The Gatherer and the Grindstone

Towards a methodological toolkit for grindstone analysis in southern Africa

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Thesis submitted in fulfilment of the degree of
Doctor of Philosophy in Archaeology

Hilary Term 2015

Abstract

Although grindstones – that is, pairs of stone implements used to grind, pound, pulverise or otherwise process intermediate materials – have been intensively studied by archaeologists in other parts of the world, in southern Africa to date they have received little attention. Despite a near-ubiquitous presence on Middle and Later Stone Age archaeological sites, their primary function in archaeological reconstructions has been as proxies for other behaviours. These include behavioural modernity; gender; particular plant types, such as geophytes/underground storage organs.

This doctoral thesis interrogates grindstones with a view not only to establishing specific (rather than proxy) uses in the southern African archaeological record, but also as a means to explore the gathered side of hunter-gatherer lifeways, which have also historically been neglected. It does this by developing a methodological toolkit for grindstone analysis in southern Africa.

Comparison of archaeological and historical literature from the southern African Grassland Biome and elsewhere suggests a tension between archaeological accounts which posit geophyte and mineral pigment grinding as a primary purpose for grindstones and ethnohistorical accounts suggesting that grass-processing was a staple of hunter-gatherer life. Finally, a corpus of putative grindstones from the site of Ha Makotoko in western Lesotho is typologically assessed and analysed for plant starches and phytoliths. It emerges that at this site, and in contrast to received wisdom, geophyte grinding was not extensive but by contrast, grass seed processing was practised. This belies models suggesting that C₄ grass seeds were unlikely to have contributed to hunter-gatherer diets, and questions interpretations of grass ‘bedding’ as well as the distinction between ‘forager’ and ‘farmer’. Most importantly, this thesis validates the idea that grindstone study is worthwhile, and should be integrated into wider lithic study in southern Africa as a matter of course.

Acknowledgements

In Oxford and England

First and foremost, I owe tremendous gratitude to my supervisor, Peter Mitchell, for imaginative insight and support over the course of my DPhil (and I'm sorry about all the brackets). I'm grateful to Charlie Arthur also for allowing me access to his excavated material and many discussions about Ha Makotoko. Brian Stewart should be thanked (or blamed!) for first taking me to Lesotho and igniting an interest in the region and inhabitants.

Alison Crowther trained me in starch analysis and has answered questions and read chapter drafts, while Adrian Parker was similarly helpful as regards phytoliths. Chris Doherty has been an endless fount of geological and microscopic information. Stephen Harris kindly allowed me to sample the *Kohautia* sp. specimen in the Oxford University herbarium.

I would like to thank Rachel King and Solomon Pomerantz for a completely deleterious first term at Oxford. Sol gets extra thanks for phytoliths, lab chat, and Thanksgivings, while Rachel should probably be thanked in all sections of this thesis as my perennial sounding board, agony aunt and partner in crime: without her manifold assistance both academic and otherwise, this thesis would certainly never have been written. I'm grateful too to Mark McGranaghan in his role as living embodiment of Bleek and Lloyd archive. Patrick Roberts I thank for advice on Science, Laura Lewis for solidarity and statistics. The inhabitants of 99 Walton Street (particularly Sarah Ekdawi and Dido) provided me with a home away from home in Oxford.

I thank the Oxford archaeobotanists (and honorary group members), particularly Alice Williams for letting me use her beautiful illustration; the Botanical Ontologists (especially Lewis Daly); and finally my mainstay in madness and source of both valuable academic information and endless procrastination, the Megathread (Rachel Crellin gets extra thanks for talking theory, Ben Copsey for his thoughts on typology, and Catherine Farfan for moving to Oxford).

Lesotho

Residents of both the Metolong catchment and Sekhutlong-sa-Lineo shared their knowledge and memories of useful plants and grindstones. In particular I thank Ntate Tseliso Khesuoe; Ntate Kezah Lepokola; Ntate Makhobalo Makotoko; 'Me Maletlatsa Makotoko; 'Me Malireko Masakale; Ntate Michael Maqokela; Ntate Tloue Mohapi; Ntate Joseph Morema; Ntate Lefaso Nchakha; 'Me Bela Nthunya; Ntate Hlenyane Seefane; Ntate Lefu Sefali; 'Me Limakhatso Shao; Ntate Malefetsane Thibli.

'Me Matikoe Matsoso, 'Me Pulane Nthunya, Ntate Joseph Ralimpe, and especially, 'Me Soldart Khantsi were exceptional research assistants.

I'm grateful also to Ntate Stephen Gill of Morija museum for helpful chats both in person and via email, and the Thorn family and staff of the Trading Post at Roma for their many kindnesses.

Ke a leboha ha holo.

South Africa

David Pearce provided helpful discussion and an image of Mapote's panel, while Chrissie Sievers made invaluable additions to the starch reference collection as well as thoughtful comments and suggestions. Lucinda Backwell supplied me with a scan of her Twyfelpoort article, and Shelona Klatzow kindly entered into discussion about her unpublished Masters thesis. Anthony Horowitz and staff at Kirstenbosch Botanical

Gardens in Cape Town provided material for the starch reference collection, while Lloyd Rossouw was good enough to grant me access to his phytolith reference collection. I'm grateful also to Geeske Langejans for help in 2012 and many useful discussions.

On the Internet and elsewhere

Adelphine Bonneau deserves a huge vote of thanks (and many minions) for introducing me to mineral characterisation and checking the pigment analysis. The phy-talk mailing list responded to queries about unknown microscopic bodies (thanks also to Gerry Carr for confirming the possibility that these might be cystoliths), and Amanda Henry and Sheahan Bestel were kind enough to enter into dialogue about various starch related things. Mike Smith and Elspeth Hayes graciously provided me with a number of publications I was unable to access elsewhere, and helpful thoughts on the state of grindstone analysis. I am grateful to staff of the USDA for providing me with various plant samples. George Malliaras, Eithne Owens and trustees of the Rachel King Laptop Fund provided usable computers for the duration of the DPhil.

Dublin

I thank Matthew Jebb and staff at the National Botanic Gardens for contributions to the starch reference collection. I am most grateful to my family. I had wanted to say that my mother's contribution was 'mostly positive' but actually, she has been my greatest support and the person whose opinion I value most. My father as well has always supported my interest in archaeology (and also in eating). Cormac, Róisín, Eithne, Gillian and George have been encouraging throughout, while my nephews are just great, frankly, even if I haven't (yet) found a dinosaur. My aunt Máiréad and my uncle Art listened to many of my woes as I was writing and never failed to provide a good argument or seven. Alex gets included here, who I thank for succour, an impressive range of animal impressions, and being my best friend.

I could not have written this thesis without the legacy, both financial and metaphorical, of my grandmother Margaret Kennedy.

Fieldwork and conference attendance during the DPhil were supported by St Hugh's College's Barbinder-Watson Fund, the School of Archaeology's Meyerstein Fund, the University of Oxford's Boise Fund, the Santander Academic Travel Fund, a Tweedie Exploration Fellowship from the University of Edinburgh, and a Horniman/Sutasoma starred award from the Royal Anthropological Institute of Great Britain and Ireland.

Table of contents

Table of contents	i
Table of figures	vii
Table of tables	xiv
Introduction: Essential domestic objects, or awkward unknowns?	1
1.1 Overview: making the case for grindstones in southern Africa	1
1.2 A return to things: a good theoretical basis for studying grindstones?	2
1.3 Structure of the thesis.....	5
1.4 Overarching aims.....	7
1.5 Specific objectives	8
Chapter 2. What Hunters Gathered: Plants	10
2.1 Overview.....	10
2.2 The Grassland Biome	11
2.3 Much ado about geophytes.....	14
2.3.1 Acquisition of geophytes	16
2.3.2 Processing geophytes.....	17
2.3.3 Historical evidence for geophyte grinding	19
2.4 Grindstones and seed processing.....	23
2.5 Grindstones and grasses?.....	33
2.5.1 Historical/ethnographic evidence for grass processing.....	36
2.6 Experimental and ethnoarchaeological contributions	39
2.7 Implications for subsistence: foragers plus?	41
2.8 Summary	43
Chapter 3. Grindstones in the Grassland Biome of southern Africa	45
3.1 Overview.....	45
3.2 Grindstone studies globally.....	46

3.3	Grindstones as proxies	47
3.3.1	Grindstones and the Behavioural Modernity Debate.....	48
3.3.2	Grindstones and particular plants.....	48
3.3.3	Gendering grindstones	48
3.3.4	Grindstones and the “other”	50
3.4	Examining published grindstones in southern Africa	51
3.5	Grindstones and typology: systems of analysis.....	52
3.6	Finding a place for grindstones	53
3.7	Grindstones within the Grassland Biome.....	53
3.7.1	Discussion	63
3.8	Summary	66
	Chapter 4. Ha Makotoko	67
4.1	Overview.....	67
4.2	Site location and composition	69
4.3	Occupation History	72
	1989 excavations.....	72
	2010 excavations.....	72
	Other sources (oral histories, intangible cultural heritage, rock art dating)	77
4.4	Justifying the Ha Makotoko grindstones as a dataset	77
4.5	Palaeoenvironments.....	77
4.6	Comparing material culture and site occupation between the 1989 and 2010 excavations.....	78
4.7	Grindstones from 1989 <i>versus</i> Grindstones from 2010.....	79
4.8	Summary	81
	Chapter 5. The invisibility of the obvious: towards a typology of grindstones at Ha Makotoko.....	83
5.1	Introduction	83

5.2	In defence of typology.....	83
5.3	Background work	87
5.4	Description of types.....	89
5.4.1	Illustration of grindstone types from the Ha Makotoko archaeological collection.....	92
5.5	Morphometrics	94
5.6	Grindstones contextualised.....	98
5.7	Observations on raw material.....	102
5.7.1	Raw material preference and pigment processing	104
5.8	Conclusion.....	105
5.9	Summary	106
	Chapter 6. Starch analysis of grindstones from Ha Makotoko.....	108
6.1	Overview.....	108
6.2	Production of starch by plants	108
6.3	Structure and characteristics of starch granules: why starch is useful for archaeologists	109
6.4	Contamination.....	113
6.5	Grindstones and starch	115
6.6	Starch analysis in southern Africa.....	115
6.7	Reference Collection Comparison	116
6.8	Basotho economic botany and the acquisition of a starch reference collection	118
6.8.1	Introduction	118
6.8.2	Methods	118
6.8.3	Details, including uses, of plants sampled for the starch reference collection	126
6.9	Morphometrics of the starch reference collection	149

6.10	Catalogue of images from the starch reference collection	154
6.11	Starch analysis as applied to grindstones from Ha Makotoko	165
6.12	Illustrations of grindstones analysed for starch.....	165
6.13	Method.....	177
6.14	Grindstones and sediments contextualised.....	179
6.15	Characterisation of starch from Ha Makotoko grindstones	180
6.16	Discussion of individual grindstones	196
6.17	Characterisation of starch from Ha Makotoko sediments.....	218
6.18	Comparing sediments and grindstones.....	222
6.19	Discussion of starch recovered from grindstones and sediments at Ha Makotoko	224
6.19.1	Low yields: poor preservation?	224
6.19.2	Greater yields in later contexts: influx of domesticates?	224
6.19.3	Grindstones and geophytes	225
6.19.4	Contamination: ancient and modern.....	226
6.20	Conclusion.....	227
6.21	Summary.....	229
Chapter 7. Phytolith analysis of grindstones and sediments from Ha Makotoko		
231		
7.1	Overview.....	231
7.2	Production of phytoliths and utility to archaeologists	231
7.3	The Sample	233
7.3.1	Contextual and typological information on the samples.....	234
7.3.2	Determining possible ‘working’ surfaces.....	235
7.4	Method.....	242
7.5	Phytolith typology	243
7.5.1	List of types	244

7.6	Interpretation of phytoliths	261
7.6.1	Sediment samples from Ha Makotoko.....	264
7.6.2	Artefactual samples from Ha Makotoko	266
7.7	Discussion	283
7.7.1	Processing grasses at Ha Makotoko.....	283
7.7.2	Chronological trends?	285
7.7.3	Comparing starch and phytolith yields	285
7.7.4	Grass families represented	286
7.8	Conclusion.....	287
7.9	Summary	287
	Discussion.....	290
8.1	Introduction	290
8.2	Synthesis of archaeological findings	290
8.2.1	Grindstone results in full.....	296
8.3	Summary of major results by chapter	302
8.3.1	Achievement of aims and objectives	306
8.4	Evaluating the methodology: a tool kit for grindstone analysis.....	307
8.4.1	Controls.....	309
8.5	What's missing: on sample size in archaeological residue analysis	310
8.6	Suggestions for further research	312
8.7	Themes for discussion	314
8.7.1	Gatherers and grasses?	314
8.7.2	Grindstones in Basotho society	319
8.7.3	Grindstones in hunter-gatherer society.....	321
8.8	Conclusion: What this awl means for hunter-gatherers.....	326
8.8.1	Gatherers with grasses?.....	327
8.8.2	The Gatherer	328

8.8.3 The Grindstone	329
Appendix A: What hunters gathered (mineral pigments).....	331
A.1 Overview	331
A.2 Uses of mineral pigment.....	331
A.3 Rock Art	332
A.4 Mineral pigments in hafting.....	337
A.4 Mineral extraction and processing.....	337
Appendix B Characterising mineral pigments at Ha Makotoko	340
B.1 Introduction	340
B.2 Methodological overview	341
B.3 Methodological specifics.....	344
B.4 Sample presented for further analysis	346
B.5 Scanning electron microscopy	348
B.5.1 Discussion of results from SEM-EDX analysis.....	367
B.6 Raman spectroscopy	367
B.6.1 Discussion of Raman spectra.....	370
B.7 General discussion	370
B.7.1 Comparison with rock art	370
B.8 Conclusion.....	372
Appendix C: Starch extraction protocol.....	374
Appendix D: Phytolith extraction protocol (following starch extraction).....	378
Bibliography	379
Online Sources.....	415
Catalogue 1: Grindstone illustrations	417

Table of figures

Figure 2.1 The southern African Grassland Biome	12
Figure 2.2 Sites within the Grassland Biome mentioned in the text.	13
Figure 2.3 A typical geophyte from the Grassland Biome	15
Figure 3.1 Figure 19 reproduced from Mazel 1992.....	52
Figure 3.2 Percentage of grindstones within total lithic assemblage at all sites within the Grassland Biome over the last 26,000 years.....	56
Figure 3.3 Percentage of grindstones within total lithic assemblage at all sites within the Grassland Biome over the last 12,000 years.....	58
Figure 3.4 Percentage of grindstones within total lithic assemblage at all sites within the Grassland Biome over the last 5,000 years.....	59
Figure 3.5 Grindstones as a percentage of total lithic assemblage at the six sites in the Thukela Basin compared by Mazel (1989).	61
Figure 3.6 Grindstones as a percentage of total lithic assemblage compared for all sites within the Thukela Basin.	61
Figure 3.7 Grindstones as a percentage of total lithic assemblage compared for sites within the Free State and western Lesotho.....	62
Figure 3.8 Grindstones as a percentage of total lithic assemblage compared for sites within the Eastern Cape and eastern Lesotho.....	63
Figure 4.1 Ha Makotoko pre-inundation, September 2012 (above); following partial inundation, April 2014 (below)	68
Figure 4.2 Site plan showing the areas of the 1989 and 2010 excavations, from Mitchell and Arthur 2014	70
Figure 4.3 South-facing section from the 2010 excavations at Ha Makotoko.....	71
Figure 4.4 Harris Matrix indicating stratigraphic location of grindstones.....	76

Figure 5.1 L177 (top) is an example of an upper grindstone class 1; L125 (bottom) is an example of an upper grindstone class 2	92
Figure 5.2 L140 is an example of an upper grindstone class 3/hammerstone.....	92
Figure 5.3 L173 is an example of a lower grindstone class 1	93
Figure 5.4 L115 (top) is an example of a lower grindstone class 2; L116 (bottom) is an example of a lower grindstone class 3	94
Figure 6.1 <i>Secale strictum</i> ssp. <i>africanum</i> , displaying the characteristic dual morphology of the Triticeae	111
Figure 6.2 Grindstones L101 and L108 with surfaces labelled.	166
Figure 6.3 Grindstone L109 with surfaces labelled.	167
Figure 6.4 Grindstones L110 and L116 with surfaces labelled.	168
Figure 6.5 Grindstones L139 and L140 with surfaces labelled.	169
Figure 6.6 Grindstone L145 with surfaces labelled.	170
Figure 6.7 Grindstones L147 and T1 with surfaces labelled. Red circles denote the location of spot samples. Scale bar measures 5cm.....	171
Figure 6.8 Grindstone L152 with surfaces labelled.	172
Figure 6.9 Grindstone L173 with surfaces labelled. Red circles denote the location of spot samples. Scale bar measures 5cm.....	173
Figure 6.10 Grindstones L173 (continued) and L181 with surfaces labelled.....	174
Figure 6.11 Grindstone L189 with surfaces labelled.	175
Figure 6.12 Grindstone L193 with surfaces labelled.	176
Figure 6.13 Sample recording form for archaeological starch.....	178
Figure 6.14 <i>Boehmeria</i> sp. (Urticaceae) cystolith courtesy of Gerald Carr (left); possible cystolith from grindstone L116 at Ha Makotoko (right).....	179
Figure 6.15 cf. Triticeae starch (contamination?) from L108	196
Figure 6.16 <u>Khoara</u> from L109.....	197

