprus is defined according to:

- The '2014 (amended) Antiquities Law of Cyprus' in which archaeology is defined as: any object, whether movable or part of immovable property, and is considered to be a work of architecture, sculpture, graphic art, painting, or generally any form of art which has through human effort been produced, sculpted, inscribed or painted in Cyprus or abroad. The aforementioned should be 100 years old, or older, produced in any manner whatsoever and from any material, and found, discovered, excavated or recovered in Cypriot territory both on land or at sea. This includes any such object(s) or parts thereof which has at a later date been added, reconstructed, readjusted or replaced subsequently (Antiquities Law Cyprus, 2014, 1120).
- In addition to the definition of archaeology in the '2014 (amended) Antiquities Law of Cyprus', I suggest that the general definition of UCH should be supplemented by the '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage' Article 1(a): 'Underwater cultural heritage (UCH)' means all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years such as:

(i) sites, structures, buildings, artefacts and human remains together with their archaeological and natural context;

(ii) vessels, aircraft, other vehicles or any part thereof, their cargo or other contents, together with their archaeological and natural context;

(iii) and objects of prehistoric character' (UNESCO, 2001, 2).

[6.5.1.1].General prerequisites

The General prerequisites set here, provide the *minimum* recommendations as to what contractors/subcontractors need to consider prior to commencing with NRS activities in the EEZ and on the CS of Cyprus. This is relevant to surveys preceding the drilling of wells such as Environmental Baseline Surveys (EBS) and Geohazard Investigations [or any other form of Supplementary Hydrographic Surveys], with the following by-standards providing the fundamental prerequisites that offshore contractors/subcontractors need to factor in from the design phase of NRS projects. This pertains to a set of overreaching specifications relevant to the effective management and *in situ* protection of UCH assets, data submission, and the technical preconditions for improving the resolution of the data outputs from geophysical and video-photography surveys for best detecting, surveying, and preserving by recorded the accidental discovery of UCH [and the wider seafloor area of the prospect area(s) in question].

Table 21: The overreaching General prerequisites that offshore oil and gas contractors/subcontractors need to consider and factor in from the design phase of NRS projects.
Precondition for supervising oil and gas survey activities that may lead to the accidental discovery of archaeological/historic assets **By-standard 01:** Ideally**,** EBS, Geohazard Investigation [or any other Supplementary Hydrographic Surveys], preceding drilling should be attended by a person or representative appointed by the relevant national heritage agency. This is a prerequisite mentioned or largely implied in different archaeological by-standards relevant to harbour expansion and offshore windfarms projects, foreseeing that archaeologists/maritime archaeologists should oversee both preliminary geophysical surveys and the overall development of the commercial project in question (Wessex Archaeology, 2007; Gribble, and Leather, 2011).

Precondition for setting up "Cultural Protection Zones (CPZ)" (i.e., buffer zones) in case a shipwreck(s) is discovered

By-standard 02: Based on the offshore archaeological by-standards available and those that have been applied in the environmental consulting industry more broadly, any archaeological/historic assets discovered during the course of upstream oil and gas operations should be protected *in situ* through the establishment of protection zones in which offshore development and any other distractive activities are prohibited. In fact, according to the legal analysis presented in **Chapter 3**, this practice of designating areas of no-development zones appears to be an area of consistent practice among different States and emerges as the most effective approach for the *in situ* preservation and future management of UCH assets from any kind of offshore commercial activities. For offshore oil and gas contractors/subcontractors who are operating in the deep-waters of Cyprus' EEZ and on the CS and accidentally discover UCH, Article 18C(1)[5] of the '2104 the Antiquities (amended) Law of Cyprus' requires them to express interest in establishing a "Cultural Protection Zone (CPZ)" around the confirmed shipwreck site(s). After the approval of the Director of the Department of Antiquities Cyprus, the DoAC will make the final recommendations regarding the size and radius of the buffer zone with this to be assessed on a case-by-case basis. As per current practices in the environmental and underwater archaeology sectors, the *minimum* radius of the buffer zone around the site should be at least 300 metres (Gribble, and Leather, 2011; Corde, et al, 2016; Wessex Archaeology Ltd, 2007).

Precondition for the submission of dataset(s) and report(s)

By-standard 03: Chapter 3 has shown that countries of EEA and elsewhere Australia as well as Cyprus both under Article 18B-(1)[6] of the '2014 (amended) Antiquities Law of Cyprus' and Article 23(1) of 'The Hydrocarbons (Prospection, Exploration and Exploitation) Regulations, of 2007 and 2009)' requires 'holders of an authorization […] to inform the Minister of all major developments in relation to the course of hydrocarbons operations. To this end, 'copies of all geological, geophysical, and other technical reports, well logs, maps, diagrams, magnetic tapes, electronic and other stored data, in any form, reports and interpretation which have been prepared by or for the holder of an authorization' (The Hydrocarbons (Prospection, Exploration and Exploitation) Regulations, 2007 and 2009, 25), should be submitted to the Ministry, concerned Departments and other stakeholders. These frameworks set the general precondition for the submission of all output data and reports from NRS projects with the Data Submission by-standards underneath providing the clarifications necessary as to the acceptable formats for generating, reporting, and submitting the data outputs for review and archiving. This pertains to a broader strategy of data re-evaluation and archiving that will guarantee the lasting preservation of these rare, expensively acquired, and sensitive datasets into the foreseeable future.

[5] See footnote 12, page 290.
[6] See footnote 4, page 264.

Technical precondition for ROV visual inspection machinery, cameras, lights, and positioning system

By-standard 04: Data analysis in **Chapter 5** has shown that ground truthing inspection and seabed surveys should be carried out with a commercial ROV equipped with the latest camera technology available at the time and lighting systems sufficient to expose with clarity and colour balance the seafloor and any accidental discoveries of UCH. The aim behind the choosing of camera and light technology is to generate data outputs of sufficient quality and resolution, enabling the responsible archaeologist [and other DoAC personnel] to perform further archaeological analysis (i.e., amphorae identification, establishing chronology and origin of the wrecking event *et cetera*). Based on the European prerequisites set in document EN16260, for ROV surveys, (2015) *Epibiota Remote Monitoring from Digital Imagery: Operational Guidelines,* to achieve this, 'before starting a survey, the camera imaging, lighting and recording modes should be adjusted to ensure that the highest quality image be maintained throughout. Testing of the cameras and lighting must ensure that well-lit, high resolution videos and by extent videos and pictures can be obtained while the ROV is in flight' (Hitchin, Turner, and Verling, 2015, 11-12). The position of the ROV should be known very precisely, and regardless of which of the three main acoustic positioning techniques is utilised (i.e., long baseline (LBL), short baseline (SBL) and ultra-short baseline (USBL) positioning) the ROV should record coordinates in real time whilst surveying the seabed. As a general note, ROV operators conducting investigations are 'prohibited from disturbing or picking up any artefacts' and should not turn off the video feed at any time during the survey (BOEM, 2020d, 1).

Technical precondition for using an Autonomous Underwater Vehicle (AUV) platform, mounted with geophysical survey machinery

By-standard 05: Similar to by-standard 04, the choice of AUV platform and geophysical survey machinery should be of the latest possible technology. This is a general prerequisite compatible with the observations made in **Chapter 5** where in the initial viewing and subsequent analysis of the geophysical data, the most modern equipment invariably producing the best results. The AUVs should be able to maintain a constant altitude over the bottom when mapping the seafloor and be manoeuvrable and capable of adapting when fluctuations occur in the seafloor geomorphology (Bellingham, 2009). It should be equipped with GPS navigation system and present accurate georeferenced data and be able to generate high-resolution seafloor reliefs by operating the mapping sonars near the seafloor (Trembanis, et al, 2020). The AUV should be equipped with sonar systems such as side-scan-sonar (SSS), multibeam-bathymetry-echosounder (MBES) and backscatter, and sub-bottom profilers (SBP), and should operate in the required water depths. The output data from these geophysical surveys should:

- allow the detection of objects, geohazards and possible 'shipwreck-like' anomalies or features of 'high archaeological potential' resting on the seafloor (SSS data);
- allow the detail and effective mapping of the seafloor in three-dimensional image reliefs (MBES data);
- reveal additional insights into the character of the broader seafloor, sediment surface and seafloor roughness (backscatter data);
- present the subsurface stratigraphy up to 10 metres for geolocating any possible substrata anomalies of geological or archaeological potential (SBP data).

Both SSS and MBES and backscatter should be operating at frequencies of hundreds of kilohertz (kHz), and the sub-bottom profiler should be operating at frequencies ranging from one to tens of kHz. The levels of frequencies for operating SSS and MBES and backscatter data are clarified in survey level 1, by-standards 06 and 07. For SBP data, each line should be recorded and provided in SEG Y format, with the choice of the operational frequency depending on the survey company.

[6.5.1.2].**Level 1** – *Appraisal* Surveys and the identification of areas, features or anomalies of 'high archaeological potential' and 'shipwreck-like character'

The following by-standards provide the operational parameters for geophysical surveys for best ensuring that elements of maritime archaeology survey are integrated into EBS and Geohazard Investigations [or any other form of Supplementary Hydrographic Surveys], preceding the drilling of wells. These were developed based on observations deriving from the operational activities of fourteen offshore hydrocarbon projects that took place in the EEZ of Cyprus and from their data outputs (see **Chapter 5**). In addition, they also consider suggestions made by other archaeological geophysical, geotechnical, and upstream operational guidelines, composed by both national and international regulatory agencies, such as such: BOEM, the European Union, IOGP, the Australia Government, and IPIECA. The specifications provided below clarify how contractors/subcontractors should prepare a geophysical survey plan that will improve the chances of discovering archaeological/historic shipwreck sites within the wider prospect location(s) (BOEM, 2017). These are relevant to SSS and MBES and backscatter surveys and aim to set the prerequisites for generating the output datasets that will provide sufficient resolution for potentially allowing technicians in the field to distinguish between shipwreck sites and geological features, with less ambiguity. Even though **Chapter 5** has shown that detecting ancient shipwrecks among other seafloor features is not a straightforward procedure (Ferentinos, et al, 2020, 1), the following may be regarded as the *minimum* standards for generating datasets suitable for seafloor characterisation, topographical identification, feature and geohazard investigation, and set the precondition for mandatory ground truthing investigation of any noted geophysical anomalies

deemed of ‘high archaeological importance’ or ‘shipwreck-like character’ in the latter stage of survey level 2 (For specifications about these terms refer to **Chapter 5**: Side-Scan-Sonar, pages 203-223 and Section: Shipwrecks with amphorae cargoes and geological features, pages 213-214) (BOEM, 2017).

The by-standards below aim to set the prerequisites for adding design elements to NRS that go beyond the purpose of solely determining the most suitable location(s) for drilling and *minimising* any risks to the environment. For SSS and MBES and backscatter surveys conducted as part of *Appraisal* surveys of upstream hydrocarbon operations, the purpose is to identify and delineate all surface conditions and potential hazards that could negatively impact safety, integrity, and efficiency of the drilling operations. The output datasets provide an acoustic relief of the seabed and pertain to a site specific evaluation of the broader prospect area(s) where drilling is planned to take place, as well as any other oil and gas related seafloor-disturbing activities. In this manner, potential geohazards such as slope instability, seabed features (e.g., canyons), shallow gas, mass transport complexes, sediment waves, gas hydrates, pock marks, mud volcanoes, and shallow faults are noted and subsequently avoided. This is to ensuring that subsequent phases of upstream hydrocarbons such as: drilling of exploratory wells, development and extraction, are performed securely and any possible geohazards and risks are eliminated. For this matter, the analysis of SSS, MBES and backscatter data are aimed at the interpretation of project-specific risks and potential impacts and are used for the characterisation of seabed lithology, geological feature identification, seabed obstructions and existing infrastructure, identification of features favourable for the presence of sensitive sessile benthic communities, and description of seafloor geology. The specifications below set the *minimum* methodological and technological preconditions for the production of SSS, MBES and backscatter data for allowing the effective exposure of the aforementioned with improved clarity as well as to allow the

effective identification of possible 'shipwreck-like' anomalies or features of 'high archaeological potential'. In effect, the data collection specifications suggested here aim to add to the operational framework of oil and gas *Appraisal* surveys and provide the clarifications necessary as to how to generate geophysical data for maritime archaeology purposes and potentially provide the basic information for wreck site characterisation and identification. With the completion of the geophysical surveys, contractors/subcontractors are required to report the discovery of 'shipwreck-like' anomalies or features of 'high archaeological potentially' in a Field Memo report (by-standard 09, pages 273-274) and engage with further ground truthing investigation as part of the procedures of survey level 2 (by-standard 11, pages 276-276).

Table 22:Survey level 1 and technical and methodological prerequisites for geophysical surveys and reporting on SSS anomalies of 'high archaeological potential'

Technical precondition for AUV Side-Scan-Sonar (SSS) surveys

By-standard 06: In the best interest of viewing the output SSS data with better clarity, SSS data should be generated with a high frequency system operating on dual-channel and dual-frequency (Søreide, 2011). The choice of the operational frequency depends on the survey company. However, it should be noted that SSS data should be of high clarity, from which it should be possible to characterise the seafloor morphology and geology, and sediment distribution, locate geological features, identify 'shipwreck-like' anomalies and features of 'high archaeological potential' and other anthropogenic or geological properties and geohazards. According to NOAA's (2017) *Hydrographic Surveys Specifications and Deliverables*, Technique 3 seen in the Acoustic Backscatter chapter, it is suggested that the line spacing of the instrument's range should be designed to provide 100% overlapping coverage, with the SSS machinery being best mounted on an AUV, operating above the seabed equal to 10% to 20% of its' scanning range, with the SSS dataset analysed in **Chapter 5** to be best generated at frequencies greater than 500 KHz (BOEM, 2015; NOAA, 2017). This is also compatible with BOEM's (2015) *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585* and should be perceived as a general suggestion that contractors should choose to follow or exceed. In addition, it is worth mentioning that the resolution of SSS data is dictated by other more complicated parameters such as the length of the pulse, 'pulse repetition rate, sound velocity in sea water and beam width' (IGOP, 2017, 38). These operational parameters depend on the SSS operator(s), the aim of which is to produce a clear sonograph showing with clarity both small and large seafloor features and anomalies, whilst providing full area coverage and correct positioning. According to IGOP, to achieve this the AUV survey platform onto which the SSS machinery will be mounted should be operating at a speed that allows an effective repetition rate and clear overlap and data coverage (i.e., the slower the speed over

ground, the greater the resolution). Following data acquisition, the SSS data should be post-processed to improve data quality and latterly developed into a stitched mosaic of the entire prospect area(s). For further clarification pertaining to the post-processing and the quality of output stitched mosaic refer to both NOAA's and BOEM's documents and Data Submission by-standard 01 (Table 25, pages 284-285) and for data production clarifications pertaining to the angle of the emitted swath refer to by-standard 08 underneath. The position of the AUV should be known precisely, and regardless of which of the three main acoustic positioning techniques will be utilised (i.e., long baseline (LBL), short baseline (SBL) and ultra-short baseline (USBL) positioning) it should present accurate georeferenced datasets.

Technical precondition for AUV Multibeam-Bathymetry-Echosounder (MBES) and Backscatter surveys

By-standard 07: Chapter 5 has shown that MBES and backscatter data for best revealing details in seafloor characterisation and topographical investigation should be mounted on AUV platforms to obtain 100% bathymetric coverage of the project area with data collected roughly 10% to 20% of the scanning range of the instrument. The output data should be generated at high resolution, with **Chapter 5** suggesting that MBES and backscatter data to be produced at operational frequencies ranging from 250 to 550 KHz and at a resolution of 1 point every 2 [or 3 metres]. This is in accordance with the International Hydrographic Organization, *Standards for Hydrographic Surveys,* 2020, publication, Order 1a Survey Standards; NOAA's (2017) *Hydrographic Surveys Specifications and Deliverables*; and BOEM, (2015) *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585* and applies to specific MBES systems. In general, the choice of operational frequencies depends on survey contractors/subcontractors, the aim of which is that the output MBES and backscatter data should meet the objectives of the survey for enabling the effective identification of geological features and anomalies, in addition to generating a detailed relief of the seafloor (Picard, et al, 2018). As a general note around frequencies for MBES and backscatter data, the IGOP suggests that AUV echo-sounding systems working at depths greater than 750 m should be 'high resolution systems operating at frequencies of 200 kHz or higher'. This is one aspect of determining how high resolution MBES and backscatter surveys for the effective identification of features can be achieved. Specifications pertaining to additional parameters, such as the range and angle of the swath (for generating MBES data) and the angular dependence of the backscatter strength (for generating backscatter data), are presented below (by-standard 08). Other parameters for determining that data are collected at the best resolution achievable by the system, such as the beam width of the system, the associated footprint on the seafloor, the pulse repetition rate, and vessel speed over ground, require technical expertise and depend on the project specifications. For this matter, the contractor/subcontractor company and the operator of the machinery should decide on these parameters, the overreaching concept being the creation of high-end 2D and 3D image reliefs of the seabed, capable of presenting an accurate representation of the broader seafloor morphology of the surveyed area and detect metric-scale features as small as 3 metres. By superimposing the backscatter on the MBES further insights should be able to be deduced pertaining to sediment surface and seafloor roughness. The processing of MBES data and backscatter data should allow the effective characterisation between geological features/anomalies and those of being of possible 'high archaeological potential' and 'shipwreck-like character'. An example of this process has been presented in **Chapter 5** through the case study of the 'Anthea-1' prospect site. Similar to by-standard 06, the output data of this process should be accurately georeferenced with the

survey vessel operating at a speed that allows an effective repetition rate and clear overlap and data coverage (i.e., the slower the speed over ground the greater the resolution).

Line spacing of geophysical surveys with Side-Scan-Sonar (SSS) and Multibeam-Bathymetry-Echosounder (MBES) and Backscatter surveys

By-standard 08: Because of the scale and complexity of the activities planned to take place both where drilling is intended to take place and in the wider prospect area(s), geophysical surveys 'are to be as large as practical in cases where uncertainty exists' (BOEM 2015, 5). In this respect the survey area should be covered in its entirety with SSS, MBES and backscatter data with the line spacing of each survey to be 'conducted along a series of regularly spaced and parallel track lines' (ibid). The survey grid should be agreed prior to commencing with surveying, with data to be acquired by following alternate parallel lines running in opposite directions and overlapping between adjacent lines. According to BOEM, 'line spacing depends upon a variety of factors, including water depth, equipment employed, and the desired resolution of the survey data'. In some instances, 'tighter line spacing may be necessary to obtain the appropriate level of coverage and data quality' (ibid). Further specifications for this have been provided by Picard, K, et al, in the *Australian Multibeam Guidelines* survey document, where the section on the *minimum* prerequisites for line-path surveys suggests that 'lines should be designed parallel to the general direction of the seabed's contours as much as possible for swath systems' (Picard, et al, 2018, 17). SSS, MBES and backscatter survey surveys should provide full (100%) seabed mapping coverage, with a *minimum* of 10% overlap. For partial coverage, where possible, it is recommended to use line spacing that will enable a subsequent in-fill mapping efforts to complete the mapping of the area. For backscatter and SSS data, coverage should be conducted in an effort to have incidence angles overlapping and according to IGOP's suggestion, this should be achieved by emitting swaths onto the seabed at angles between 20 and 60 degrees (Lamarche and Lurton, 2017). This 20 to 60 'degrees criterion is advised for several reasons including signal stretch, avoidance of total internal reflection events, and permitting a simple relationship between reflection coefficient and impedance' and pertains to compensating for the high variability of individual backscatter intensities and thus allowing the possible detection of different features/anomalies regardless of how these are orientated on the seabed (IGOP, 2017, 61; Parnum, and Gavrilov, 2011).

Precondition of reporting all Side-Scan-Sonar (SSS) anomalies of 'high archaeological potential' or 'shipwreck-like character' and preliminary SSS Field Memo

By-standard 09: All SSS anomalies of 'shipwreck-like character' or 'high archaeological potential', discovered during EBS, Geohazard Investigations [or any other Supplementary Hydrographic Surveys], should be noted and presented in a Field Memo following the completion of all marine geophysical surveys. This Field Memo report should be submitted and presented to the responsible national heritage agency, namely the DoAC, preceding survey level 2 and subsequent ROV ground truthing inspection surveys. The noted anomalies presented in this document should then be visually assessed (as per by-standards 10 and 11 seen in survey level 2) the aim of which is to lessen the chance of endangering any nearby archaeological sites and *maximising* the potentials of discovering UCH in the wider prospect area(s). The SSS Field Memo should illustrate the SSS anomalies of 'high archaeological potential' and 'shipwreck-like character' that should be surveyed as part of survey level 2, supplemented with the following information:

- Projected coordinates of the specific feature/anomaly (in X, Y and in decimal degrees);
- SSS contact ID;
- SSS Survey line number;
- Target Width (in metres);
- Target Height (in metres);
- Target Length (in metres);
- Target Shadow (in metres);
- Target Description;
- Recommended buffer zone, if applicable;
- Survey line number ID;

As per the procedures of survey level 2 procedures, the features/anomalies presented in the SSS Filed Memo should be photographed in their entirety, with the data to be submitted to the responsible heritage agency for reassessments and archiving. For additional information as to what needs to be included in this Field Memo, refer to NOAA's (2017) *Hydrographic Surveys Specifications and Deliverables* in the Side-Scan-Sonar Deliverable and Side-Scan-Sonar Contact Attribution chapters. The output document should be submitted in PDF and PDF/A formats for archiving purposes

[6.5.1.3].**Level 2** – Visual inspections of features or anomalies of 'high archaeological potential' and 'shipwreck-like character'

In addition to geophysical survey, **Chapter 5** has shown that in order to clearly distinguish geological features and potential geohazards from shipwreck sites further ground truthing surveys via Remotely Operated Vehicles (ROV) are required. According to the operational framework of the oil and gas industry, ROV visual inspection surveys are usually conducted both before and after the drilling of wells, the aims of which are predominantly related to industry purpose objectives. For instance, in the immediate vicinity of where the drilling is planned to take place, the seabed is subject to systematic ROV video recording. This is by operating the ROV on pre-programmed line-pathed or transects radiating surveys with video-photography data being collected and latterly processed to ensure that the geophysical anomalies/features noted as part the EBS do not pose risks to drilling (ExxonMobil Exploration and Production Cyprus (Offshore) Limited, 2018a; 2018b; 2018c; ENI Cyprus LTD, 2017a; 2017b; 2017c). The length and radius of the line-path and transect surveys varies between different offshore oil and gas contractors/subcontractors with specifications pertaining to each provided on a case-by-case basis. Following the completion of visually

assessing the adjacent area of drilling, further ROV surveys are conducted after the drilling of wells. The purpose of these supplementary visual inspections is to record the characteristics around the wellhead area and guarantee that structures/objects related to the drilling were not left behind (ibid).

From these two visual inspection survey methodologies, accidental discoveries of UCH during NRS have been made in the context of pre-programmed line-path or transect surveys preceding the drilling of wells, with this being the case for the shipwreck discoveries of 'Eratosthene-Eni and 'Aphrodite-Noble'. The data analysis of these sites in **Chapters 4** and **5**, has revealed that ROV video-photography datasets generated during the course of oil and gas explorations present deficiencies, limiting how much archaeological information can be deduced. This is because the ROV survey methodological parameters and technological machinery clarifications are absent, with the latter clarified in the General prerequisites section above, and the following by-standards providing the *minimum* methodological specifications for contractors/subcontractors operating in the EEZ of Cyprus. These provide guidelines as to how ROV inspections should be conducted and what additional surveys offshore contractors/subcontractors should conduct to *maximise* the potential for discovering UCH sites, and thereby lessening any chances of endangering any nearby [unconfirmed but awaiting discovery] archaeological sites (i.e., shipwrecks) from planned drilling activities.

Table 23: Survey level 2 prerequisites and technical parameters for conducting ROV visual inspections after the completion of geophysical surveys
General methodological clarifications for ROV visual inspections both before and after the drilling of wells **By-standard 10:** For ROV surveys conducted as part of survey level 2, including the visual assessment of noted SSS anomalies/features of 'high archaeological potential' or 'shipwreck-like character' as per survey level 1, by-standard 09, the flight elevation of the ROV should be maintained at a constant speed (between ~ 0.5 - 1 ms (1-2 kt)) and automatically set at a height above the seabed to avoid stirring up silt that might obscure the image. A clear survey plan should be adhered to in order to survey as many anomalies as possible situated in the immediate vicinity of where drilling is planned to take place. A 1

km radius area should be established around the well site, in which survey transects should be set to provide 100% area coverage with each running lengthwise from one end to another. The ROV should hold a straight course along the entire length of each transect, and should be stopped when archaeological assets (i.e., scatter amphorae or other historical/archaeological objects/sites) or a shipwreck site are discovered. The preliminary survey of both shipwreck sites and scatter materials (i.e. amphorae) should be carried out on a circular taking, recording the discovered finds in their entirety from all possible angles (as per by-standards 13 and 14).

For shipwreck site discoveries, further attention and detailed investigation is required and as such ROV operators should suspend survey level 2 procedures and engage with the procedures stated in survey level 3. This pertains to achieving the effective preservation by record of shipwrecks sites and reengaging with the producers of survey level 2 as soon as the prerequisites of survey level 3 are fulfilled (see survey level 3, by-standards 13 and 14). For scatter material (i.e., amphorae or debris trails) no more data are required besides them being surveyed in their entirety and from all angles.

As a general note, prior to commencing with surveying, the camera should be positioned at a high angle [at roughly 45° to 90°]. The camera should be fixed at the same orientation throughout the survey in order to ensure that a constant and uninterrupted view of the seabed is obtained (i.e., the ROV frame should not be visible). The zoom of the camera should be set at a *maximum* wide-angle setting and left unchanged, ensuring consistent images for all transects. The overlay data such as the measure of depth, real time coordinates and altitude should also be seen in the output video-data, but should not overly clutter the screen. The lighting and recording modes should be adjusted to ensure that the highest quality image is maintained throughout and lighting must ensure that well-lit, high-quality pictures of clear clarity and colour balance are obtained while the ROV is in flight (Hitchin, et al, 2015, 12).

Precondition of visually assessing Side-Scan-Sonar (SSS) anomalies of 'high archaeological potential' or 'shipwreck-like character' noted in the output Feld Memo of survey level 1

By-standard 11: In addition to conducting pre-programmed line-path or transect surveys prior to drilling, all SSS anomalies of 'high archaeological potential' or 'shipwreck-like character' noted in the output SSS Field Memo of survey level 1 (by-standard 09), should be visually assessed, preceding the drilling of wells. Essentially, the prenoted SSS targets that were not surveyed as part of the pre-programmed line-pathed or transects surveys, should be the subject of further ground truthing investigations. This means that as per this by-standard, offshore oil and gas contractors/subcontractors operating in the deep-waters of the EEZ and on the CS of Cyprus for the purpose of NRS, should abide to conduct additional ROV targeted surveys on all prenoted SSS anomalies found in the wider prospect area(s). This is part of a broader mitigation strategy for lessening any chances of endangering any nearby archaeological sites by visually assessing specific prenoted anomalies and thereby *maximising* the chances of discovering UCH. The survey of all SSS anomalies/features of 'high archaeological potential' and 'shipwreck-like character' should follow the basic principles evaluated above (by-standard 10) and ensure that surveys are conducted in a manner that delineates any concerns of features/anomalies of 'high archaeological potential' and 'shipwreck-like character' mentioned in the submitted Field

Memo of survey level 1 by-standard 09 are left unrecorded. This can be achieved either by conducting additional seabed video transects that should aim to encompass the assessment all of the anomalies/features in question, or by simply conducting targeted ground truthing investigations on each of the noted anomalies/features mentioned in the output Filed Memo of survey level 1 (by-standard 09).
<u>Precondition for surveying before and after drilling if (a) shipwreck(s) are discovered within the immediate vicinity of the prospect location(s)</u> **<u>By-standard 12</u>**: According to the *Best Available Techniques Guidance Documents on Upstream Hydrocarbon Exploration and Production* (European Union, 2019), in case that an archaeological/historic shipwreck(s) is discovered within the wider prospect area(s), contractors/subcontractors are obligated to survey the site(s) before and after drilling as part of risk-based environmental monitoring programme. The results of both surveys should be presented in the Risk Assessment and Mitigation Strategies section of the Minimum Professional Reporting by-standards, pages 300-302, the aim of which is for contactors/subcontractors to recognise, model and predict the effects of their work on UCH and evaluate if drilling and other by-product activities may cause any damage to the discovered shipwreck site(s).