Figure 6.17 (From top to bottom) <i>Watsonia</i> sp (note mechanical damage to top left side of granule); <i>Hordeum</i> sp. granule from L109, possibly damaged.	198
Figure 6.18 (From top to bottom) <i>Watsonia</i> sp. starch from L116; Possible cystolith from L116	199
Figure 6.19 (From top to bottom) cf. Triticeae; <i>Zantedeschia</i> sp.; possible <i>Secale</i> sp. starch from L139	200
Figure 6.20 <u>Lematla</u> granule from L140	201
Figure 6.21 From top to bottom) <i>Themeda triandra</i> ; <i>Zantedeschia</i> sp.; <i>Albuca</i> sp. from L140	202
Figure 6.22 <i>Watsonia</i> sp. from L140.....	203
Figure 6.23 (From top to bottom) <i>Tulbaghia</i> sp.; <i>Themeda triandra</i> and <u>Khoara</u> from L147	204
Figure 6.24 (From top to bottom) <u>Machacha metsa</u> , <u>Poho tšela</u> ; <i>Watsonia</i> sp., from L147	205
Figure 6.25 <u>Morokolo poli</u> , from L147.....	206
Figure 6.26 <u>Rethe la ntja</u> from L152	206
Figure 6.27 (top to bottom): cf. Triticeae; NRC P2; and unidentified damaged starch from L152	207
Figure 6.28 <i>Crinum</i> sp from L173	208
Figure 6.29 (From top to bottom) <i>Themeda triandra</i> ; <i>Watsonia</i> sp.; <u>Hloenya/Lematla</u> (indistinguishable here) from L173.....	209
Figure 6.30 (From top to bottom) NRC O3; NRC O3A, NRC R2 from L173.....	210
Figure 6.31 (From top to bottom) NRC O2; a cluster of gelatinised granules from L173. IKI stain is visible in the unpolarised photo.....	211
Figure 6.32 cf. Triticeae cluster from L189	212
Figure 6.33 (From top to bottom) <i>Tulbaghia</i> sp ; <i>Themeda triandra</i> ; <u>Rethe la ntja</u> from L189	213

Figure 6.34 <i>Watsonia</i> sp (top); <u>Morokolo Poli</u> (bottom) from L189	214
Figure 6.35 <i>Zea</i> sp. or <i>Sorghum</i> sp. cluster; <i>Vigna</i> sp from L193	215
Figure 6.36 (From top to bottom): <i>Gunnera</i> sp.; cf. Triticeae; <u>Mofoka tiali</u> from L193..	216
Figure 6.37 From top to bottom: <u>Poho tšela</u> ; NRC 01, NRC P1 from L193,	217
Figure 6.38 NRC R1 from L193	218
Figure 7.1 Illustrations of grindstones L101 and L108.....	237
Figure 7.2 Illustrations of grindstones L122 and L181.....	238
Figure 7.3 Illustration of grindstone L173.....	239
Figure 7.4 Surface 'F' of L173.....	240
Figure 7.5 Illustration of grindstone L193 with surfaces labelled.....	241
Figure 7.6 Type 0201	244
Figure 7.7 Type 0203	245
Figure 7.8 Type 0205	246
Figure 7.9 Type 0206	247
Figure 7.10 Type 0207.....	247
Figure 7.11 Type 0208.....	248
Figure 7.12 Type 0209.....	249
Figure 7.13 Type 1902.....	250
Figure 7.14 Type 0703.....	250
Figure 7.15 Type 0704.....	251
Figure 7.16 Type 0705.....	252
Figure 7.17 Type 0801.....	252
Figure 7.18 Type 0802.....	253
Figure 7.19 Type 1601.....	254
Figure 7.20 Type 1801.....	254
Figure 7.21 Type 1802.....	255
Figure 7.22 Type 1901.....	255

Figure 7.23 Type 1906.....	256
Figure 7.24 Type 1907.....	257
Figure 7.25 Type 2001.....	257
Figure 7.26 Type 2002.....	258
Figure 7.27 Type 2003.....	259
Figure 7.28 Type 2201.....	260
Figure 7.29 Type 2202.....	260
Figure 7.30 Differential production of phytolith morphotypes by different plant parts. Illustration by Alice Williams.....	261
Figure 7.31 Morphotypes represented in sediment samples from contexts 052 (top) and 002 Hearth (bottom).	265
Figure 7.32 Morphotypes represented in sediment samples from context 002.....	266
Figure 7.33 Morphotypes represented on L101 US1 (top); WBA (middle); WBB (bottom).....	268
Figure 7.34 Phytolith morphotypes represented on L101 C.	269
Figure 7.35 Phytolith morphotypes represented in L108 US1 (top); WBA (middle); WBB (bottom).....	271
Figure 7.36 Phytolith morphotypes represented in L122 US1 (top); WBA (bottom)...	273
Figure 7.37 Phytolith morphotypes represented in L122 WBB (top) and WBC (bottom).	274
Figure 7.38 Phytolith morphotypes represented in L173 WBA (top); WBB (middle); WBC (bottom).....	276
Figure 7.39 Phytolith morphotypes represented in L173 WBD (top); WBE (middle); WBF (bottom).....	277
Figure 7.40 Phytolith morphotypes represented in L181 WBA (top); WBB (bottom).	279
Figure 7.41 Phytolith morphotypes represented in L193 US1 (top); WBA (middle); and WBB (bottom).....	281

Figure 7.42 Phytolith morphotypes represented in L193 WBC (top); WBD (middle); and WBE (bottom).....	282
Figure 7.43 Phytolith morphotypes represented in L193 WBF (top) and WBG (bottom)	283
Figure 8.1 <i>Chaîne opératoire</i> of Basotho grindstone use	321
Figure 8.2 <i>Chaîne opératoire</i> of grindstone use at Ha Makotoko	325
Figure A.1.1 The panel that Mapote executed for Marion How	335
Figure B.2.1 L106, 5cm scale.....	342
Figure B.2.2 L146 with red pigment visible on surface, 5cm scale	342
Figure B.2.3 L157, 5cm scale.....	343
Figure B.2.4 L173, red pigment visible towards left side, 5cm scale	346
Figure B.2.5 L185 with white pigment visible, 5cm scale	347
Figure B.2.6 L194 with pigment visible on upper surface, 5cm scale.....	347
Figure B.2.7 SEM photo of L106 pigment.....	348
Figure B.2.8 EDX spectrum, L106 spectrum 1.....	349
Figure B.2.9 L106 EDX spectrum, spectrum 2.....	349
Figure B.2.10 L146.1 SEM photo showing location of spectrum 1.....	350
Figure B.2.11 L146.1 EDX spectrum.....	351
Figure B.2.12 L146.2 SEM photo showing location of spectrum 2.....	352
Figure B.2.13 L146.2 EDX Spectrum 2.....	352
Figure B.2.14 L146.2 EDX Spectrum 3.....	353
Figure B.2.15 L146.2 EDX spectrum 7	353
Figure B.2.16 L157.1 SEM photo showing location of spectrum 2.....	354
Figure B.2.17 L157.1 EDX spectrum 2	355
Figure B.2.18 L157.2 SEM photo showing location of spectrum 1.....	355
Figure B.2.19 L157.2 EDX Spectrum 1.....	356

Figure B.2.20 L173.1 SEM photo showing location of spectrum 1, white boxes indicate bodies characteristic of haematite.....	357
Figure B.2.21 L173.1 EDX spectrum 1	357
Figure B.2.22 L173.1 EDX spectrum 4.....	358
Figure B.2.23 L173.3 SEM photo showing location of spectrum 1 with location of spectrum 4 indicated by smaller white box.....	359
Figure B.2.24 L173.3 EDX spectrum 1	359
Figure B.2.25 L173.3 EDX spectrum 4.....	360
Figure B.2.26 L185 SEM photo showing location of spectrum 2	361
Figure B.2.27 L185 EDX spectrum 2	361
Figure B.2.28 L194.1 SEM photo showing location of spectrum 4.....	362
Figure B.2.29 L194.1 EDX spectrum 4.....	363
Figure B.2.30 L194.2 SEM photo showing location of spectrum 4. Haematite flakes are indicated by the white boxes	364
Figure B.2.31 L194.2 EDX Spectrum 4.....	364
Figure B.2.32 L194.2 EDX spectrum 5.....	365
Figure B.2.33 L194.3 SEM photo showing location of spectrum 1.....	366
Figure B.2.34 L194.3 EDX spectrum 1	366
Figure B.2.35 Composite Raman spectra for L146.1	368
Figure B.2.36 Composite Raman spectra for L157.....	368
Figure B.2.37 Composite Raman spectra for L173 sample 1	369
Figure B.2.38 Composite Raman spectra for L194.1	369
Figure B.2.39 SEM photo of rock art red pigment from Nic Eoin and Bonneau 2014	370
Figure B.2.40 EDX spectra of rock art red pigment from Nic Eoin and Bonneau 2014..	371
Figure B.2.41 Raman spectrum from red pigment sample at ARAL 175 from Nic Eoin and Bonneau 2014.....	371

Table of tables

Table 2.1 Macrobotanical remains from Grassland Biome sites.....	25
Table 4.1 Ha Makotoko phases with dates and grindstone bearing contexts	73
Table 4.2 Grindstones tabulated for 1989 excavations.....	79
Table 4.3 Grindstone counts for the 2010 excavations.....	80
Table 4.4 Grindstone counts from the 2010 excavations, un-phased MSA assemblages in Trench 61.....	80
Table 5.1 Morphometric data for Lower Grindstones class 1 at Ha Makotoko	95
Table 5.2 Morphometric data for Lower Grindstones class 2 at Ha Makotoko	96
Table 5.3 Morphometric data for Lower Grindstones class 3 at Ha Makotoko	96
Table 5.4 Morphometric data for Upper Grindstones class 1 at Ha Makotoko.....	97
Table 5.5 Morphometric data for Upper Grindstones class 2 at Ha Makotoko.....	97
Table 5.6 Morphometric data for type Upper Grindstone 3 at Ha Makotoko.....	98
Table 5.7 Grindstone types by phase at Ha Makotoko	99
Table 5.8 Grindstone types in contexts without phases at Ha Makotoko	99
Table 5.9 Raw materials used in grindstone manufacture by grindstone type at Ha Makotoko	102
Table 5.10 Raw materials used in grindstone manufacture by phase at Ha Makotoko.	103
Table 5.11 Raw materials used in manufacture of pigment-stained <i>versus</i> . non pigment- stained grindstones.....	104
Table 6.1 Table of plants analysed for the starch reference collection.....	121
Table 6.2 Morphometric characteristics of the starch reference collection	149
Table 6.3 Phase, date, and contextual information for sediments and grindstones sampled for starch	180
Table 6.4 Starch characterised on L101, L108, 109, L110, and L116.....	182
Table 6.5 Starch characterised on L139, L140, L145, L147, and L152,	186

Table 6.6 Starch characterised on L173, L181, L189.....	190
Table 6.7 Starch characterised on T1 and L193.....	194
Table 6.8 Starch analysed from sediments at Ha Makotoko in order of age.....	219
Table 7.1 Type 0201	245
Table 7.2 Type 0203	245
Table 7.3 Type 0205	246
Table 7.4 Type 0206	247
Table 7.5 Type 0207	248
Table 7.6 Type 0208	248
Table 7.7 Type 0209	249
Table 7.8 Type 1902	250
Table 7.9 Type 0703	251
Table 7.10 Type 0704	251
Table 7.11 Type 0705	252
Table 7.12 Type 0801	253
Table 7.13 Type 0802	253
Table 7.14 Type 1601	254
Table 7.15 Type 1801	254
Table 7.16 Type 1802	255
Table 7.17 Type 1901	256
Table 7.18 Type 1906	256
Table 7.19 Type 1907	257
Table 7.20 Type 2001	258
Table 7.21 Type 2002	259
Table 7.22 Type 2003	259
Table 7.23 Type 2201	260
Table 7.24 Type 2202	261

Table 7.25 Phytolith counts and percentages for plant parts in context (052)	264
Table 7.26 Phytolith counts and percentages for plant parts in context (002)	264
Table 7.27 Phytolith counts and percentages for plant parts in context (002 Hearth) ..	264
Table 7.28 Phytolith counts and percentages for plant parts in L101	266
Table 7.29 Phytolith counts and percentages for plant parts in context (052)	266
Table 7.30 Phytolith counts and percentages for plant parts, L108.....	269
Table 7.31 Phytolith counts and percentages for plant parts in sediment sample from 052, repeated	269
Table 7.32 Phytolith counts and percentages for plant parts on L122	272
Table 7.33 Phytolith counts and percentages for plant parts on L173	275
Table 7.34 Phytolith counts and percentages for plant parts on L181	278
Table 7.35 Phytolith counts and percentages for plant parts in context (002) repeated	278
Table 7.36 Phytolith counts and percentages for plant parts on L193	280
Table 8.1 Table synthesising data from Ha Makotoko grindstones.....	291
Table 8.2 Summarised botanical information for grindstones from Ha Makotoko.	295
Table 8.3 Summarised botanical information for sediments from Ha Makotoko.	296
Table 8.4 Residue analysis methods used for Ha Makotoko grindstones.	307

Introduction: Essential domestic objects, or awkward unknowns?

"Africa provides a ready crop of fanciful interpretations...they cannot fail to appeal to the more imaginative and, perhaps, the more romantic side of our natures. For example, the grindstones found on coastal sites were interpreted by one South African investigator as 'gravy dishes for epicureans among the natives'" (Clark 1970: 20)

1.1 Overview: making the case for grindstones in southern Africa

In southern Africa, grindstones on hunter-gatherer sites tend to be considered worthy of note (especially where they have visible coloured residues adhering) but not worthy of analysis, except in rare, isolated cases. It might even be said that their interpretation has not moved particularly far beyond seeing them as gravy dishes. They are, however, ubiquitous. In the 40 or so sites examined in detail for this thesis, well over 1000 grindstones have been recovered, giving an average of about 35 grindstones per site. 35 artefacts which are put to one side, rather than being analysed, 35 artefacts whose potential to reveal the past is dismissed, or distorted by using them as ill-suited proxies for other behaviours.

If grindstones are poorly understood in southern Africa, as this thesis discusses they have received more attention elsewhere: Chapter 3 of this work explores how ideas from other international contexts – usually agropastoralist societies, but in the case of Australia, hunter-gatherer societies – have become influential in southern Africa, but have not been tested *in situ*. Taking these ideas further than face value is important, as grindstones have been shown in these societies to be “the essential domestic object” (Biskowski *et al* 1999: 1), accompanied by a whole suite of skills, gestures and actions, yet these may differ cross-culturally.

At the same time as shaky implementation in southern Africa of thoughts from elsewhere on the subject of grindstones, ideas and assumptions from sometimes frail

ethnohistorical sources have resulted in autochthonous interpretations of grindstones. These have also been minimally (if at all) tested.

A focus on grindstones used by hunter-gatherers in southern Africa, as well as occasional comparison with other places and other people, helps to narrow down an unwieldy suite of definitions into something more manageable, and begins to unlock the neglected potential of grindstones, whose very ubiquity, I argue, makes them worthy of study.

1.2 A return to things: a good theoretical basis for studying grindstones?

Various approaches within anthropology, archaeology and other social sciences have, in recent years, encouraged a new focus on 'things', emphasising one etymological root of the Old German *ding* as a gathering or assemblage (OED Third Edition 2008) to evoke connotations of the relations and networks that might bring the 'thing' into being. These approaches suggest that a focus on things (as distinct from human relationships with them) has, ironically, been missing from the disciplines that purport to focus on them: Archaeology, Material Culture studies, Science and Technology studies. They suggest that a thing-ology is perhaps what archaeology can best contribute to wider theory debates.

Many of the ideas expressed within what, for this thesis, might best be known as Symmetrical Archaeology (Olsen 2007; 2010; Shanks 2007; Witmore 2007; 2014; 2015; Webmoor & Witmore 2008; Olsen *et al.* 2012) but which are known elsewhere as the Ontological Turn (Carrithers *et al.* 2010; Alberti *et al.* 2011), Symmetrical Anthropology (Latour 2007) or the New Materialities (Bennett 2010), are well-observed and prescient, reminding us that ontological separations of past:present, human:thing (or human:animal/human:plant) and, of course, nature:culture are neither universal nor always necessary. They also suggest that human-centric approaches to relationships

between humans and other entities (or, collapsing the ontology fully, simply the relationships between all entities) are not necessarily the best way of understanding the relationships themselves (see also van der Veen 2014).

However, there are ethical problems with certain elements of the movement (Bennett 2010). Not least of these is that equating humans with other entities (things, places, animals, plants) may achieve advances in treatment of the other entities (discussion of 'human' rights for non-human primates, for instance) but potentially infringe upon human rights themselves. For example, the symmetrical conception of landscape as equally constituted by many actors (Olsen 2007) is at odds with 'traditional' anthropological/archaeological concepts of landscape (Sauer 1925; Bender 1993; 2001; Tilley 1994; Hirsch & O'Hanlon 1995; Ucko & Layton 1999) as human-oriented and constructed, which may empower local inhabitants (Nic Eoin & King 2013; King & Nic Eoin 2014).