[6.5.1.4].**Level 3** – *Reconnaissance* surveys of confirmed archaeological sites (i.e., shipwrecks)

As per survey level 2, ground truthing or seabed surveys may lead to the accidental discovery of shipwrecks, and as such ROV operators are required to conduct further *reconnaissance* survey when this occurs. Essentially, the discovery of a shipwreck site triggers the prerequisite for engaging with the procedures set out in survey level 3, meaning that survey level 2 procedures should be suspended until the following guidelines are fulfilled. The by-standards provided underneath aim to ensure the adequate survey and thereby preservation by record of discovered shipwrecks and for this matter ROV operators contractors/subcontractors are obligated to abide to the following as soon as a shipwreck discovery occurs. The by-standards provided here derive from the observations made from the operational activities of fourteen offshore hydrocarbon projects that took place in the EEZ of Cyprus and suggests that the absence of archaeological survey by-standard on both national and international levels for visually assessing shipwrecks when discovered during NRS (**Chapter 3**) yields problematic results that considerably limit how much archaeological information can be deduced.

Chapters 4 and **5** suggested that this occurs because ROVs are operating on pre-programmed line-path-surveys (such as the survey procedures described in survey level 2), and are usually stopped momentary to visually assess shipwrecks sites with little effort being made to scientifically record and thereby effectively preserve sites/scatter artefacts by record. The following section provides the clarifications necessary as to how ROV operators are to achieve the scientific preservation by record of shipwreck discoveries made accidentally during the course of NRS, by requiring contractors/subcontractors to invest a small amount of additional survey time and follow the specific procedures detailed below. Essentially, by triggering survey level 3 as soon as a shipwreck discovery occurs whilst conducting survey level 2 pre-programmed line-pathed or transects surveys, contractors/subcontractors are abiding to the highest heritage standards in achieving the effective preservation by record of UCH with little additional financial cost.

Table 24: Survey level 3 prerequisites and technical specification for ROV video surveying and conducting Structure from Motion (SfM) surveys on confirmed shipwrecks

ROV video-photography methodological preconditions for surveying discovered shipwreck(s) [and adjacent debris]

By-standard 13: The absence of *minimum* technical and methodological prerequisites, were first addressed in **Chapter 3**, arguing that the lack of legislations on an international level has left an unfortunate lacuna as to how UCH should be surveyed, and thereby preserved by record, when UCH is accidentally discovered during the course of NRS. As a result, only a few States provide specifications as to how the discovery, survey, reporting, and *in situ* preservation and by record of archaeological/historical assets found accidentally during oil and gas operations should be achieved, through national guidelines and other soft laws. The following methodological clarifications provide the specifications necessary for how shipwreck sites and adjacent debris field areas should be preserved by record and these derive from the suggestions made by other custodian [heritage] departments such as Australia and the USA, and other international regulatory agencies, such as the European Union, the International Association of Oil & Gas Producers (IOGP), and the International Petroleum Industry Environmental Conservation Association (IPIECA).

For this matter it is recommended that:

- Visual inspections of shipwrecks should last from 10 to 20 minutes depending on the size of the site. For shipwrecks of substantial size contractors/subcontractors must spend as much time as necessary to visually assess the site in question in its entirety and implement the methodological procedures provided below (by-standard 14).

- The recording process should combine both still-photography and video recording for enabling the more effective post-processing of the datasets in developing detailed photogrammetric/orthomosaic models. Also, the application of still-photography would enable a more systematic inspection of the site by emphasising specific diagnostic features on the wreck (such as: the amphorae and other exposed artefacts, the anchor(s) and the wooden hull. For metal wrecks the stern and bow should be emphasised and in particular the aim should be to record the name of the vessel and other important structural and cargo components, if exposed) (BOEM, 2021d). Guidelines as to which features should require more emphasis could be provided by the representative appointed by the DoAC attending the survey as per the General prerequisites by-standard 01, page 266.
- In addition to the core physical remains of the shipwreck, the adjacent area should be surveyed so as to determine the size of the debris field. This may include the proposed area(s) of impact of the wreck site itself, and the nearby debris filed. The area of interest should be determined through the usage of SSS data and for this matter, potentially associated scars on the seafloor in the immediate vicinity of the wreck and other seafloor features, such as drag scars, mounding, or depression marks should be visually assessed (BOEM, 2021d).

As a general note, the ROV video-photography surveys should be carried out at three different angles, bird's-eye view, high angle, and eye level, with the closest angle to be set 1 metre from the site and the furthest 5 metres, ideally without disturbing the site and any unique features and avoiding stirring up silt. The overall survey of the shipwreck site and the immediate surrounding area should be carried out based on the basic principles of Structure from Motion (SfM) with video-recording carried out first, followed by the application of photography, whilst surveying the site in its entirety in a circular or spiral route (Pacheco-Ruiz, et al, 2019). Additional information pertaining to the methodological process for generating photogrammetric/orthomosaic models are provided underneath (by-standard 14).

ROV video-photography and methodological precondition for conducting Structure from Motion (SfM) photogrammetry/orthomosaic surveys on confirmed shipwreck discoveries only

By-standard 14: The discovery of a shipwreck site during NRS requires the ROV video data to be collected and latterly post-processed to create orthomosaic/photogrammetry models. For this matter, ROV operators are required to implement the principles of Structure from Motion (SfM) when survey level 3 is triggered, with the following methodological process to apply only for effective preservation by record of confirmed shipwrecks found in the deep-sea of Cyprus during NRS activities. They are to be applied only for the effective preservation by record of the wreck's core and not for the entire adjacent area of the site.

SfM provides the opportunity to create low-cost 3D photogrammetry/orthomosaic models and employs overlapping images acquired from multiple viewpoints. This can be achieved through video-recording, the prerequisites of it being that the sequential images should present 'an overlap of 50%–75%' with the camera being fixed at a set position at 'a roughly perpendicular/oblique angle, 1–2 m above' the site and data collected at a stead slow paste (Bayley and Mogg, 2020, 1412). According to Bayley and Mogg, common approaches applied in the past, include circular or spiral tracks (Pacheco-Ruiz, et al, 2019; Pizarro, et al, 2017) or a 'lawn-mower' pattern zig-zagging over the site (Burns, et al ,

2015) both of which can guarantee the effective preservation of the site if static scenes, consistent light and 100% coverage is achieved throughout (Bayley and Mogg, 2020,1412). Occlusion and blue-water image space should be kept at a *minimum.* The end video product should not be blurred, underexposed or overexposed and for this matter Bayley and Mogg suggest that the light should not be directly cast on the subject. Instead, light should be cast onto the site at an oblige angle. For this matter, the camera configuration should be adjusted according to the field conditions and the focal length lens and should be fixed for greater accuracy, precision, and stability (no-zooming while surveying), prior to engaging with procedures of this by-standard (Cucchiaro, et al, 2018). Whilst surveying, the ROV should operate at a slow steady pace and at consistent height, capturing the entire site first, with additional flyovers over the site to provide complete coverage and high image overlap (Micheletti, et al, 2015). This methodological process should generate point correspondence across multiple images and effectively allow the stitching of images together for generating an unscaled [3D] photomosaic/orthomosaic map.

Prior to commencing with surveying, contractors/subcontractors need to also consider setting ground control points (GCP). Usually, these should be physically placed at the outer boundaries of the site, uniformly distributed, not aligned or clustered, with BOEM suggesting that these should be set at the bow, amidships port and starboard sides and stern of the site for best determining the size of the vessel (BOEM, 2021d). The GCP should enclose the site, and for this purpose it is recommended to use different targets or benchmark points. These should be surveyed as part of the process, colour coded and georeferenced with the corresponding coordinates of each to be provided in the output AIA report (i.e., red point: coordinates; blue point: coordinates). The purpose of setting up GCP is to information the post-processing process, the outcome of which is to be able to generate scalable, georeferenced photomosaic/orthomosaic models. In the scenario that it is not possible to physically set GCP, it is recommended that ROV operators should pick various distinct features from the site, take a picture and note the precise coordinates of each. To inform the outcome of this process they should be able to map these features and indicate in the output AIA report exactly where these are found.

For post-processing the video data to photomosaic/orthomosaic models it is suggested to use *Agisoft Metashape*. For information pertaining to the technical process of post-processing refer to Shervais's and Dietrich's *Structure from Motion (SfM) Photogrammetry Data Exploration and Processing Manual* (Shervais and Dietrich, 2016). The choice of software for generating the photomosaic/orthomosaic models depends on the contractors/subcontractors, the aim of which is to generate accurate georeferenced, high quality and detailed models. The output models and video data of the site should be discussed in the AIA and only in exceptional circumstances and after discussions with the licence holder company and the DoAC the procedures of survey level 4 may be triggered. For further clarifications regarding the reporting of shipwrecks and scatter materials refer to the Minimum Professional Reporting by-standards section, pages 286-304.

[6.5.1.5].**Level 4** – Sampling of artefacts and structural components

In exceptional cases, the discovery of a shipwreck may require further sampling procedures. This may occur only for shipwreck sites deemed by the DoAC to be of exceptional scientific interest or outstanding value and political interest and only if more data are required to assess the site. It is suggested that the decision to engage with this process should be justified by the

DoAC, discussed and agreed with the licenced holder company and the contractors/subcontractors. Triggering this procedure is not intended to be a punitive measure, but instead it should be perceived as a necessary procedure, implemented only in exceptional circumstances to allow the gathering of necessary key information for further understanding sites deemed of outstanding scientific value and uniqueness.

Sampling procedures undertaken at the Skerki bank and Ashkelon, were conducted for the purpose of recovering specific diagnostic artefacts 'that might provide the most information'. This includes artefacts such as coins, ceramic objects (i.e., fine wares and amphorae) and other non-ceramic objects (such as: stone, glass, metal *et cetera*), as well as other prestige goods of significant value (Adams, 2004, 39) and other structural components of the wreck (i.e., parts of the hull to verify details of construction). The decision about what should be sampled, should derive from the video-photography data and the photogrammetric/orthomosaic models generated from the survey level 3 procedures and for this matter the responsible archaeologists appointed by the DoAC should conduct a detailed desk-based assessment of all exposed (top level) artefacts, the aim of which is to make suggestion as to which specific artefacts/structural components or materials should be recovered. To achieve this, the process of artefact/structural components recovery requires a commercial ROV to be equipped with hydraulic robot manipulators (i.e., robotic arms) capable of lifting objects with weight greater than 150 kg. Attached to the robotic arm, a gripper with three/four finger-intermeshing jaws or two/three finger-floating jaws with gripping force ranging from 100 kilogram-force (kgf) to 500 kgf should be utilised for lifting the selected artifacts and/or structural components (Sivčev, et al, 2018). The recovered materials should be then placed in a basket, tray, or a drawer. This should be attached to the ROV, enabling the effective and safe retrieval of the recovered samples to the surface. The compartments should be capable of holding the weight of the recovered materials both in

water and at the surfaced and should ensure their effective storage both during and after the completion of the process. During the course of sampling an elevator system should be put in place, with the ROV surfacing the recovered materials one by one to guarantee the effective preservation of the recovered samples. The entire process should be directed by a specialist maritime archaeologist, appointed by the DoAC, who will be accountable for supervising the entire process and delivering the decisions taken in consultation with the DoAC as to which materials/artefacts and structural components should be recovered. The appointed individual should also be accountable for the safe recovery of samples. Completing the process of sampling, all recovered artefacts/objects and structural components from the wreck site should be sent to the DoAC for further preservation and conservation. The recovered evidence should be then studied in detail by specialists in the field, appointed by the DoAC, and cross-examined with the data emerging from survey levels 1, 2, 3 and the output AIA report, the results of which should be the publishing of an official archaeological publication in the format of a monograph or an article(s).

[6.5.1.6].**Level 5** – Excavation

Site excavations are required only if a confirmed shipwreck site is in immediate danger of being destroyed by development plans (i.e., anchoring of the pontoon or drilling vessel or drilling or pipeline/cable installations) and when no other solutions have been formulated between the DoAC, the licence holder company, and the involved contractors/subcontractors to preserve the site *in situ*. Excavation is a complex process and requires significant planning and is expected to affect the budget and timeframes of the prospect project in question. For this reason, triggering level 5 should be avoided by all means but it nevertheless remains a last resort approach only when UCH is in immediate danger and no real intention of moving the location of the drilling site or altering the route of the planned pipeline or anchoring the pontoon or the drilling vessel at a safe distance from the confirmed shipwreck site(s) has been

expressed. In the unlikely scenario of *ex-situ* preservation, all involved stakeholders should engage in a dialog to plan the excavation of the endangered site in question and determine the scale, aims and objectives, timeframes, processes, technical, and methodological practices and budget. This should be developed in close collaboration with the appointed maritime archaeologists of the DoAC, and the licence holder company and the involved contractors/subcontractors on a case-by-case basis, the aim of which is to develop a strategic plan that will meet the needs, requirements, limitations and constrains of both. It is expected that the licence holder company will undertake the costs for the *ex-situ* preservation of the endangered site in question and only after the fulfilment of the agreed excavation plan licencing for drilling will be offered.

[6.5.3]. Minimum Professional Data Submission by-standards

Chapter 5 has shown that since 2017 when this project started, contractors/subcontractors appear to selectively choose what datasets to submit and in what formats. This section sets out the necessary specifications for data generated during the course of EBS, Geohazard Investigations [or any or any other Supplementary Hydrographic Surveys] to be submitted to the relevant national heritage agency (Table 25). The Data Submission by-standards draw upon the preconditions necessary for contractors submitting reports, ROV video-photography, MBES and backscatter, and SSS. These will help to ensure effective data re-evaluation, reassessment and archiving that will guarantee the lasting preservation of these rare, expensively acquired, and sensitive datasets. This is relevant regardless of whether UCH has been discovered or not, as datasets should be ideally submitted for reassessments purposes and additional academic evaluation (**Chapter 5**). It is my position that even though collecting large amounts of geophysical and visual datasets generated in the context of oil and gas explorations can be a challenge for managing and preserving in the near future, **Chapter 5** has effectively underlined that there is much interdisciplinary research that can be done to

better understand the remote deep heritage of Cyprus through this data. The datasets and the output AIA should be provided with the completion of the *Exploration/Appraisal* but preceding the *Development* phase (Figure 56, page 239).

Table 25: The specifications necessary for data submission generated during the course of Environmental Baseline Surveys (EBS), Geohazard Investigations [or any or any other Supplementary Hydrographic Surveys] as part of natural resource surveys (NRS).

Side-Scan-Sonar (SSS)

By-standard 01: Ideally, SSS should be provided in the following formats:

- each individual survey line should be provided in eXtended Triton format (.XTF);
- each individual line should be geo-referenced and provided in a GEOTIFF (.TIFF) format;
- all data should be submitted in a processed (.XML) format;
- The SSS stitched mosaic of the site should be geo-referenced and provided in GEOTIFF (.TIFF) format. The output of this should be exported in 20-centimetre and 1 metre analyses;
- Each survey line should also be provided in PDF and PDF/A file formats.

These specifications are aligned with prerequisites seen in BOEM's (2017) *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585.* For further clarifications refer to the Archive Sustainability Strategy section below, page 311-312 (Table 28).

Multibeam-Bathymetry-Echosounder (MBES) and Backscatter

By-standard 02: MBES and backscatter data should be provided in the following formats:

- ASCII text (.TXT or .XYZ);
- Bathymetric Attributed Grid (BAG) containing all datasets discussed in the Reporting by-standards**,** section Seafloor Feature Analysis, pages 293-298 (i.e. including the different visualisation models generates as per the requirements of this section);
- A Triangulated Irregular Network (TIN) model of the surveyed area should be submitted as well as a Bathymetric model in ASCII format;
- Nine GEOTIFF (.TIFF) mosaics of the entire survey area at 1, 2 metres and 50-centimetre analyses from the output TIN (x3) and Bathymetric models (x3) and backscatter data (x3) respectively should be provided (Refer to section Seafloor Feature Analysis, pages 293-298);
- All other models generated for the purpose of the AIA should be provide in GEOTIFF (.TIFF) format (including both 2D and 3D exports and other visualisation techniques);
- The bathymetry survey line (navigation path) should be also submitted in Shapefile (.SHP) line template.

For further clarifications refer to the Archive Sustainability Strategy section below, page 311-312 (Table 28).

ROV videos, photographs and models

By-standard 03: ROV videos of all survey line paths and the specific video-recordings illustrating the discovery archaeological/historic asset(s) should be submitted. These should be compatible with more than one video codec system and should be accompanied with processed High Definition (HD) photographs and screenshots illustrating the UCH discoveries made from each line path. This is relevant to both scatters of materials and shipwrecks. The data submission requirements set here are aligned with ISO standards for archiving video-photography datasets, suggesting that contractors/subcontractors should submit the ROV video data in two or more video code and container formats respectively. For further clarifications as to what are the applicable video code and container formats refer to the Archive Sustainability Strategy section below, page 310 (Table 27). With regards to images extracted from ROV videos and stills generated during the course of ROV surveys, ISO's document 19263-1 *Photography — Archiving systems — Part 1: Best Practices for Digital Image Capture of Cultural Heritage Material* suggests that it is best to produce and archive them in TIFF format, as it offers a fully lossless compression of images, that can store a considerable amount of data, is ideal for images of this nature, and is expected to be supported long into the future. This is also the case for the orthomosaic/photogrammetric models, as contractors/subcontractors are expected to generate and latterly submit the panorama export of the models in TIFF format(s) and the 3D export in VRML and PDF formats. For further specifications refer to *Agisoft Metashape User Manual Professional Edition, Version 1.5* sections, Exporting Results, pages 39-53.

Reports

By-standard 04: Contractors/subcontractors conducting NRS in the deep waters of Cyprus EEZ and on the CS are required to submit the following reports:

- Strategic Environmental Assessment (SEA);
- Environmental Baseline Survey (EBS);
- Geohazard Investigation reports;
- Environmental Social Health Impact Assessments (ESHIA);
- Environmental Impact Assessment (EIA);
- Archaeological Impact Assessment (AIA).

These documents should be submitted in both PDF and PDF/A document formats for archiving purposes with further explanations pertaining to this presented in the Archive Sustainability Strategy section below, page 309 (Table 26).

[6.5.4]. Minimum Professional Reporting by-standards

An Archaeological Impact Assessment (AIA) seeks to analyse the data outputs of upstream operations[7] and demonstrate that any archaeology/heritage assets situated within the broader prospect area(s) have been identified and received the appropriate consideration. This assessment is aligned with the SoW prerequisites set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus,* which stipulates that Desk Based Assessments should address 'specific concerns (of archaeological artefacts, marine protected areas, fishery restricted areas, cables, pipelines, *et cetera*)' (Ministry of Agriculture, Rural Development and Environment, with the input of the Departments of Environment and Fisheries and Marine Research, Cyprus, 2017, 5). Ideally, the AIA should be developed prior to drilling and submitted for review to the relevant national heritage agency as a stand-alone document. Following discussions and approval it should be integrated in the final ESHIA or EIA. In this instance, the report and the analyses presented therein, is aligned with the interest of the responsible stakeholder heritage agency, namely the DoAC, guaranteeing that contractors/subcontractors are in full conformity with Articles 18A[8] and 18B-(1)[9] of the '2014 (amended) Antiquities Law of Cyprus'. Thus, it is my position that an AIA should be composed regardless of whether UCH asset(s) are discovered or not. This prerequisite is aligned with the general requirement of the Chartered Institute for Archaeologists (CifA), which has desk-base assessments assessing 'the significance of the known or predicted heritage assets' within a proposed development area (Chartered Institute for Archaeologists, 2020, 4). In the scenario that UCH asset(s) are confirmed, contractors/subcontractors should implement a risk assessment plan and mitigation

[7] The term upstream operations refers to datasets generated during the *Appraisal* phase in the context of EBS, Geohazard Investigation, [or any other Supplementary Hydrographic survey], with this to pertain to SSS, MBES and backscatter, ROV videos and photographs and SBP datasets.
[8] See footnote 3, page 264.
[9] See footnote 4, page 264.

strategies to guarantee the *in situ* preservation of the discovered heritage asset(s). To ensure that this is achieved, contractors/subcontractors are expected to evaluate and model the effects of predictable and unpredictable operational parameters and by-processes of oil and gas development and production on the discovered UCH. According to CifA's desk-base guidelines, 'an assessment of the impact of proposed development or other land-use changes on the significance of the heritage assets and their settings' should be composed with the specification pertaining to what is expected to be addressed as possible mitigation strategies mentioned in Risk Assessment and Mitigation Strategies section, pages 300-302 (ibid). For discovered shipwrecks, contractors/subcontractors should undertake a detail analysis of the site in the relevant section (Section: The discovery of a shipwreck/or scatter materials (archaeological analysis), pages 298-300) and submit the generated ROV video-photography datasets and the output photogrammetric/orthomosaic models generated as part of survey level 3, as soon as possible and prior to drilling. This is part of a broader data analysis strategy where all submitted datasets showing the discovered shipwreck sites will be further studied internally by the appointed maritime archaeologists of the DoAC in consultation with other DoAC personnel for deciding if additional sampling is required and thereby triggering survey level 4 procedures. In the case where UCH asset(s) are not discovered, contractors/subcontractors should evaluate geophysical datasets (as per section: Seafloor Feature Analysis section, pages 293-298) in a manner that delineates any concerns for UCH asset(s) being left unidentified and unrecorded. In effect, an AIA specifies the SoW by clarifying what Desk Based Assessments composed as part of EBS for 'archaeological artefacts' should encompass, with this report to be developed and submitted regardless if a shipwreck discovery occurs or not and prior to the commencement of drilling. Ultimately, the decision to implement the survey levels and the associate Survey, Data Submission and Reporting by-standards evaluated here primarily falls under the remit of the national heritage

agency, namely the DoAC. Based on the 2017 SoW, it is also clear that other governmental agencies, such as the Ministry of Agriculture, Rural Development and Environment, and the Departments of Environment and Fisheries and Marine Research, can equally stipulate that AIA's should be written. It is my aspiration that after the completion of this study I will attempt to liaise with all of the relevant governmental agencies, departments and Ministries to achieve the implementation of the suggestions made here. The following sections present the clarifications necessary as to what analysis techniques and information should be prepared and latterly enclosed in each section of the AIA report.

A. Non-technical summary and baseline conditions

The purpose of this section is to provide a general description of the specific block(s) and the offshore prospect area(s) as well as an overview of the planned drilling activities and brief project outline as per the clarifications set in CifA's *Standard and Guidance for Historic Environment Desk-Based Assessments* section 3.2.2 (Chartered Institute for Archaeologists, 2020). Additional information in this section should include a baseline condition study referring to the relevant deep sea archaeology discoveries made in the context of NRS or other explorational/educational survey cruises in the EEZ of Cyprus, or the eastern Mediterranean more broadly. Information pertaining to this were presented in **Chapter 2** of the study, Deep Sea Archaeology in the eastern Mediterranean and the Exclusive Economic Zone of Cyprus, pages 45-51. For the last part of this section, a brief summary of the survey activities and information related to the discovery of any new UCH resources should also be included. Here, contractors are obligated to mention the basic archaeological/historic evidence with regards to the nature, character, size and quantity, and tentative chronology of the site(s), scatter materials, debris trails or shipwrecks, if discovered as part of their planed NRS activities. Photographs of the UCH asset(s) should not be presented in this section.

This section should be accompanied by a map showing the location of the leased block, with shapefiles marking the area outline of the proposed prospect location(s) and point feature(s) showing the exact drilling location(s). In the scenario of UCH assets being discovered (either a shipwreck site or scatter materials), an additional MBES base-map with contours showing the distance between the find(s) and the proposed well(s) should be also enclosed. In this section, information regarding the exact coordinates of the archaeological/historical assets should not be disclosed.

B. Legislation

This section aims to give an account of the international and national frameworks concerned with the protection of cultural heritage resources from offshore oil and gas operations in all maritime zones of Cyprus including those of the EEZ and the CS. For additional information and further clarifications pertaining to this refer to **Chapter 3** of the study. Ideally, in this section of the report contractors/subcontractors will be expected to highlight the protected status granted to the UCH by evaluating the following international frameworks:

- The Council of Europe (1992) 'European Convention on the Protection of Archaeological Heritage (Revised)' (aka. 'The Valletta Convention');
- ('Barcelona Convention') '1995 Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean' (SPA/BD Protocol);
- ('Barcelona Convention') 'Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil';
- The '2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage' ('2001 UNESCO Convention').

Furthermore, information relevant to the national legislation of Cyprus and the protection of UCH specifically in the deep waters of the EEZ and on the CS, including frameworks which

foresee the safeguarding of UCH by harmful industrial activities such as drilling, should also be included, with specific notice to be given to:

- '2014 (amended) Antiquities Law of Cyprus', Articles 18A[10], 18B-(1)[11] and 18C(1)[12];
- The 'Hydrocarbons (Prospection, Exploration and Exploitation Law) of 2007', Article 13(1).h[13];
- The 'Hydrocarbons (Prospection, Exploration and Exploitation) Regulations of 2007 and 2009)', Article 23(2).(a).(i)[14];
- The 'Assessment of Impact on the Environment of Certain Plans and Programs of 2005', General Provisions (Part II)[15].

In the last part of this section contractors/subcontractors should assert that the operational activities of EBS, Geohazard Investigations [or any or any other Supplementary Hydrographic Surveys] were conducted in accordance with the following national and international

[10] See footnote 3, page 264.
[11] See footnote 4, page 264.
[12] **Article 18C(1):** 'asserts the right to the Council of Ministers, following the suggestions of the Director of the Department of Antiquities Cyprus, and by declaring her/his decision through the Cyprus Government Gazette, to declare "Cultural Protected Zones (CPZ)" for Underwater Cultural Heritage sites of archaeological or artistic value, that are either confirmed or suspected to exist at specific or approximate locations within the Exclusive Economic Zone and on the Continental Shelf (ibid., 1121). This further states that within this CPZs actions such as: a) installations of artificial island and structures, b) anchoring of vessels, c) fishing activities both commercial or not, diving, d) drilling, the usage of explosions or placing of explosions in the marine environment, e) in general any activities directed at UCH regardless they threatening the in situ state of UCH or not are strictly prohibited' (Antiquities Law Cyprus, 2014, 1120).
[13] **Article 13(1).h:** Contractors are expected to abide to the 'protection of biological and mineral resources and of national treasures possessing artistic, historic or archaeological value' (The Hydrocarbons (Prospection, Exploration and Exploitation) Law, 2007, 13).
[14] **Article 23(2).(a).(i):** 'the holders of an authorization are bound to inform the Minister of all major developments in relation to the course of hydrocarbons operations. To this end, copies of all geological, geophysical and other technical reports, well logs, maps, diagrams, magnetic tapes, electronic and other stored data, in any form, reports and interpretation which have been prepared by or for the holder of an authorization' (The Hydrocarbons (Prospection, Exploration and Exploitation) Regulations, 2007 and 2009, 25).
[15] **General Provisions (Part II):** For more information refer to **Chapter 3**, The National Legislation of Cyprus and its Safeguarding of the Underwater Cultural Heritage of the Island, page 103-105.

guidelines and specify the ways in which these guidelines were met. This is relevant to the following:

- Regulatory administrative acts of '2022 of the Antiquities Law of Cyprus', Minimum professional by-standards for safeguarding deep sea archaeological/historic assets found in the Exclusive Economic Zone. Guidelines for offshore oil and gas contractors/subcontractors conducting Marine Geohazard Investigations, Environmental Baseline Surveys [or any other Supplementary Hydrographic Surveys], preceding the drilling of wells (forthcoming);
- European Commission. (2019). *Best Available Techniques Guidance Documents on upstream hydrocarbon exploration and production.* Strasbourg: European Union;
- IOGP. (2017). *Guidelines for the conduct of offshore drilling hazard site surveys*. 1-46. https://www.iogp.org/bookstore/product/guidelines-for-the-conduct-of-offshore-drilling-hazard-site-surveys/ [accessed 27-12-2020].
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- NOAA. (2017). *Hydrographic Surveys Specifications and Deliverables.* 1-162. https://nauticalcharts.noaa.gov/publications/docs/standards-and-requirements/specs/hssd-2017.pdf [accessed 13-05-2019];
- IHO. (2020). *Standards for Hydrographic Surveys. 6th Edition*. 1-49. https://iho.int/uploads/user/pubs/Drafts/S-44_Edition_6.0.0-Final.pdf [accessed 27-12-2020].

C. Field data

This section of the AIA report should provide a detailed description of the survey activities and ‘and all forms of investigations’ that took place during the course of the EBS, Geohazard Investigations [or any or any other Supplementary Hydrographic Surveys], as per the suggestions made in section 3.2.1, Chartered Institute for Archaeologists, 2020, *Standard and Guidance for Archaeological Field Evaluation,* page 7. This section should address the following:

- what kind of geophysical machinery (i.e. SSS, MBES and backscatter) were utilized and the systems used (i.e. AUV and ROV); how were the surveys conducted (i.e. at what frequencies, resolution and tow heights above the seafloor *et cetera*); what were the aims and objectives of each geophysical method; at what resolution, grid (i.e. points per meter for MBES data) and frequencies (i.e. KHz for the SSS, MBES and backscatter data) were the output datasets generated. Contractors/subcontractors are also expected to disclose specific technical information, clarifying the range and angle of the swath (for generating MBES and SSS data) and the angular dependence of the backscatter strength. Additional parameters such as the beam width and length of the system, the associated footprint on the seafloor, the pulse repetition rate, and vessel speed over the ground should be provided so as to determine the data collection standards. A map should display the navigation path for each geophysical survey method (that is for SSS, MBES and backscatter [and SBP]) with information pertaining to the navigation path of each survey, data coverage and overlap;
- what kind of ROV and camera system was used for the visual inspection survey; how were the visual inspections conducted; how many lumens and what type of lights were used. A map should accompany this information showing the navigation path, data coverage and overlap of the ROV video-photography survey. Additional information

pertaining to the resolution of the generated images and video should also be provided as well as who was the responsible subcontractor. Further details pertaining to the personnel involved, duties and responsibilities, and the research vessel and the contractor/subcontractor companies should also be disclosed.

This section should also discuss information related to the postprocessing of the SSS, [SBP] and MBES and backscatter and ROV videos and image datasets, addressing the methodologies and software(s) used for visualising, filtering, and correcting these datasets. To illustrate this, representative data examples showing the datasets before and after processing should also be provided. This is in accordance with the prerequisite set by the Chartered Institute for Archaeologists, document, *Standard and Guidance for Archaeological Geophysical Survey*, Annex 2: Report Content and Methodology, contractors/subcontractors should include details of their field work as well information pertaining to 'the method(s) of data capture, data processing and presentation' (Chartered Institute for Archaeologists, 2020b). Last, contractors/subcontractors should discuss the survey quality and if any problems or issues were encountered that may affect the ability of maritime archaeologists and other DoAC personnel to identify potential cultural resources in the surveyed area.

D. Seafloor Feature Analysis

This section of the AIA should focus on the analysis of the geophysical data generated as part of survey level 1, the aim being to assess the 'character' of the proposed prospect area 'and 'determine the presence or absence of anomalies' of 'archaeological potential' (Chartered Institute for Archaeologists, 2020, 8; 2020b, 4). For this matter, this section should focus explicitly on the analysis of SSS individual lines and the output mosaic, as well as the MBES and the associated backscatter mosaics, so as to provide detail descriptions pertaining to the:

- the overall geomorphology of the wider prospect survey area;

- the geological and geomorphological characteristics of the seafloor (specific features/anomalies of interests);
- the detailed bathymetry of the area;
- geological and geohazard features/anomalies that may oppose potential danger to drilling activities;
- features/anomalies of 'high archaeological importance' and 'shipwreck-like character', if any;
- the detection and distinguishing between geological features and anthropogenic geohazards (i.e. ocean debris), if possible.

When feasible, it is recommended that the analysis and identification undertaken here should be accompanied by ROV photographic data illustrating the nature and character of the what the specific anomalies/features and other topographical characteristics seen in the datasets represent. For more information pertaining to this approach refer to **Chapter 5** section, Side-Scan-Sonar geological features and seabed geomorphology and 'Anthea-1' prospect site analysis sections pages 204-212 and 227-231 respectively. The output Field Memo report generated as part of survey level 1 (by-standard 09, pages 273-273) requirement should also be attached in this section also.

Here contractors/subcontractors should present the results of different analytical methods applied to the datasets, the aims of which is to address the abovementioned aims and objectives of the section. For instance, for the analysis of the MBES data, contractors/subcontractors should present a Triangulated Irregular Network (TIN) model and a Bathymetric (Digital Terrain Model (DTM)) model with the following analyses applied:

- A 2D projection of either the TIN or the DTM model should be provided for the purpose of delivering insights into the general seafloor geomorphology, topography, and seabed characterisation. The objective of this analysis is to provide information

pertaining to geomorphological features of ‘high archaeological potential’ and ‘shipwreck-like character’. An example pertaining to the analysis of 2D TIN models can be seen in **Chapter 5**, section ‘Anthea-1’ prospect site, pages 227-231;

- In addition, it is suggested that a variety of post-processing visualisation techniques should be applied on the MBES 2D TIN or the DTM models, the aim being to ‘improve the chance of feature detection’ (Duckers, 2013, 5) and to illuminate elevation features that may seem very small and undetectable at first glance. Because, ‘in almost all cases, a single visualisation technique will not be sufficient to extract the full amount of information from the data’ it is recommended that contractors/subcontractors should ideally combine at least three visualisation techniques so as to reveal if the already noted geomorphological features of ‘high archaeological potential’ or if any additional small features that were not initially detectable from the initial MBES 2D TIN or DTM models ‘present evidence of ‘shipwreck-like’ outline’ (Kokalj and Hesse, 2017, 34). According to Kokalj and Hesse, the ‘choice of a visualisation technique depends on a number of factors; the most important being the topography of the landscape, and morphology and size of the sought after features’ (ibid., 34-35). This does not account for additional factors for interpreting data and the output images such as the personal preferences, perception and ‘counterintuitively’ of the analyst (ibid). For this matter, contractors/subcontractors should refer to Kokalj’s and Hesse’s handbook of *Airborne Laser Scanning Raster Data Visualisation: A Guide to Good Practices* and consider applying at least three visualisation techniques as per those mentioned in section 2, Description of techniques, pages 14-27, (such as: Sky-view factor, Multidirectional Hillshade, Openness, Slope, Multi-scale integral invariants, Laplacian-of- Gaussian (LoG), Cumulative visibility; Local dominance and etc). The choice of which

technique should be applied should be compatible with the general topographical specifications mentioned in section 3, Guidance for selection of techniques, pages 32-45 and the general topographical appearance of the MBES 2D TIN or DTM models of the wider prospect area (i.e., 'in areas of moderate to steep topography, sky-view factor works best'; 'In areas with flat or very gentle to moderate topography, local dominance, trend removal, and local relief model are very helpful'; and *et cetera*) (ibid., 34);

- A 3D projection of the TIN or DTM models is encouraged but not necessary. This analysis should present any additional information about the general seafloor geomorphology, topography and seabed characterisation adding to the information presented as part of the initial 2D analysis.

For the analysis of the backscatter data contractors/subcontractors should include two output models presenting:

- an analysis focusing explicitly on the backscatter data, the purpose of which should be the examination of the surface hardness, seabed type and morphology, surface sediment characteristics, as well as information pertaining to any nearby environmental habitats, anthropogenic features and geohazards. The end objective of this analysis is to characterises as many features/anomalies from the MBES and SSS data analysis and distinguish between those that present characteristics of a 'shipwreck-like character' or 'high archaeological potential' and those of geological/geohazard character. The output of this analysis is to present a thorough inspection of the aforementioned datasets and delineate any concerns for UCH asset(s) being left unidentified and unrecorded.
- the backscatter data should be superimposed onto the TIN model with the transparency of the backscatter set at around 30% to 50%. The purpose of this is to

reveal additional insights into the broader seafloor characterisation supplemented by bathymetric information for best understanding and explaining the general prospect area(s). For more information pertaining to the backscatter data analysis refer to **Chapter 5**, section 'Anthea-1' prospect site, pages 227-231.

In order for contractors/subcontractors to generate as much information as possible, similar analytical methods should also be applied to the SSS mosaic with them being expected to present and assess the mosaic first on its own, and then overlain on the 2D bathymetric TIN model. This approach aims to detect primarily anthropogenic features and geohazards such as shipwrecks, marine debris and sunken objects and should also include information relevant to seabed geomorphology, sediment characteristics and geological features. In addition, contractors/subcontractors are expected to present the analysis of each individual SSS strip and to present associated photographic data pertaining to different features/anomalies noted as per survey level 1, by-standard 09 (pages 273-273), that have also been subsequently visually assessed during survey level 2, as per by-standard 11 (pages 276-276). This aims to *minimise* any margin for error and provide a positive identification of each SSS anomaly with supporting photographic data. This relates to placing the appropriate emphasis on scientifically analysing all geophysical datasets generated as part of NRS from a marine archaeology perspective and thereby demonstrating that the issue of UCH has received the appropriate scientific emphasis and have been studied accordingly. For examples of how the SSS strips and mosaic should be analysed, refer to **Chapter 5**, section Side-Scan-Sonar, pages 203-223.

The general information emerging from each dataset should be analysed and presented at the end of each section summarising the aforementioned aims and objectives. The ultimate aim of this section is to eliminate any concerns regarding the character and nature of all [noted] geophysical anomalies identified in each dataset, arguing that whether UCH assets

have been discovered or not, UCH has received the appropriate consideration and emphasis. This is achieved through a broader data analysis strategy, where through focusing on the wider seafloor topography, geomorphology, and feature/anomaly identification/characterisation, contractors/subcontractors can effectively illustrate that the geophysical data generated as part of NRS (such as: SSS, MBES and backscatter datasets) were examined from a marine archaeology perspective and thus any concerns for UCH sites/assets being left unrecorded have been delineated.

E. The discovery of a shipwreck/or scatter materials (archaeological analysis)

In the case of a shipwreck site(s) discovery(ies), contractors/subcontractors should present the orthomosaic/photogrammetric model(s) of the site(s), as required by the stipulations of survey level 3. Thus, as per CifA's *Standard and Guidance for the Collection, Documentation, Conservation and Research of Archaeological Materials*, contractors/subcontractors are required to undertake the assessment of data for the purpose of generating 'a site-specific level analysis' (Chartered Institute for Archaeologists, 2020c, 6 and 3). For this reason, the discovered shipwreck site(s) should be discussed in this section, the aim being to deduce archaeological insights into the site(s) tentative origin, cargo, chronology, hypothetical sailing trajectory and identity. According to CifA's *Code of Conduct* for the purpose of this analysis, and only if a shipwreck site is discovered, it is recommended that a specialist archaeologists/maritime archaeologist should be subcontracted (Chartered Institute for Archaeologists, 2020d). A map of the site should be presented in this section marking the exact location of the shipwreck site in relation to the drilling site and the preliminary buffer zone of 300 meters around it. A representative picture of the site should accompany this map and contours should indicate at what depth was the site discovered. A second map should present the exact location of the georeferenced photomosaic of the site with associated

information pertaining to the established buffer zone and its relation to the drilling site and block area. A base-map of MBES data with contours should be used for this analysis.

In the case that scatter materials (i.e. debris trails or scatter amphorae) are discovered, contractors/subcontractors should map the artefacts on the SSS mosaic base-map and provide information concerning other adjacent features/anomalies that may indicate the core physical remains of the site. Essentially, the aim here is to evaluated that 'back-tracing' the scatter amphorae or debris trail has been investigate and any concerns were delineated. In addition, the analysis should make suggestions of any significant and potentially associate scars and other seafloor features, such as drag scars, mounding, or depressions marks that may be linked with the core remains of sites in case these were not visually assessed.

Representative data samples from the ROV video-photography should be included to demonstrate the quality of the records with the discovered UCH asset(s) shown surveyed from different angles. For more information refer to **Chapter 5,** Insights into ROV Video-Photography data generated during oil and gas activities, pages 191-200. In this section a table with the coordinates of the shipwreck site(s) and/or the scatters/debris discovery should be provided in X, Y and in decimal degrees, accompanied by photographs showing the find(s). Additional information pertaining to the shipwreck site(s) or the scatters/debris, should include the survey line ID, the file(s) of the video record(s) and video ID. It is also required to present a table informing about the ground control points (GCP) that were established and surveyed as part of survey level 3 (by-standard 14, page 279-280). If physically set in the site, contractors/subcontractors are expected to present the exact coordinates of each, according to colour code, and provide an associated picture. In the case GCP were not physically set, it is recommended that ROV operators should pick various distinct features of the site, take a picture and note the precise coordinates. These features should be presented here, with a table providing supplementary information in regards to the

exact coordinates corelating to each GCP and photographic data illustrating and describing where each GCP is located in the site and how it can be identified. The coordinates of the UCH discovery(ies), both shipwrecks and scatter materials/amphorae should be disclosed here in X, Y and in decimal degrees coordinates, accompanied also with a submitted Shapefile(s) (.SHP) for archival purposes.

F. Risk Assessment and Mitigation Strategies

In this section of the report, contractors/subcontractors should provide a detailed analysis of the main threats emerging from drilling activities and how drilling can affect the *in situ* preservation of the discovered UCH assets. This section should be written only in case of a shipwrecks discovery occurs and the purpose of this is for contractors/subcontractors to evaluate different mitigation strategy, discuss and/or model the potential effects of drilling and any other by-process on the nearby confirmed shipwreck site(s) according to the following four sections.

- the effects of resuspending and disposing of sediment/rocks over the side of the rig on the discovered shipwreck site;
- the effects of discharging or accidental spilling of other water-based and low-toxicity oil-based muds and other contaminating substances on the discovered shipwreck site;
- the impact of drilling and other installation of infrastructure, such as the laying of pipelines, the deployment of anchors or other bottom disturbing activities on the *in situ* preservation of the discovered shipwreck site;
- and identify any other operational activities that may potentially threaten the *in situ* preservation of the discovered shipwreck site (i.e. spillage).

In accordance with the general prerequisites set by CifA in both *Standard and Guidance for Archaeological Field Evaluation* and *Standard and Guidance for Archaeological Geophysical Survey*, the presence of archaeology —in this case a shipwreck site— within a given

development site requires ‘the formulation of a strategy to mitigate a threat to the archaeological resource’ (Chartered Institute for Archaeologists, 2020, 4; 2020b, 4). For this manner contractors/subcontractors are expected to recognise, model, and predict and proposed mitigation strategies for the effects of their work on the discovered shipwreck site, with this pertaining to both planned and unplanned parameters and by-processes (such as the anchoring of the pontoons or the drilling ship anchors, and the installation of pipelines).

In this section, contractors/subcontractors should express their intention to be in accordance with General prerequisites of by-standard 02 (page 267), and thus, proceed in establishing a buffer zone for the confirmed shipwreck site. In the scenario of a shipwreck(s) being discovered, the contractor/subcontractor should present the results of the ROV survey conducted after the drilling of the well(s), in accordance with survey level 2, by-standard 12 (page 277) showing the site in its entirety via different images. Ideally, an analysis should accompany the images informing about the state of the site both before and after drilling, informing if any damage or changes have occurred. This approach is part of a broader mitigation strategy that essentially aims to provide more scientific data on how drilling affects archaeological/historic assets situated in close proximity to the prospect area(s). The location of the site, the established buffer zone and the drilling area(s) should all be presented in a map with information pertaining to the established buffer zone being at least 300 metres in radius and the distance from the drilling site being ideally at least another 200 metres further from the established buffer zone. For unplanned accidents (such as oil and gas spillages) and their effect on shipwrecks, contractor/subcontractors are expected to model the expected impact of the incidents on UCH and propose possible mitigation strategies. This can be addressed by evaluating different ‘procedures suitable to collect appropriate data on potentially polluted shipwrecks’ as per the suggestion made in Alcaro, et al, the *Development of European Guidelines for Potentially Polluting Shipwrecks* document and this may include additional

surveys such as wreck site examination via ROV video-photography, electro acoustic surveys and other desk based predictions such as oil spill modelling. Essentially, the main concept of this section is for the licence holder company to abide to different mitigation strategies, through surveying, monitoring, and modelling, in the unlike scenario of the discovered shipwreck(s) being affect by both planned or unplanned oil and gas activities and by-processes. For further information about possible risk management and mitigation strategies refer to the 2019 European Commission documents on *Best Available Techniques, Guidance Documents on Upstream Hydrocarbon Explorations and Production*; IPIECA (2020) *Sustainability Reporting Guidance for the Oil and Gas Industry*; Cordes, E. et al. (2016) Environmental Impact of the Deep-Water Oil and Gas Industry: A review of Guide Management Strategies. *Frontiers in Environmental Science* 4.58; and IOGP (2017) *Guidelines for the Conduct of Offshore Drilling Hazard Site Surveys*; and **Chapter 6**, section The risks and impacts of upstream operations on archaeological/historic assets, pages 245-248.

G. Summary and conclusion

The summary of the report should draw upon all information generated therein, where:

- In the case that UCH assets (i.e. shipwreck site(s)) are discovered, contractors/subcontractors are expected to summarise the different risk management strategies and mitigation plans, for the *in situ* preservation of the discovered assets. Furthermore, a brief summary about the shipwreck and the extant cargo highlighting the scientific and archaeological importance of the site should accompany the overall description. A map showing the location of the confirmed heritage site(s) in the context of the wider EEZ should be presented, zoomed at the specific block in which the site(s) was found accompanied by bathymetric contours and an associated picture of the site. Examples of this can be seen at **Chapter 4**, *Oil and Gas Archaeology* and

Underwater Cultural Heritage Discoveries made in the context of Natural Resource Surveys, Figures 14, 23 and 31 pages 134, 151 and 167, respectively.

- In the scenario that UCH assets have not been discovered, contractors/subcontractors should summarise the information evaluated in the Seafloor Feature Analysis section stating that all noted geomorphological anomalies/features within the prospect area(s) were examined and visually accessed and indeed that no UCH assets were recorded in the wider prospect area(s). Lastly, a summary of SSS, MBES and backscatter data analysis should be presented summarising the main geological, geomorphological finds and characteristics of the wider prospect area(s).

H. Official Statements

In this section contractors should present four different statements stamped and signed by the licence holder company, contractors/subcontractor, marine survey companies, and responsible Project Director, confirming that:

- all datasets both RAW and processed, reports (SEA, EIA, EBS, ESHIA, Geohazard Investigations), and images and models included in the AIA were submitted to the responsible heritage agency, namely the DoAC;
- the ROV visual inspection of the site(s) or the scatters/debris were conducted in accordance with the specifications detailed in survey levels 2 and 3;
- the relevant prospection project(s) was conducted in accordance with the ‘Minimum professional by-standards for safeguarding deep sea archaeological/historic assets found in the Exclusive Economic Zone. Guidelines for offshore oil and gas contractors/subcontractors conducting Marine Geohazard Investigations, Environmental Baseline Surveys [or any other Supplementary Hydrographic Surveys], preceding the drilling of wells’ as issued under the forthcoming ‘regulatory administrative acts of 2022’ of the ‘Antiquities Law of Cyprus’;

- the ‘2014 (amended) Antiquities Law of Cyprus’ was recognised and implemented, ensuring that the best interest of DoAC was met. For this reason, this statement will confirm that any UCH assets discovered during the course of the prospection project(s) were protected *in situ* with buffer zones as well as other risk management strategies applied in accordance Articles 18A of the ‘2014 (amended) Antiquities Law of Cyprus’. This statement will also confirm that the discovered site(s) were also effectively preserved by record and that all necessary datasets were submitted in accordance with the ‘regulatory administrative acts of 2021 (forthcoming)’ of the Antiquities Law of Cyprus and Article 18B-(1) of the ‘2014 (amended) Antiquities Law of Cyprus’.

[6.6].Archiving of datasets

The preconditions outlined above foresee the submission of reports, SSS, MBES and backscatter, and ROV video-photographs datasets generated during upstream operations to the responsible national heritage agency. Continuing with a profusion of data types of varying quality and size will undoubtedly lead to further problems into the future, including issues of how the DoAC will ensure the deposit of such datasets with them, as well as how they will be effectively integrated into existing systems, archived, and migrated in the future as software and information standards change (BOEM, 2015; 2017). This section will evaluate some of the main factors affecting the preservation of stored datasets and will outline a sustainable strategic plan that could be adopted by the DoAC to ensure the effective management and long-lasting preservation of these rare and sensitive digital resources.

While current methods for data preservation vary widely, scholars agree that careful 'management of digital resources is an important aspect of the responsible conduct of research' (Niven and Pierce-McManamon, 2011). Indeed, 'digital archiving is different from traditional archiving' and it should be concerned beyond preserving solely the physical object (i.e. hard drive, CD-ROM, *et cetera*) in which datasets are stored (ibid). For instance, data on hard drives, which in this instance is how datasets are currently submitted and thus stored at the DoAC, are estimated to last for a period roughly between three to ten years, depending on the hard drive, after which any data on them is a 'ticking bomb' (Learn Photography, 2014). This is because computer disks, hard drives and other magnetic and optical media degrade and present malfunctions with the passage of time and thus any datasets stored within them are put in jeopardy over the long term without a clear archival strategy.

According to the *Guide to Good Practice* developed by Niven and Pierce-McManamon, on behalf of the Archaeology Data Service (ADS), the only accredited digital repository in the UK for geophysical and heritage data archiving, museums, heritage agencies

and other repositories have ‘typically treated the physical media on which archaeological data are recorded as artifacts and stored them as such: in boxes, on shelves’ (Niven and Pierce-McManamon, 2011). In fact, this was the case when I was first granted access to 750 GB of data in 2018, which was generated as part of the 2010 and 2012 Ocean Exploration Trust (OET) cruises. These datasets were stored at the Department of Geology Cyprus (DoGC) on two separate hard drives and I was told that no one accessed them since the day that they were submitted eight and six years previously. This is a perfect example of how methods of digital archives, if unaltered, will result in digital resources becoming inaccessible and subsequently unusable to future researchers (ibid). Niven and Pierce-McManamon argue that this is a fundamental issue which is intertwined with the issue of data formats becoming outdated when stored over a long period of time. According to Condron et al, this occurs due to the rapid changes in software and hardware technology, ultimately rendering any datasets older than ten years usable (Condron, et al, 1999). The following section seeks to provide solutions to these two issues arguing that in order to effectively preserve a digital archive and any valuable data stored therein, it should not be treated in a static manner. To this end, the best solution for effectively preserving the datasets generated during the course of this project, and in this instance prevent losing terabytes of expensively acquired geophysical and visual information showing the deep seas of Cyprus, preservation practices should be implemented. This section aims to promote an effective strategic management plan pertaining to the effective preservation of the digital information acquired and developed during the course of this thesis for future use and accessibility (Niven and Pierce-McManamon, 2011).

[6.6.1].Archive Sustainability Strategy

Moving away from physical records to digital archives has shown that the lack of sustainability strategies for digital resources have left an unfortunate lacuna, the result of which is that databases are treated in a static manner and any digital data becomes either damaged or completely destroyed with time, thus rendering them unusable or outdated in a period of roughly ten to fifteen years (Condron, et al, 1999; Niven and Pierce-McManamon, 2011; Firth, 2011). This is an ever-relevant issue that renders the implementation of a sustainable model for the effective preservation of the digital archive of the deep seas of Cyprus a key outcome of this thesis. The purpose of an archive is on one hand, to monitor the preservation state of the datasets annually, convert datasets to new formats when necessary, and ensure that datasets are backup in different media when the archive grows in the following years. The archive sustainability strategy plan is outlined in Figure 58, which is a simplified overview of a sustainable and inexpensive model that can guarantee the effective management of both the database and (geo)database of this thesis. The model can be further developed with the completion of the study and ideally it is recommended that the DoAC appoints a digital archivist who will

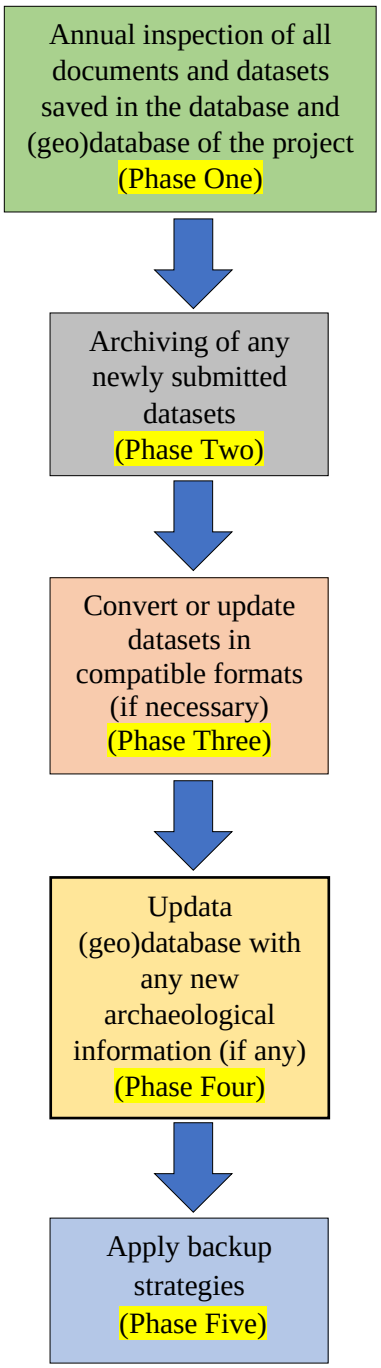

Figure 58: The Archive Sustainability Strategy for the database and (geo)database of the project *Deep-Sea Archaeology in the Exclusive Economic Zone of Cyprus*. Source: ΑΧΙΛΛΕΑΣ ΙΑΣΟΝΟΣ.

inspect and ensure that all stages and associated tasks related to the archive are undertaken annually. The final section below evaluates some of the existing data storage strategies that are worth considering for backing up data beyond a single media.

For each phase of this data sustainability plan different tasks will be undertaken. The annual inspection phase aims to detect any corrupted files and repair them before any valuable data are lost. This would help to ensure that all archived datasets are effectively preserved and remain accessible into the foreseeable future. It is suggested that the best way to do this in practice is to run a mirror archive with the same data being stored on two different systems, with one located onsite at the DoAC and the other at offsite storage facility, such as a secure government data centre. The idea is that when corrupt files in the onsite system are detected, the operator will go to the offsite backup and replace them.

Phase two aims to add to the archive any new data submitted to the DoAC. As work in the deep seas continues data will continue to be submitted to the DoAC resulting in a continually developing archive that is not static. This would exempt the oil and gas contractors/subcontractors from any obligation for them to be responsible for the archiving any of the data generated during the course of EBS, Geohazard Surveys, [or any other type of Supplementary Hydrographic Surveys], as such. The end aim of this strategic plan is the further updating of the project's (geo)database, following the completion of this thesis, by continually integrating data and site coordinates as new accidental discoveries of UCH are made in the context of offshore oil and gas operations (Phase four). In effect, by updating the project's (geo)database, the DoAC can have a more proactive role in overseeing the work of contractors/subcontractors who are operating in the EEZ of Cyprus. The (geo)database will give heritage managers the latest information regarding the whereabouts of deep sea UCH discoveries that will enable them to better protect these sites from other commercial projects such as oil and gas, pipeline and cable laying and deep sea mining in the near future. This will

allow the DoAC to effectively monitor and thus, promote the *in situ* safeguarding of all known deep water UCH discoveries from the aforementioned commercial projects that are most likely to be taking place in the EEZ of Cyprus in the near future. This is similar to the monuments inventory for land-based and shallow water archaeological sites with the concept evaluated here being simply an extension of this record to encompass sites found in the deep waters of the island.

Phase three seeks to the convert the submitted digital datasets into appropriate formats for lasting preservation. The suggestions for the Tables 26, 27 and 28 are primarily based on the International Organization for Standardization (ISO), ADS, and NOAA's National Centers for Environmental Information (formerly known as the National Oceanographic Data Center) data submission guidelines, and are concerned with the archiving of: reports, ROV video-photography, and geophysical datasets.

- According to ISO document: 19005, *Document Management - Electronic Document File Format for long-term Preservation*, page-oriented documents should be submitted in PDF format, which is universally accredited to be 'completely independent from software and the output device' (ISO, 2005) (Table 26). To ensure the lasting preservation of these page-oriented documents, ISO suggests that files should also be backed up in PDF/A, since this particular format has been characterised by the industry to be ideal for guaranteeing long-term data readability and reproducibility.

Table 26: The ideal formats for archiving word orientated document(s). Relevant to Data Submission by-standards 01, 02 and 04, pages 284-285.

	Ideal Preservation Formats
Page-Oriented Documents (i.e. reports)	• PDF • PDF/A

- The preservation of video formats is more complicated than documents and photographic data as there have are more factors to be considered. These are the container format, which codifies and structures the digital information storied therein, and the codec system, which is essential for software to encode (i.e. play) the digital video and audio (Smithsonian Institution Archives, 2020; ISO, 2012). This means that in order to achieve the effective long-term preservation of ROV videos generated during the course of upstream operations, data should be saved in a non-lossy container format that should be accessible in the future by more than one video codec system (i.e. both on Apple and Windows computers). This means that ROV video datasets should be saved in two or more video code and container formats respectively, with the following suggestions primarily based on ISO's document 14641-1 *Electronic Archiving — Part 1: Specifications Concerning the Design and the Operation of an Information System for Electronic Information Preservation.* Table 27 provides the optimal suggestions for archiving the generated ROV video data, with contractors/subcontractors and the archivist having to choose to submit/or convert the submitted video-data in at least two different combination formats.