I suggest, following the stated intention of the Symmetrical Archaeologists that they see their movement as a corrective, rather than as a revolution, that maybe more profitable is what they disdain as "philosophical polytheism ...[associated with]...a slide into eclecticism" (Witmore 2007: 548). Symmetrical Archaeology can best be seen as correcting the tendency of material culture studies (Buchli 2002; Tilley 2006; D. Miller 2010) to focus solely on human-imparted meaning on things, at the expense of considering things and materials themselves: non-human, non-intentional agency (*contra* Gell 1998); a (re)focus on material properties or raw materials (Kuhn 1995; 2004; Ingold 2007; Tilley 2007; Sternke *et al.* 2009). That the Symmetrical Archaeologists effectively achieve this correction via incorporation of Actor-Network approaches (Latour 1996) is evident from references within Webmoor & Witmore (2008: 7). Thus, a focus on the relationships between what they term multiple, equal

‘actants’, or what I prefer to keep terming humans, things, animals and plants, emerges as key, where no actant is privileged and affect is achieved by the network/relationship (brought about by the properties, affordances and characteristics of each actant working in tandem with those of others) rather than any actant alone. As a result, the processing of gathered materials and all associated symbolism, function, and achievements emerges as a result of engagement between human, action, raw material properties, plant properties, desires, aims, etc. This thesis recognises that i) things are important, not just because of their human-granted agency, but because of their fundamental characteristics, but also that ii) it is their relationship with humans that is paramount: indeed, the recognition of “vibrant matter” (Bennett 2010) by humans in the past, the ways they worked together to create worlds which may no longer exist, is, *contra* Witmore and colleagues, precisely what makes archaeology interesting and uniquely placed to contribute to the world.

But if I disagree fundamentally with many statements of the Symmetrists, why do I cite them? Is it a form of theoretical list-ticking to show that the graduate student is fully aware of current thought in her discipline? Truthfully, probably at least partially. But more so it is because the Symmetrists remind us that we must focus on things, objects, artefacts, tools, and technologies, for their own intrinsic interest. Given that this thesis focuses on what I have termed neglected objects, a focus on the intrinsic properties, allowances, and affordances of grindstones helps to correct this neglect. And this is where I leave the Symmetrists, preferring to focus then on the relationship between grindstones and humans in order to ask what is achieved through this relationship, and why I regard it as a key element of the southern African Middle and Later Stone Ages. I argue, moving back towards the frameworks of gender archaeologists of the 1980s and early 1990s, that a focus on neglected objects permits a focus on neglected sectors of society. Because technology *is* society made durable (Latour 1991; Dobres 2000), and a

practice framework whereby objects are read as mnemonics for the people who made, used and imparted meaning upon them (Spector 1983; Conkey 1991; A. Jones 2007) is, I argue, the most valuable approach archaeologists can adopt to material culture, whether it exists in the past or the present.

This thesis is a manifesto, then, for neglected material culture, an evaluation of why it is important, why we cannot afford to ignore it, and how we can rehabilitate such an ignored category via functional analysis. It also focuses on a historically neglected (in comparison with the ‘hunter’ part of its binomial) activity – gathering – and how the object and the activity interlink and inter-inform. Light is shed on grindstones, gatherers, gathered materials and the relations between them by taking a technological approach¹ (Dobres 2000) that focuses on what technology *does* (Pfaffenberger 1988) through functional analyses of it, which, in turn, reflect the actions, gestures and skilled artisanship of its original makers and users (Mauss 1973; Leroi-Gourhan 1993). These become discernable by understanding what the grindstones were used for (i.e. what they *did*) and considering the human role in these activities. At this point, I largely leave overt discussion of social theory until Chapter 8, and move on to discuss the structure of this thesis as a whole.

1.3 Structure of the thesis

Chapter 2 of this thesis explore the southern African archaeological record of gathered materials (plants, although see Appendices A and B for consideration of another gathered material, mineral pigments): a category fundamentally under-studied, setting it apart from that which is hunted, reclaiming a hitherto negative category (negative in

¹ Note, however, that Dobres, writing in 2000, was able to observe that materials research was largely at the science/technical end of archaeology, while more interpretive analyses were suspected as being “little better than armchair speculation” (2000:63). This is where the Symmetrical/Materialities corrective can best be of use, in incorporating materials analysis as an important aspect of interpretive archaeology and allowing it to emerge as fruitful ground for theorisation (see e.g. Ingold 2007 and responses).

the sense that it has tended to exist only in opposition to hunted materials). The nature of these resources necessitates a (re)evaluation of hunter-gatherer plant use, from archaeological, historical and ethnographic sources. It also requires, to a certain degree, a consideration of indigenous species and later domesticated imports, and a consideration of forager-farmer contacts that might have facilitated use of the latter. To paraphrase Hilary Deacon (1976), this thesis is about *how* and *what* hunters gathered, as opposed to *where*. This chapter defines and explores this category, asking how plants might have come into contact with grindstones, and what archaeological signatures we might expect to encounter as a result, providing hypotheses for testing via functional analysis later in the thesis.

Chapter 3 surveys what grindstones have been said (by archaeologists) to be and do, reviewing what we know about those found within the Grassland Biome of southern Africa. This knowledge, and the gaps in this knowledge even more, helps to pinpoint ideas for ways to research grindstones more fruitfully, and why this is useful at all.

Chapters 2 and 3 conclude the exploration into the current state of knowledge and the gaps therein within the wider Grassland Biome, while also showing why grindstones might be important, and giving some ideas for what they might have done. Chapter 4 then narrows the thesis' focus from southern Africa and the Grassland Biome to one site in western Lesotho, exploring a corpus of recently excavated "grindstones, hammerstones and introduced rocks" from the site of Ha Makotoko, presenting contextual and site information for the study that follows.

Chapters 5-7 then take the knowledge explored in, and questions provoked by, Chapters 2 and 3, and applies it to the development of a methodological tool kit for approaching grindstones in order to find out what they did. Chapter 5 presents a typology for grindstones at the Ha Makotoko, based on macroscopically visible characteristics of the

grindstone corpus (morphometrics, raw material, macroscopically visible residues and wear). This typology then informs the subsequent chapters on residue analysis while the feedback loop is closed in the concluding discussion of the thesis and information from residue analysis is cross-referenced with the typological discussion. Chapter 6 discusses starch analysis carried out on 15 objects from the site and six sediment samples, testing hypotheses on plant grinding in southern Africa as reviewed in Chapter 2. Chapter 7, the final microbotanical analysis chapter, presents results of phytolith analysis on six objects from Ha Makotoko, offering a companion project to the starch programme, and allowing a fuller evaluation of the archaeology of plant grinding than is permitted by one microbotanical approach alone.

Chapter 8 ties together the different strands of analyses to examine what grindstones did at Ha Makotoko, and how this should inform wider site interpretations. Predictions from the literature review of the wider Grassland Biome as to what grindstones were used for are assessed in light of the functional analysis from Ha Makotoko, and I pose questions as to how these results (which throw a focus on the gathered, as opposed to the hunted) may alter our interpretation of hunter-gatherer lifeways overall.

1.4 Overarching aims

Throughout, emphasis is made of the fact that ignoring a sizeable material culture component of hunter-gatherer lifeways results in ignoring the people who made and used this material culture. Instead, I aim to show that we cannot afford to neglect these objects, because they reveal aspects of hunter-gatherer subsistence not accessible through other means. Indeed, our understanding of the role of the 'gatherer', despite explicit consideration by Hilary Deacon (1976; 1993) and others, has still to catch up with that of the 'hunter', which, as the ongoing 'hunters-with-sheep' debate (Sadr 2003; Smith 2005; McGranaghan 2015) illustrates, is becoming ever more nuanced. I suggest

that by studying the key piece of material culture for the gatherer, we can begin to explore ideas of what constitutes this identity role.

Rather than just revealing the gap in the current state of knowledge, my objective is to create and test a methodological tool kit to rehabilitate grindstone analysis into a fruitful area of study for southern African archaeology: this has been done for other regions globally, so there is little to suggest it cannot be achieved here. It must, however, be tested *in-situ*, as results and predictions from other regional contexts cannot be imported wholesale: the lack of work to date on both starch and artefactual phytolith analysis in Lesotho, and the relative lack within the Grassland Biome and southern Africa more generally, necessitates the proof of concept on a pilot project from Ha Makotoko. Supplemented by a botanical reference collection, this toolkit is then used to test assumptions about grindstone use derived from the literature in order to say what grindstones did at Ha Makotoko, before suggesting how it might be expanded beyond the site, and what assumptions as to the nature of hunter-gatherer lifeways this might cause us to question.

1.5 Specific objectives

Literature on gathered materials in the Grassland Biome of southern Africa is reviewed in Chapter 2 in attempt to achieve an accurate grasp of the current state of knowledge of gathered materials (both specifically and as a particular class) in the region. This literature presumes that grindstones had specific uses in southern Africa: that they were used to process geophytes (underground storage organs) but were not used to process grass seeds, and that grass seeds did not form a dietary staple for hunter-gatherers in southern Africa. Microbotanical analyses of starches and phytoliths on grindstones (in Chapters 6 and 7 respectively) directly evaluate this question, and are discussed in attempt at delivering a more nuanced interpretation of the roles different plants played in hunter-gatherer lifeways. For the starch analysis, an essential supplementary aim is

the compilation of a reference collection of plant starches (including microphotography, morphometrics and information on uses of the plant) from known economically useful plants both in the immediate vicinity of Ha Makotoko and within the wider Grassland Biome. This reference collection is presented in chapter 6.

A second literature review of grindstones within the Grassland Biome is carried out in Chapter 3 with the aim of visualising how grindstones are currently understood in the region. Published grindstones from 39 sites in the region are then examined in order to see what can be said about such objects given current levels of analysis: my view is that such analysis does not deliver much in the way of understanding, and that a typology specifically directed at grindstones is necessary for inter-site comparison. Chapter 5 then attempts to deliver this for the corpus at Ha Makotoko, and shows how it enables intra-site comparison and might be profitably mobilised for use in the wider Biome.

Finally, Chapter 8 feeds information from the different methods explored in this thesis into an interpretation of what grindstones mean at Ha Makotoko; how the methodology discussed here might be improved and expanded for application to wider regional contexts; and most importantly, how exploration of gathered materials and grindstones shed light on the enigmatic character of 'the gatherer'.

Chapter 2. What Hunters Gathered: Plants

“Eat food. Not too much. Mostly plants” (Pollan 2008:1)

2.1 Overview

It seems that worldwide, hunter-gatherers do an excellent job of following Pollan’s now-famous maxim. Although our knowledge of the plants consumed by hunter-gatherers of the Middle and Later Stone Ages is still considerably sparser than our knowledge of the faunal contribution to their diet, a certain degree of uniformity with historic/contemporary hunter-gatherers is assumed. Of course, it should be acknowledged that unlike post-agrarian/industrial consumers today, hunter-gatherers past and present may have less choice in following the maxim: the quantity and type of food consumed is more likely to do with resource availability, and the exercising of preference would have been a luxury rather than a *de facto* right. The archaeological absence (both in terms of evidence and indeed interest within the literature) of gathered materials may be seen as a feminist issue: since the response (Dahlberg 1983; Brumbach & Jarvenpa 2006) to *Man the Hunter* (Lee & DeVore 1968), a focus on archaeobotany has been seen as a way of adding identity to what Tringham (1991: 94) has referred to as “faceless blobs”. While Spector’s task differentiation framework (1983) may be problematised, as it too unquestioningly connects ethnographically known “women’s work” with archaeological material culture, a simpler connection can be made: marginalisation of classes of objects (e.g. grindstones, plant materials) simply because they are poorly understood necessarily entails marginalisation of the people who worked with these material cultures, be they male, female or non-specific. It follows, then, that an improved understanding of these material cultures can lead to an improved understanding of the people who used and made them.

Taking one traditionally marginalised area, this chapter surveys gathered plants and arguments as to their use within southern Africa, focusing particularly on sites within southern Africa's Grassland Biome. Experimental and ethnoarchaeological literature from elsewhere in the world is presented as complementary to this. Later in this thesis, the gathered materials discussed form the basis of the microbotanical reference collections (See Chapter 6), while the arguments reviewed in this chapter form the basis of hypotheses to be tested throughout the thesis.

2.2 The Grassland Biome

The Grassland Biome of southern Africa is found on the high central plateau of the sub-continent, covering the entirety of Lesotho, but also areas of the Free State, KwaZulu-Natal and Eastern Cape provinces of South Africa. Although it is mostly flat, it also includes parts of the Maloti-Drakensberg escarpment to the east. With a mean annual rainfall of 400-2000 mm, the vegetation is dominated by grasses, and trees are relatively rare, although plants with underground storage organs abound. This entire region (as shown in Figures 2.1 and 2.2 below) is taken as a discrete area, following Rutherford & Westfall (1994), however areas of the Maloti-Drakensberg over 2800m above sea level are occasionally separated into an Afromontane Biome (Mitchell 2002): as this thesis does not focus specifically on this area but rather includes it in a broader regional survey, it is incorporated into the Grassland Biome for ease of comparison and reference. A focus on this area affords a corpus of some 39 sites with Middle and Later Stone Age occupations: many of these include assemblages with grindstones (see Chapter 3), but in this chapter, only those with published plant remains are discussed.

Figure 2.1 The southern African Grassland Biome: (above) the eastern Highlands of Lesotho near Sehonghong, September 2009; (below) the western Lowlands/Foothills of Lesotho near Ha Makotoko, September 2012

Figure 2.2 Sites within the Grassland Biome mentioned in the text. Abbreviations are as follows: BWE (Bonawe); CHS (Collingham Shelter); CLS (Clarke's Shelter); COL (Colwinton); DI1 (Diamond 1); DR (Driel); GEH (Gehle); GH (Good Hope); GRA (Grassridge); HM (Ha Makotoko); HIG (Highlands); HOL (Hololo crossing); KT (KwaThwalayakhe); LIK (Likoaeng); MAQ (Maqonqo); MMH (Mauermanshoek); MS (Mbabane Shelter); MGE (Mgede); MHL (Mhlwazini); MZ (Mzinyashana) (INK) iNkholimahashi; NKP (Nkupe); NT (Ntloana Tsoana); OS (Orange Springs); PIT (Pitsaneng); RAV (Ravensraig); RKS (Rooikrans); RFT (Roosfontein); RCC (Rose Cottage Cave); SEH (Sehonghong); SIH (eSinhlonhlweni); SIK (Sikhanyisweni); STA (Strathalan A); STB (Strathalan B); TAN (Tandjesberg); TV (Te Vrede); TIE (Tienfontein 2,4A&7); TL (Tloutle); TWY (Twyfelpoort); WES (Westbury).

2.3 Much ado about geophytes

"In some real sense geophytes make the Middle and Later Stone Age record in southern Africa" (H.J. Deacon 1993)

In 1993 Hilary Deacon made a case for geophytes (plants with underground storage organs, generally rich in carbohydrates) having been the major component of subsistence over the last 100,000 years outside of the savannas. 'Planting an idea' can be seen as a summarising an interest which began with his earlier work at in the Eastern Cape Province of South Africa, in which he noted the apparent importance of geophyte depositions in the archaeological record (H.J. Deacon 1976). Earlier still than this work is the excavation at De Hangen by Parkington & Poggenpoel (1971). which reports large quantities of geophytes However, it is difficult to assess the veracity of H.J. Deacon's (1993: 86) claim that

"a survey of the remains of food plants from archaeological contexts in South Africa shows that geophytes, primarily bulbs and corms, were a major food resource"

given that, as he himself acknowledges, evidence from outside of the Fynbos Biome is minimal: Mazel (2004) argues with the geophyte dominance hypothesis for the Thukela Basin in KwaZulu-Natal, based on the macrobotanical remains from Nkupe, where fruits dominate, citing Richard Lee's (1979) observation that geophytes are not importantly ranked among the !Kung. Given that Mazel's work represents arguably the only sustained programme of archaeobotanical analysis in the Grassland Biome, his comment is perhaps warranted². Nevertheless, geophytes have certainly been identified as important components to past human diets based on occurrences at numerous sites across southern Africa (e.g. Leslie Brooker 1980; Carter *et al.* 1988; Manhire 1993; Binneman 1994; 1997; 1998; Opperman 1996).

² However it is worth noting that (unidentified) corms *were* recovered from Nkupe and other sites within the Thukela Basin, and also that the taphonomic factors governing the preservation of soft and hard tissue would presumably privilege the recovery of seeds and kernels over relatively soft geophyte tissues.

Figure 2.3 A typical geophyte from the Grassland Biome, *Gladiolus dalenii* is native to the Maloti-Drakensberg and a known economically useful plant in Lesotho (see Chapter 6)

Additionally, numerous historical accounts attest to their importance. The seventeenth to nineteenth century travellers de Sampaio, Niehof, Thunberg, Burchell, Cumming, Backhouse (listed in order of date, all in Skead 2009) list multiple geophytes consumed for both edible and medicinal purposes by the indigenous inhabitants of southern Africa, including *Babiana* sp., *Cyperus* sp., *Gladiolus* sp. (Figure 2.3), *Moraea* sp., and various Alliaceae among others. The same travellers also tasted these geophytes, as indicated by passages from their diaries: Niehof, for example, noted that the taste of *Moraea fugax* was like “earth-nuts, or chestnuts, although others taste like aniseed and sweetish” (Niehof 1654, reproduced in Skead 2009:5). Thunberg comments that the same bulb tasted akin to potatoes (Thunberg 1772, reproduced in Skead 2009: 33), while Burchell

found that *Allium dregeanum* were “as good tasted as garden onions” (Burchell 1811, reproduced in Skead 2009: 93).