Table 27: The 'container' and video codec formats for archiving ROV video(s) datasets. Relevant to Data Submission by-standard 03, page 285.

	Container Format	Video codec
ROV Videos	• MPEG-4 • Advanced Authoring Format (.AAF) • Quicktime (.MOV) • Flash Video (.FLV)	• Windows Media Video (.WMV) • Divx (.DIVX) • Motion JPEG (MJPEG)

- For marine geophysical datasets, different data centres and survey companies prefer to generate and thus submit data in different formats (**Chapter 5**). This suggests that there is no single acceptable format for archiving marine geophysical datasets, consequently, Table 28 presents an overview of the main data formats that are suitable for the submission and conversion of each data type that will enable the preservation of the data in both RAW, processed and other suitable formats. The following suggestions derive from the ADS *Marine Survey: A Guide to Good Practice*, Section 3: Archiving Marine Survey data, and NOAA's National Centers for Environmental Information (formerly known as the National Oceanographic Data Center) data submission guidelines (Niven and Pierce-McManamon, 2011).

Table 28: An overview of the main data formats suitable for the submission and/or the conversion of each of the submitted geophysical dataset.

Data format	**Information**	**Marine Geophysical Datasets**
ASCII text (.TXT and .XYZ)	The ASCII format has been recognised as the best option for long term preservation. For the effective preservation of datasets, the ADS suggest that files should also be saved in other formats. The ADS and NOAA suggest that the ASCII format can effectively guarantee future accessibility due to it is wide compatibility with different software packages. Relevant to Data Submission by-standards 02 page 284.	MBES and backscatter data [and SBP data]
Bathymetric Attributed Grid (BAG)	This is a processed format for MBES and backscatter data, usually for exported georeferenced rasters. It is used primarily for transferring data between contractors and subcontractors. It is ideal for saving large volumes of already processed data, and any associated metadata. In this instance, the BAG format should include exports of all studied Seafloor Features Analysis from the AIA, pages 293-298. Refer to Data Submission by-standard 02, page 284.	MBES and backscatter data

6.POLICY RECOMMENDATIONS(Survey Levels and Minimum Professional by-standards)

Data format	Information	Marine Geophysical Datasets
eXtended Triton Format (.XTF)	This format has been characterised as the 'industry standard' for saving primary RAW SSS data but can also be effectively used for saving other different types of data such as bathymetry, navigation, and telemetry. According to the ADS the XTF format is the 'best option for the long term preservation' of SSS, as some software packages support the export of (.XTF) to ASCII (Niven and Pierce-McManamon, 2011). Refer to Data Submission by-standards 01, page 284.	SSS data
GEOTIFF (.TIFF)	A GEOTIFF (.TIFF) is a georeferenced raster image, exported usually from RAW or processed SSS, MBES and backscatter datasets. These images are usually implemented in an ArcGIS (geo)database and according to the ADS, GEOTIFF's have long been recognised as a *de facto* preservation standard for image displays. This format it is known to be the most suitable method for preliminary study of marine geophysical datasets and is recognised as a safe, long lasting data preservation method that can be effectively integrated and sustained in developing (geo)databases (Niven and Pierce-McManamon, 2011). Refer to Data Submission by-standards 01 and 02, page 284.	MBES and backscatter data and SSS individual lines, orthomosaic and photogrammetric models
Extensible Markup Language (.XML)	This is a processed format for SSS data and is ideal for the circulation and further study of the data. With regards to long-lasting preservation, it seems that other formats such as ASCII texts and the XTF may be more suitable, but it is nevertheless recognised as widely accessible from a variety of software packages. Refer to Data Submission by-standard 01, page 284.	SSS data
SEG Y (.SEGY)	This format is usually used for the submission of unprocessed SBP and in some cases for SSS data. Even though, it is not an ideal format for archiving datasets, largely because only a limited number of software packages can read SEG Y files, this particular format was first developed in 1973 and is the accepted industry standard for the output SBP datasets. It will most likely be used into the foreseeable future. Refer to General prerequisites by-standards 05, page 268-269.	SBP data
PDF and PDF/A	According to ISO, PDF an PDF/A formats are ideal for the preservation and study of exported SBP data and other word orientated documents such as the AIA, EIA and ESHIA reports *et cetera*.	SBP data and AIA, SBA, EIA, ESHIA reports *et cetera*

6.POLICY RECOMMENDATIONS(Survey Levels and Minimum Professional by-standards)

The last phase of this sustainability plan aims to highlight the necessity of backing up the submitted datasets in at least one more archival media, besides the hard drive on which they are currently stored. In effect, the idea here is to evaluate two different storage resources that can be utilised in the near future for effectively preventing the loss of any datasets in the case that the original hard drive fails. For the preservation of geophysical datasets, data centres such as the European Marine Observation and Data Network (EMODnet) encourages registered users from both public and private sectors to release marine geophysical datasets (MBES data in particular) for safekeeping and subsequent accessibility through the EMODnet website[16]. Even though EMODnet provides a unique opportunity for long term management and accessibility of datasets, it seems that the decision to submit oil and gas datasets and maintaining an open access policy depends very much on the status ascribed to them by the State (i.e. confidential or not). For instance, the UK Oil and Gas authority maintains an open access data policy —with certain restrictions— when it comes to sharing oil and gas data[17]. Through the National Data Repository users are given the opportunity to view and download a variety of dataset such as seismic, geophysical and well-data and the purpose of this, according to UK Oil and Gas, is to improve the commercial, operational and technical performance of the UK oil and gas industry (ibid). Cyprus, on the other hand, maintains a strictly confidential approach in sharing or making datasets accessible due to on-going geopolitical tensions with Turkey, deriving explicitly from the energy agenda of the island. Recent illegal and unlicensed advancements of Turkey in the EEZ of Cyprus and the alleged commissioning of drillings in the already leased ENI/Total Block 7 (Figure 1, **Chapter 2**, page 56) suggests that making even the slightest amount of information available may be taken advantage of (OGJ, 2019). Inevitably, this renders the possibility of submitting datasets

[16] For EMODnet's website visit, https://www.emodnet.eu/ [accessed 25-12-2020].
[17] This can be seen at UK Oil & Gas website, https://www.ogauthority.co.uk/data-centre/ [accessed 25-12-2020].

to any data centre with an open access policy, such as EMODnet, the National Oceanographic Data Center) and others, not only unfeasible but potentially dangerous.

In consideration of this, I believe the safest solution to store the project's datasets is within government data servers, either at the Hydrocarbons Service, at Ministry of Energy, Commerce and Industry where all seismic dataset are stored; or at the National Hydrographic Committee, at the Department of Lands and Surveys[18] where all Airborne Laster Bathymetry (ALB) Data are archived (Cyprus Hydrocarbons Company, 2020b). Ideally, both national agencies have the appropriate repositories for archiving 'big data' and perhaps the DoAC can develop an arrangement with them in the following years that will on one hand allow the effective deposition and archiving of datasets and, on the other hand, maintain access and enable future management and accessibility to other researchers interested in studying the deep sea digital archive and (geo)database of Cyprus. This would be the most cost-effective solution for data archiving for the DoAC but could be complicated in terms of data accessibility. In this respect, the DoAC should perhaps consider setting up a server in the DoAC where the active archive of the database and (geo)database of the project will be saved, worked on and managed. This would allow regular updates based on the suggestions made in the Archive Sustainability Strategy plan above. The mirror archive can then be treated as the static archive and placed in one of the government data centres. It would only need to be accessed for regular updates from the active archive or to replace any corrupt files in the onsite system if/when they are detected. It is my position that the creation of a digital archive is a necessary step for the DoAC that will enable the effective management and lasting preservation of these rare, expensive, and sensitive datasets.

[18] For the Department of Lands and Surveys web portal follow the link, https://portal.dls.moi.gov.cy/en-us/Pages/The-Department-of-Lands-and-Surveys-Web-Portal.aspx [accessed 25-12-2020].

[6.7].Conclusion

To conclude, in this chapter I have argued that there are a number of threats emerging from drilling operations, rendering the *in situ* safeguarding and preservation by record of cultural resources discovered accidentally during the course of NRS the CSR of offshore oil and gas contractors. For this reason, the study has presented a series of survey levels with the associate minimum professional by-standards developed specifically to the operational framework of oil and gas *Appraisal* surveys. These have been developed based on observations made on datasets submitted to the DoAC from fourteen different oil and gas contractors operating in the EEZ and on the CS of Cyprus (see **Chapter 5**) and derive from the best practices that are already being actively used by both national and international regulatory agencies, such as such: BOEM, CifA, the Australian Government, the European Union, IOGP, and IPIECA. It was suggested that in order to protected UCH both by record and *in situ*, EBS and Geohazard Investigations [or other types of Supplementary Hydrographic Surveys] should incorporate elements of maritime archaeology surveying. The survey levels and the by-standards developed in this chapter intend to promote the 'best practical means' at a technical and operational level for the effective discovery, survey, *in situ* and by recorded preservation, reporting, data-submission and archiving of datasets and deep sea UCH discoveries made in the context of NRS, with practically little additional field costs. It is my position that these guidelines will help to increase our chance of discovering UCH and thereby lessen the chance of endangering any nearby archaeological sites and assets, as well as ensure the effective protection of UCH sites in all maritime zones, as issued under Articles 18A[19] and 18B-(1)[20] of the '2014 (amended) Antiquities Law of Cyprus' and in effect further clarify the vague SoW prerequisites set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus*, which

[19] See footnote 3, page 264.
[20] See footnote 4, page 264.

stipulates Desk Based assessments to address ‘specific concerns (archaeological artefacts, marine protected areas, fishery restricted areas, cables, pipelines, *et cetera*)’ (Ministry of Agriculture, Rural Development and Environment, with the input of the Departments of Environment and Fisheries and Marine Research, Cyprus, 2017, 5). To this end, regardless of whether UCH is discovered or not, contractors/subcontractors should consider producing an AIA demonstrating that the likelihood of any heritage assets situated within the broader prospect area(s) have been identified and received the appropriate consideration. The last section of this chapter has put forward a sustainability plan for the preservation of these rare, expensive and sensitive datasets, arguing that the digital archive and any valuable data stored therein should not be treated a static manner. With the submission of datasets that have clear reuse potential in the future to the DoAC, it is clear that for them, digital archiving needs to be an ongoing task with the backing-up and converting the submitted datasets into archivally stable formats and archiving them in on-site and off-site storage facilities. There should be no further reliance upon individual copies of data being stored on single hard drives. In effect, this thesis has effectively created a sites and monuments record for the deep seas of Cyprus and this is a resource that can have an active use in the future. It can be a tool used by the heritage agency for the active management of deep sea UCH and should be continued to be used and added to as other datasets become available.

7. CONCLUSION

The thesis has demonstrated that it is possible to conduct academic research and add new information to the developing record of deep water Underwater Cultural Heritage (UCH) in the Exclusive Economic Zone (EEZ) of Cyprus through studying datasets generated during oil and gas explorations. This data collection and analysis was possible only through the implementation of the relevant legislation of the island and the support of the national heritage agency. Prior to this, deep sea UCH in the eastern Mediterranean was discovered accidentally and occasionally reported as a byproduct of military and explorational/educational driven projects (**Chapter 2**). With specific emphasis on the oil and gas sector, this thesis has demonstrated that even though offshore drilling operations constitute a threat to deep sea UCH preservation, the very same industry can also be considered an undeniable 'data-source' that can yield the discoveries of new archaeological sites.

The data assembled from various deep water projects were presented in **Chapter 4**, which contains the first monument list of Cyprus' deep sea archaeological sites. This is part of a (geo)database that includes the site-coordinates of eight shipwreck sites, six of which were found in the EEZ of Cyprus. The final version of this (geo)database will be deposited with the Department of Antiquities Cyprus (DoAC) at the conclusion of the research. What is presented in this thesis are aspects and discussions of a much richer dataset that could not be disclosed in full due to word count restrictions or data confidentiality reasons drawn up as part of my agreement with the DoAC to gain access to this material for the purposes of this study. In this instance, three wrecks and one amphorae alley were accidentally discovered during the course of oil and gas operations and are published for the first time in this thesis. Alongside the shipwrecks is information on roughly 300 scatters of materials which are comprised mostly of ancient amphorae (Figure 35, **Chapter 5**, page 190). From these 300 scatter amphorae, 100 were identified and spatially examined and interpreted as simply transport containers disregarded by ancient mariners who sailed the sea-lanes of the eastern Mediterranean

(**Appendix**, pages 336-392). It is possible, however, that if future surveys are conducted in the suggested areas presented in Figures 12 and 13, **Chapter 4**, pages 127 and 131 that these could form parts of amphorae alleys or debris trails ending at shipwrecks. For the moment, however, the evidence is too sparse and thus it is prudent to be careful not over interpret it. Further discussion of the two shipwreck sites found situated in the EEZs of Lebanon and Egypt has been excluded from the thesis, which simply aimed to analyse the material in the EEZ of Cyprus. Clearly shipwrecks and scatter materials do not obey national boundaries, and this is an area that can be developed following the completion of this thesis and is an opportunity for collaboration and cooperation between the different maritime States of the eastern Mediterranean.

From a maritime archaeological perspective, the results of this study are insufficient to augment the existing maritime framework of the island, beyond a recognition that there would have been far more deep water seafaring than the existing evidence would suggest. A larger dataset is required. A way to facilitate this would be a broader study of deep sea UCH discoveries throughout the eastern Mediterranean region that would augment the already established framework of long-distance trade, economic development and interconnectivity of the region (**Chapter 4**, Discussing the Deep Sea Archaeology of Cyprus, pages 172-180). **Chapter 2** indicated that there is an archaeological record for roughly 42 known deep water shipwreck sites found in the broader region. While this is rather sparse, there are undoubtedly more deep water sites that have been discovered accidentally as part of oil and gas operations, or other commercial driven projects, in the EEZs of Egypt and Israel, but which remain unpublished. Consequently, it is clear that the approach seen in this thesis could be expanded through cooperation between the different heritage agencies in these countries and the establishment of a network of heritage managers and scholars. This academic network of deep sea experts could investigate the issue of deep sea UCH in the eastern Mediterranean Sea

through the continued collection of reports, and if possible, datasets and site coordinates, on deep sea shipwreck sites and scatters of materials. This collection could lend itself to a larger regional (geo)database and both individual and synthetic publications on the sites and scatters. This project could be based on the research model of *Oil and Gas Archaeology*[1] proposed here, which has data [both geophysical and video-photography] being extracted from the offshore industry [and beyond] and studied in an academic setting. It is my position that such a study has much to contribute to the subdiscipline of maritime archaeology, with **Chapter 2** demonstrating that such a holistic publication on the deep sea UCH of the eastern Mediterranean region has yet to be written, but which nevertheless remains necessary. By doing so, I believe this will raise the academic profile of the archaeological record of deep sea cultural heritage, ultimately leading to the integration and reinterpretation of open water finds in future synoptic studies on the maritime history of the region.

In effect, through the creation of a large regional (geo)database of deep water shipwrecks and scatter materials of the eastern Mediterranean and by drawing together a range of expertise through a network of deep sea scholars, it may be possible to distil the full scale of maritime networks, connectivity and interactions. This can 'serve to create a more nuanced perspective on how ancient communities viewed, experience and exploited maritime space for different social, economic, and political goals' and shed light onto on-going academic discussions of the subdiscipline of maritime archaeology such as: where deep water wrecks larger than wrecks found in coastal locations, and do deep water wrecks have different cargoes from coastal wrecks (Leidwanger and Knappett, 2018, 5). In addition, the data gathering exercise on an eastern Mediterranean level will allow the development of a broader holistic study on the maritime framework of the region, by evaluating approaches similar to those applied on land, such as landscape archaeology, where 'big data' can be statistically and spatial

[1] For the definition of the term *Oil and Gas Archaeology*, refer to **Chapter 1**, page 7, footnote 4.

analysed so as to encourage 'descriptive approaches of connectivity tied to physical geography that have sometimes inhibited the development of more social explorations of maritime mobility and the formation of places' (ibid., 6). It is my position that through these approaches and by comparing, spatially mapping, statistically analysing and cross examining deep water finds with coastal water sites, it will be feasible to further our understanding about the underdeveloped approach of what Leidwanger and Knappett refers to as the 'human geography of maritime space' (ibid., 3). The above-mentioned can contribute in deconstructing new narratives or challenge existing ones about maritime interaction during specific periods, by distilling patterns of maritime trade, sea routes and connectivity based on 'direct archaeological evidence'. The desire outcome of this would be the development of a maritime framework of long-distance connectivity and trade, connecting patterns of coastal sailing and trading and human mobility on the coastal forefront and further in land (ibid., 4).

Nevertheless, this study was initially developed in order to contribute to the implementation of Article 18A[2] of the '2014 (amended) Antiquities Law of Cyprus' of the DoAC. This importantly states that 'any archaeology on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on'. I would suggest that this has been effectively achieved with **Chapter 3** demonstrating the potential of the data gathering exercise undertaken in the context of this thesis was possible due to Article 18B-(1)[3] of the same law. It is my position that both frameworks

[2] **Article 18A:** 'Any archaeology on the Continental Shelf (CS) and the Exclusive Economic Zone (EEZ) either known or unknown, belongs to the government, from now and on' (Antiquities Law Cyprus, 2014, 1120).

[3] **Article 18B-(1):** asserts the right to the DoAC to monitor activities of 'licenced agencies, contractors or individuals operating in the Exclusive Economic Zone and on the Continental Shelf of Cyprus'. If discoveries of UCH are made, licenced contractors (such as those related to offshore oil and gas activities) 'are required to report to the Director of the Department of Antiquities Cyprus the discovery of UCH sites, regardless if such were made intentionally or not, and for this manner contractors operating should thereby submit geographical coordinates and additional information' (The Antiquities Law Cyprus, 2014, 1120).

have made this thesis project legally viable and at the same time the project has effectively contributed to the implemented of both Articles 18A and 18B-(1).

Further research into the laws of Cyprus, in **Chapter 3**, has shown that other national frameworks also foresee the protection of UCH from offshore commercial operations including:

- Article 13(1).h[4], of 'The Hydrocarbons (Prospection, Exploration and Exploitation Law), of 2007';
- Article 23(2).(a).(i)[5] of 'The Hydrocarbons (Prospection, Exploration and) Regulations, of 2007 and 2009)';
- The 'Assessment of Impact on the Environment of Certain Plans and Programs of 2005', General Provisions (Part II).[6]

Chapters 3 and **6** have demonstrated that UCH in the EEZ and on the CS is an issue heavily regulated by State legislation, with this being primarily relevant, but not explicit to heritage law. This has been effectively highlighted through the analysis of different national laws, suggesting that there is indeed areas of common practice between different States of the EEA and elsewhere (see: **Chapter 3**, Overview of different National Legislations concerned with the protection of UCH on the Continental Shelf and in the Exclusive Economic Zone, in the European Economic Area and elsewhere, pages 85-95). Although this thesis is centred on Cyprus, the analysis of different national laws has revealed that most countries involved in oil and gas exploration activities in the deep-waters of the EEZ and on the CS foresee the effective

[4] **Article 13(1).h:** Contractors are expected to abide to the 'protection of biological and mineral resources and of national treasures possessing artistic, historic or archaeological value' (The Hydrocarbons (Prospection, Exploration and Exploitation) Law, 2007, 13)

[5] **Article 23(2).(a).(i):** 'the holders of an authorization are bound to inform the Minister of all major developments in relation to the course of hydrocarbons operations. To this end, copies of all geological, geophysical and other technical reports, well logs, maps, diagrams, magnetic tapes, electronic and other stored data, in any form, reports and interpretation which have been prepared by or for the holder of an authorization' (The Hydrocarbons (Prospection, Exploration and Exploitation) Regulations, 2007 and 2009, 25).

[6] **General Provisions (Part II):** For more information refer to **Chapter 3**, The National Legislation of Cyprus and its Safeguarding of the Underwater Cultural Heritage of the Island, pages 103-105.

protection and management of UCH through different petroleum or hydrocarbons rules and regulations in addition to heritage laws. Along with local laws, there is also the issue of the protection for UCH inherent in international law. For instance, party States of international frameworks, such as UNLOSC[7] and 'The Valletta Convention',[8] are given leeway as to the extent to which they can choose to enforce the protection of UCH in all maritime zones. Clearly for Cyprus the protection of UCH assets in deep water is an issue of concern for more than one Ministries and Departments in addition to the DoAC (**Chapters 3** and **6**).

As it currently stands, Article 18C(1)[9] of the '2014 (amended) Antiquities Law of Cyprus', asserts the establishment of 'Cultural Protection Zone' (CPZ) for UCH sites 'that are either confirmed or suspected to exist at specific or approximate locations within the Exclusive Economic Zone and on the Continental Shelf' (The Antiquities Law Cyprus, 2014, 1120). Even though this Article awaits implementation, the safeguarding of sites discovered in the EEZ and on the CS of Cyprus, is unofficially undertaken via the establishment of buffer zones and mitigation agreements with the industry, guaranteeing that drilling will not take place in the buffer zone itself and nor for a further 300 to 1,5000 metres from the proposed drilling area (**Chapter 3**, Discussing the National Legislation of Cyprus, pages 105-109). This is indeed one way for protecting UCH assets *in situ*, but it remains an unofficial one, as it is not legally permissible to hold liable contractors/subcontractors who may accidentally cause the damage

[7] For more information refer to **Chapter 3**, Underwater Cultural Heritage in the Exclusive Economic Zone and Continental Shelf according to the United Nations Law of the Sea Convention, pages 64-69. For the purpose of reinforcing this statement refer explicit to Article 303(v) evaluated at the end of the section, page 68.

[8] For more information refer to **Chapter 3**, 'The European Convention on the Protection of Archaeological Heritage (Revised) (1992)' ('The Valletta Convention'), pages 73-74, with Articles 1(2), 1(2)(iii) and 1(3) being relevant to the statement above.

[9] **Article 18C(1)** asserts the right to 'the Council of Ministers, following the suggestions of the Director of the Department of Antiquities Cyprus, and by declaring her/his decision through the Cyprus Government Gazette, to declare "Cultural Protected Zones (CPZ)" for Underwater Cultural Heritage sites of archaeological or artistic value, that are either confirmed or suspected to exist at specific or approximate locations within the Exclusive Economic Zone and on the Continental Shelf' (Antiquities Law Cyprus, 2014, 1120).

or even destruction of UCH found within these buffer zones. Therefore, this thesis advocates for the establishment of CPZs,[10] alongside the implementation of Article 18C(1), for the six shipwreck sites detailed in **Chapter 4**. Thus far, scientific studies have yet to be composed, addressing what is the optimal distance for eliminating the possibility of UCH being affected by drilling and by-product processes. This can be addressed through an interdisciplinary study, undertaken in combination with marine biologists, aiming to document the impact and extent of drilling and any other related by-processes on archaeology and the environment more broadly. A solution to this is presented in level 2 survey, by-standard 12, page, 277, where it is suggested that in case archaeological/historic assets (i.e. shipwrecks) are discovered within a wider prospect area(s), the contractors/subcontractors are obligated to survey the site before and after drilling as part of risk-based environmental monitoring programme. This by-standard is in accordance with the technical specifications set by the European Commission, and its implementation and latter study of datasets in an academic setting can potentially provide the data necessary to fill the unfortunate lacuna left in the scientific literature about the effects of drilling and any associated by-processes on UCH.

An alternative solution to the CPZ is to attempt to list sites of special interest at the 'scientific, aesthetic, cultural or educational levels', such as the six shipwrecks evaluated in **Chapter 4**, as 'Specially Protected Areas of Mediterranean Importance' (SPAMI). According to Article 21[11] (Specially Protected Areas) of the '1994 Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the

[10] The concept of CPZ has been rejected by the international community in at least three different occasions due to concerns of 'creeping jurisdiction' being in conceptual contradiction with what is legally permissible in the EEZ and on the CS under UNLOSC (**Chapter 3**). This renders the implementation of Article 18C(1) an issue open to legal debate, with this framework, as it currently stands, being highly aspirational and directorial with its implementation depending on the DoAC, the relative Ministry and the government of Cyprus more broadly.

[11] For further clarifications pertaining to Article 21 refer to **Chapter 3**, '1995 Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean' (SPA/BD Protocol), pages 75-77.

Continental Shelf and the Seabed and its Subsoil', sites qualifying based on Article 8(2)[12] of the '1995 Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean' can be listed as SPAMI and in effect be protected *in situ*, by offshore oil and gas operations, or by any other kind of commercial activities, through the establishment of protected zones (Article 21a(ii)). Within these specially protected areas, UCH sites can be officially granted a protected status under international environmental law, whilst being in fully conformity with UNLOSC. By doing so party States can effectively implement archaeological heritage into the sphere of Foreign Policy through a cultural heritage diplomacy agenda. According to 'The Barcelona Convention' Annex I, General Principles paragraph A, section D[13], this is because SPAMIs can be established only through bilateral or multilateral regional cooperation agreements, between party States of 'The Barcelona Convention'. In effect, this pertains to how archaeology, under international environmental law, can play a bigger role in consolidating geopolitical alliances of corporation, similar to the EastMed Gas Forum,[14] and become part of a broader statement in response to Turkey's confrontational Foreign Policy in escalating tensions over the on-going dispute between Greece and Cyprus over sea boundaries and drilling rights. The decision to list archaeological heritage as SPAMI and developing a cultural diplomacy agenda with a broader purpose in regional geopolitics rests explicitly on the

[12] **Article 8(2):** 'The SPAMI List may include sites which: […] are of special interest at the scientific, aesthetic, cultural or educational levels' (United Nations Environmental Program Mediterranean Action Plan, 2005, 80)

[13] **Annex I ,General Principles paragraph A, section D:** 'The SPAMIs will have to constitute the core of a network aiming at the effective conservation of the Mediterranean heritage. To attain this objective, the Parties will develop their cooperation on bilateral and multilateral bases […]' (United Nations Environmental Program Mediterranean Action Plan, 2005, 94)

[14] EastMed Gas Forum is an international organisation established in 2020 by Cyprus, Egypt, Greece, Israel, Italy, Jordan, and Palestine, aiming to serve as a market platform for natural gas producers, consumers, and transit countries in the region to develop existing resources and develop the infrastructure for future exploitation, in addition to regulating natural gas policies in the region that protect the rights of member States to preserve their resources, the signatories said in a joint statement after the online ceremony. For more information refer to the Enterprise, The State of the Nation website, https://enterprise.press/stories/2020/09/23/eastmed-gas-forum-charter-signed-by-founding-members-22322/ [accessed 10/01/2021].

government of Cyprus and the DoAC, but nevertheless remains possible under the Protocol as it currently stands.

By gathering, re-analysing, archiving, and requesting follow ups on reports and datasets for the purpose of this study, this project has provided a template for communication between the DoAC and the offshore oil and gas industry that has proven to be mutually beneficial. For the national heritage agency of Cyprus, [and as per **Chapter 3** in certain countries of the EEA and elsewhere] this project, has demonstrated that archaeological assets are protected under heritage, environmental and hydrocarbon/petroleum exploration and exploitation laws, adding validity to the Department's actions in asserting control over UCH assets in all maritime zones of Cyprus. To ensure that this has been effectively achieved, this project has developed the first monument list in a developing (geo)database that will enable the effective management of known sites in the deep waters of Cyprus. I would suggest that through this (geo)database the DoAC can now have a more proactive role with contractors/subcontractors operating in the EEZ regarding the whereabouts of deep sea UCH discoveries, and in effect protect known sites *in situ* from future commercial development projects such as oil and gas exploration and exploitation activities, pipeline and cable laying projects and in the future deep sea mining. In order for the DoAC to effectively maintain this proactive role, **Chapter 6** has put forward a sustainable and inexpensive archive sustainability plan where both of the project's database and (geo)database, and by extent the datasets stored therein, will be annually inspected, managed and updated (Figure 58, **Chapter 6**, page 307). For this purpose, it is suggested that the DoAC should appointed a responsible personnel for inspecting and ensuring that all stages and associated tasks related to the archive are undertaken .