As H.J. Deacon (1993) notes, the consumption of geophytes makes sense: as carbohydrate-rich, relatively high-calorie (and evidently often tasty) consumables, they would presumably feature as welcome additions to any hunter-gatherer’s diet (Stahl 1984).

H.J. Deacon (1976) comments not only on the importance of geophytes, but of a particular family, the Iridaceae, and specifically of the genus *Watsonia*, which he refers to as a staple at Melkhoutboom. The importance of the Iridaceae appears to be upheld by an examination of archaeobotanical remains from sites within the Grassland Biome (see Table 2.1): seven sites out of 21 with identified macrobotanical remains revealed evidence for Iridaceae geophytes, four of which included *Watsonia* spp., (compared with one site each for members of the Amaryllidaceae and Hyacinthaceae families).

2.3.1 Acquisition of geophytes

Rock art (Vinnicombe 2009a: 272) and historical accounts (e.g. Baines 1861, reproduced in Skead 2009: 315) indicate that digging sticks weighted with bored stones were used in extracting geophytes. This is confirmed archaeologically by the association of a preserved stick with geophyte remains at Augussie shelter, Eastern Cape Province (Binneman 1994). Given the generally perishable nature of the wooden digging sticks themselves, bored stones and adzes have frequently been used or discussed as proxies for digging sticks and the extraction of geophytes in the archaeological record (Mazel 1989; Mitchell *et al.* 1994). Adzes as proxies for plant processing have been problematised by several authors: Hobart (2003), for example, notes the likelihood that adzes were also used in manufacturing bone points. While Binneman & H.J. Deacon (1986) found conclusive usewear evidence for woodworking on adzes from Boomplaas, Williamson’s (2004) residue work at Sibudu confirms that MSA adzes were at least occasionally used in processing collagen (and thus, by inference, bone) Thus, the use of

adzes as proxies for any form of plant processing (let alone geophyte extraction, since this requires an extra level of extrapolation) is problematic. Chapter 3 in this thesis plots non-ochred grindstone frequencies against total formal/utilised tool counts (following M.A. Smith 1988; Mazel 1989) from sites within the Grassland Biome, in an effort to determine whether there are any temporal trends in plant processing. However, the initial plan to compare adze frequencies in the same way as Mazel (1989), which might have proven/disproven an association between grindstones and geophytes (since adzes have been used as a proxy for the latter) was rejected as I felt that the frequent conflation of grindstones and “ground stone” (which often includes bored stone, i.e. digging stick weights) would bias the data.

2.3.2 Processing geophytes

The emphasis on geophytes has been taken up by numerous archaeologists (Parkington & Poggenpoel 1971; H.J. Deacon 1976; 1979; 1993; Carter *et al.* 1988; Mitchell 1996; Wadley 2000; Youngblood 2004; H.J. Deacon & Wurz 2005; Youngblood 2008), while others associate geophytes with grindstones (Cable 1984; Mazel 1989; Mitchell 1996; Wadley 2000).

However, one of the benefits to geophyte consumption is that although they may in some instances require cooking, they are most conveniently packaged for this: they come ready-wrapped in skins and thus do not require the addition of an exterior wrapping/vessel to protect the edible interior prior to consumption. For the same reason they can be directly placed in a fire in order to cook the contents, if desirable, although many geophytes are palatable raw (Stahl 1984).

In fact, it is difficult to understand why most geophytes consumed as food³ would be processed at all: while pounding, grinding and grating some geophytes (e.g. manioc) is required in order to expose the cyanogenic compounds in cells to extra-cellular hydrolysing enzymes (Stahl 1989), there are no southern African plants for which this would be necessary.

Moreover, grinding/pounding alone does not detoxify, but rather reduces particle size, such that a greater surface area can subsequently be exposed to a leaching agent, which can then reduce tannin content and promote palatability (Stahl 1989). Reduction of dietary fibre may also be desirable and can certainly be achieved through grinding/pounding, but also by other means: Vincent (1985:137–138) observed Hadza expectorating fibre from tubers post-mastication, which would seem to result in lower wastage and greater efficiency than the transfer from veld to grindstone to mouth. Grindstone processing of southern African geophytes is certainly possible (even plausible), perhaps most so in the case of tannin-rich genera such as *Watsonia*. However, if *Watsonia* sp. was habitually ground in order to be leached of tannins, thought must be given to how the leaching step would have been achieved: in both Mesolithic Europe and the pre-contact Americas tannins were leached from acorns through a number of labour-intensive processes including boiling, soaking (in mud or water, a process hastened by the inclusion of wood ash) (Kubiak-Martens 1999). Bettinger *et al* (1997) note that the labour involved in these processes (and possibly the requirement for ceramic vessels) may have inhibited adoption of acorns as a staple foodstuff until relatively late in time. Evidence for concentrations of *Watsonia* sp. (or other tannin-rich

³ Thornton-Barnett (2013) has suggested that the high incidence of geophytes involved in Basotho traditional medicines and the fact that these plants are mostly ground (which ethnographic fieldwork in the Metolong Dam catchment confirms - Nic Eoin, unpublished field notes) prior to use reveals a link between grindstones and medicinal plant use in Later Stone Age contexts. The pertinent point here is that a link between grindstones and edible geophytic plants is, by contrast, *not* suggested.

geophytes) in pits is lacking in southern Africa, and boiling them must have been difficult prior to the advent of pottery: despite this, *Watsonia* sp. is well represented in southern African pre-ceramic contexts, which may suggest that tannin leaching was not a priority.

A further clue as to why geophytes might be ground for food is provided by Jacot Guillarmod (1971), who notes that the roots of *Pelargonium bowkeri* were (according to Basotho informants) ground by hunter-gatherers into porridge for their infants: although geophytes are conveniently packaged for the majority of society, those with less efficient somatic processing equipment (i.e. jaws and teeth) – the very old, the very young, the infirm – might struggle to consume particularly fibrous ones.

2.3.3 Historical evidence for geophyte grinding

Aside from logical arguments for geophyte processing, an alternative root for the association between grindstones and geophytes comes from discussion of plant remains at De Hangen: while neither Cable (1984), Mazel (1989), Mitchell (1996) nor Wadley (2000), explicitly discuss their associations between grindstones and geophytes⁴, Parkington and Poggenpoel (1971: 21) suggest that a common name for *Watsonia* sp., *hotnotsbrood*, indicates that “the corms were probably also ground and roasted before being eaten” . Before discussing the veracity of this suggestion and its context, I briefly introduce other potential sources for the linkage. It should be noted that early European travellers’ accounts of the sub-continent do not suggest an overwhelming interest in what indigenous peoples were eating. Plants are frequently described, but the primary

⁴ H.J. Deacon (1976: 106-107) never explicitly links geophytes and grindstones, stating instead “There is little direct evidence of the preparation of the edible plants. Rubbers and grindstones occur in the site and presumably some plants were ground as meal...while Baboons eat *Watsonia* raw, their prehistoric human counterparts had the option of more elaborate processing”. He also refers to the use of the powdered corm of *Hypoxis argentea* as a famine food by the Xhosa. This is as far as he goes on the subject, however. Given the importance he places on geophytes, and the relative lack of importance placed on grindstones, inferable from their emission from tabulated assemblages at both Melkhoutboom and Highlands, it might even be argued that he felt there was no evidence for such a link.

interest seems to be in the exotic or beautiful (the genus *Protea* is listed 166 times in Skead's *Historical Incidence of Plants in southern Africa*, or about once every two pages) or what was useful to them specifically: good or bad grazing for their animals, for instance. In that vein then, such travellers' accounts must be regarded as the expression of occasional curiosity rather than a comprehensive account of the plants used by the indigenous peoples they encountered. Nevertheless, Mazel and Parkinson too (1981:24) ground their association between grindstones and geophytes in a historical account:

“they invited our men to eat cake which appeared to made of root flour kneaded with the dung of oxen” (de Sampaio 1630, cited in Raven-Hart 1967:133).

Two isolated accounts of similar practice are listed in Skead's (2009) compendium

i) “A certain little root grows in the earth which the Hottentots roast in winter and use it in place of bread. Some grind these roots to meal.” (Niehof, 1654, reproduced in Skead 2009: 5).

ii) “Here I heard much talk of a hottentot watermelon which is said to be a large and succulent root, called *kou*...by the Hottentots, who grind it down to a meal and bake it like bread” (Thunberg 1774, reproduced in Skead 2009: 35).

These two accounts, along with de Sampaio's, constitute the sum total of references to the grinding of geophytes within Skead's compendium: while the work cannot be called comprehensive, as certain areas (notably Lesotho) are very sparsely covered, and bearing in mind the caveats of traveller's accounts discussed above, it could at least be termed representative. On the other hand there are various references to the grinding or processing of non-geophytes (*Citrullus lanatus*, or *tsamma* melon, seeds, for instance) suggestive of other uses for grindstones.

Nomenclature must be problematised in the use of historical accounts to support the grindstone-geophyte hypothesis: the issue of to whom specifically the accounts refer, and the plants in question. All three historical accounts listed above appear to refer to

pastoralist Khoekhoe groups, rather than hunter-gatherers: both Niehof and Thunberg explicitly refer to “Hottentots”, while Skead confirms that de Sampaio’s account also refers to Khoekhoe pastoralists. Furthermore, Parkington and Poggenpoel’s emphasis on *Watsonia* sp. as *hotnotsbrood* (i.e. “Hottentot’s bread”) suggests that it is used by Khoekhoe pastoralists as such, without reference to other groups. It should also be noted that multiple plants are referred to by this name, not all of which are geophytes: the cycad *Encephelartos* sp., for example, is referred to as the “hottentot bread tree” by Pringle (1821, reproduced in Skead 2009: 81).

While these historical accounts nonetheless confirm that processing of geophytes was considered a sensible business by at least one indigenous group, we should be cautious about extrapolating to other groups, given that we know there to be differences in the use of certain plants among contemporary southern African ethnic groups: for instance, Jacot Guillarmod (1971:440) comments that *Lycoperdon* sp. (among other plants) is eaten stewed by Nguni, but not Basotho. There is also the problem of what, exactly, is meant by a term like *Hotnotsbrood*: does it mean that the geophyte in question was literally made into bread? I suggest that the meaning is subtler – that it took the *place* of bread. As Michael Pollan (2001:203-204) notes in a different context (the potato in nineteenth-century Ireland)

“‘bread root’ was what the English sometimes called the potato, and the symbolic contrast between the two foods loomed large in the debate, never to the potato’s advantage”.

The emphasis here is clear – for the English, a nation of bread-eaters and (historically) potato-doubters, the potato was an inferior bread-substitute, the placeholder for what they saw as the major dietary carbohydrate. It follows, then, that as bread can be seen as the staff of life for most Europeans in the modern period, European travellers to southern Africa observing indigenous peoples consumption of certain geophytes might

have made the observation that this must be their equivalent to bread, but not necessarily that the plant in question was made into bread.

The linkage between grindstones and dietary geophytes, despite the assertions of previous authors, and with the acknowledgement that it may be of occasional nutritional benefit (Stahl 1989), is thus at best equivocal. A key goal of this thesis will be to test this assertion through functional analysis (see Chapter 6). It should be mentioned here that a previous attempt was made to assess the veracity of this relationship through functional residue analysis: a number of the most recent (presumed) hunter-gatherer grindstones from Rose Cottage Cave were tested by Carol Wallace (1996), then a student at the University of the Witwatersrand, Johannesburg⁵. No doubt due to the fact that starch analysis was then in its relative infancy (with many of the factors governing preservation and contamination poorly understood) and, as Wallace herself acknowledged, the paucity of her reference collection, the attempt was largely unsuccessful, although she was able to describe the morphology of the microfossils encountered. The fact that numerous starches were described as “large” led Wadley (2000: 91) to suggest that they might have come from geophytes. This is problematic, given that not all geophytes produce large starch granules (see *Merwillia plumbaea* in Chapter 6, for example). A further clue might be found in my attempt to re-analyse some of Wallace’s own conclusions: she noted the presence of “five-sided angular grains” which were not present in her (entirely geophyte-based) reference collection (Wallace 1996:40) – these could plausibly be *Zea mays* granules, either artefactual (given the age of the grindstones in question) or contaminant. Given that there are no micrographs or measurements provided for these bodies, apart from stating that there is little reason to

⁵ Wadley’s (2000) very brief mention of some of these results, also refers to Bronwynne Williamson’s (2000) residue analysis of (the same? Related?) tools from the same site, and it is occasionally difficult to tell to whom Wadley is referring when discussing the plant microfossils.

believe the large granules to be geophytes, I can do nothing other than speculate. But if not geophytes, then what other plants might be associated with grindstones?

2.4 Grindstones and seed processing

Table 2.1 lists all identified and published macrobotanical remains from sites within the southern African Grassland Biome (mapped in Figure 2.1). However, due to the nature of these remains (from sediment, rather than as microfossils in direct association with grindstones) it is difficult to infer how they were processed. As with geophytes, travellers' accounts give ideas for some species: *Citrullus lanatus* seeds, as previously mentioned, were ground (apparently by Bushmen specifically, rather than by Khoekhoe pastoralists), with William Somerville noting in 1801 that

“The chief food of the Bosjiemen is the gum of the *Mimosa karoo* and meal from the seed of the wild Water Melon” (reproduced in Skead 2009: 259).

However, there is little information on the consumption/processing of most of the plants recovered, other than more recent work (contemporary ethnobotanical accounts of their consumption by agropastoralists, for instance). We can assume that at least some of the plants recovered from sites within the Grassland Biome were also processed on grindstones: while fruit is unlikely to be ground, extractive processing of one kind or another (pounding to remove the hard exocarp of a nut from the internal endosperm) may have rendered many plants edible or more palatable. In fact, by considering what a grindstone *does*, we may be better able to determine the likelihood of it being used to process plant material: a grindstone (or rather, the association between upper and lower grindstone) can be regarded as a type of weapon against otherwise unyielding food. By abrading, pulverising, crushing, pounding, or otherwise reducing, it can extract edible matter, or process matter to make it more palatable. Thus, it makes no sense to think of using a grindstone to process soft fruit, but it does make sense to use it to extract soft(er) fruit from an external shell, as in the case of a nut.

Other matter that might have been extracted from seeds includes oil, and H.J. Deacon (1976) discussed the potential importance (given their considerable presence) of oil-bearing seeds and kernels (*Calodendrum capense*, *Pappea capensis*, and *Podocarpus falcatus*) at Melkhoutboom (Fynbos Biome) and Highlands (Grassland Biome). Macroremains of these plants occur at other sites within the Grassland Biome: *Podocarpus* spp. at seven sites, *Calodendrum* sp. at four, suggesting that they may have been of some importance. Elsewhere in southern Africa, the storage of oil seeds at Boomplaas in *Boophane disticha* leaf-lined pits has been interpreted variously as reflecting the precious nature of the seeds and the need to store them (H.J. Deacon 1976), or as being of possible ritual importance (Pearce 2008). Given the relative lack of storage for most gathered plants in the MSA and LSA (a reason cited by H.J. Deacon (1993) as proof of further utility of geophytes: it is unnecessary to store them since in a sense, they store themselves underground until use) these seeds were obviously a valued resource. But how might the oil have been extracted? East African ethnobotanical accounts discuss seeds boiled within pots to extract oils (Morgan 1981; Grillo 2012), but we are left with little explanation as to how oil might have been extracted in pre-pottery contexts (from which most of the seeds were recovered from the Grassland sites): grinding them is one of the few ways this might have been achieved (although this would presumably have resulted in considerable wastage, given the porosity of the stone). While lipid analysis is beyond the scope of this thesis, see Fullagar *et al.* (2015) for a method suitable for use on grindstones, and which could be applied in southern Africa.

Table 2.1 Macrobotanical remains from Grassland Biome sites. In Table 2.1 below, abbreviations follow those listed in Figure 2.2, although not all sites in Figure 2.1 have (published) macrobotanical remains. For ease of reference they are listed again here: CHS (Collingham Shelter); DR (Driel); HIG (Highlands); MAQ (Maqonqo); MMH (Mauermanshoek); MS (Mbabane Shelter); MGE (Mgede); MHL (Mhlwazini); MZ (Mzinyashana) (INK) iNkholimahashi; NKP (Nkupe); RKS (Rooikrans); RFT (Roosfontein); RCC (Rose Cottage Cave); SEH (Sehonghong); SIH (eSinhlonhlweni); STA (Strathalan A); STB (Strathalan B); TAN (Tandjesberg TIE (Tienfontein 2,4A&7); TWY (Twyfelpoort); WES (Westbury). Plant parts represented in Table 2.1 are abbreviated as follows: C (corm); L (leaves); O (other macro-remain); R (reed); S (seed).

Family	Species	DR	CHS	HIG	MAQ	MMH	MS	MHL	MGE	MZ	INK	NKP	RKS	RFT	SEH	SIH	STA	STB	TAN	TIE	TWY	WBY	Total
Acanthaceae	<i>Blepharis integrifolia</i>							S															1
	<i>Thunbergia</i> sp.											S											1
Achariaceae	<i>Kiggelaria africana</i>		S					S				S											3
Amaryllidaceae	<i>Boophane</i> sp.			L																			1
Anacardiaceae	<i>Ozoroa</i> sp.											S											1
	<i>Rhus</i> sp.		S					S					S		S				S				5
	<i>Sclerocarya</i> sp.															S							1
Apiaceae	<i>Heteromorpha trifoliata</i>													S									1
Apocynaceae	<i>Landolphia</i> sp.								S			S											2
	<i>Rauvolfia caffra</i>											S											1
	<i>Secamone</i> sp.															S							1
Aquifoliaceae	<i>Ilex mitis</i>							S															1
Araceae	<i>Zantedeschia albomaculata</i>		S																				1
Araliaceae	<i>Cussonia paniculata</i>		S					S				S											3
Asparagaceae	<i>Asparagus</i> sp.		S					S															2

Family	Species	DR	CHS	HIG	MAQ	MMH	MS	MHL	MGE	MZ	INK	NKP	RKS	RFT	SEH	SIH	STA	STB	TAN	TIE	TWY	WBY	Total
Asteraceae	<i>Chrysanthemoides molinifera</i>		S																				1
	<i>Helichrysum</i> sp.														S								1
	<i>Osteospermum imbricatum</i>							S															1
	<i>Printzia</i> sp.														S								1
	<i>Senecio</i> sp.														S								1
	<i>Xanthium strumarium</i>	S																					1
Boraginaceae	<i>Cordia</i> sp.															S							1
	<i>Cynoglossum</i> sp.		S					S															2
Burseraceae	<i>Commiphora</i> sp.						S					S											2
Celastraceae	<i>Cassine</i> spp.		S		S		S	S								S							5
Connaraceae	Cf. <i>Cnestis natalensis</i>											S											1
Cucurbitaceae	Cf. Cucurbitaceae											S	S							S			2
	<i>Acanthosycos</i> sp.											S											1
	<i>Citrullus</i> sp.				S		S	S					S			S			S				6
	<i>Cucumis</i> sp.											S											1
	<i>Kedrostis</i> sp.		S				S																2
	<i>Lagenaria</i> sp.	O	S=C				S																3

Family	Species	DR	CHS	HIG	MAQ	MMH	MS	MHL	MGE	MZ	INK	NKP	RKS	RFT	SEH	SIH	STA	STB	TAN	TIE	TWY	WBY	Total
	<i>Momordica</i> spp.				S			S	S	S		S				S							6
	<i>Trochomeria</i> sp.											S											1
Cupressaceae	<i>Widdringtonia</i> sp.							S															1
Cyperaceae	<i>Cyperus usitatus</i>			C											C								2
Ebenaceae	<i>Diospyros austro-africana</i>					S		S				S											3
	<i>Diospyros</i> spp.				S			S		S	S	S			S				S				7
	<i>Euclea</i> sp.		S			S		S	S			S				S							6
Euphorbiaceae	Cf. Euphorbiaceae						S					S											2
	<i>Croton</i> sp.		S				S	S								S							4
	<i>Dalechempia</i> sp.											S											1
	<i>Jatropha</i> sp.		S				S																2
	<i>Ricinus</i> sp.		S		S			S			S												4
Fabaceae	<i>Acacia</i> spp.	O			S		S				S					S							5
	<i>Albizia</i> sp.						S																1
	<i>Astragalus</i> sp.							S															1
	<i>Cassia</i> sp.						S	S				S				S							4
	<i>Ophrestia oblongiflora</i>		S																				1
	<i>Rhyncosia</i> sp.							S				S											2

Family	Species	DR	CHS	HIG	MAQ	MMH	MS	MHL	MGE	MZ	INK	NKP	RKS	RFT	SEH	SIH	STA	STB	TAN	TIE	TWY	WBY	Total
	<i>Vigna unguiculata</i>		S					S					S										3
Flagellariaceae	<i>Flagellaria</i> sp.															S							1
Hyacinthaceae	<i>Scilla natalensis</i>	C																					1
Hypoxidaceae	cf. <i>Hypoxis</i>																					O	1
Icacinaeae	<i>Cassinopsis ilicifolia</i>		S					S															2
Iridaceae	cf. Iridaceae	C																		C			2
	<i>Crocasmia aurea</i>		S																				1
	<i>Freezia corymbosa</i>			C																			1
	cf. <i>Hesperantha</i> sp.														C								1
	<i>Freezia-Tritonia</i>																	C					1
	<i>Gladiolus</i> sp.												S										1
	<i>Hespereanthus</i> sp.														S								1
	<i>Moraea tritea</i>														C								1
	<i>Watsonia</i> sp.												C		c		C	C					4
Juncaceae	<i>Juncus</i> sp.														S								1
Lamiaceae	<i>Clerodendrum</i> sp.											S											1
	<i>Vitex rehmanii</i>		S																				1
Lauraceae	<i>Cryptocarya</i> sp.							S				S											2

Family	Species	DR	CHS	HIG	MAQ	MMH	MS	MHL	MGE	MZ	INK	NKP	RKS	RFT	SEH	SIH	STA	STB	TAN	TIE	TWY	WBY	Total
Malvaceae	<i>Brachychiton</i> sp.								S														1
Malvaceae	<i>Gossypium</i> cf											S											1
	<i>Grewia</i> spp.		S		S	S	S	S	S	S		S	S			S			S	S			12
	<i>Sterculia</i> sp.											S											1
Meliaceae								S															1
Melanthaceae	<i>Melanthus</i> sp.							S				S											2
Menispermaceae	<i>Coccolus</i> sp.											S											1
Moraceae	<i>Ficus</i> sp.							S				S				S							3
Myriaceae	<i>Myrica</i> sp.											S											1
Myrtaceae	<i>Eugenia</i> sp.		S																				1
	<i>Syzygium</i> sp.							S															1
Ochnaceae	<i>Ochna</i> sp.		S				S		S		S	S				S							6
Oleaceae	<i>Olea austro-africana</i>						S	S	S	S	S	S				S							7
Oleaceae	<i>Olea capensis</i>							S	S			S											3
Passifloraceae	<i>Adenia</i> sp.						S					S											2
Penaeaceae	<i>Olinia emarginata</i>							S															1
	<i>Olinia</i> sp.							S															1
Piperaceae	<i>Piper capense</i>							S															1
Pittosporaceae	<i>Pittosporum viridifolium</i>							S															1
Poaceae	<i>Cymbopogon</i>														S								1

Family	Species	DR	CHS	HIG	MAQ	MMH	MS	MHL	MGE	MZ	INK	NKP	RKS	RFT	SEH	SIH	STA	STB	TAN	TIE	TWY	WBY	Total
	sp.																						
	<i>Eragrostis</i> sp.																			L			1
	<i>Ehrharta</i> sp.																			S L			1
	<i>Phragmites australis</i>			O											S							O	3
	<i>Sorghum bicolor</i>							S															1
	<i>Sorghum</i> sp.	O	S				S	S															4
	<i>Themeda triandra</i>														S	S				S			3
	<i>Zea mays</i>							S					S O										2
Podocarpaceae	<i>Podocarpus</i> spp.		S		S		S	S	S	S		S				S							8
Primulaceae	<i>Maesa alnifolia</i>							S															1
	<i>Myrsine africana</i>		S					S				S											3
	<i>Rapanea melanophloes</i>		S					S	S			S											4
Proteaceae	<i>Leucosidia</i> sp.											S											1
	<i>Protea</i> sp.							S							S								2
Rhamnaceae	<i>Berchemia</i> sp.							S															1
	<i>Rhamnus</i> sp.							S															1
	<i>Scutia myrtina</i>							S				S											2
	<i>Zisiphus</i> sp.						S									S							2

Family	Species	DR	CHS	HIG	MAQ	MMH	MS	MHL	MGE	MZ	INK	NKP	RKS	RFT	SEH	SIH	STA	STB	TAN	TIE	TWY	WBY	Total
Rosaceae	<i>Agrimonia adorata</i>		S																				1
	<i>Prunus</i> sp.	S	S		S			S				S	S							S	S		8
Rubiaceae								S															1
	<i>Canthium inerme</i>							S															1
	<i>Canthium</i> sp.							S				S											2
	<i>Fadogia</i> sp											S											1
	<i>Oxyanthus gerrardii</i>		S																				1
	<i>Pachystigma</i> sp.							S	S			S											3
	<i>Pavetta</i> sp.		S					S															2
	<i>Pygmaeothamnus</i> sp.		S					S	S			S											4
	<i>Vangueria</i> sp.		S																				1
Rutaceae	<i>Calodendrum capense</i>		S		S				S	S		S											5
	<i>Teclea</i> sp.						S																1
	<i>Toddaliopsis breidenkampii</i>											S											1
	<i>Vepris</i> sp.						S				S					S							3
	<i>Zanthoxylum</i> sp							S															1
Salicaceae	<i>Salix</i> sp.														S								1
Salvadoraceae	<i>Salvadora</i>											S											1

Family	Species	DR	CHS	HIG	MAQ	MMH	MS	MHL	MGE	MZ	INK	NKP	RKS	RFT	SEH	SIH	STA	STB	TAN	TIE	TWY	WBY	Total
	<i>angustifolia</i>																						
Santalaceae	<i>Colpoon compressum</i>		S									S											2
	<i>Osyridicarpus shimperianus</i>							S															1
	<i>Osyris</i> sp.							S															1
Sapindaceae	<i>Allophylus</i> sp.						S																1
	<i>Pappea capensis</i>		S																				1
Sapotaceae	<i>Bequaertiodendron</i> sp.							S															1
Solanaceae	<i>Withania somnifers</i>							S															1
Ulmaceae	<i>Celtis africana</i>		S		S		S	S	S	S	S	S				S							9
Vitaceae	<i>Cyphostemma</i> sp.						S	S															2
	<i>Rhoicissus</i> sp.							S				S			S	S							4
Xanthorrhoeaceae	<i>Aloe</i> sp.														S			S					2
	<i>Aloe saponaria</i>														O								1
	<i>Bulbine aloides</i>			C																			1
	<i>Kniphofia</i> sp.														S								1

2.5 Grindstones and grasses?

I wish now to assess the archaeological likelihood that grass seeds might have been processed by grindstones, as this is testable through phytolith analysis.

Based on macroremains, the case does not seem prepossessing: remains of eight species of Poaceae have been recovered from 11 sites in the Grassland Biome. However, two of these are domesticates: *Sorghum* sp. and *Zea mays*. Given that the preoccupation of this thesis is with hunter-gatherers, and that these are undoubtedly agropastoralist domesticated imports, they cannot have been a major portion of subsistence for hunter-gatherers in any except the most recent of contexts (and arguably not even then, given that any supply would have to have been obtained from contact with farmers).

Despite the lack of evidence on grasses as food within the Biome, grasses interpreted as bedding (and as such, often unidentified) were also observed in late Holocene contexts at Mhlwazini (Mazel 1990) and Tienfontein 7 (Leslie Brooker 1980), and in late glacial contexts at Sehonghong (Carter *et al.* 1988) and Strathalan B (Opperman 1996a). These sites are part of a much wider corpus of sites within southern Africa at which large deposits of grass/plant material occur and are interpreted as bedding, e.g. Big Elephant Shelter in Namibia (Wadley 1997a), De Hangen, Diepkloof, Andriesgrond and Renbaan in the Western Cape (Liengme 1987; Parkington & Poggenpoel 1987), Sibudu in KwaZulu Natal (Wadley *et al.* 2011). While at Sibudu, the interpretation of the grass and sedge deposits as bedding was made via micromorphological examination of sediments and comparison with experimental replicas indicating trampling (C.E. Miller & Sievers 2012), certainly at the Western Cape sites and Big Elephant Shelter, interpretation seems to have been made with reference to ethnohistorical accounts alone (Stow 1905; Lichtenstein 1928; Liengme 1987; Parkington & Poggenpoel 1987). As both Liengme (1987) and Wadley *et al.* (2011) observe, the term “grass bedding” may be misleading,

as the deposits may represent other functions – Wadley *et al.* (2011) suggest that it is simply the creation of compacted grass-lined floors for sleeping and working on, while Liengme's (1987) compositional analysis of the deposits at Renbaan reveals a quantity of iridaceous waste more suggestive of a refuse deposit than a specialised sleeping area. I suggest that if multiple functions can be accepted for such deposits, as seems warranted, we must also consider the possibility that the grass in question may represent food waste: at sites such as Tienfontein 7, where the grasses were identified as the known edible species *Themeda triandra* and *Eragrostis* sp. (and, in fact, accompanied by a grindstone) this seems particularly likely. Such security cannot be spread to most of the other sites⁶ where identification of grass remains has not been prioritised.

The lack of interest in the possible dietary consumption of wild grasses by hunter-gatherers may be due to the perceived difficulty of identifying their remains:

"Apart from geophytes, it is possibly grass grains that may have provided a further food source in the Cape Midlands habitat under natural climax (grassveld) conditions. This cannot be demonstrated in direct archaeological observations, but the form of grindstones found could suggest the preparation of small hard foods of this type" (H.J. Deacon 1976:146).

The grindstone to which Deacon refers is present only as an illustration (i.e. it is not described), but it appears to show the development of a facet similar to that encountered on Basotho upper grindstones (known as *litšiloane*, singular *tšiloane*) used for domesticated grass (maize and sorghum) processing. Deacon's rather doubtful assessment is, if anything, more dismissive in his 1993 review, where he states that grass seed collecting was unimportant within the Grassland Biome. This dismissal of grass seeds as food is not unique: for example, Parkington (1991) suggests that the preferential gathering of geophytes over grass seeds makes sense from an optimal

⁶ However, edible sedges occur in the 'bedding' layers at Sibudu (Sievers 2011)

foraging perspective, given the higher caloric return obtainable from the former, while Sealy (2006:574) states baldly in relation to isotopic data on human diet in the southernmost Cape,

“there is no evidence that [prehistoric] people ate grasses. C4 grasses are likely to have contributed to human diets principally via the meat of grazing animals”.

In fact, the assumption that grasses were so minimal a component to hunter-gatherer diets has even contributed to theorisation as to the differential development of agriculture in different parts of Africa: Marshall & Hildebrand (2002) suggest that because of the importance of geophytes to southern African hunter-gatherer diet, lower-ranked resources such as grasses were overlooked, as was the development of facilities necessary to preserve and store them (with the implicit assumption that delayed-return economies may lead to the development of agriculture). There is a certain element of absent evidence in all of these arguments, as Marshall and Hildebrand implicitly acknowledge (2002: 128), as the wide body of archaeo/ethnobotanical knowledge they cite as evidence for wild grass processing by hunter-gatherers and herders is entirely derived from north Africa, with the lack of data from further south attributed to taphonomy.

However, these data do exist in more southerly archaeobotanical records, if relatively sparsely: Radomski and Neumann (2011) report “unknown” Chloridoideae grass phytoliths (in addition to identified domesticates) on grindstones from Nigeria dated to 500 AD, while more conclusively, and further south still, (Mercader 2009) reports MSA grass seed consumption in Mozambique, which he explicitly contrasts to the perceived lack of importance of grass as a resource within the southern African literature.

2.5.1 Historical/ethnographic evidence for grass processing

In Chapter 7 I assess the evidence for grass processing at Ha Makotoko, but more pertinent here is that in addition to the archaeological evidence for grass processing, the references in ethnobotanical and historical accounts within southern Africa document the processing of grasses specifically by hunter-gatherers (rather than Khoekhoe groups, as is the case with geophyte processing). None of these are to be found within Skead's historical compendium: as noted above, early travellers appear to have been primarily concerned with grass as fodder for animals rather than as food for themselves/other humans even where its dietary potential may have been obvious, as in the case of John Barrow in 1798, who noted vast stands of wild African rye (*Secale strictum* ssp. *africanum*) in the Roggeveld (so named for the rye itself) (Skead 2009:70). Neither is there much mention made in the Bleek and Lloyd archive of late nineteenth century /Xam folklore, where there is no direct reference to grass seed processing for food (Mark McGranaghan, pers. comm. 10/12/2014), although interestingly several similes in discussion of other topics are suggestive of a familiarity/close attention to grass species: the processing of seeds/berries (the word is the same in /Xam) of other plants is discussed with reference to "corn" ("husks, which are like the corns' skins", from the story of "Quagga makes flour", BC 151 A2 1 074). The reference to cereals may derive from colonial, rather than traditional, experiences however, as it seems unlikely that a wild (i.e. non-crop plant) grass would be referred to as "corn" by Lucy Lloyd or her /Xam informants from the Northern Cape.

Deacon (1993:88) himself notes one of the cases (before dismissing the likelihood of analogous behaviour in "non-marginal" environments) of uncited anecdotal evidence for human harvesting of grass seeds from ant/termite nests. Dunn (1931:31) refers to this directly, observing that

"the ants were also robbed of their stores of grass seed. The seeds were ground on a flat rock, winnowed, and made into a kind of porridge by boiling it in a clay pot"

Parkington and Poggenpoel (1971) refer to the recovery of termites from grass layers as an indication that they may have been consumed, but in light of Dunn's observation, it seems at least possible that termites or ants might have been incidental recoveries in grass harvesting, rather than *vice versa*. Recovery of grass seeds from insect nests would seem to negate (Parkington 1991) suggestion that consumption of grass seeds is inefficient in terms of labour outlay. Even where insects were not so obliging, Parkington's comment seems unwarranted: Harlan (1989:80) notes the

“widespread misconception about wild-grain harvests to the effect that these are desperation or last-resort practices to avert starvation”,

while various experiments and ethnographic observations attest to the productivity of wild grass collection: 1kg wild einkorn (*Triticum monococcum*) per hour's work in Turkey (Harlan 1967), 10kg per morning's work gathering wild grasses⁷ in Saharan Africa (Chevalier 1932)⁸.