For commercial companies, contributing data to this thesis and its (geo)database holds the potential for them to gain recognition and publicity for their discoveries, work that can be seen to fulfill their Corporate Social Responsibilities (CSR) towards UCH. This can potentially

help offset any negative publicity over climate change, non-renewable energy, geopolitics and ocean pollution that may come their way as part of their work offshore. **Chapter 6** argued that archaeological assets in close proximity to offshore prospect sites are in immediate danger from offshore drilling activities (i.e. drilling, or pipeline laying). The likelihood, however, of States suspending the activities of an offshore oil and gas project because archaeology was discovered, or even threatened, is thought to be highly unlikely. As a mitigation strategy to this, **Chapter 6** proposes what has been generally applied in the industry for some time now, that is the establishment of buffer zones around confirmed deep sea UCH sites. In addition to this, the chapter proposes the specifications necessary to ensure the adequate survey and thereby preservation by record of any newly discovered archaeological/historic asset(s). This should precede the drilling of well(s), with the integration of the survey levels 1, 2 and 3 and the associate minimum professional by-standard suggested in **Chapter 6** providing the best practical solutions for the effective survey, discovery, evaluation, and preservation by record and *in situ*, of cultural heritage resources discovered accidentally during natural resource surveys (NRS). In effect, it is hoped that the survey levels and the associate survey by-standards will be integrated into new national policies after the completion of this study, meaning that licenced oil and gas contractors/subcontractors will be abiding by the highest heritage standards, with practically little additional field survey cost. In addition, through presenting the Remotely Operated Vehicle (ROV) videos and photographic data collected in the context of this study through different public outreach projects, the offshore oil and gas industry is given the opportunity to highlight its' CSR in discovering, surveying and preserving both by record and *in situ* the deep sea [cultural] heritage of Cyprus. These pertain to how public outreach projects such as Photography Exhibitions, Open Access (geo)databases, 2D Websites, and 3D Virtual Museum websites can make the inaccessible deep sea UCH accessible by offering a dry

dive outreach experience to a broader audience[15]. In effect, contractors/subcontractors can raise the profile of the island's deep sea heritage and increase awareness and educate the general public of Cyprus about the rich and diverse deep sea heritage of the island. The ROV video-photographic datasets can also be presented in juxtaposition with evidence exhibiting the problem of marine refuse, deep sea floor contamination and ocean littering, aligning such awareness projects with the broader aims and objectives of the *United Nations Decade of Ocean Science for Sustainable Development* agenda, *Goal 14*, paragraph 1, 'by 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution' (United Nations Sustainable Development Goals, 2020)

Ultimately through working together for the purpose of this study commercial companies and the DoAC have implemented Article 18A[16] of the '2014 (amended) Antiquities Law of Cyprus'. This is evident from 2017 and onwards, when the DoAC was first officially recognised as a consultant stakeholder agency, with an archaeological clearance being set as a prerequisite preceding the drilling of wells. In fact, **Chapter 6** has shown that this is in accordance with the prerequisites of the Scope of Work (SoW) set out in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus*, which stipulates Desk Based Assessments to address 'specific concerns (archaeological artefacts, marine protected areas, fishery restricted areas, cables, pipelines, *et cetera*)'. At the time of writing (2021), however, such archaeological desk base assessments that explicitly concern the issue of deep water UCH discoveries made accidentally during the course of oil and gas operations in the EEZ of Cyprus have yet to be composed. This study has revealed that

[15] Ideas about public outreach and offering a 'drive dive' experience to the 'inaccessible' UCH where discussed at the *International Conference in Management of Accessible Underwater Cultural and Natural Heritage Sites: "Dive in Blue Growth"*. For more information refer to the BlueMed's website, https://bluemed.interreg-med.eu/international-conference/ [accessed 10/04/2020].
[16] See footnote 1, page 319

the discovery of UCH is being reported in Filed Memos that are usually included in the Environmental Social Impact Health Assessments (ESHIA) and Environmental Impact Assessments (EIA), indicating that the prerequisite set in the 2017 SoW is still to be implemented. **Chapters 3** and **6** suggest that this is because both Cypriot domestic legislation and international heritage related legal frameworks lack the necessary specifications about how UCH should be surveyed and adequately evaluated when accidentally discovered during the course of such operations.

Analysis of side-scan-sonar (SSS), multibeam-bathymetry-echosounder (MBES) and backscatter and ROV video-photography datasets in **Chapter 5** revealed that different set of standards for the production and submission of datasets exist. The examination of these datasets has delivered a rare insight into how the oil and gas industry conducts Environmental Baseline Survey (EBS) and Geohazard Investigations [or any other Supplementary Hydrographic Surveys] and generates geophysical and ROV video-photography datasets. These can be utilised for preserving by record the discovery of accidental deep sea UCH assets and the deep sea environment more broadly, but present data deficiencies. For instance, ROV video-photography surveys of accidental discovery of UCH lack a cohesive survey methodology, whilst also from a technical point of view contractors/subcontractors are utilising different ROV camera and light systems. This is an important parameter for video-recording at depths where there is absolutely no natural light. **Chapter 5** examined this, arguing that the use of appropriate light systems and up-to-date camera systems can be the difference between a good deep video-photography record and a bad one. This is because images captured with insufficient lighting have exposure issues (i.e. the image appears too dark) and can appear largely unclear and distorted (Shutterstock, 2014). Such poor-quality imagery is more difficult to then use to create photomosaics, orthomosaic and photogrammetric models and often results in increasing postprocessing time. Further to this issue, **Chapter 4** has also shown that the poor ROV video-

photography quality limits how much archaeological information can be deduced, with the output archaeological interpretations of oil and gas discoveries, being somewhat ambitious.

The analysis of four different visual datasets, generated from 2011 to 2018 (figure 37, **Chapter 5**, page 195), has demonstrated this and the requirement for implementing a more standardised survey methodology and machinery use. This resulted in the suggestion of General prerequisites, by-standard 04 (page 268) and survey levels 2 and 3 by-standards 10-12 and 13-14 (275-277 and 278-280 respectively) and Data Submission by-standard 03 (page 285), seen in **Chapter 6**. Together these set out the technical and methodological preconditions necessary for surveying and thereby preserving by recorded accidental deep sea UCH discoveries. Through the implementation of the survey level 1 and 2 and the associate by-standards provided therein, ROV operators conducting deep sea surveys can produce datasets that will enable the effective identification of archaeological sites and their extant cargo with much less ambiguity than at present. Determining the issue of costs can be addressed in the context of a latter study. This could be undertaken through working with different marine survey companies and asking them to estimate the costs of implementing the suggested guidelines of **Chapter 6** in the context of a hypothetical project design where the only difference would be: the accidental discovery of a shipwreck site; the discovery a few scatter materials; and no evidence of deep sea UCH. In effect, this could provide an accurate understanding as to how much *Appraisal* surveys for NRS purposes cost, and what the costs of implementing the General prerequisites, of survey levels 1 to 3 and the associate by-standards enclosed therein of **Chapter 6** would be. It is my position that modelling the potential costs involved, and demonstrating the costs of alternatives such as dedicated UCH and environmental survey missions, can raise the chances of marine survey companies adopting the survey levels and the associate minimum professional by-standards of the study and perhaps integrate them within different operational and marine survey frameworks in the future.

7. CONCLUSION

The data analysis exercise undertaken in **Chapter 5** has shown that SSS, MBES and backscatter datasets are produced with clear industry objectives in mind, primarily for determining the most suitable location(s) for drilling. Inevitably, this means that these datasets are produced for the purpose of seabed characterisation and geohazard investigation and not for effective identification of UCH sites. The preliminary analysis of them, seen in **Chapter 5**, demonstrates that these datasets are generated and then submitted to the DoAC at different frequencies, resolutions and formats. In the light of this observation, the study focused on the analysis of SSS, MBES and backscatter datasets generated in 2018 by ExxonMobil, as part of the 'Anthea-1', 'Glaucus', and 'Pegasus' prospect projects. These were selected because they were produced at significantly higher frequencies and resolution in relation to any other submitted datasets. **Chapter 5** demonstrated that this specific set of SSS, MBES and backscatter datasets were produced at an adequate resolution for presenting the deep sea seafloor and exhibiting geological environmental and man-made anomalies with clarity. In this instance, even though seabed anomalies were effectively detected, described and preliminary characterised, the study postulated that in order to understand their nature, and thus distinguish archaeological sites (i.e. amphorae wrecks) from geological features, requires further ground truthing investigations via ROV video-photography, or required the geophysical datasets to be generated at much higher frequencies. For features smaller than 3 metres, such as scatter materials (i.e. amphorae), the analysis of MBES and backscatter data has shown that these cannot be surveyed, and hence, it is up to the exigencies of ROV flight paths to discover and thereby preserve them by record. In response to this, the study has proposed that following the completion of survey level 1, by-standard 09 (pages 273-274) contractors/subcontractors should provide Field Memo report, reporting on all SSS anomalies/features of 'shipwreck-like character' or 'high archaeological potential', discovered during NRS *Appraisal* surveys, following the completion of all geophysical surveys. These noted SSS anomalies should be then

surveyed as per the procedures described in survey level 2 in order to *maximise* the potential for discovering UCH sites, and thereby lessening any chances of endangering any nearby archaeological sites (i.e., shipwrecks) from planned drilling activities. In case a shipwreck site(s) is discovered contractors/subcontractors should trigger the procedures of survey level 3 and ensure that further *reconnaissance* survey on the confirmed shipwreck site are conducted as per the relevant by-standards 13-14 (pages 278-280). It is my position that the implementation of these guidelines and the continuing development of an 'Atlas of SSS sonographs' for Cyprus, alongside further study of different MBES and backscatter datasets would contribute in the development of a more in depth understanding of Cyprus' deep sea heritage. To successfully address this, I propose the instigation of a broader interdisciplinary academic study on these datasets that can contribute to heritage resources being more securely identified prior to ground truthing investigations (ROV video-photography). The optimal output result of this study, and by-extent the academic contribution of it to the sub-discipline of maritime archaeology, would be the development of a profile of how shipwreck-sites are manifested in the aforementioned datasets in the deep seas of Cyprus and how modern and ancient debris, as well as shipwreck sites and geological features, can be distinguished with less ambiguity. It is my position that the results of this proposed study can be of particularly useful to industry experts and non-geophysical specialists, such as heritage managers and academic archaeologists, who work with these kinds of datasets. The ultimate purpose of this would be to further determine the SoW set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus,* that unfortunately does not contain the necessary specifications with regards to how, with what machinery, and at what frequencies and resolution geophysical datasets should be generated; as well as other more complicated parameters relevant to: what should the beam width and the associated footprint on the seafloor of the system be, and at what rate should pulse repetition should be collected, and at what vessel

speed should surveys be conducted. Further discussions should be undertaken by the DoAC with the Ministry of Agriculture, Rural Development and Environment, at the Departments of Environment, and Fisheries and Marine Research, and at the Ministry of Energy, Commerce and Industry, at the Department of Hydrocarbons Services, for future access to study additional geophysical datasets concerning the deep seas of Cyprus.

In the absence of national and international appropriate archaeology by-standards relevant to the discovery, survey, reporting, data-submission and preserving by record and *in situ* of accidental deep sea UCH assets made in the context of NRS, **Chapter 6** has proposed the best technical and operational solutions that effectively address how offshore oil and gas contractors/subcontractors should produce, submit and interpret geophysical and ROV video-photography datasets from the perspective of maritime archaeology. These suggestions derive from observations made on the data from the operational activities of fourteen offshore hydrocarbon projects that took place in the EEZ of Cyprus (**Chapter 5**), with the output by-standards of the study worked to specify the *minimum* requirements for different levels of surveying, tailored specifically to the operational framework of deep-water oil and gas explorations. These were developed in accordance with other pre-existing national and international archaeological by-standards, and other geophysical/geotechnical and upstream operational guidelines (see: **Chapter 3**, section Common Practices in National laws for the management and *in situ* protection and preservation by record of cultural heritage resources discovered accidentally during the course of oil and gas explorations, pages 95-101; and **Chapter 6**, section Review of archaeological by-standards and offshore oil and gas operations, pages 249-258). The survey levels and the associate minimum professional by-standards provided therein acknowledge that the discovery of UCH is important and offers a great opportunity for the advancement of knowledge, and as such needs to be adequately recorded and evaluated. They recognise that the additional work necessary for the recording of UCH

should be both fair and proportional and not be onerous and place a heavy time and financial burden on the companies undertaking it and who are not themselves maritime archaeologists. **Chapter 6** has demonstrated that these recommendations can be effectively implemented by adapting EBS and Geohazard Investigations [or other types of Supplementary Hydrographic Surveys] to incorporate elements of maritime archaeology surveying. They intent to promote a standardised methodology for regulating how offshore oil and gas contractors/subcontractors, produce, submit and interpret geophysical datasets from the perspective of maritime archaeology, and also how ROV inspections should be conducted in order to *maximise* the potential of discovering, adequately surveying and preserving by record and *in situ* archaeological/historic assets. The outcome of the survey levels and the associate by-standards is the development of an Archaeological Impact Assessment (AIA), regardless of whether UCH is discovered or not, for the purpose of demonstrating that any potential heritage assets situated within the broader prospect area(s) have been identified and received the appropriate consideration (see **Chapter 6**, Minimum Professional Reporting by-standards, page 286-304). In effect, by doing so licensed contractors would be abiding by the highest heritage standards, guaranteeing that any negative effects on UCH are taken into consideration at an early stage of the project, reported, studied appropriately, and mitigated.

The contribution of this study goes beyond archaeological research and academia. The observations emerging from it can be develop into an interdisciplinary and multipurpose deep sea agenda. CSR strategies can be one aspect of this with ROV video-photography datasets being a valuable tool for raising awareness and education. For the DoAC, academics, and politicians in the field of hydrocarbon explorations and explorations, this agenda could also encompass a cultural diplomacy agenda to be implemented in the wider Foreign Policy of the island. Legally, the analyses of the datasets contained in this thesis can instigate discussions for implementing both national and international frameworks and also creating new policies for

better regulating how the offshore oil and gas industry operates. Academic studies on geophysical datasets, on the issue of the deep sea archaeology and the environment more broadly, can advance the knowledge-base of Cyprus' deep sea heritage. Ocean Littering and deep sea contamination can also be another issue of discussion and policy making as often the ROV video data reveal the presence of marine refuse, discarded by passing ships and military exercises. Finally, recent advancements in 3D modelling and Virtual Reality provide a somewhat nuanced opportunity for virtual accessibility to the inaccessible deep seas. The *Virtual Archaeology Museum*[17] for deep sea UCH developed recently by the BOEM exemplifies how deep sea UCH when discovered by the oil and gas industry can be developed into an immersive by-product for outreach and education. Such outreach activities for Cyprus can be developed in the future either by establishing my own private company or through a University/Institution/Research Centre, after securing the support and data access approval from the DoAC and other relevant Departments from the concerned Ministries.

To conclude, this study was developed as an initiative that promised the DoAC that academic research on deep sea UCH based on datasets generated during the course of oil and gas explorations could effectively contribute towards the implementation of Article 18A[18] of the '2014 (amended) Antiquities Law of Cyprus'. This has been effectively achieved. Through this thesis, Cyprus, can be viewed as a pioneering case study in effectively promoting research on oil and gas datasets. It stands with other similar pioneer projects undertaken in places such as the North Sea and the Gulf of Mexico, where through the reuse of oil and gas datasets researchers have provided new insights to the Doggerland[19] or added to the sparse record of deep water discoveries information about new shipwrecks such as that of the Mardi Gras (Ford,

[17] To experience BOEM's, *Virtual Archaeology Museum* follow the link, https://www.boem.gov/Virtual-Archaeology-Museum/ [accessed 21-05-2020].
[18] See footnote 1, page 319.
[19] For more information about the Doggerland project refer to the University of Bradford, *Europe's Lost Frontiers* website, https://www.bradford.ac.uk/archaeological-forensic-sciences/research/europes-lost-frontiers/ [accessed 21-05-2019].

et al, 2010). Equally, through the use of oil and gas datasets, this project has successfully added to the [deep water] maritime archaeology repertoire of the island and that of the eastern Mediterranean more broadly with three new ancient shipwrecks sites, namely 'Aphrodite-Noble', 'Eratosthene-Eni' and 'Calypso Appraised – ENI&TOTAL', and one amphorae alley, 'Alley I-block 8'. This was one aspect of the project, with the main aim of it moving beyond the reuse of data for archaeological research, into the realm of policy making through the suggestion of the survey levels and the associate Survey, Data Submission and Reporting and by-standards. The insights provided in **Chapter 5** and the recommendations made in **Chapter 6** go beyond simply utilising the datasets provided from the oil and gas industry for the purpose of an academic study. This is because the end objective of this thesis has been to effectively promote a standardised methodology for better regulating how offshore oil and gas contractors/subcontractors, produce, submit and interpret geophysical datasets from the perspective of maritime archaeology, and also how ROV inspections should be conducted in order to *maximise* the potential of discovering, adequately surveying and preserving by record and *in situ* archaeological/historic assets. The ideal end result of it should be the implementation of the developed survey levels and associate by-standards either in the 'regulatory administrative acts of 2022' of the 'Antiquities Law of Cyprus' or to supplement the unspecific SoW set in the 2017 *Guidelines for offshore Environmental Baseline Survey for Oil & Gas Exploration Activities in Cyprus.* UNESCO has yet to respond to the call for developing the necessary industry by-standards, yet perhaps if awareness is raised and scholars undertake similar initiatives, collaborate with heritage agencies, and agree upon how to utilise the datasets developed by the offshore industry, this may lead to fundamental changes on an international level and new insights into the largely overlooked deep seas.

[8.1].Section 1, The 2010 Ocean Exploration Trust Expedition, Scatter of Materials


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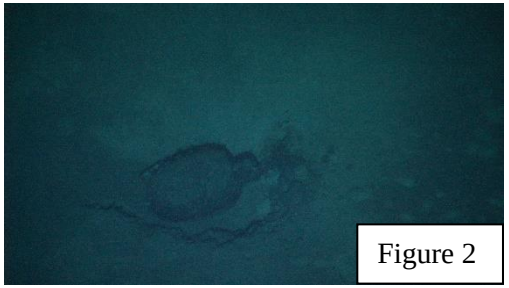
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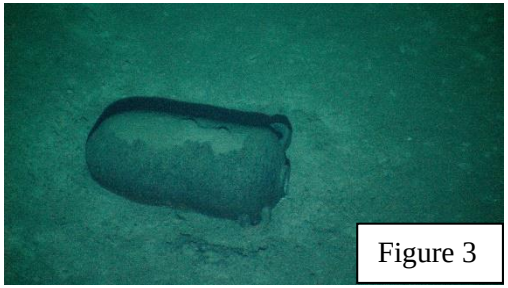
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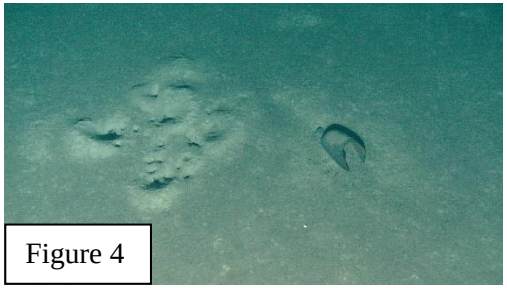
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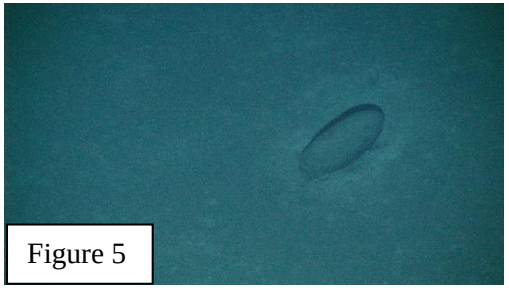
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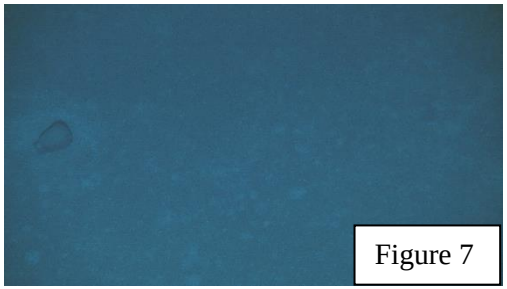
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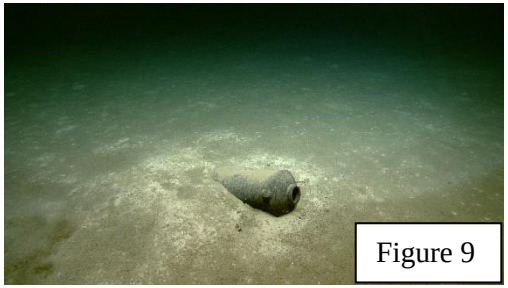
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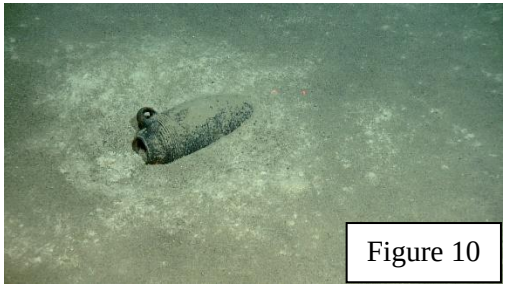
9. APPENDIX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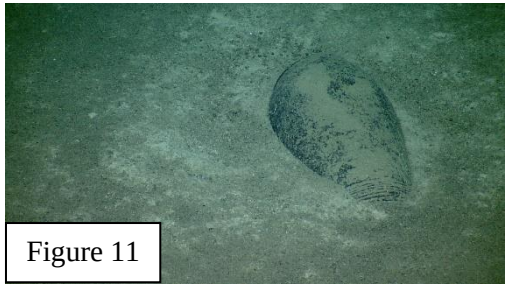
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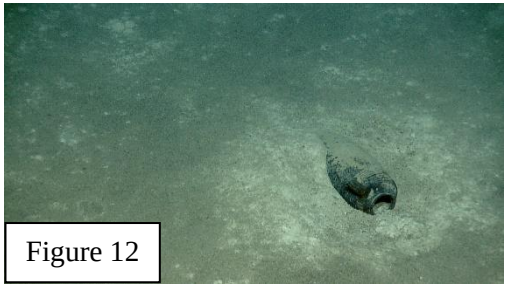
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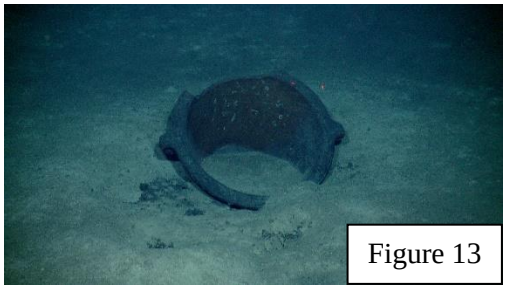
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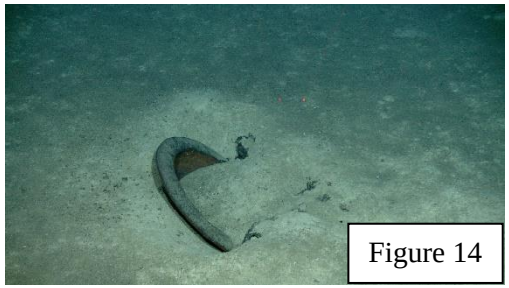
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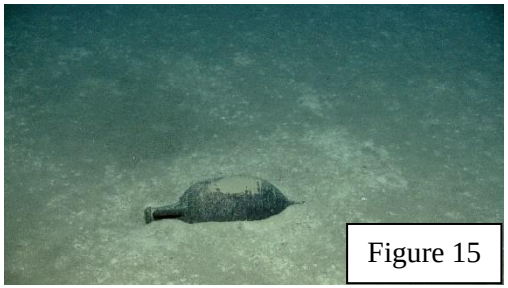
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9. APPENDIX


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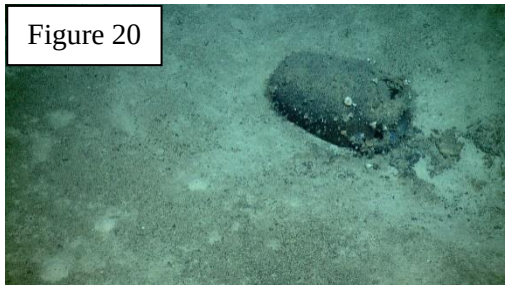
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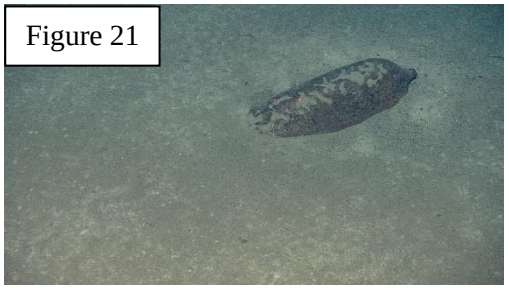
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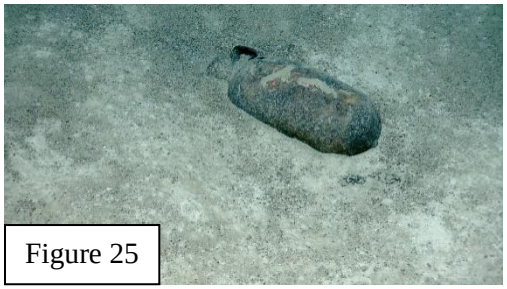
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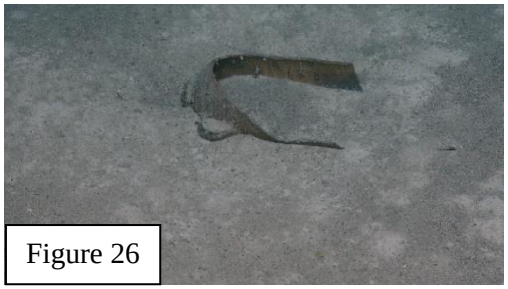
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9.APPENDIX


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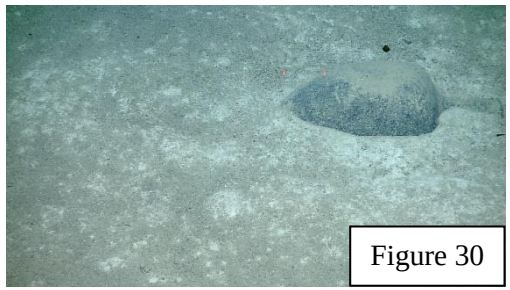
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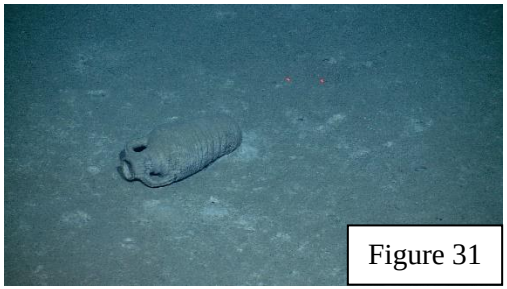
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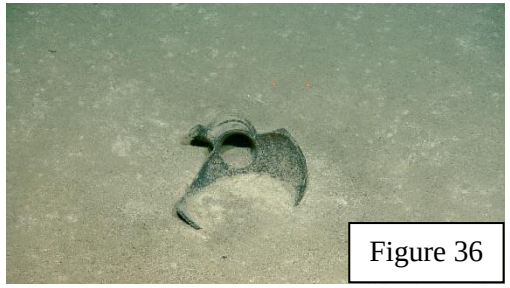
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9. APPENDIX