The caloric values of wild grass seeds are variable, and possibly because of this (or simply due to a research lacuna), no data are available on the energy returns of southern African grasses. Cane comments in the case of Australian utilised species, however, that each kilogram of damper (manufactured from various seeds) required about three to six hours work, giving a return of about 246-810 kcal/hour (Cane 1989). Given these figures, Cane is doubtful that grass seeds could have been an important dietary staple (while acknowledging their undoubted role as dietary supplement). However, given my own observations of grindstone use for domesticated cereal processing (which is pre-winnowed and husked) in areas of southern Lesotho, where women spend on average an hour grinding a higher-calorie grain (usually maize) to feed their families for each

⁷ Possibly *Eragrostis* sp. (see Harlan 1989:86 for discussion)

⁸ Harlan (1989:81) comments on Chevalier's findings that hulls may not have been removed prior to weighing and thus net yield could be reduced by 10-20%, but as he further notes “making allowance for over-estimation and processing, the figure of 1-2kg/h could surely be achieved and the effort would be highly rewarding”.

meal, it seems foolish to overlook the potential of wild grass seeds as either a supplement or a more substantial dietary contribution.

Thus, although grass processing may be seen as an intensification of existing resources given the extra preparation necessary to render it edible/palatable (where intensification is defined simply as the input of extra labour in order to diversify/increase the subsistence base), there is no reason to discount it out of hand. Further historical/ethnographic evidence for grass processing comes from Sehonghong, Lesotho: in an oral testimony recorded in the 1970s, an elderly Mosotho, Ntate Liselo Rankoli, recalled Bushmen in the rock shelter at Sehonghong harvesting *moseka* or *tšane* (*Eragrostis* sp., according to Jacot Guillarmod 1971, who confirms this use) with stone sickles and grinding the seeds into meal or porridge (Vinnicombe 2009b).

Thus, from these sources we thus know that hunter-gatherers within the Grassland Biome were processing wild grasses as food. In that light, I suggest that the cross-referencing of Basotho ethnobotany on perceived edible grasses is relevant (in contrast to the information on geophyte processing: there is no evidence for hunter-gatherers grinding geophytes, thus information obtained from the economic botany of other groups is less directly useful). Jacot Guillarmod (1971) lists the following wild grasses as “famine foods” in Lesotho: *Eleusine africana*, *Eragrostis chloromelas*, *E. cilianensis*, *E. curvula*, and *Sporobolus fimbriatus*. Many other wild grasses in Lesotho, e.g. *Themeda triandra*, are noted as being edible by other sources (Peters & Vogel 2005), and more still are listed by Jacot Guillarmod and others as being processed for use in medicines. Given the reasonably good evidence for the processing and consumption of wild grasses by hunter-gatherers and others, both further afield within southern Africa and specifically within the Grassland Biome, I submit that wild grasses may have formed an important component of subsistence, *contra* H.J. Deacon (1976; 1993), Parkinson (1991), Hildebrand & Marshall (2002), and Sealy (2006). It is simply that the techniques

for analysing this in the archaeological record have been lacking until relatively recently: Chapter 7 of this thesis attempts to redress this by subjecting grindstones from Ha Makotoko (western Lesotho) to phytolith analysis.

2.6 Experimental and ethnoarchaeological contributions

Another strand of analysis may be useful in determining ‘what hunters gathered’ and ground: experimental and ethnoarchaeological work with grindstones. This enables us to see what might be possible given particular combinations of raw material and practice, and to extrapolate from this to the observed material and conditions in an archaeological context.

Although not as extensive as experimental studies of flaked lithic technologies, a valuable corpus of experimental plant-processing work on grindstones exists in the literature, although this is not derived from southern Africa⁹. Studies discussed here come from the Americas, Australia, Europe, the Levant and West Africa, and are almost entirely derived from agropastoralist contexts.

Broadly speaking, experiments fall into two classes: those aimed at developing a corpus of reference usewear for comparison with archaeological analogues (see e.g. Dubreuil 2004; Hamon 2008) and those assessing the efficiency of different grinding equipment and studying the ergonomics and suitability of different tool pairings (e.g. Adams 1989; 2002; 2010; 2013; Wright 1992; Mauldin 1993). Broadly speaking, this second class of experiments attempt to assess if form is correlated with function, e.g. whether gross morphology can predict subsistence strategy (differences between grindstones used by farmers and those used by foragers). Some useful predictions have been made by such experiments: Mauldin (1993) found that women were able to process foods faster on larger lower grindstones while Wright (1992) observed that upper grindstones were

⁹ See, however, Vogelsang 2006 for ethnographic observations of meat processing in Namibia, and Wadley 2010b for experimental work with ochre processing.

liable to wear out much faster than lower grindstones. This is confirmed by Delgado-Raack & Risch's (2009) ethnographic survey, which determined that the lifespan of an upper grindstone was half that of the lower grindstone, based on the principle that the wear of two abrasive surfaces in constant contact is inversely proportional to their size. Adams (1999) attempted to examine Mauldin's findings that larger lower grindstones were universally more efficient: by breaking down 'efficiency' (e.g. does efficiency = comfort?) she found that rather than directly correlating with size of grindstone, use of a larger lower grindstone permits use of a larger upper grindstone, where hands can be used side-by-side rather than atop one another. This enables use of the entire body's muscle power when grinding, rather than just one arm. Thus, grindstones of smaller size (as may be encountered in hunter-gatherer, rather than agropastoralist, contexts) may be less able to deliver 'efficient' or 'intensive' processing of materials. However, it is probably worth questioning how far efficiency is universally important, particularly within a broader spectrum hunter gatherer diet.

Another frequent component of this second (non-use-wear related) class of experiments is ethnoarchaeology (as seen in Hamon & LeGall's 2013 study of Minyanka querns from Mali): this adds another element of the 'known' into the experimental formula. While uniformitarianism should not be assumed, this can be invaluable: grinding activities the world over share a number of basic similarities as regards kinetics and aims (they even share processing materials, e.g. maize in both the Americas and Africa) and can thus be used as analogues where we wish to study kinetics, aims, logistics and restrictions.

Some of the conclusions obtained from this global work emerge as pertinent to southern African (indeed any) grindstone-use contexts. The first is the development of reciprocal patterns in pairs of upper and lower grindstones, as discussed by Delgado-Raack and Risch (2008) whereby through intensive use together, a lower grindstone will develop a *concave* profile, while an upper grindstone will develop a *convex* profile accordingly. McConnell and Smith (2003) add to this with an ethnoarchaeological observation from

Australia that through the processing of hard, siliceous materials such as seeds, upper grindstones (or ‘mullers’) develop a characteristic facet. H.J. Deacon (1976) suggested that where this facet was observed on southern African grindstones it might derive from grass seed processing, while noting the absence of direct evidence for such an event (although see earlier in this chapter for critique of this). Given these observations, we might question whether the processing of softer geophyte tissue would result in any such characteristic morphological development. Unfortunately little, if any, ethnoarchaeological or experimental work into the processing of geophytes with grindstones exists in the literature: most studies discussing the processing of geophytes appear to rely on residue analysis rather than usewear (e.g. Fullagar *et al* 2006), which possibly indicates the low-intensity of any usewear derived from such processing. This is at odds with studies of geophyte processing on other tools (e.g. those used in slicing or chopping, which are generally make use of more fine-grained materials such as obsidian) where usewear under high magnification is said to be diagnostic of geophyte contact (Berehowy 2013). Thus in investigating a corpus of grindstones, we might look for gross morphological features guiding interpretations of use: this emerges as particularly pertinent in the quest for evidence of seed-processing, but is possibly less useful in the search for geophyte processing, and suggests that residue analysis (via starch and phytoliths) may be a better way of identifying specific use.

2.7 Implications for subsistence: foragers plus?

Given the common assertion that it was the domestication of previously used (and managed with varying degrees of intensity) wild grasses that catalysed the origins of agriculture in the Near East and north of the Sahara (Marshall & Hildebrand 2002), the suggestion that wild grasses played a more important role in subsistence than has been previously mooted necessarily requires us to rethink typological groupings of farmers

and foragers in southern Africa. While geophytes have been discussed as promoting a different style of subsistence that did not require storage or wide-scale processing (Marshall & Hildebrand 2002), H.J. Deacon (1993; 1976) asserted that they would have been maximised as resources through a certain degree of land management, in this case fire: since geophyte growth is promoted in the post-fire succession of fynbos bushfires, he theorises that humans could have (and probably did) made use of “firestick farming” (H.J. Deacon & J. Deacon 1999) following Jones (1969)) to manage the geophytes, “without which they would not be a targetable resource” (H.J. Deacon & Wurz 2005: 2143). That this fire-management took place is also attested by various historical accounts collated by Skead (2009), although once again it is difficult to be sure to whom the accounts refer. Occasionally farmers are mentioned, however Burchell (1812, reproduced in Skead 2009: 349) notably observed a case of fire management by Bushmen, apparently to promote game, although it is surely not impossible that multiple aims were achieved by this.

Both cases – collection of geophytes and of grasses – seem to indicate a more complicated relationship with plants than the typical forager/farmer distinction. Of course, this is not necessarily news: for several decades it has been recognised that this binary typology is unsatisfactory at best, that foragers may produce, and farmers collect¹⁰ (Harris & Hillman 1989; Marshall & Hildebrand 2002; Terrell *et al.* 2003; Mitchell 2004; Neumann 2005; Denham *et al.* 2007; Barker 2009). But further probing may bear fruit: should we rethink our categorisations still further? Following presentation of results from Ha Makotoko, which constitute the first comprehensive functional analysis of grindstone technology from a site in southern Africa, this will be discussed in Chapter 8.

¹⁰ And see the concept of “hunters with sheep” (Sadr 2003), but see also e.g. A.B. Smith 2005 for opposition to this.

2.8 Summary

This chapter surveyed the archaeology of gathered materials in the Grassland Biome of southern Africa. Gathered materials are considered to be more neglected than their hunted counterparts, and I articulated the fact that we must understand them in order to understand the people who gathered them. This argument, that we learn of the people who used a material culture from the material culture itself, methodologically links the focus on gathered materials with the focus on grindstones, as both have hitherto received too little attention from southern African archaeologists.

Published plant remains from the 39 within the biome were tabulated, and I took a targeted look at gathered materials to consider their relationship with grindstones and what this may reveal about what is present and absent from the record.

One of the only hypotheses as to the direct use of grindstones (as opposed to proxy use, which is discussed in Chapter 3) in southern Africa is that they were used to process geophytes. I discussed the likely historical origins of this hypothesis, and problematised it: as such, it became a key hypothesis for evaluation via my functional analysis of grindstones, and is evaluated in Chapter 6.

Following the discussion of grindstones and geophytes, I turned to what is currently archaeologically invisible (and, as such, perhaps, dismissed by prominent archaeologists) although ethnohistorically demonstrated: that hunter gatherers routinely processed grasses for use as foods. Arguments as to efficiency were evaluated, and I hypothesised that should an archaeological record for grass processing by southern African hunter gatherers be proven, this would necessarily alter our interpretation of hunter-gatherer *versus* farmer lifeways. As such, a linkage between grasses and grindstones joins the “geophyte hypothesis” as a key area of inquiry for functional analysis later in the thesis (Chapter 7).

Finally, a brief survey of ethnoarchaeological and experimental work with grindstones elsewhere in the world was made, which provided indications of morphological

correspondences (if any) between grindstone form and geophyte and grass seed processing. This provides comparative context for typological and residue analysis later in this thesis.

Chapter 3. Grindstones in the Grassland Biome of southern

Africa

“Although grinding tools are found in abundance, they are seldom actively used in interpreting the past. Many grinding tools have probably not even been recognised as tools. The handling of grinding and pounding tools found during excavations depends on the excavation policy, or rather the excavators’ sphere of interest...A traditional bias and low form-variability have probably conspired to deny reciprocating grinding tools all but superficial consideration” (Lindström Holmberg 1998: 123)

3.1 Overview

Although Lindström Holmberg is referring to grindstones within the Swedish Mesolithic and Neolithic, her words apply equally well to the consideration and valuation of grindstones on a global basis. Historically, grindstones have been artefacts of least interest to archaeologists, possibly due to their apparently unprepossessing appearance, bulkiness, and the difficulty of assigning them to typologies: these considerations will be returned to below. What is at odds with this lack of interest, as Lindström Holmberg observes in her regional case, but which again applies equally well on a global scale, is the ubiquity of these artefacts worldwide, in almost every archaeologically known society. Indeed, they have been referred to as “the essential domestic object” (Biskowski *et al.* 1999:1), and are used in processing a variety of different raw materials worldwide. This global presence and long history may relate most significantly to the simplicity of the artefact type: while McBrearty & Brooks (2000) place grindstones as originating within the Middle Stone Age, cases have been made for their presence in the Acheulean (Goren-Inbar *et al.* 2002), and it takes little imagination to connect them with the evolutionary continuum of the earliest stone tools used for chopping and pounding by hominids and other primates (Mercader *et al.* 2007; Haslam *et al.* 2009; Koops *et al.* 2009). Another factor may be the necessary nature of their raw material composition: grindstones could be called true relics of the Stone Age, as a form of basic kit that exists

from the earliest Early Stone Age or Lower Palaeolithic well into post-metallurgical periods as far as the present day in many small-scale agricultural societies worldwide (including Lesotho). In fact, the very ubiquity of grindstones may contribute directly to their invisibility – the invisibility of the obvious. This chapter surveys the state of grindstone analysis worldwide, before narrowing in on the Grassland Biome of southern Africa, in order to present the existing state of knowledge about these objects.

3.2 Grindstone studies globally

While their study cannot yet be termed a major area of archaeological enquiry, researchers have looked into the function and form of grindstones in a variety of contexts, finding that throughout their history grindstones have been variously used in the processing of grains (Weiss *et al.* 2008), tubers (Revedin *et al.* 2010) and other plants (Cane 1989; Goren-Inbar *et al.* 2002), ochre (Henshilwood *et al.* 2011) hides (Dubreuil & Grosman 2009), small mammals (Yohe *et al.* 1991) and other meat (Vogelsang 2006).

These functions have been discovered through a variety of analyses: usewear (Adams 1988; 2002; Adams *et al.* 2009; Dubreuil & Savage 2014); experimental approaches (Adams 1989; 2010); ethnoarchaeology (David 1998; Hamon & Le Gall 2013); characterisation of inorganics (Henshilwood *et al.* 2011; Nic Eoin & Bonneau 2014); starch analysis (Langejans 2006; Fullagar *et al.* 2008; Field *et al.* 2009); phytolith analysis (Fullagar *et al.* 2008; Radomski & Neumann 2011) and typological approaches, both archaeological (M.A. Smith 1988a; M.A. Smith 2004; Adams 2002) and ethnohistoric (Dunn 1931; Walton 1953).

Analyses have been carried out in many different contexts worldwide (though far from comprehensively): Europe (Revedin *et al.* 2010; Hamon 2007; 2008; Hamon & Graefe

2007; Revedin *et al.* 2010), Australia (M.A. Smith 1988a; M.A. Smith 2004; Cane 1989; Fullagar 1998; Hayes *et al.* 2014), the Americas (Piperno & Holst 1998; Adams 1999; Biskowski *et al.* 1999; Adams 2002; Pearsall *et al.* 2004; Zarrillo & Kooyman 2006; Messner 2011), North Africa and the Levant (Wright 1992; 1994; Dubreuil & Grosman 2009; Eitam 2009; Snir *et al.* 2015), Asia (Barton 2005; Liu *et al.* 2010). Pertinent to the focus of this thesis, however, is the fact that grindstone analyses have mostly examined agricultural or semi-sedentary societies rather than hunter-gatherers. The exception to this is in Australia: for this reason a contextual comparison with Australian cases is maintained sporadically throughout this thesis.

For southern Africa, then, although we can use global studies of grindstones to suggest possible artefactual use and social significance, these are no substitutes for *in situ* functional and typological studies (Walton 1953; Wallace 1996; Langejans 2006; Henshilwood *et al.* 2011). In the absence of detailed study of hunter-gatherer grindstones in southern Africa, grindstones have been seen as having a binary role: in plant or ochre processing, such that where ochre is not visible to the naked eye, a plant processing role is assumed (although see Vogelsang 2006 for an ethnoarchaeological case from Namibia that disputes this).

3.3 Grindstones as proxies

Based on these assumptions, grounded implicitly in examples from elsewhere and only rarely in ethnohistorical references from southern Africa, grindstones have assumed another role: that of proxy.

3.3.1 Grindstones and the Behavioural Modernity Debate

McBrearty and Brooks (2000:531) cite the appearance of grindstones 300,000BP as evidence for behavioural modernity¹¹. Counter-intuitively, it is not ochre visible on grindstones that is taken as evidence of behavioural modernity, but the fact that these grindstones suggest plant processing: as discussed above, this belies the surely unavoidable parallels (and to my mind, likely evolutionary continuum) between MSA and LSA grindstones and non-human primate tools used in extractive foraging/plant processing, as well as a possible separation between grindstones used for ochre and those used for plant processing (see later in this thesis discussion of grindstone L173).

3.3.2 Grindstones and particular plants

This association between grindstones and plant processing of particular kinds is pervasive – Huffman (2006) associates certain types of Iron Age grindstones in the South African Limpopo province with maize grinding, without reference to functional analysis, and an attempt by Langejans (2006) to distinguish between maize and sorghum starch on the same grindstones failed due to the similarity between the two genera. Similarly, Mitchell (2013) associates grindstones in early farming communities of southern and south-central Africa with the processing of plant domesticates, despite the lack of functional enquiry into this. Finally, the association between geophytes and grindstones referred to by several authors (Mazel & Parkington 1981; Mitchell 1996; Wadley 2000), and discussed in more depth in Chapter 2, has never been confirmed.