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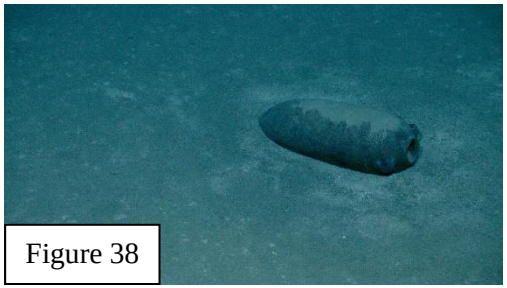
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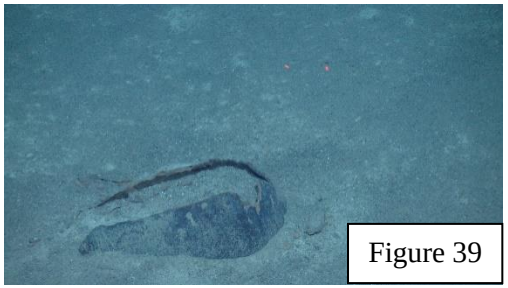
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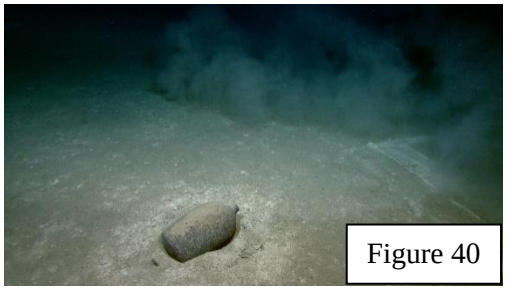
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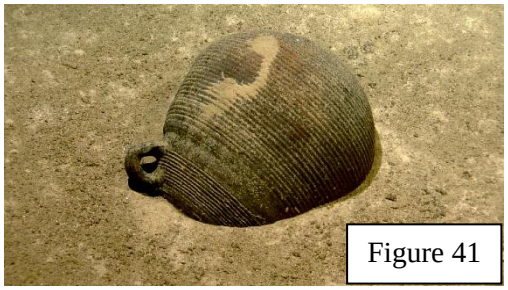
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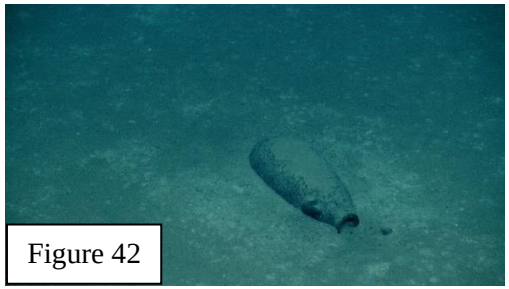
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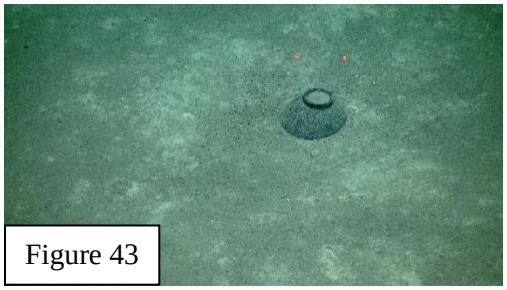
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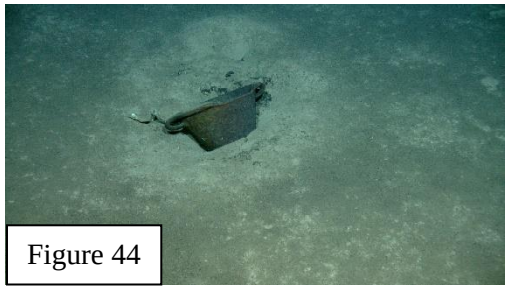
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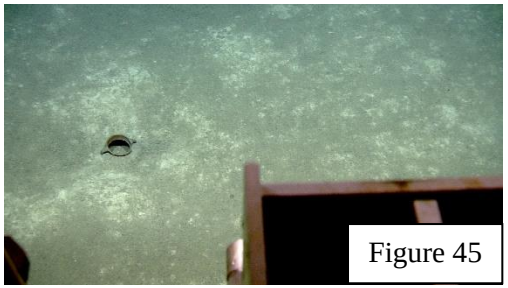
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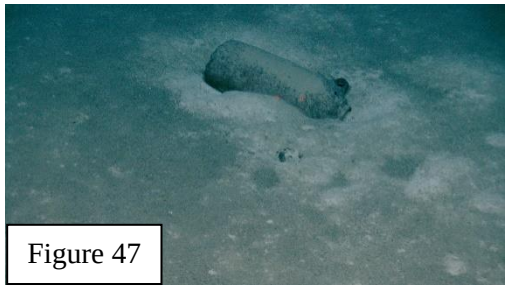

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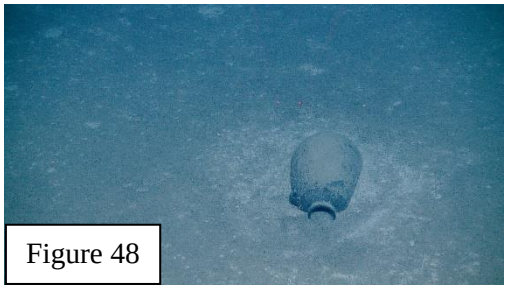

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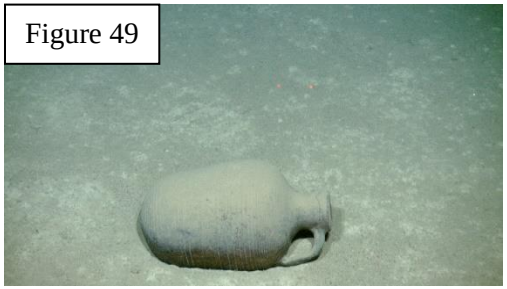

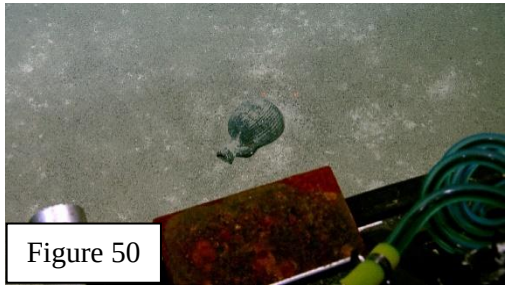

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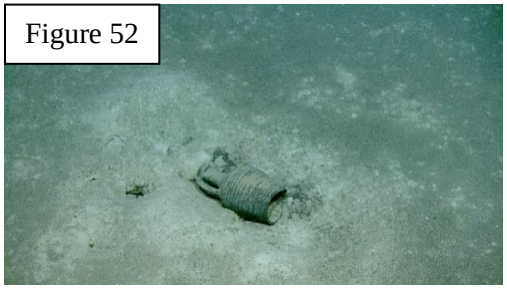

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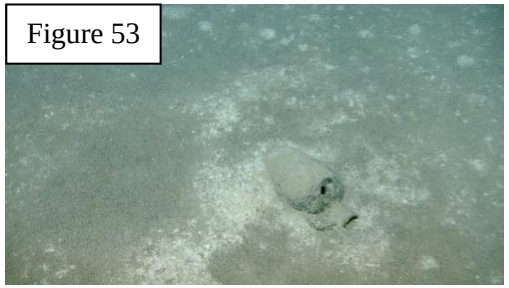

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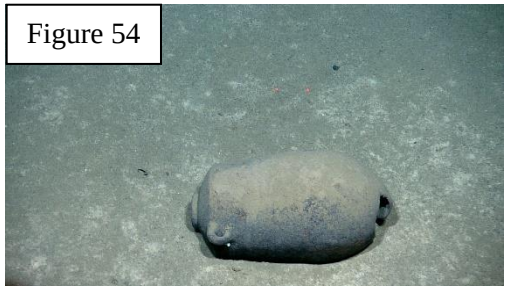


9. APPENDIX

Figure 55

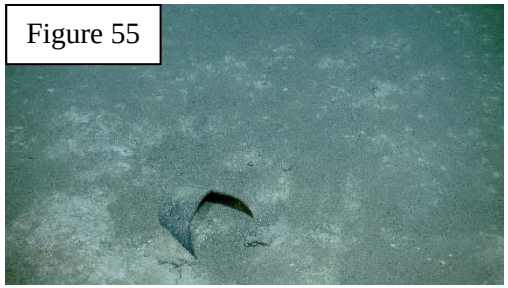


Figure 56

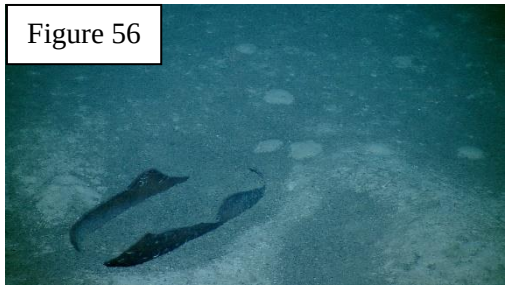


Figure 57

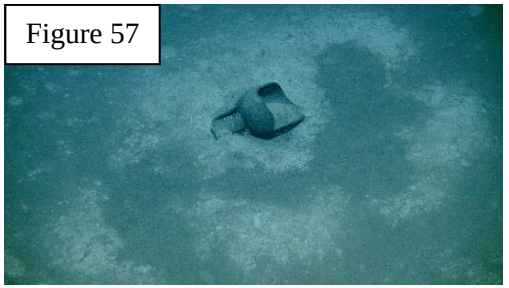


Figure 58

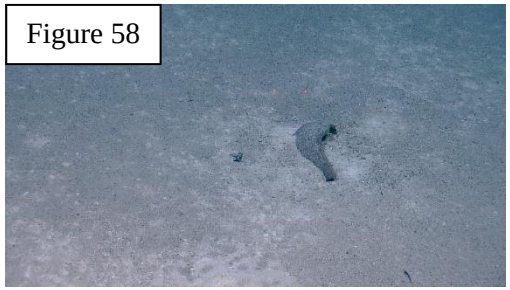


Figure 59



Figure 60

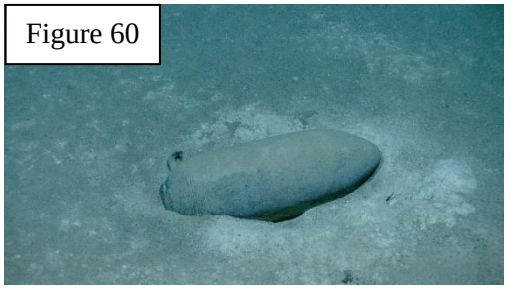


Figure 61



Figure 62



Figure 63



Figure 64



Figure 65



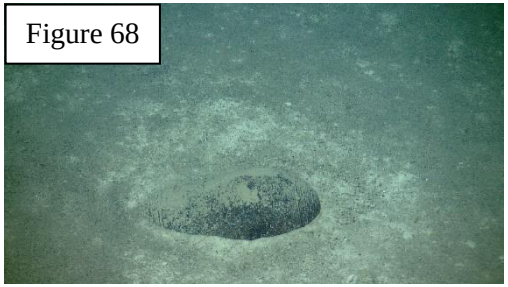
Figure 66





Figure 67

Figure 68



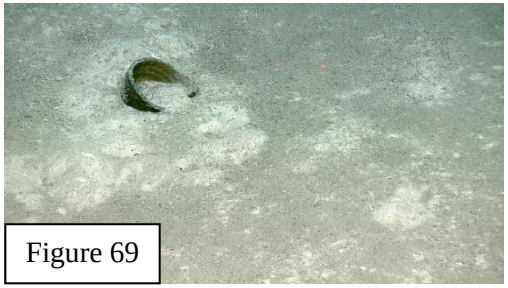


Figure 69



Figure 70

9. APPENDIX

[8.1.1].Table 1, Analysis of the Scatter of Materials noted during the 2010 Ocean Exploration Trust Expedition

Figure ID Corelating to Section 1, the 2010 OET Expedition Scatter of Materials

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
1	Perhaps Almagro 54 / Late Roman 4 (LR4)	Perhaps 2nd – 3rd centuries AD **Roman period**	Gaza	Average, 50% – 75% present. Half of the main body and foot area are missing	The amphora seems to be facilitating the growth of corals	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
2	Late Roman 2 (LR2) / Peacock and Williams Class 43	4th – 7th centuries AD **Late Roman / Early Byzantine periods**	Levant	Good, 75% – 90% present. Handles seem to be missing	The amphora appears to be facilitating the growth of corals.	Peacock, D. P. S., and Williams, D. F. (1986). *Amphorae and the Roman economy: An introduction guide.* London: Longman Publishing Group. 182.
3	Phoenician (Persian Period Amphora)	6th – 7th centuries BC **Cypro-Archaic period**	Levant	Intact, over 90% present	Nothing to Report	Regev, D. (2004). The Phoenician Transport Amphora. In Eiring, J., and Lund, J. (eds.) *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, Monographs of the Danish Institute at Athens* 5. 337-352. Aarhus: Aarhus University Press

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
4	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
5	Perhaps Almagro 54 / Late Roman 4 (LR4)	Perhaps 4th century AD **Late Roman / Early Byzantine periods**	Unknown	Intact, over 90% present	Details obscure in photographic data	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
6	Almagro 54 / Late Roman 4 (LR4)	5th – early 6th centuries AD **Late Roman / Early Byzantine periods**	Gaza	Intact, over 90% present	Nothing to Report	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
7	Perhaps Late Roman 2 (LR2) / Peacock and Williams Class 43	Unknown	Unknown	Good, 75% – 90% present	Details obscure in photographic data	Peacock, D. P. S., and Williams, D. F. (1986). *Amphorae and the Roman economy: An introduction guide*. London: Longman Publishing Group. 182.
8	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible

9. APPENDIX

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
9	Tripolitania II	1st – 4th centuries AD **Roman period**	Tripolitania (modern Lybia)	Good, 75% – 90% present	The amphora is half buried under sediment	Arthur, P. (1982). Amphora production in the Tripolitanian Gebel. *Libyan Studies* 13, 61-72.
10	Perhaps Almagro 54 / Late Roman 4 (LR4)	mid-5th – 6th centuries AD **Late Roman/Early Byzantine period**	Gaza	Good, 75% – 90% present	The amphora is half buried under sediment	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
11	Unknown	Unknown	Unknown	Good, 75% – 90% present	The amphora is half buried under sediment	Reference not possible
12	Perhaps Almagro 54 / Late Roman 4 (LR4)	mid-5th – 6th centuries AD **Late Roman/Early Byzantine period**	Gaza	Average, 50% – 75% present	The amphora is half buried under sediment	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
13	Cooking pot	3rd – 4th centuries BC **Hellenistic period**	Egyptian	Intact, over 90% present. Chipped at the rim area	Nothing to Report	Ballard, B., Opaiț, A., and Cornwell, K. (2017). Deep-water archaeological discoveries on Eratosthenes Seamount. *Deep-Sea Research Part II* 150, 4-21.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
14	Perhaps cooking pot	Unknown	Unknown	Good, 75% – 90% present	The amphora is half buried under sediment	Reference not possible
15	Koan amphora	1st century BC **Hellenistic period**	Kos	Intact, over 90% present	Nothing to Report	Hein, A., Georgopoulou, V., Nodarou, E., and Kilikoglou, V. (2007). Koan amphorae from Halasarna – investigations in a Hellenistic amphora production centre. *Journal of Archaeological Science* 35, 1049-1061.
16	Perhaps Almagro 54 / Late Roman 4 (LR4)	mid-6th – 7th centuries AD **Late Roman/Early Byzantine period**	Palestine	Intact, over 90% present. Chipped at the shoulder area	Nothing to Report	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
17	Perhaps vase or a storage jar	Unknown	Unknown	Intact, over 90% present	Details obscure in photographic data	Reference not possible
18	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	The amphora seems to be facilitating the growth of corals	Reference not possible
19	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
20	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	The amphora seems to be facilitating the growth of corals	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean.* 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
21	Perhaps Africana 2D Grande	3rd – 4th centuries AD **Roman period**	Unknown	Good, 75% – 90% present	The amphora is half buried under sediment	Archaeology Data Service. (2005h). *Archives: Amphora: Details of Africana 2D Grande*. [accessed 18/03/2019].
22	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
23	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
24	Almagro 54 / Late Roman 4 (LR4)	5th – early 6th centuries AD **Late Roman/Early Byzantine period**	Gaza	Intact, over 90% present	Nothing to Report	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
25	Perhaps Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Good, 75% – 90% present	The amphora is half buried under sediment	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean.* 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
26	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
27	Cooking pot	3rd – 4th centuries BC **Hellenistic period**	Egyptian	Good, 75% – 90% present	Nothing to Report	Ballard, B., Opaiţ, A., and Cornwell, K. (2017). Deep-water archaeological discoveries on Eratosthenes Seamount. *Deep-Sea Research Part II* 150, 4-21.
28	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
29	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean.* 1015-1022. England: British Archaeological Reports 2185 (1), 2010.
30	Unknown	Perhaps Hellenistic	Unknown	Intact, over 90% present	The amphorae is completely buried under sediment	Reference not possible

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
31	Late Roman 1 (LR1)	3rd – 4th centuries AD **Roman period**	Cilicia	Intact, over 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean.* 1015-1022. England: British Archaeological Reports 2185 (1), 2010.
32	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
33	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
34	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
35	Late Roman 5 (LR5) / Peacock and Williams Class 46	2nd – 3rd centuries AD **Roman period**	Palestine	Good, 75% – 90% present	Nothing to Report	Peacock, D. P. S., and Williams, D. F. (1986). *Amphorae and the Roman economy: An introduction guide.* London: Longman Publishing Group. 191.
36	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
37	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
38	Almagro 54 / Late Roman 4 (LR4)	5th – early 6th centuries AD **Late Roman/Early Byzantine period**	Gaza	Intact, over 90% present	Nothing to Report	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
39	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
40	Perhaps Africana 2B / Pseudo-Tripolitanian	3rd century AD **Roman period**	Central Tunisia	Good, 75% – 90% present	Nothing to Report	Archaeology Data Service. (2005i). *Archives: Amphora: Africana 2B Pseudo-Tripolitanian*. [accessed 18/03/2019].
41	Late Roman 5 (LR5)	6th century AD **Late Roman/Early Byzantine period**	Palestine	Intact, over 90% present	Nothing to Report	Reynolds, P. (2005). Levantine amphorae from Cilicia to Gaza: a Typology and Analysis of Regional Production Trends from the 1st to 7th Centuries. LRCW I. *Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry*. 563-612. England: British Archaeological Reports International Series, 1340, 2005.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
42	Tyre amphora	Late 1st century BC to 1st century AD **Hellenistic period**	Tyre	Intact, over 90% present	Nothing to Report	Wicenciak, U. (2016). Ceramic patchwork in Hellenistic to Byzantine Phoenicia: regionalization and specialization of vessel production. *Polish Archaeology in the Mediterranean* 25, 619-690.
43	Unknown	Unknown	Unknown	Average, 50% – 75% present	The amphora is completely buried under sediment	Reference not possible
44	Cooking pot	3rd – 4th centuries BC **Hellenistic period**	Egyptian	Intact, over 90% present	Nothing to Report	Ballard, B., Opaiţ, A., and Cornwell, K. (2017). Deep-water archaeological discoveries on Eratosthenes Seamount. *Deep-Sea Research Part II* 150, 4-21.
45	Unknown	Unknown	Unknown	Average, 50% – 75% present	The amphora is completely buried under sediment	Reference not possible
46	Unknown	Unknown	Unknown	Average, 50% – 75% present. Half of the main body and foot area are missing	Nothing to Report	Reference not possible

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
47	Tripolitanian II	1st – 4th centuries AD **Roman period**	Tripolitania (modern Lybia)	Good, 75% – 90% present	The amphora is half buried under sediment	Arthur, P. (1982). Amphora production in the Tripolitanian Gebel. *Libyan Studies* 13, 61-72.
48	Possible Phoenician amphora (Kommos amphora)	8th – 9th centuries BC **Cypro-Geometric period**	Levant, Cyprus and Crete	Intact, over 90% present	Nothing to Report	Regev, D. (2004). The Phoenician Transport Amphora. In Eiring, J., and Lund, J. (eds.) *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, Monographs of the Danish Institute at Athens* 5. 337-352. Aarhus: Aarhus University Press.
49	Possible Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	The amphora seems to be facilitating the growth of corals	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean.* 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
50	Perhaps pilgrim flask or Juglet	Unknown	Unknown	Intact, over 90% present	Nothing to Report	Ballard, B., Opaiţ, A., and Cornwell, K. (2017). Deep-water archaeological discoveries on Eratosthenes Seamount. *Deep-Sea Research Part II* 150, 4-21.
51	Pithos fragment	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
52	Sinopean 'carrot' amphora	4th – 5th centuries AD **Late Roman/Early Byzantine period**	Athens and Palestine	Poor, 50% – 25% present. Part of the main body and foot area are missing	Nothing to Report	Opaiţ, A. (2010). Sinopean, Heraklean and Chersonesan "Carrot" Amphorae. *Ancient Civilizations from Scythia to Siberia* 16, 371-401.
53	Unknown	Unknown	Unknown	Average, 50% – 75% present	The amphora is completely buried under sediment	Reference not possible
54	Phoenician (Persian Period Amphora)	6th – 7th centuries BC (750 to 700 BC) **Cypro-Archaic period**	Levant, Cyprus and Crete	Intact, over 90% present. Chipped at the lower bottom area. Foot missing	Nothing to Report	Regev, D. (2004). The Phoenician Transport Amphora. In Eiring, J., and Lund, J. (eds.) *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, Monographs of the Danish Institute at Athens* 5. 337-352. Aarhus: Aarhus University Press.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
55	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
56	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
57	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
58	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
59	Possible Ottoman amphora (based on the context of the 'Ottoman Pistol' wreck)	18th – 19th centuries AD **Ottoman period**	Unknown	Intact, over 90% present	Details obscure in photographic data	'Ottoman Pistol' wreck, **Chapter 4**, pages 120-122
60	Almagro 54 / Late Roman 4 (LR4)	5th – early 6th centuries AD **Late Roman/Early Byzantine period**	Gaza	Intact, over 90% present	Nothing to Report	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
61	Ottoman Juglet (based on the context of the 'Ottoman Pistol' wreck)	18th – 19th centuries AD **Ottoman period**	Unknown	Intact, over 90% present	Unknown	'Ottoman Pistol' wreck, **Chapter 4**, pages 120-122
62	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
63	Probably Roman juglets made of glass	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
64	Juglet	Unknown	Unknown	Good, 75% – 90% present	Details obscure in photographic data	Reference not possible
65	Ottoman Juglet	16th – 20th centuries AD **Ottoman period**	Unknown	Average, 50% – 75% present	Unknown	Reference not possible

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
66	Perhaps Ottoman amphora (based on the context of the 'Iron Anchors' wreck)	16th – 17th centuries AD **Ottoman period**	Unknown	Intact, over 90% present	Nothing to Report	'Iron Anchors' wreck, **Chapter 4**, pages 116-120
67	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
68	Unknown	Unknown	Unknown	Average, 50% – 75% present	The amphora is completely buried under sediment	Reference not possible
69	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
70	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean.* 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

[8.2].Section 2, The 2012 Ocean Exploration Trust Expedition, Scatter of Materials

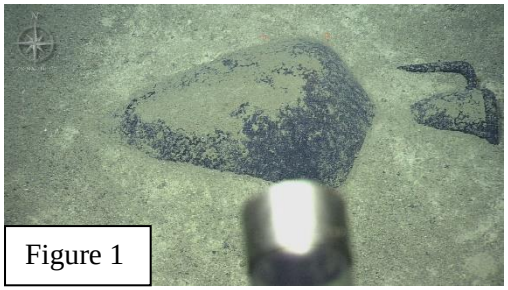
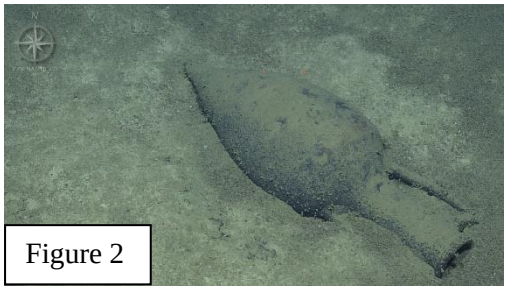


Figure 1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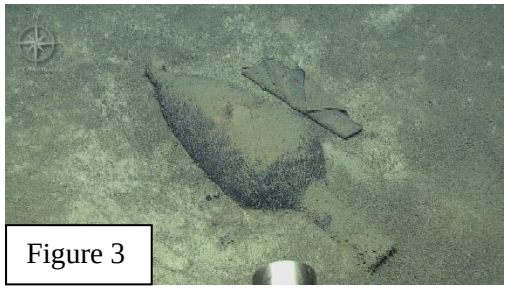
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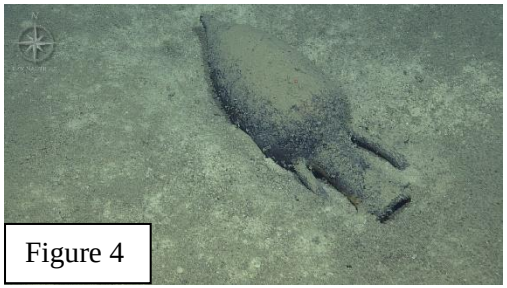
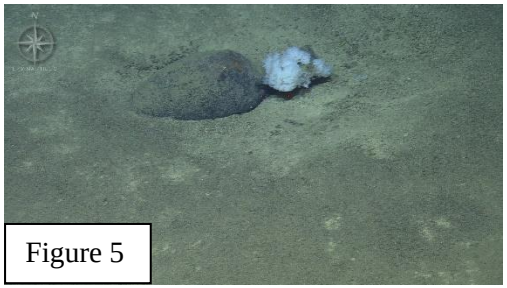


Figure 4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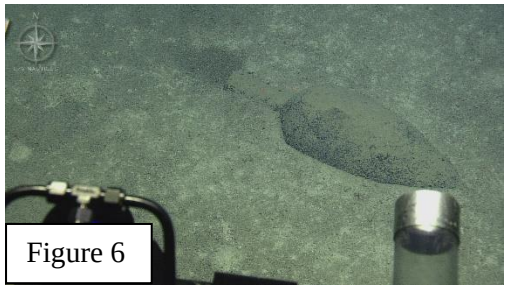


Figure 6

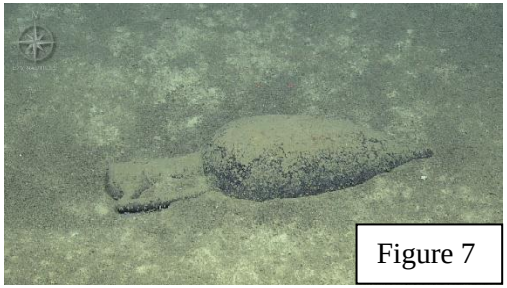


Figure 7


Figure 8

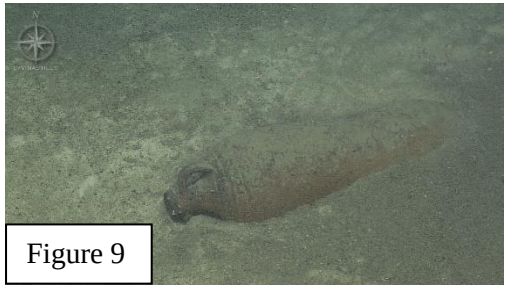


Figure 9

9.APPENDIX

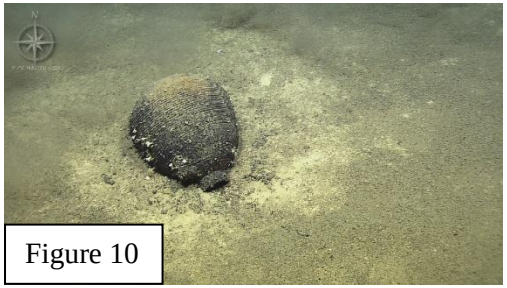


Figure 10

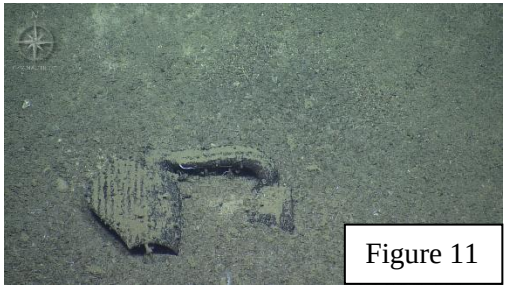


Figure 11



Figure 12



Figure 13



Figure 14

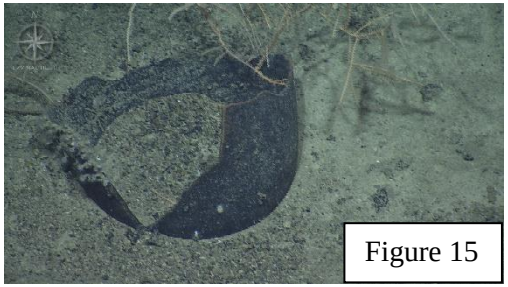


Figure 15



Figure 16



Figure 17



Figure 18

9. APPENDIX



Figure 19

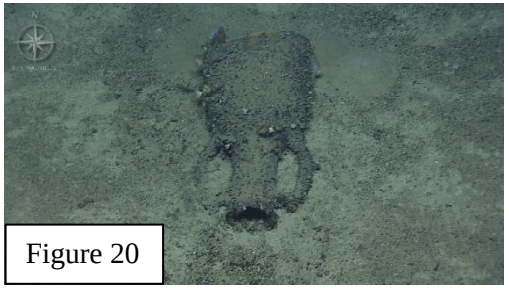


Figure 20

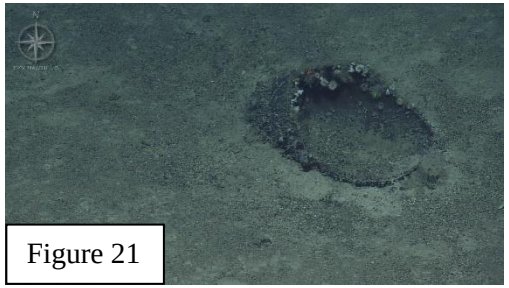


Figure 21



Figure 22

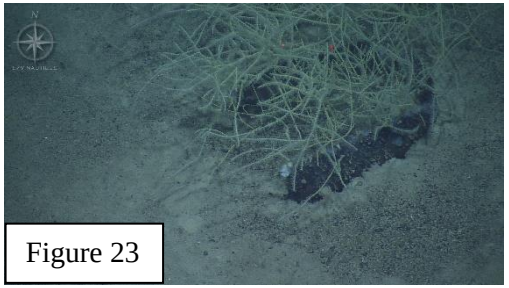
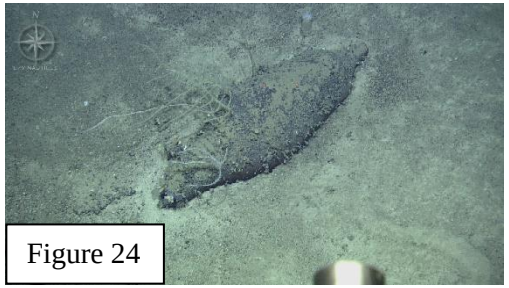