3.3.3 Gendering grindstones

The last proxy, while promoted explicitly by only one author (Parkington 1990) for southern Africa, is pervasively assumed on a global basis. This is the association of grindstones with women. While I have discussed elsewhere in this thesis the reasonable

¹¹ That the emphasis in Middle Stone Age archaeology on the origins of behavioural modernity (a problematic concept in and of itself) is perhaps ill-advised is reinforced by new findings of symbolic capacity in other members of the genus *Homo* (Zilhão *et al.* 2010; Joordens *et al.* 2014)

grounds for associating the archaeology of gathered resources with women, unlike some other archaeologists (Hastorf 1991; Lindström Holmberg 1998) I am less inclined to follow an extreme version of Janet Spector's task differentiation framework (Spector 1983; Conkey & Spector 1984) in associating grindstones solely with women¹². This is because of the (largely untested) use of grindstones for multiple purposes other than plant-processing, ochre grinding being the most visibly apparent (this does not appear as a problem to Lindström Holmberg (1998: 127), who while acknowledging the possibility that ochre and tobacco were processed on grindstones by men continues her association of grindstones with women). If the task-differentiation framework were to be adhered to, the fact that men (perhaps not exclusively) are known to have painted southern African rock art (Mitchell 2006) would indicate their association with grindstones as they would prepare their own pigment.

Further support for the non-gender specific association of grindstones in a southern African context comes from Wadley's (1997b) discussion of grindstones in Holocene burial contexts. In Oakhurst Cave, grindstones were found with multiple burials dated to the mid-Holocene, while at Nelson's Bay Cave, an ochre-stained grindstone accompanied a child burial dated to 2660±150BP. Grindstones appear in burials of all sectors of society (males, women, children) at multiple sites, including Snuifklip, Melkhoutboom, and Weltevreden. Indeed, Wadley notes that the *second most common grave good* (after ostrich eggshell beads) in these Holocene Eastern and Western Cape contexts was, "surprisingly" (117), upper and lower grindstones both ochre-stained and otherwise. In a Lesotho context, a grindstone topped the burial cairn of the woman recovered at Pitsaneng (Hobart 2003). Two conclusions may be drawn from this study: the first, that grindstones cannot be unquestioningly associated with any gender, either in life or

¹² Conkey (1991:86), for example, rejects simplistic associations, with her argument best read as a thought experiment into the imposition of *any* gendered division of labour operating at hunter-gatherer sites– it is in this regard that I try to use it here.

death, and the second that this inclusion of grindstones in burials is indicative of a much higher status for grindstones than ‘mere’ functional tools used for mundane, utilitarian purposes. Further support for this latter part may come from the possible identification of some of the painted stones from Boomplaas (H.J. Deacon 1979) as grindstones (David Pearce, pers. comm. 19/7/2014) and later in this thesis, an ochre-stained grindstone (L173) in an apparently intentionally dug pit thought to date from the early Holocene¹³.

3.3.4 Grindstones and the “other”

While I feel that a strict task-differentiation framework association of women and grindstones should be rejected (following Wadley 1997b), the original point made by Spector (1983; Conkey & Spector 1984) and Conkey (1991), that this framework permits consideration of neglected forms of material culture as a way into a neglected sphere of society, i.e. the role of women, is valid and may be taken further. Gero (1991), writing in the same seminal volume as Conkey, suggested that the rejection of utilised flakes as a category in lithic analysis (with a corresponding privileging of “formal tools”) was to reject those who manufactured and used them, very probably women (but possibly also other “other” members of society apart from young, agile males: children, apprentices, and older individuals). By ignoring classes of material culture that may plausibly associate with minority sections of society not served by traditional narratives, we further marginalise these individuals and groups, and in doing so, bias our archaeological interpretations. By embracing “non-formal” tool types such as utilised flakes, grindstones, or lumped categories such as “ground stone”, we can explore these poorly understood parts of societies. However, because our taxonomies of material culture are explicitly defined around flaked lithic “formal tools”, typological analysis of the ‘other’ is hindered from the start, and systems of analysis thus require alteration.

¹³ This is based on stratigraphic interpretation: direct dating of material from the deposit is underway, but was unfortunately not completed in time for inclusion in this thesis

3.4 Examining published grindstones in southern Africa

The use of grindstones as unquestioned proxies and avoidance of detailed study is tangled up with the patchy (often implicit, rather than explicitly defined) typology and taxonomy used to discuss them: Lindström Holmberg (1998:124) discusses the “haphazard classification and...random terminology” into which she entered when she began examining Neolithic grinding tools in Scandinavia. Terminology used to refer to grindstones is diverse, various, and often grounded in use-specific associations (“quern stones”, “pestles”) or regional language (“mano”, “metate”, “muller”), which may be unsuitable elsewhere, though this does not stop authors from using it. Categories are also often blended together: the aforementioned “ground stone” for instance, which may include items as diverse as stone rings, bored stones and grindstones. When, later in this chapter, grindstone counts at sites within the southern African Grassland Biome are compared, grindstones are necessarily lumped with “ground stone” because certain authors have grouped them together in lithic tabulations (e.g. Thorp 2000). This obscures the fact that ground stone is not a particularly appropriate epithet for grindstones: it implies a passive state (the stone is ground by something else in its formation) rather than an active relationship between two stones that simultaneously abrade each other through use. It also belies the diversity of ground stone as a category: stone rings, stone bowls, bored stone and grindstones (upper and lower) may all be included, yet oddly, apparently not hammerstones (which from ethnohistorical records we know to have functioned dually as upper grindstones; Dunn 1931). Even those authors who do separate grindstones from ground stone do so without explicit justification, which leads to confusion: at Collingham Shelter, Mazel (1992: 23) discusses grindstones and ground stone separately, but a photographed artefact (see Figure 3.1) is described as ‘ground stone’ (without further elaboration) when, judging from the image, it appears to share many of the characteristics of a lower grindstone (see Chapter 5).

Fig. 19. Collingham Shelter: ground stone. TBS, 2; BSV2L, 1 (scale in centimetres).

Figure 3.1 Figure 19 reproduced from Mazel 1992: although referred to as 'ground stone', this artefact looks like a lower grindstone

It is apparent, then, from discussion of the southern African material alone, that grindstones do not fit easily within existing typologies of formal tools (e.g. J. Deacon 1984; Inskeep 1987), and are thus excluded from formal tool counts, appearing in “waste” categories when fragmented and “utilised” categories when not, while ground stone is often listed separately from any of these categories.

3.5 Grindstones and typology: systems of analysis

Further contextualisation of this state of grindstones as having fallen through the cracks of lithic analysis can drawn from comparison with Australia, the area for which hunter-gatherer grindstones are best studied. In spite of the discernible differences between the ‘seed grinder’ type (probably an innovation of the later Holocene (M.A. Smith 2004; 2012), although see Fullagar & Field (1997) and Fullagar *et al* (2015) for the possibility of older cases) and other, less formally shaped grindstones, the latter are nonetheless grouped into typologies (M.A. Smith 1988a; 1988b; 2004). This is in distinct contrast to southern Africa where they are neglected. There are benefits of adhering to a system of reduction (Dibble 1995), arguably all the more so in the case of grindstones which, more

than any other lithic tool are formed through use. However, eliminating working typologies and groups within lithic analysis makes comparative analysis between different assemblages almost impossible (and see Chapter 5 for further elaboration of this).

3.6 Finding a place for grindstones

This thesis attempts to redress this balance, finding a place for grindstones within broader systems of tool typologies to allow the inclusion of this hitherto neglected material culture type into general site lithic analyses. This is achieved through no novel systematic innovation (other than, perhaps, the emphasis on micro-residue analysis) but rather by applying the same methods of analysis to grindstones as we do to other lithic categories: recording of dimensions, weight, raw material, gross morphology etc. A methodology aimed at delivering working techno-types for the wider region (which will require testing at other sites and refinement accordingly) was tested for Ha Makotoko, and is discussed in Chapter 5. The rest of this chapter takes what is currently known about grindstones from sites within the southern African Grassland biome and follows a method suggested by M.A. Smith (2004) dividing grindstone count per total lithic tool assemblage per dated context. This can present intensity of grindstone use over millennia, across the region. From this method we can see what is knowable about grindstones based on the existing analytical data from excavated assemblages. I suggest that what we cannot discern from this method is as important as what we can, as it highlights the gaps in our knowledge and emphasises the need for more detailed analysis and what this could achieve.

3.7 Grindstones within the Grassland Biome

Given the shortcomings of density analysis it is generally agreed that analysis of a particular tool class divided by an entire assemblage may be a more accurate gauge of

intensity of site occupation (Jerardino 1995). Here, non-ochre-stained grindstones¹⁴ and ground stone (lumped here for analysis since otherwise certain sites cannot be included) per dated assemblage are plotted for sites in the Grassland Biome. The fact that the sites offer contexts of different ages (from the Pleistocene through to the most recent LSA) allows the observation of trends over time although the sample is necessarily biased towards the late Holocene, given the greater number of published sites dating to this time period. This is largely an artefact of Aron Mazel's (1989; 1990; 1992; 1993; 1996; 1997; 1999; 2004) pioneering work in the Thukela Basin, which was focussed on exploring Holocene sequences.

Percentages are plotted by radiometric dates (which should be read as “not older than”). Upper layers (where these postdate 500BP) have occasionally been lumped where surface assemblages of LSA material would go otherwise undated. Total numbers of grindstones, ground stone and hammerstones were counted per layer and divided by the total number of tools (both formal and utilised) to arrive at the grindstone percentage within an assemblage. This then acts as a proxy for the intensity of plant-processing on-site similar to the method used by Mazel (1989). However, adzes are not regarded here as a suitable proxy for plant processing (see comments in Chapter 2) and are not tracked alongside grindstones. By the same token, ochre-stained grindstones are removed from analysis. Smith (2004) carried out chi-square tests on his data, but this was rejected as a possibility for this analysis: sample number was often less than five (rendering a chi-square inappropriate) but also because the fact that total number of

¹⁴ Ethnographic information and residue analysis discussed elsewhere in this thesis suggest that grindstones used to process dietary plants are not used to process ochre, and should thus be separated as they represent different functions. While analysis of ochre-stained grindstones in the same way as non-ochreous grindstones is desirable, it is currently impossible due the nature of the data-set: since authors do not commonly tabulate ochreous grindstones separately from others, numbers cannot be accurately dated

grindstones is not simply be a function of total assemblage size is already demonstrated by the differences between percentages for different layers at individual sites.

Figure 3.2 presents a scatter plot of all sites within the Grassland Biome for which grindstones are reported with reasonable control over dates. Some sites, e.g. Rose Cottage Cave, were mostly finely resolved but had some layers (e.g. layer Pt) spanning multiple millennia. In this case only the problematic layers were rejected. Following this initial master-plot, three sub-regions of the biome which were singled out to explore more localised patterns. These are shown in (Figure 3.5 to Figure 3.8).

Figure 3.2 Percentage of grindstones within total lithic assemblage at all sites within the Grassland Biome over the last 26,000 years. Site abbreviations are as follows: BWE (Bonawe); CHS (Collingham Shelter); CLS (Clarke's Shelter); COL (Colwinton); DI1 (Diamond 1); DR (Driel); GEH (Gehle); GH (Good Hope); GRA (Grassridge); HM (Ha Makotoko); HOL (Hololo crossing); KT (KwaThwalayakhe); LIK (Likoaeng); MAQ (Maqonqo); MMH (Mauermanshoek); MS (Mbabane Shelter); MGE (Mgede); MHL (Mhlwazini); MZ (Mzinyashana) INK iNkholimahashi; NKP (Nkupe); NT (Ntloana Tšoana); OS (Orange Springs); PIT (Pitsaneng); RAV (Ravenscraig); RKS (Rooikrans); RFT (Roosfontein); RCC (Rose Cottage Cave); SEH (Sehonghong); SIH (eSinhlonhlweni); SIK (Sikhanyisweni); TAN (Tandjiesberg); TV (Te Vrede); TIE (Tienfontein 2&7); TL (Tloutle); TWY (Twyfelpoort); WES (Westbury).

Figure 3.2 shows the overall picture of grindstone frequency within the Biome in the last 26,000 years (with the earliest dated layer from Sehonghong approximately 25,100 BP). Despite the over-representation of sites from the most recent Holocene, some slight intensification over time is apparent, especially looking at those sites where grindstone percentages rise above 10% of total lithic assemblage (e.g. Likoaeng, iNkholimahashi). This becomes more apparent when we focus in on the Holocene (Figure 3.3): it is not just that there are more sites, but the greatest proportions of grindstones within overall assemblages are reached, with grindstones at iNkolimahashi and Mhlwazini reaching percentages of over 50% in the last 1000 years. However, across the Biome, percentages rarely top 10% of the total assemblage, indicating that despite slight intensification at some (not all) sites, plant processing was generally an activity of low intensity. Only 15 of 38 sites have assemblages from any period in which grindstones represent more than 10%. An even closer look at the last 5000 years (Figure 3.4) reveals patterns to be even less clear-cut, with the idiosyncrasies of individual sites in evidence: any trend towards intensification is not straightforward and upward, but more complex, with localised peaks and troughs within site sequences.

Figure 3.3 Percentage of grindstones within total lithic assemblage at all sites within the Grassland Biome over the last 12,000 years. Site abbreviations are as follows: BWE (Bonawe); CHS (Collingham Shelter); CLS (Clarke's Shelter); COL (Colwinton); DI1 (Diamond 1); DR (Driel); GEH (Gehle); GH (Good Hope); GRA (Grassridge); HM (Ha Makotoko); HOL (Hololo crossing); KT (KwaThwalayakhe); LIK (Likoaeng); MAQ (Maqonqo); MMH (Mauermanshoek); MS (Mbabane Shelter); MGE (Mgede); MHL (Mhlwazini); MZ (Mzinyashana) INK) iNkhohlimahashi; NKP (Nkupe); NT (Ntloana Tšoana); OS (Orange Springs); PIT (Pitsaneng); RAV (Ravenscraig); RKS (Rooikrans); RFT (Roosfontein); RCC (Rose Cottage Cave); SEH (Sehonghong); SIH (eSinhlonhlweni); SIK (Sikhanyisweni); TAN (Tandjiesberg); TV (Te Vrede); TIE (Tienfontein 2&7); TL (Tloutle); TWY (Twyfelpoort); WES (Westbury).

Following presentation of sites within the wider Biome, I now discuss regional data. Information from the Thukela Basin as a whole (Figure 3.6) can be compared with previous work by Mazel (1989) in which he summarised six sites (reproduced in Figure 3.5). Mazel (1989) observed an increase in the presence of geophytes and adzes in the later Holocene, which he regarded as reflective of the intensification of plant strategies. While he did not present specific data on grindstone proportions, he noted that these increased too (note that these may have included ochreous grindstones, and may have excluded ground stone). By adding sites Mazel published later (1990; 1992; 1993; 1996; 1997; 1999), we can see that while trends in grindstone percentages reflect this putative intensification of plant processing on a broader regional and chronological scale, site specific trends peak differently, usually in the middle, rather than the end, of their respective sequences. Sikhanyesweni is the exception to this. In fact, *contra* Mazel, any regional peak in plant processing appears to be between 2,500-4,000BP rather than any later, although as in the wider Biome, the number of sites with proportions of grindstones exceeding 10% increases towards the present.

Figure 3.5 Grindstones as a percentage of total lithic assemblage at the six sites in the Thukela Basin compared by Mazel (1989). Abbreviations are as follows: CLS (Clarke's Shelter); DI1 (Diamond 1); GEH (Gehle); MGE (Mgede); NKP (Nkupe); SIK (Sikhanyisweni)

Figure 3.6 Grindstones as a percentage of total lithic assemblage compared for all sites within the Thukela Basin. Abbreviations are as follows: CLS (Clarke's Shelter); DI1 (Diamond 1); DR (Driel); SIH (eSinhlonhlweni); GEH (Gehle); GH (Good Hope); KT (KwaThwalayakhe); INK (iNkholimahashi); MAQ (Maqonqo); MS (Mbabane Shelter); MGE (Mgede); MHL (Mhlwazini); MZ (Mzinyashana); NKP (Nkupe); SIK (Sikhanyesweni).

In the Free State/western Lesotho region (Figure 3.7), an apparent near-hiatus in grindstone use between about 3,500 to 5,900BP is evident. While at Ntloana Tšoana this reflects a hiatus in site occupation (i.e. there are no dated layers from this period), at Twyfelpoort and Mauermanshoek there are dated layers without grindstones at this time. Note that the figure of 50% at Tienfontein 7, at 70BP, is based on a very ephemeral occupation in which there are only two utilised/formal tools in total, including one grindstone.

Figure 3.7 Grindstones as a percentage of total lithic assemblage compared for sites within the Free State and western Lesotho. Abbreviations are as follows: HOL (Hololo crossing); HM (Ha Makotoko); MMH (Mauermanshoek); NT (Ntloana Tšoana); OS (Orange Springs); RCC (Rose Cottage Cave); RKS (Rooikrans); TAN (Tandjiesberg); TIE 2, TIE 7 (Tienfontein); TL (Tloutle); TWY (Twyfelpoort), WES (Westbury).