Figure 23



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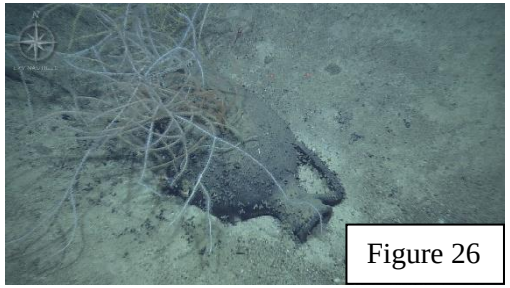

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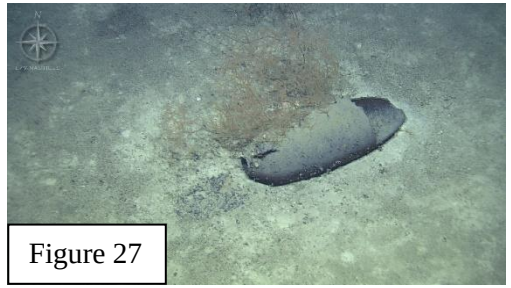
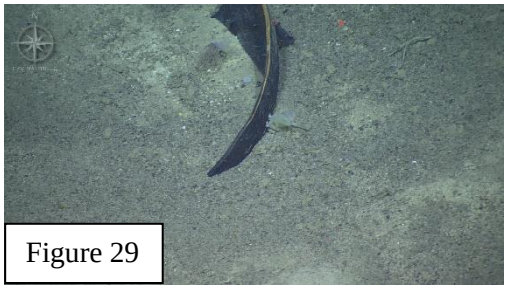


Figure 27

9. APPENDIX

Figure 28





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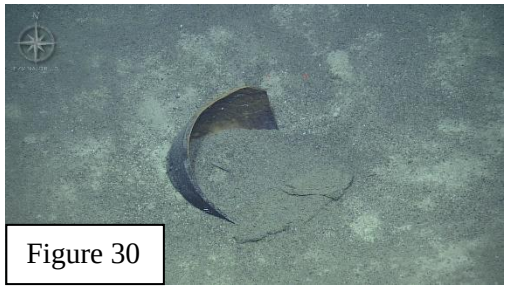

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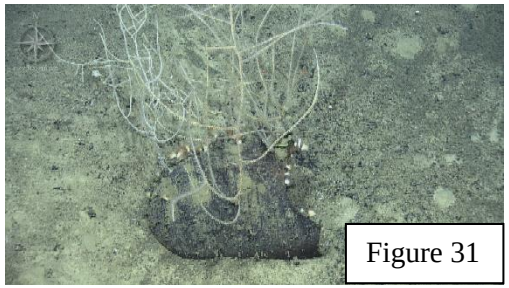

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Figure 32



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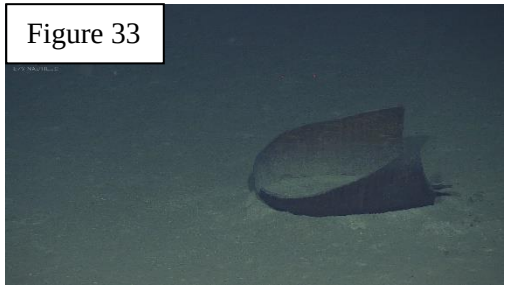

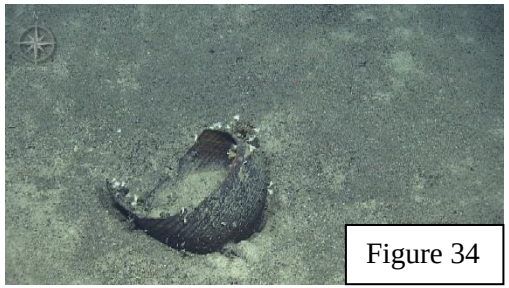

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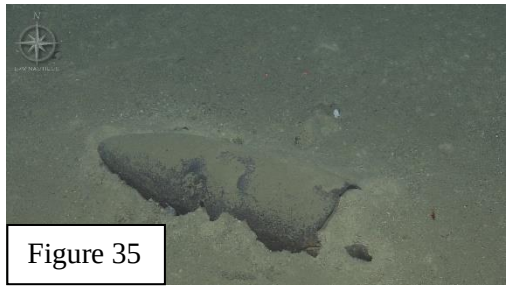

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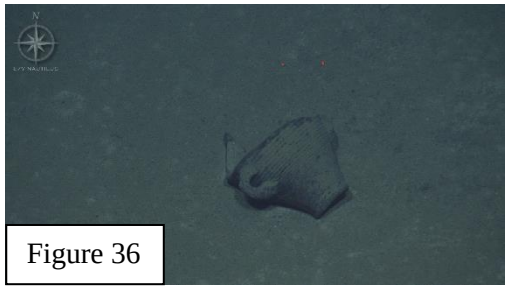

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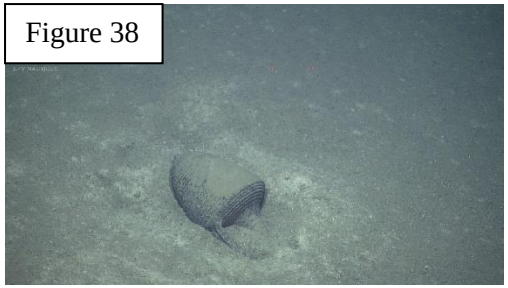
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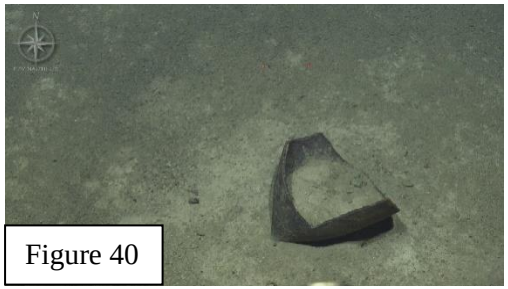
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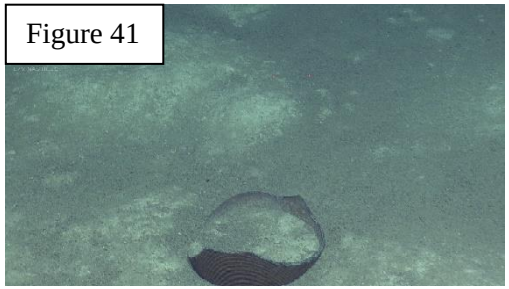
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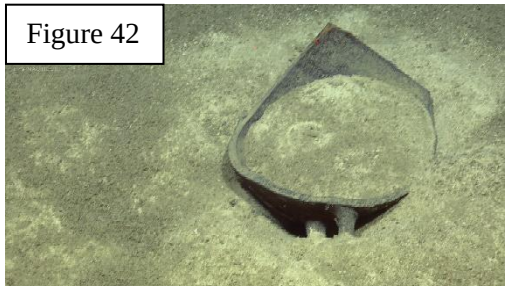
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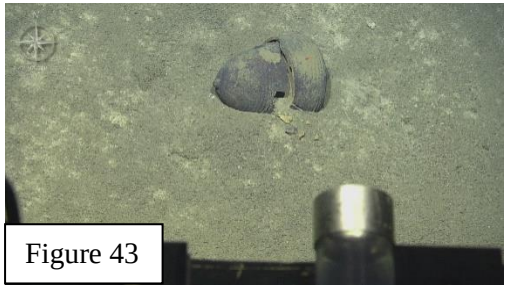
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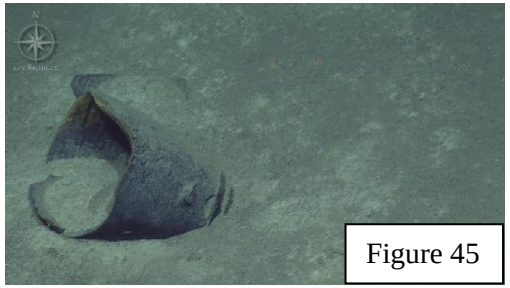
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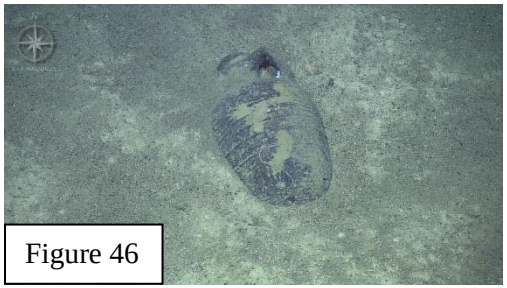
9. APPENDIX



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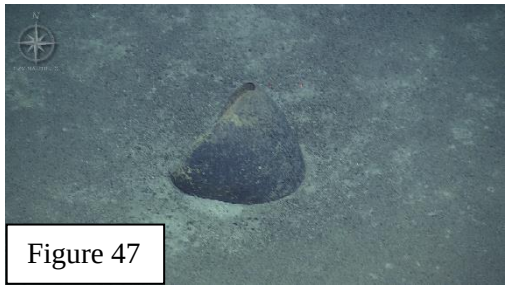

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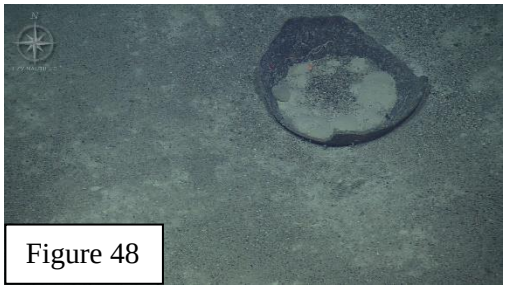

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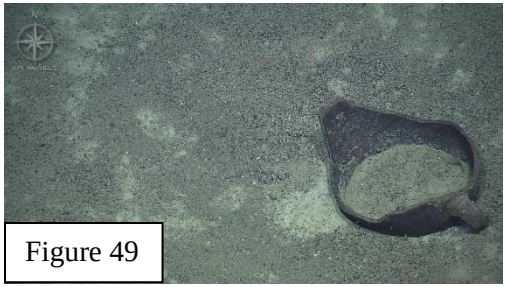

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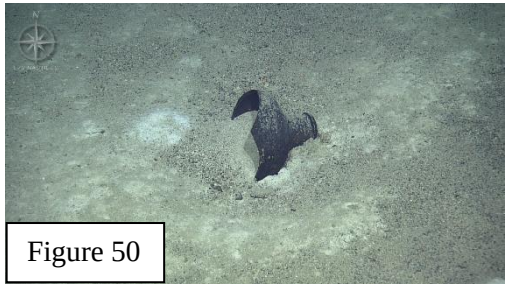

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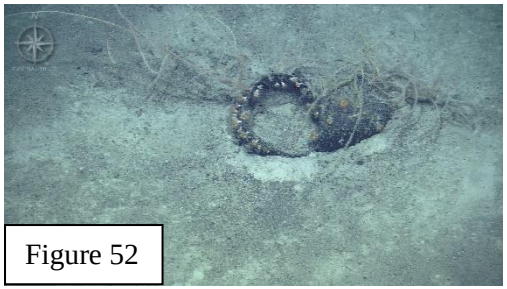

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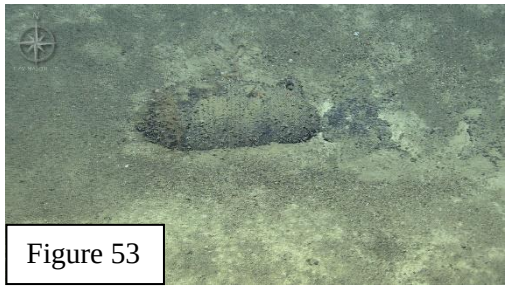

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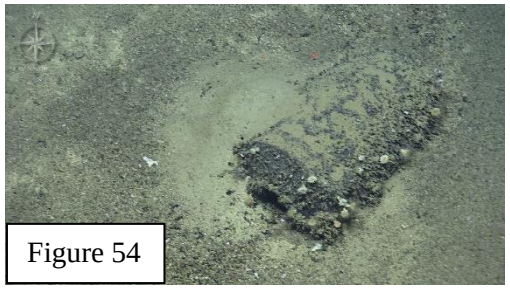

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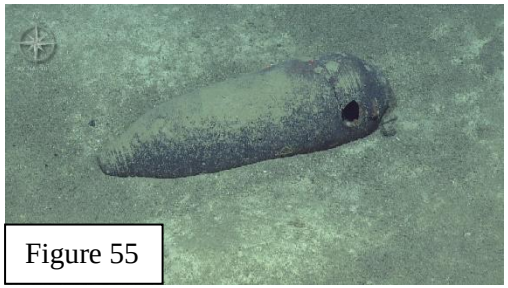
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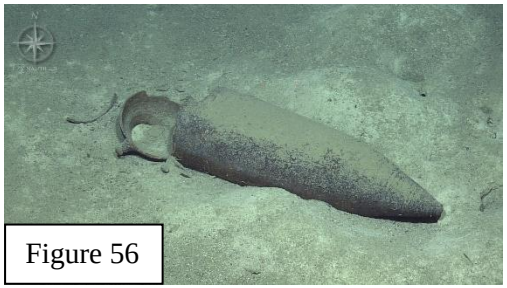
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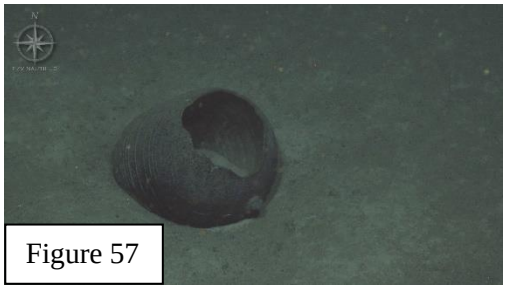
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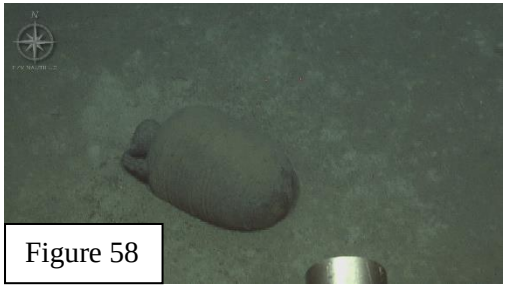
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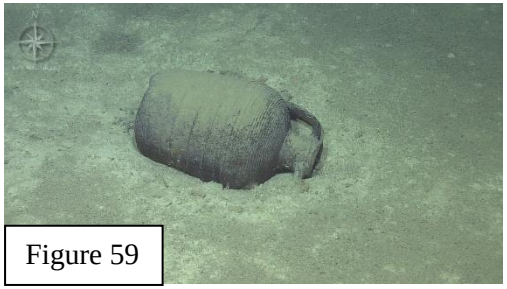
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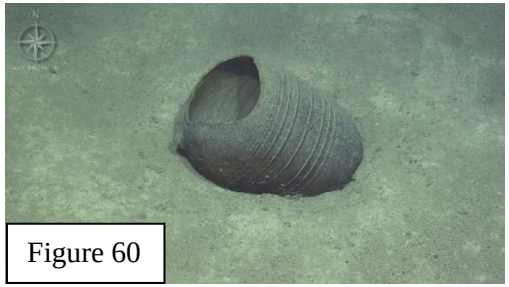
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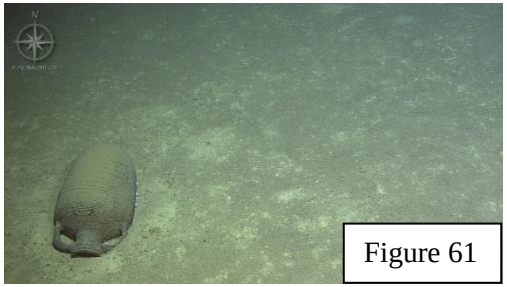
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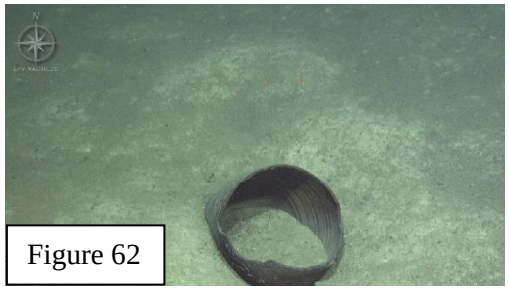
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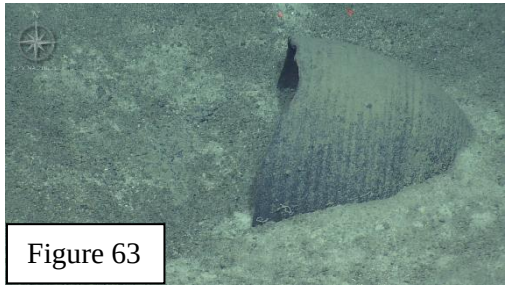


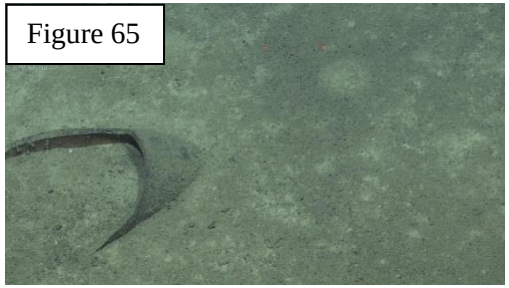
Figure 63

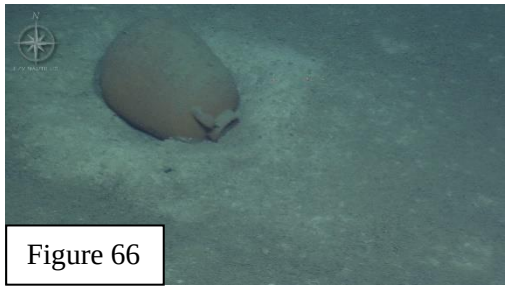
9. APPENDIX

Figure 64



Figure 65





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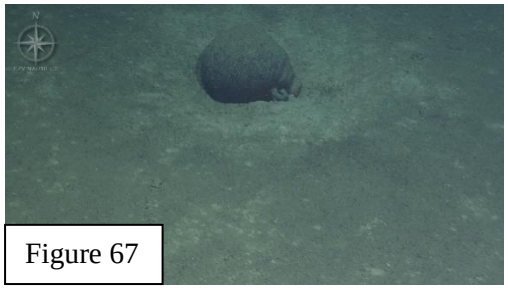

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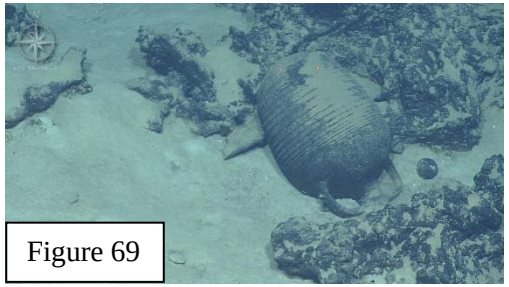

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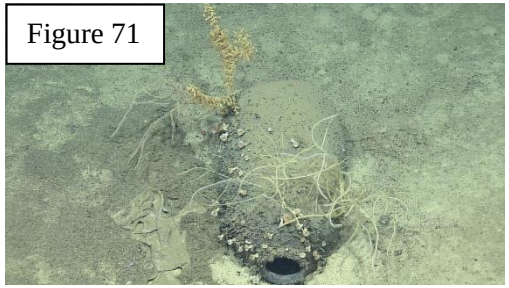
Figure 71



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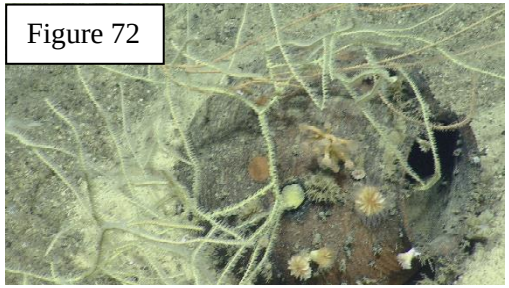

9. APPENDIX



Figure 73

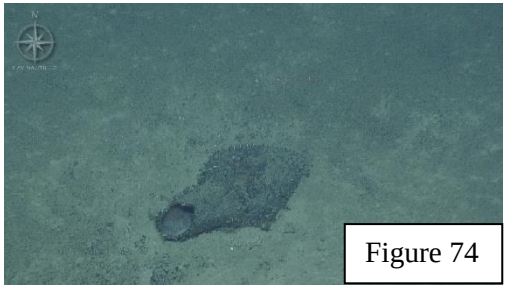

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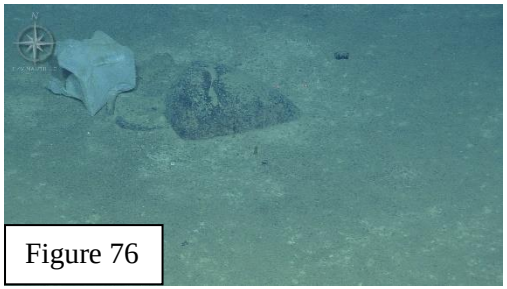
Figure 75



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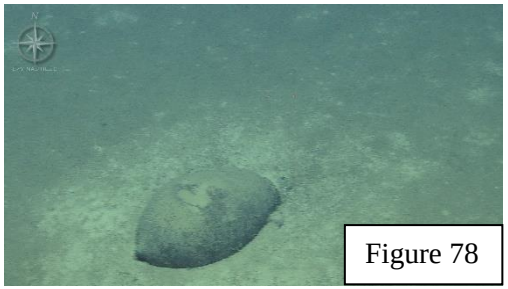

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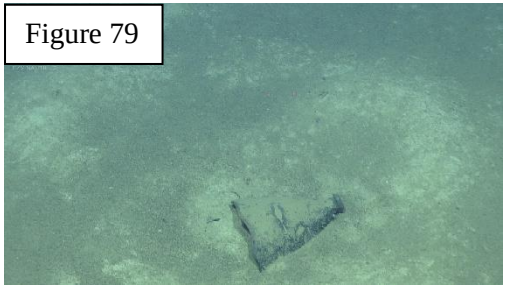


Figure 79



Figure 80



Figure 81

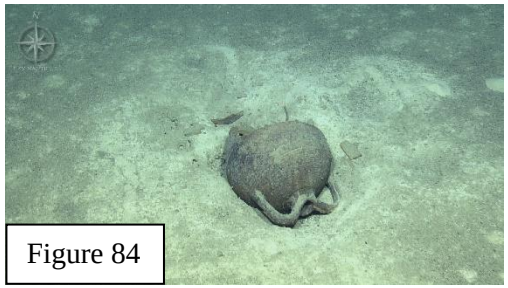
9. APPENDIX



Figure 82



Figure 83



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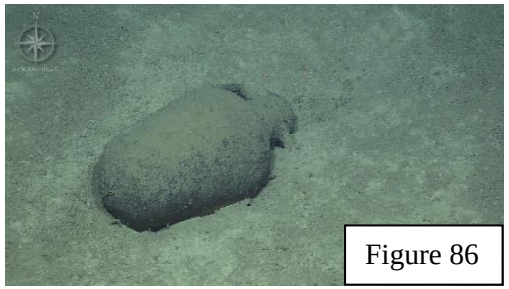

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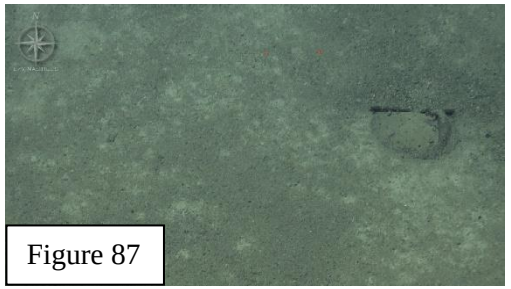

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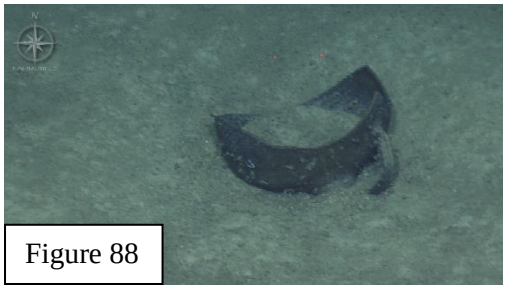

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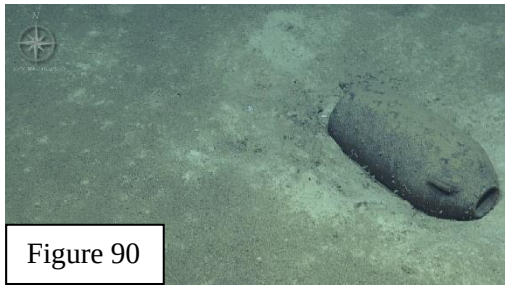

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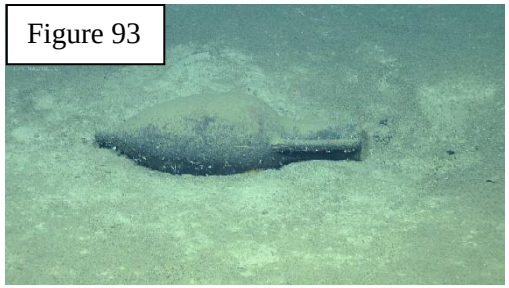
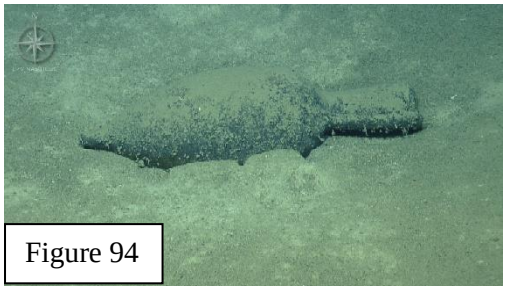
Figure 92



Figure 93





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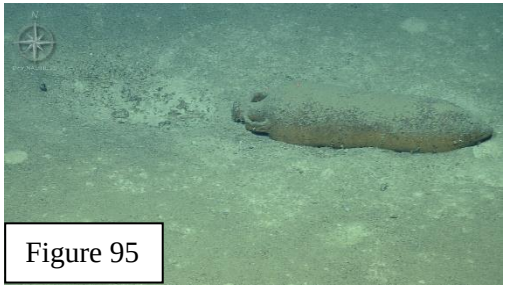

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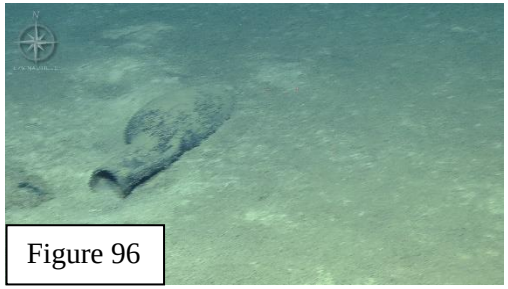

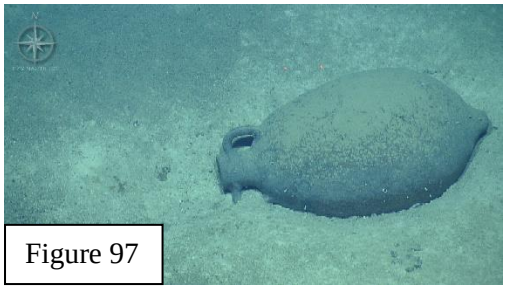

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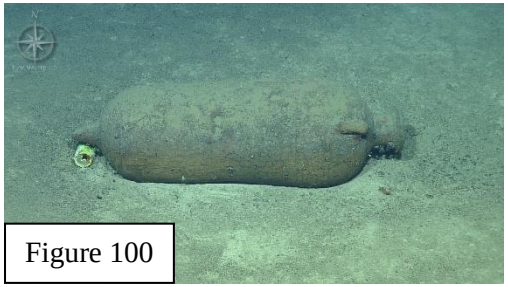
Figure 98



Figure 99

9. APPENDIX



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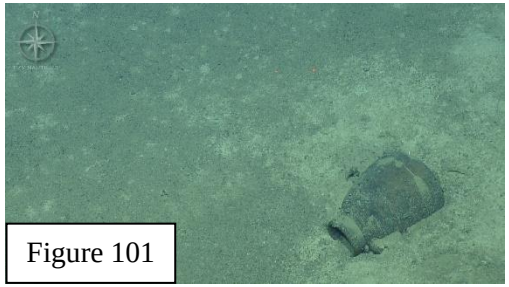

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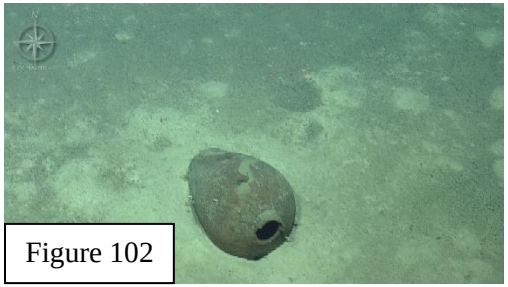

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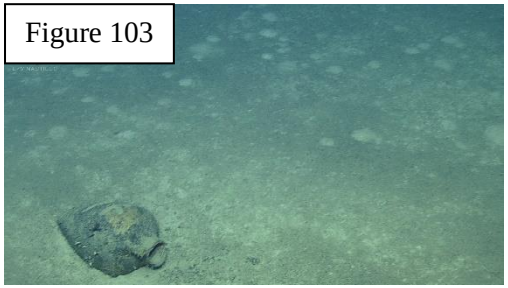

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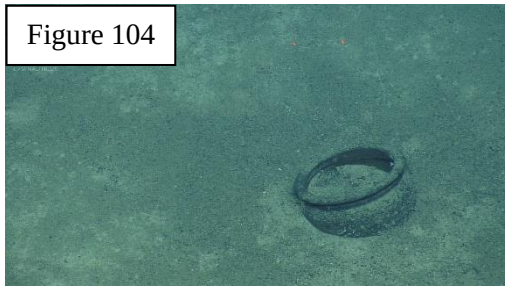

Figure 104



Figure 105

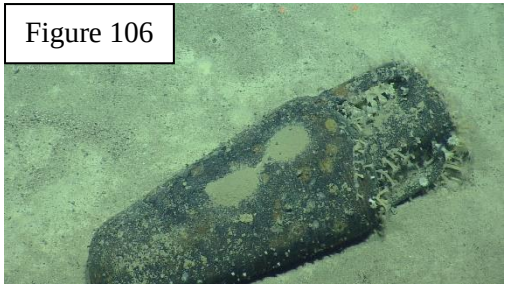

Figure 106

9. APPENDIX

[8.2.1].Table 2, Analysis of the Scatter of Materials noted during the 2012 Ocean Exploration Trust Expedition

Figure ID Corelating to Section 2, the 2012 OET Expedition Scatter of Materials

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
1	Perhaps Chios	5th – 6th centuries BC **Cypro-Archaic period**	Chios, Black Sea, Pergamon, Delos, Athens, and Alexandria	Intact, over 90% present	The amphora is half buried under sediment	Monakhov, S. (2003). *Греческие Амфоры В Причерноморье,Типология Амфор Ведущих ЦентровЭкспортеров Товаров в Керамической Таре*. Москва: Саратов.
2	Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Intact, over 90% present	Nothing to Report	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.
3	Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Good, 75% – 90% present. Handles appear to be missing	Nothing to Report	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.
4	Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Intact, over 90% present	Nothing to Report	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
5	Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Good, 75% – 90% present	Nothing to Report	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.
6	Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Good, 75% – 90% present	The amphora is half buried under sediment	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.
7	Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Intact, over 90% present	Nothing to Report	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.
8	Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Intact, over 90% present	Nothing to Report	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.

9. APPENDIX

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
9	Colchean (Ch IC2)	3rd century AD **Roman period**	Abkhazia	Intact, over 90% present	The amphora is half buried under sediment	Vnukov, Y. S. (2011). Colchean Amphorae from Abkhazia. In Tzochev, C., Stoyanov, T., and Bozkova, A. (eds.) *Production and trade of amphorae in the Black Sea. Acts of the international round table held in Kiten, Nessebar and Sredetz, September* 26-30, 2007. 271-278. Sofia: Patabs II
10	Late Roman 5 (LR5)	6th century AD **Late Roman/Early Byzantine period**	Palestine	Intact, over 90% present	Nothing to Report	Reynolds, P. (2005). Levantine amphorae from Cilicia to Gaza: a Typology and Analysis of Regional Production Trends from the 1st to 7th Centuries. LRCW I. *Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry*. 563-612. England: British Archaeological Reports International Series, 1340, 2005.
11	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
12	Canaanite jar	15th – 16th centuries BC **Late Bronze Age or Late Cypriot period**	Egypt, Cyprus, Israel, Palestine and perhaps elsewhere	Intact, over 90% present	The amphora is half buried under sediment	Rauh, N. (2020). *Canaanite Jar Found at Mycenae. Canaanite Jars and Trade in the Late Bronze Age Mediterranean*. https://web.ics.purdue.edu/~rauhn/canaanjar.htm [accessed 09-02-2020].

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
13	Tripolitanian II	1st – 4th centuries AD **Roman period**	Tripolitania (modern Lybia)	Intact, over 90% present	The amphora is half buried under sediment	Arthur, P. (1982). Amphora production in the Tripolitanian Gebel. *Libyan Studies* 13, 61-72.
14	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
15	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	The amphora seems to be facilitating the growth of corals	Reference not possible
16	Late Roman 5 (LR5)	Early 2nd – 3rd centuries AD **Roman period**	Palestine	Intact, over 90% present	Nothing to Report	Reynolds, P. (2005). Levantine amphorae from Cilicia to Gaza: a Typology and Analysis of Regional Production Trends from the 1st to 7th Centuries. LRCW I. *Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry*. 563-612. England: British Archaeological Reports International Series, 1340, 2005.
17	Late Roman 1 (LR1)	6th – 7th centuries AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

9. APPENDIX

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
18	Herakleian (S IVE type)	Late 4th – early 5th centuries AD **Late Roman/Early Byzantine period**	Herakleian	Good, 75% – 90% present	The amphora is half buried under sediment	Vnukov, Y. S. (2017). Overseas trade in the Black Sea Region and the formation of the Pontic market from the first century BCE to the third century CE. In Kozlovskaya, V. (ed.) *The Northern Black Sea in Antiquity*. 100-138. Cambridge: Cambridge University Press.
19	Cooking pot	Unknown	Unknown	Intact, over 90% present	The cooking pot is half buried under sediment	Reference not possible
20	Sinopean 'carrot' amphora	4th – 5th centuries AD **Late Roman/Early Byzantine period**	Athens and Palestine	Average, 50% – 75% present. Part of the main body and foot area are missing	Nothing to Report	Opaiţ, A. (2010). Sinopean, Heraklean and Chersonesan "Carrot" Amphorae. *Ancient Civilizations from Scythia to Siberia* 16, 371-401.
21	Unknown	Unknown	Unknown	Poor, 50% – 25% present	The amphora seems to be facilitating the growth of corals	Reference not possible
22	Leptiminus II	1st – 3rd centuries AD **Roman period**	Leptiminus, the Sahel region of Tunisia	Intact, over 90% present	The amphora seems to be facilitating the growth of corals	Opaiţ, A. (2000). Early Roman Amphorae from Leptiminus. *Rei Cretariae Romanae Favtorvm Acta* 36, 439-442.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
23	Unknown	Unknown	Unknown	Poor, 50% – 25% present	The amphora seems to be facilitating the growth of corals	Reference not possible
24	Perhaps Late Roman 3 (LR3)	4th – 5th centuries AD **Late Roman/Early Byzantine period**	Western Asia Minor, including, Ephesusthe, Meander Valley, Kusadasi, Miletos and possibly Pergamon	Average, 50% – 75% present	The amphora seems to be facilitating the growth of corals	Archaeology Data Service. (2005j). *Archives: Amphora: Details of Late Roman Amphora 3*. [accessed 18/03/2019].
25	Unknown	Unknown	Unknown	Poor, 50% – 25% present	The amphora seems to be facilitating the growth of corals	Reference not possible
26	Late Roman 13 (LR13)	Late 6th – 8th century AD **Late Roman/Early Byzantine to Byzantine periods**	Cyprus	Good, 75% – 90% present	Nothing to Report	Demesticha, S. (2005). Some thoughts on the production and presence of the Late Roman Amphora 13 on Cyprus. In Briese, B. M., and Vaag, E. L. (eds.) *Trade Relations in the eastern Mediterranean from the Late Hellenistic Period to Late Antiquity. The Ceramic Evidence.* 169-178. Denmark: University Press of Southern Denmark

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
27	Unknown	Unknown	Unknown	Good, 75% – 90% present	The amphora seems to be facilitating the growth of corals	Reference not possible
28	Probably Roman juglet made of glass	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
29	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
30	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
31	Unknown	Unknown	Unknown	Poor, 50% – 25% present	The amphora seems to be facilitating the growth of corals	Reference not possible
32	Late Roman 13 (LR13)	Late 6th – 8th century AD **Late Roman/Early Byzantine to Byzantine periods**	Cyprus	Intact, over 90% present	Nothing to Report	Demesticha, S. (2005). Some thoughts on the production and presence of the Late Roman Amphora 13 on Cyprus. In Briese, B. M., and Vaag, E. L. (eds.) *Trade Relations in the eastern Mediterranean from the Late Hellenistic Period to Late Antiquity. The Ceramic Evidence.* 169-178. Denmark: University Press of Southern Denmark.
33	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
34	Unknown	Unknown	Unknown	Poor, 50% – 25% present	The amphora seems to be facilitating the growth of corals	Reference not possible
35	Unknown	Unknown	Unknown	Good, 75% – 90% present	Nothing to Report	Reference not possible
36	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
37	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
38	Herakleian (S IVC type)	2nd century AD **Roman period**	Herakleian	Intact, over 90% present	The amphora is half buried under sediment	Vnukov, Y. S. (2017). Overseas trade in the Black Sea Region and the formation of the Pontic market from the first century BCE to the third century CE. In Kozlovskaya, V. (ed.) *The Northern Black Sea in Antiquity*. 100-138. Cambridge: Cambridge University Press.
39	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
40	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
41	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
42	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
43	Unknown	Unknown	Unknown	Average, 50% – 75% present	Nothing to Report	Reference not possible

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
44	Herakleian (S IVJ type)	2nd century AD **Roman period**	Herakleian	Good, 75% – 90% present	The amphora is half buried under sediment	Vnukov, Y. S. (2017). Overseas trade in the Black Sea Region and the formation of the Pontic market from the first century BCE to the third century CE. In Kozlovskaya, V. (ed.) *The Northern Black Sea in Antiquity*. 100-138. Cambridge: Cambridge University Press.
45	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
46	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Good, 75% – 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.
47	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
48	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
49	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
50	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
51	Perhaps Greco-Italic	2th – 4nd centuries BC **Hellenistic period**	Tyrrhenian and Adriatic Italy, including Magna Graecia, southern Latium, Campania, Ischia, Etruria, Taranto, Salento, Spina/Adria and Aquileia	Intact, over 90% present	Details obscure in photographic data	Will, L. E. (1982). Greco-Italic Amphoras. *Hesperia: The Journal of the American School of Classical Studies at Athens* 51:3, 338-356.
52	Unknown	Unknown	Unknown	Poor, 50% – 25% present	The amphora seems to be facilitating the growth of corals	Reference not possible
53	Almagro 54 / Late Roman 4 (LR4)	5th – early 6th centuries AD **Late Roman/Early Byzantine period**	Gaza	Intact, over 90% present	The artefact is half buried under sediment	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
54	Canaanite jar	13th – 14th centuries BC **Late Bronze Age or Late Cypriot period**	Egypt, Cyprus, Israel, Palestine and perhaps elsewhere	Intact, over 90% present	The amphora is half buried under sediment and also appear to be facilitating the growth of corals	Rauh, N. (2020). *Canaanite Jar Found at Mycenae. Canaanite Jars and Trade in the Late Bronze Age Mediterranean*. https://web.ics.purdue.edu/~rauhn/canaanjar.htm [accessed 09-02-2020].

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
55	Perhaps Almagro 54 / Late Roman 4 (LR4)	mid-6th – 7th centuries AD **Late Roman/Early Byzantine period**	Palestine	Intact, over 90% present	Nothing to Report	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
56	Almagro 54 / Late Roman 4 (LR4)	5th – early 6th centuries AD **Late Roman/Early Byzantine period**	Gaza	Intact, over 90% present. Chipped at the shoulder area	Nothing to Report	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
57	Perhaps Late Roman 5 (LR5)	6th century AD **Late Roman/Early Byzantine period**	Palestine	Average, 50% – 75% present. Part of the main body is missing.	The amphora is half buried under sediment	Reynolds, P. (2005). Levantine amphorae from Cilicia to Gaza: a Typology and Analysis of Regional Production Trends from the 1st to 7th Centuries. LRCW I. *Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry*. 563-612. England: British Archaeological Reports International Series, 1340, 2005.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
58	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.
59	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Good, 75% – 90% present. Foot area appears to be broken	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.
60	Perhaps Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Poor, 50% – 25% present. Neck, handles, rim and part of the main body are missing	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
61	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.
62	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
63	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
64	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	The amphora seems to be facilitating the growth of corals	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
65	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
66	Late Roman 6 (LR6)	3rd – 8th centuries AD **Roman to Late Roman/Early Byzantine and Byzantine periods**	Palestine, Beirut and Istanbul	Intact, over 90% present	Nothing to Report	Archaeology Data Service. (2005k). *Archives: Amphora: Details of Late Roman Amphora 6*. [accessed 18/03/2019].
67	Late Roman 5 (LR5)	6th century AD **Late Roman/Early Byzantine period**	Palestine	Intact, over 90% present	Nothing to Report	Reynolds, P. (2005). Levantine amphorae from Cilicia to Gaza: a Typology and Analysis of Regional Production Trends from the 1st to 7th Centuries. LRCW I. *Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry*. 563-612. England: British Archaeological Reports International Series, 1340, 2005.
68	Samian / Type Solokha I	4th century BC **Hellenistic period**	Rhodes and Samos	Intact, over 90% present	The artefact is half buried under sediment	Grace, V. (1971). Samian amphoras. *Hesperia* 40:1, 52-95.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
69	Late Roman 13 (LR13)	Late 6th – 8th centuries AD **Late Roman/Early Byzantine to Byzantine periods**	Cyprus	Intact, over 90% present	Nothing to Report	Demesticha, S. (2005). Some thoughts on the production and presence of the Late Roman Amphora 13 on Cyprus. In Briese, B. M., and Vaag, E. L. (eds.) *Trade Relations in the eastern Mediterranean from the Late Hellenistic Period to Late Antiquity. The Ceramic Evidence.* 169-178. Denmark: University Press of Southern Denmark
70	Cooking pot	3rd – 4th centuries BC **Hellenistic period**	Egyptian	Intact, over 90% present	Nothing to Report	Ballard, B., Opaiţ, A., and Cornwell, K. (2017). Deep-water archaeological discoveries on Eratosthenes Seamount. *Deep-Sea Research Part II* 150, 4-21.
71	Unknown	Unknown	Unknown	Intact, over 90% present	The amphora seems to be facilitating the growth of corals	Reference not possible
72	Perhaps cooking pot	Unknown	Unknown	Intact, over 90% present	The cooking pot seems to be facilitating the growth of corals	Reference not possible
73	Khersonesan (Type I-A-1)	Late 4th century BC **Hellenistic period**	Khersonesan	Intact, over 90% present	The amphora seems to be facilitating the growth of corals	Monachov, S. J., and Rogov, E. I. (1990). Amphorae of the Panskoe I Necropolis, Antiche Mura. *AMA* 7, 128–53.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
74	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
75	Pascual 1 / Peacock and Williams Class 6	1st century BC to 1st century AD **Hellenistic period**	Catalan coastal north-eastern Spain, Gaul at the sites ofbAspiran, Montans and Corneilhan	Intact, over 90% present	The amphora seems to be facilitating the growth of corals	Peacock, D. P. S., and Williams, D. F. (1986). *Amphorae and the Roman economy: An introduction guide.* London: Longman Publishing Group. 93-95.
76	Perhaps Late Roman 13 (LR13)	Late 6th – 8th century AD **Late Roman/Early Byzantine to Byzantine periods**	Cyprus	Intact, over 90% present	The artefact is half buried under sediment	Demesticha, S. (2005). Some thoughts on the production and presence of the Late Roman Amphora 13 on Cyprus. In Briese, B. M., and Vaag, E. L. (eds.) *Trade Relations in the eastern Mediterranean from the Late Hellenistic Period to Late Antiquity. The Ceramic Evidence.* 169-178. Denmark: University Press of Southern Denmark
77	Almagro 54 / Late Roman 4 (LR4)	5th – early 6th centuries AD **Late Roman/Early Byzantine period**	Gaza	Intact, over 90% present	The artefact is half buried under sediment	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
78	Opaiţ C1	4th – 5th centuries AD **Late Roman/Early Byzantine period**	Ballana Lower Nubia	Intact, over 90% present	Nothing to Report	Archaeology Data Service. (2005l). *Archives: Amphora: Details of Opaiţ C1*.[accessed 18/03/2019].
79	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
80	Cooking pot	1st – 4th centuries BC **Hellenistic period**	Egyptian	Intact, over 90% present	Nothing to Report	Ballard, B., Opaiţ, A., and Cornwell, K. (2017). Deep-water archaeological discoveries on Eratosthenes Seamount. *Deep-Sea Research Part II* 150, 4-21.
81	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
82	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
83	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
84	Günsenin 4	12th – 13th or 14th centuries AD **Frankish period**	Trabzon, Black Sea	Intact, over 90% present	Nothing to Report	Hill, T. (2016). *A Guide to Late Roman and Byzantine Amphorae*. 1-44. https://www.academia.edu/31914041/A_Guide_to_Late_Roman_and_Byzantine_Amphorae [accessed 18/03/2019].
85	Perhaps Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Good, 75% – 90% present. Handless and rim are missing	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.
86	Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Intact, over 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.
87	Cooking pot perhaps similar to figure 80	1st – 4th centuries BC **Hellenistic period**	Egyptian	Intact, over 90% present	The artefact is almost entirely buried under sediment	Ballard, B., Opaiţ, A., and Cornwell, K. (2017). Deep-water archaeological discoveries on Eratosthenes Seamount. *Deep-Sea Research Part II* 150, 4-21.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
88	Unknown	Unknown	Unknown	Poor, 50% – 25% present	Nothing to Report	Reference not possible
89	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
90	Almagro 54 / Late Roman 4 (LR4)	5th – early 6th centuries AD **Late Roman/Early Byzantine period**	Gaza	Average, 50% – 75% present. Chipped at the foot area	Nothing to Report	Archaeology Data Service. (2005g). *Archives: Amphora: Details of Almagro 54*. [accessed 18/03/2019].
91	Unknown	Unknown	Unknown	Fragmentary, less than 25% present	Nothing to Report	Reference not possible
92	Perhaps Late Roman 1 (LR1)	5th century AD **Late Roman/Early Byzantine period**	Cyprus	Good, 75% – 90% present	The amphora seems to be facilitating the growth of corals	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean*. 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
93	Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Intact, over 90% present	Nothing to Report	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.
94	Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Intact, over 90% present	Nothing to Report	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.
95	Colchean (Ch IC2)	3rd century AD **Roman period**	Abkhazia	Intact, over 90% present	The amphora is half buried under sediment	Vnukov, Y. S. (2011). Colchean Amphorae from Abkhazia. In Tzochev, C., Stoyanov, T., and Bozkova, A. (eds.) *Production and trade of amphorae in the Black Sea. Acts of the international round table held in Kiten, Nessebar and Sredetz, September* 26-30, 2007. 271-278. Sofia: Patabs II.
96	Perhaps Rhodian (Type I-E-2)	1st century BC to 1st century AD **Hellenistic period**	Rhodes	Intact, over 90% present	Details obscure in photographic data	Monachov, S. (1995). Rhodian amphoras: developments in form and measurements. In Stolba, V. F., and Hannestad, L. (eds.) *Chronologies of the Black Sea area in the period c.400-100 BC.* 69-95. Aarhus: Aarhus University Press.

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
97	Opaiţ C1	4th – 5th centuries AD **Late Roman/Early Byzantine period**	Ballana Lower Nubia	Intact, over 90% present	Nothing to Report	Archaeology Data Service. (2005l). *Archives: Amphora: Details of Opaiţ C1*. [accessed 18/03/2019].
98	Unknown	Unknown	Unknown	Good, 75% – 90% present. Rim and handles are missing	The amphora is half buried under sediment	Reference not possible
99	Unknown	Unknown	Unknown	Poor, 50% – 25% present	The amphora is completely buried under sediment	Reference not possible
100	Tripolitanian II	1st – 4th centuries AD **Roman period**	Tripolitania (modern Lybia)	Intact, over 90% present	The amphora is half buried under sediment	Arthur, P. (1982). Amphora production in the Tripolitanian Gebel. *Libyan Studies* 13, 61-72.
101	Augst 46	1st century AD **Roman period**	Unknown origin but perhaps originated from Palestine	Fragmentary, less than 25% present	The amphora is half buried under sediment	Archaeology Data Service. (2005m). *Archives: Amphora: Details of Augst 46*. [accessed 18/03/2019].

Figure ID	Possible Amphora Type	Chronology	Origin	State of Preservation	Other Observations	Comparand
102	Almagro 51C / Peacock and Williams Class 23	3rd – mid-5th centuries AD **Roman to Late Roman/Early Byzantine period**	Portugal, produced in the Tejo and Sado valleys, and in Algarve	Average, 50% – 75% present. Rim and handles are missing	Nothing to Report	Peacock, D. P. S., and Williams, D. F. (1986). *Amphorae and the Roman economy: An introduction guide.* London: Longman Publishing Group. 132.
103	Unknown	Unknown	Unknown	Good, 75% – 90% present	Details obscure in photographic data	Reference not possible
104	Cooking pot	Unknown	Unknown	Intact, over 90% present	The artefact is half buried under sediment	Reference not possible
105	Colchean (Ch IC2)	3rd century AD **Roman period**	Abkhazia	Intact, over 90% present	The artefact is half buried under sediment	Vnukov, Y. S. (2011). Colchean Amphorae from Abkhazia. In Tzochev, C., Stoyanov, T., and Bozkova, A. (eds.) *Production and trade of amphorae in the Black Sea. Acts of the international round table held in Kiten, Nessebar and Sredetz, September* 26-30, 2007. 271-278. Sofia: Patabs II.
106	Late Roman 1 (LR1)	3rd – 4th centuries AD **Late Roman/Early Byzantine period**	Cilia	Intact, over 90% present	Nothing to Report	Opaiţ, A. (2010). On the origins of Carthage LR Amphorae 1. In Menchelli, S., Santoro, S., Pasquinucci, M., and Guiducci, G. (eds.) *LRCW3 Late Roman Corse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and archaeometry. Comparison between western and eastern Mediterranean.* 1015-1022. England: British Archaeological Reports 2185 (1), 2010.

[8.3].figure 59

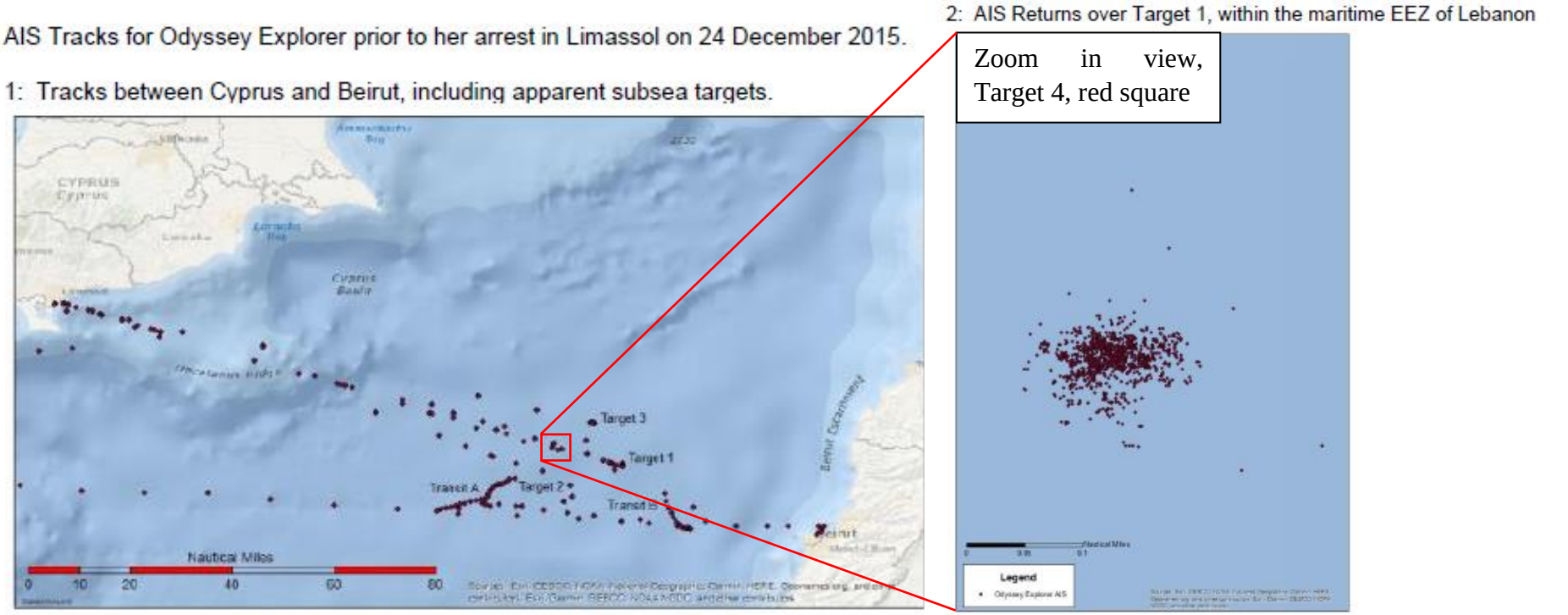

figure 59: The Automatic Identification Systems (AIS) transmissions of the vessel, which refers to the vessel's real time position and Target 4, squared in red, where Engima's vessel spend roughly 4 hours onsite. The figure was taken from Maritime Observatory, Maritime Archaeology Sea Trust, and OceanMind (2020). *Protect Intel: Summary briefing note re Enigma shipwreck recovery and Dr Sean Kingsley*. [Unpublished]. 14.

[8.4].Chronological Table of the Study

Cultural Period	Date Range	
Late Cypriot or Late Bronze Age	1600 – 1050 BC	(17th to 11th centuries BC)
Cypro-Geometric	1050 – 750 BC	(11th to 8th centuries BC)
Cypro-Archaic	750 – 480 BC	(8Th to 5th centuries BC)
Cypro-Classical	480 – 310 BC	(5th to 4st centuries BC)
Hellenistic	310 – 30 BC	(4th to 1st centuries BC)
Roman	30 BC – 330 AD	(1st BC to 4th centuries AD)
Late Roman / Early Byzantine	330 – 650 AD	(4th to 7th centuries AD)
Byzantine	750 – 1191 AD	(8th to 12th centuries AD)
Frankish	1191 – 1489 AD	(12th to 15th centuries AD)
Venetian	1489 -1571 AD	(15th to 16th centuries AD)
Ottoman	1571 – 1878 AD	(16th to 19th centuries AD)
British	1878 – 1960 AD	(19th to 20th centuries AD)
Modern	1960 AD – to now	(20th to now centuries AD)

The chronological table of the study for the pre-Roman periods derives from Karageorghis 2003 book, *The Cyprus collections in the Medelhavsmuseet* page xiii and Papantoniou 2003, *Religion and Social Transformation in Cyprus: From the Cypriot Basileis to the Hellenistic Strategos* chronological table page xvv, but simplified for the purpose of the study; For the Late Roman/Early Byzantine to the Byzantine periods, the time-line follows the suggestions made by Given, Knapp, and Coleman in the 2003, *The Sydney Cyprus Survey Project: Approaches to Regional Archaeological Survey*, page 30; and for the Frankish periods and forward it follows the Department of Antiquities Cyprus chronology seen at the link, http://www.mcw.gov.cy/mcw/da/da.nsf/DMLchtable_en/DMLchtable_en?OpenDocument [accessed 18-01-2021].

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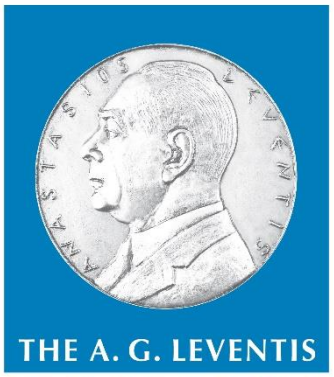
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