In eastern Lesotho and the Eastern Cape (Figure 3.8), the pattern is diffuse: while Sehonghong has a long sequence of variable grindstone use, and Likoaeng a shorter one, the Eastern Cape sites generally show very low proportions of grindstones (<1%) or lack them altogether (Te Vrede and Bonawe), with the exception of Grassridge at 6890BP. Opperman notes that at Bonawe “plant food was perhaps not of much importance” (Opperman 1987: 121) and the lack of grindstones would appear to bear

this out, not only here but elsewhere in the Eastern Cape. As with the Free State and western Lesotho sites, proportions are consistently lowest between 3,000 to 6000BP, indicative of the same hiatus: at the Lesotho sites this reflects a general occupation hiatus at this time (Peter Mitchell pers. comm. 28/3/2015).

Figure 3.8 Grindstones as a percentage of total lithic assemblage compared for sites within the Eastern Cape and eastern Lesotho. Abbreviations are as follows: BWE (Bonawe); COL (Colwinton); GRA (Grassridge); LIK (Likoaeng); PIT (Pitsaneng); RAV (Ravenscraig); SEH (Sehonghong); TV (Te Vrede).

3.7.1 Discussion

Apart from the recent intensification visible when all sites within the biome are plotted (which may be a partial artefact of better preservation and more excavated layers dated to this period), an earlier peak in grindstone proportions is evident: at both Sehonghong and Rose Cottage Cave, grindstone proportions peak in the early Holocene, with earlier high points in the Pleistocene, although at Sehonghong this is during the LGM and at Rose Cottage this is post-LGM. Good Hope, Sikhanyisweni, and Grassridge all share the early Holocene peak (between about 6,000-9,500BP) with proportions over 15% reached at this time. Other sites show a miniature version of this peak at this time, with

Ha Makotoko and Ntloana Tšoana reaching their highest peaks of 2.5% and 3.5% respectively (but bear in mind that this is data from the 1989 excavations only). While two sub-regions (western Lesotho and the eastern Free State; eastern Lesotho and the Eastern Cape) show a hiatus as indicated by grindstone proportions (of less than 1%) between about 3,000 to 6,000BP, this pattern is not seen in the Thukela Basin/KwaZulu Natal sites: indeed, the period 2,500 to 4,000 years ago is probably the most intensive period of grindstone use in this sub-region.

Overall, there appears to be a weak upward trend in the most recent Holocene (after a near hiatus between 6,000 to 3,000BP outside of the Thukela Basin), with an earlier peak in plant processing evident at five sites between 9,000 and 6,000 years ago. Trends in the Pleistocene are harder to track, since only two sites (Rose Cottage Cave and Sehonghong) have thorough sequences from this period. It seems, however, that plant processing was always important at these sites. This is perhaps to be expected, given their interpretation as large base camps (Mitchell 2002). By contrast, plant-processing appears to have been least important south of the Drakensberg. A curious omission from the database are the sites of Strathalan A and B (Opperman & Heydenrych 1990; Opperman 1996a; Opperman 1996b) for which extensive plant remains are reported but at which sites no grindstones are recorded: it is not known if this is because they were simply not included in analysis or if they were actually absent. If the latter, despite the plant remains, Strathalan A and B would not be at odds with other neighbouring sites.

I suggest that, on the whole, on-site trends are more representative of localised resources, responses and preferences: the early Holocene peak represented at five sites cannot be tied to any particular region as it appears at one site in the Free State, one in the Eastern Cape, one in eastern Lesotho and two in KwaZuluNatal. Neither can it be said that this represents a broad regional trend, since other sites with dated

assemblages to this period do not share the trend, for example, Te Vrede, Nkupe, and Mgede.

These results (slight intensification but with considerable individual site variation), are at odds with those reported for Australia, particularly the Central Arid Zone, where a discernable trend towards later Holocene intensification was found by M.A. Smith (1988; 2012) based on i) the presence for the first time and ii) the increase over time in numbers of specialised seedgrinders. Smith rejected the possibility that this trend was reflective of new resource opportunities or increased production pressure and suggested that resource stress, due to population growth in the early Holocene which limited freedom of movement for successive generations, which promoted a need to intensify/diversify existing subsistence, was more likely to have been responsible (M.A. Smith 1988; 2004; 2012). However, this apparent trend is complicated by the appearance of grindstones dating to 30,000BP at Cuddie Springs (Fullagar & Field 1997). Fullagar and Field suggest (based on usewear and residue analysis) that although these grindstones lack the specialised morphology of the Holocene seed grinders, they were used to process seeds, indicating that this response was not confined to the later Holocene. Smith does not support the notion that these seedgrinders were *in situ*, but rather that they had shifted stratigraphically due to post-depositional disturbance (M.A. Smith 2004; 2012). Fullagar *et al.* (2015) have recently countered with the analysis of fragmented Pleistocene grindstones from securely dated deposits, claiming that usewear on these grindstones is consistent with seed-grinding.

Despite the apparent differences in plant processing intensification (or lack thereof) as indicated by grindstone frequencies between the southern African Grassland Biome and Australia (particularly the Central Arid Zone), elsewhere in this thesis I suggest that interpretations in southern Africa might do well to take Australian interpretations of

and approaches to grindstones into account, especially as regards seed-processing (Chapters 2, 7, 8).

3.8 Summary

Following Chapters 2 which reviewed the “gathered record” of southern Africa with reference to the Grassland Biome, this chapter surveyed the existing state of knowledge of grindstones in the region. This was prefaced with a discussion of why grindstones might be neglected by archaeologists and why this is problematic. It also surveyed proxy uses for grindstones, most notably behavioural modernity, particular plants, and as representing women. Discussion of the idea of ‘grindstones = women’ led me to reject it as a straightforward link, suggesting instead that ‘grindstones = other,’ i.e. sectors of society hitherto marginalised by the hegemony of hunted resources within archaeological narratives. Reviewing the case for grindstones as grave goods within southern Africa (including Lesotho) it emerged that grindstones were conceivably higher status objects than is often assumed by archaeologists today. Examining the proportions of grindstones within total lithic assemblages for sites within the Grassland Biome showed only weak sub-regional patterns and considerable variability between sites, but with possible evidence of apparent hiatuses in plant processing at times and a proliferation of grindstones towards the more recent Holocene. The chapter concluded that due to the unwillingness of archaeologists to consider grindstones alongside flaked stone tools (and to study them in the same way) this level of analysis was the highest currently achievable for the wider biome. It was suggested that adopting the methodology outlined in this thesis, inter-site comparisons might become easier. Chapter 5 takes this idea and details my attempt to create a typology for grindstones at Ha Makotoko with the eventual aim of extrapolating this typology to the wider Grassland Biome.

Chapter 4. Ha Makotoko

4.1 Overview

Situated on the south bank of the Phuthiatsana River, in western Lesotho's Maseru district, the site referred to here as Ha Makotoko (see Figure 4.1) first became known to archaeologists as ARAL 175 in Lukas Smits' (1983) survey of rock art in Lesotho. Although referred to locally as *Lepoqong*, meaning "place of dust" or *Lehaha-la-Qebeletshane*, possibly after the name of a Bushman inhabitant (Mitchell & Arthur 2014), following excavations by Peter Mitchell and John Steinberg in 1989, it has been known to archaeologists by the name of the neighbouring village, Ha Makotoko (Mitchell 1993). Following the decision to construct the Metolong Dam, a project aimed at supplying fresh water to Lesotho's capital city, Maseru, which has flooded a 14 km stretch of the Phuthiatsana river valley including Ha Makotoko and the neighbouring site of Ntloana Tšoana, the cultural heritage of the area was re-assessed by the Metolong Cultural Resource Management (MCRM) Project, under the direction of Peter Mitchell and Charles Arthur. For this reason, the area surrounding Ha Makotoko is referred to as the 'Metolong Catchment' in this thesis in keeping with practice elsewhere (Mitchell & Arthur 2010; 2012a; 2012b). As part of the MCRM project, the decision was made to undertake major re-excavations of Ha Makotoko and Ntloana Tšoana, as well as smaller excavations elsewhere in the river valley, focusing on the hunter-gatherer occupation of the river valley (Mitchell & Arthur 2010; Mitchell & Arthur 2012a). As part of the MCRM programme, oral history and intangible heritage components were also undertaken as well as excavation and rock art recording/salvage, allowing contextualisation of the most recent (predominantly Basotho) phases of life at the site to the present day, as it had remained in use for both sacred and quotidian practices until it was inundated (Gill & Nthoana 2010; Monyane & Phafoli 2011; Nic Eoin & King 2013; King & Nic Eoin 2014).

Following completion of the dam in 2014, the shelter has since been flooded and the multi-millennial occupation and use of Ha Makotoko by local people came to an end, as did use of the river valley itself as a source of raw materials and useful plants.

Figure 4.1 Ha Makotoko pre-inundation, September 2012 (above); following partial inundation, April 2014 (below)

4.2 Site location and composition

As mentioned above, Ha Makotoko is situated on the south bank of the Phuthiatsana (itself a tributary of the Caledon/Mohokare River) valley (which may have been known to hunter-gatherers as “Qalooe” (Gill & Nthoana 2010)), at 29°20'S, 27°48'E, and at an elevation of 1640 m asl. The shelter has a total area of 820 m², a width along the dripline of approximately 60 m, and a depth of 22 m, making it the largest shelter in the valley (See Figure 4.2). Prior to inundation it received sunshine for much of the day, in all seasons, due to its northwesterly aspect.

Lesotho is entirely located within the Summer Rainfall Zone of southern Africa and as such experiences a temperate climate, while the local vegetation surrounding Ha Makotoko is *Cymbopogon-Themeda* grassland of the lowlands ecological zone (Staples & Hudson 1938; SMEC 2008). Local botanical taxa are more thoroughly listed in Chapter 6, while the area's fauna is now relatively impoverished, with only small mammals recently present, which is at odds with the nineteenth century record as indicated by oral histories which included eland (*Tragelaphus oryx*), red hartebeest (*Alcelaphus buselaphus*), black wildebeest (*Connochaetes gnou*) and plains zebra (*Equus quagga*) (Mitchell & Arthur 2014).

The shelter is composed, as is the rest of the valley, of Clarens Formation sandstone, part of the Karoo supergroup, and overlaid with basalt lavas of the Lesotho formation (Schmitz & Rooyani 1987; Johnson *et al.* 2006). The riverbed in front of the shelter is well-stocked with rounded basalt cobbles, the predominant raw material source of grindstone manufacturers at the site and today, while sandstone would have been available from the fabric of the shelter itself (Nic Eoin & King 2013).

Figure 4.2 Site plan showing the areas of the 1989 and 2010 excavations, from Mitchell and Arthur 2014

Figure 4.3 South-facing section from the 2010 excavations at Ha Makotoko. Figure reproduced from Mitchell and Arthur 2014 Fig. 7

4.3 Occupation History

1989 excavations

The 1989 excavations at the site (Mitchell 1993) uncovered six square metres of deposit (down to bedrock) towards the rear of the shelter and revealed evidence of an early Holocene occupation dating between approximately 8,000 and 6,400BP and no evidence of Pleistocene occupation of the site, in contrast to Ntloana Tšoana. Two test trenches closer to the dripline were also excavated.

2010 excavations

The excavations undertaken as part of the MCRM project were carried out in six areas within the rockshelter (Figure 4.2). The excavation made use of a system of single context recording (Museum of London Archaeological Service 1994) before being grouping into phases, where phases refer to

“sub-divisions of the stratigraphic sequence at Ha Makotoko...based on AMS dates, sedimentary composition and artefactual associations” (Mitchell & Arthur 2014: 212).

These re-excavations revealed a much longer (both later and earlier) sequence of occupation than had been indicated by the 1989 excavations, with an infinite radiocarbon date of >52,200BP for Context 190, just above bedrock, including MSA, Robberg, Oakhurst¹⁵, Wilton and post-classic ceramic Wilton industries as well as some Iron Age material on the surface of the site (See Figure 4.3). Analysis of MSA and earlier LSA material is ongoing, although discussion of the early Holocene/late Pleistocene occupations has recently been published (Mitchell & Arthur 2014), while grindstones from all periods are the focus of the functional analysis component of this DPhil. Table 4.1 below indicates grindstone-bearing contexts and their corresponding phases based on information from Mitchell & Arthur (2012b; 2014) as well as unpublished site

¹⁵ Divided into earlier and later phases based on the presence of Woodlot scrapers (Mitchell and Arthur 2012b)

records provided by Charles Arthur. Following Table 4.1, a Harris Matrix (Figure 4.4) illustrates grindstones from the 2010 excavations in sedimentary context, with chronological and phase information.

Table 4.1 Ha Makotoko phases with dates and grindstone bearing contexts (information drawn from Mitchell and Arthur 2012; 2014; Unpublished excavation notes)

Phase	Dates	Grindstone bearing contexts
1	Final LSA/Late Iron Age-Modern. Modern date from Square 54, 58 (UGAMS-8983)	Main area: (001), (002), (004), (141)
2	Final LSA	All areas: (018-020)(076), (003), (021)
3	Final LSA	Main area: (012)
4	Later Oakhurst 9110±30 BP (UGAMS-8984) at top of phase	Main area: (023)
5	Later Oakhurst (Woodlot)	-
6	Later Oakhurst (Woodlot) 9320±30 BP (UGAMS-8985) equivalent to top of BLOS-UR from 1989 excavations (9290±90 BP, Pta-5204)	-
7	Oakhurst(Pre-Woodlot) 10,060±30 BP (UGAMS-8986) 9970±90 BP (Pta-5205)	Main area: (091)
-	Robberg 12,580 ± 35 BP (UGAMS-11594)	Trench 52
8	Minimum age of 25,000 BP (UGAMS-11595) from Area 61, and 28,700 BP (UGAMS-11598) which is the date of the latest MSA	Main area: (030), (074), (116), (120), (109), (119) Area 61: (184)
9	Top of this phase is dated to 40,100±230 BP (UGAMS-8988). (190) is dated to >52,200 BP	Main area: (192), (172), (200), (052), (190) Area 61 (202)
10		Main area: (078)

Grindstone matrix all areas, all contexts
Harris Matrix and Phasing

Figure 4.4 Harris Matrix indicating stratigraphic location of grindstones (labelled 'L101' etc) in the 2010 excavations at Ha Makotoko. Colour coding denotes which grindstone belongs to which context, while grindstones labelled in bold have been subject to residue analysis for this thesis. All grindstones were examined typologically.

Other sources (oral histories, intangible cultural heritage, rock art dating)

A variety of other sources cast light on the most recent phases of occupation at Ha Makotoko. A rock art panel with black figures at the site has a radiocarbon date of 600-300 cal. BP (Adelphine Bonneau, pers. comm. 23/6/2014), while on-site kraals confirm Basotho use of the site as indicated by oral testimonies (Ntate Malefetsane Thibli, pers. comm. 19/9/12; Nic Eoin, unpublished field notes).

4.4 Justifying the Ha Makotoko grindstones as a dataset

The Ha Makotoko corpus of 'grindstones, hammerstones, and introduced rocks' from the 2010 excavations was chosen to test the predictions for grindstone use detailed in Chapters 2 and 3 in this thesis based on a number of criteria: the site is centred in the middle of the Grassland Biome; the excavations made use of a system of single context recording which offered fine-grained control over object locations; organic preservation was known to be good (Lombard 2012); and finally since the excavations were recent, objects were known to have been minimally handled prior to residue analysis. No objects from the 1989 excavations were directly analysed for this thesis.

4.5 Palaeoenvironments

This section summarises palaeoenvironmental information from the MCRM final report (Mitchell & Arthur 2012b). As the neighbouring site of Ntloana Tšoana was also re-excavated as part of the MCRM project, palaeoenvironmental information from this site can help to shed light at conditions at Ha Makotoko.

Faunal identifications made by Genevieve Dewar (University of Toronto) reveal a trend towards greater exploitation of species preferring more open habitats in Phases 4-6 at the site than in the earlier Phase 7, with browsers such as eland (*Tragelaphus oryx*) and klipspringer (*Oreotragus oreotragus*) declining relative to an increase in grazers and

mixed feeders. Microfaunal data indicate climatic conditions through the differential representation of different species of African vleis rats (*Otomys* sp.), with *O. sloggetti* (which prefers colder, drier conditions and is present today only at altitudes above 2500 m within Lesotho) occurring only in pre-Woodlot phases (i.e. Phase 7), while the humidity-preferring *O. irroratus* appears only later (Phases 4-6).

Explorations of stable carbon isotopes by Patrick Roberts *et al.* (2013) reveal very low delta 13 values (below 24‰) throughout the MSA sequence, indicative of nearly 100% C₃ grassland composition in MIS 3, with a trough appearing at 24,000 BP corresponding to increased expansion of cold-adapted taxa towards the LGM. From 13,000 cal. BP, increasingly positive values are seen, indicative of pre-Holocene warming and an expansion of C₄ plants. There is considerable fluctuation throughout the sequence, arguing against a simplistic trend towards heating or cooling.

Charcoal identifications made by Debra Costen (University of Bournemouth) for the 2010 excavation material appear to echo those made by Amanda Esterhuysen for the 1989 excavation material. These are discussed in greater detail elsewhere (Esterhuysen & Mitchell 1997; Mitchell & Arthur 2012b) but notably, a fragment of *Xymalos monospora* (today found only in moist evergreen montane forests to the east of Lesotho) dating to 9335 ± 50 BP at Ntloana Tšoana (less than 2km upstream from Ha Makotoko) indicates wetter conditions at the onset of the Holocene.

4.6 Comparing material culture and site occupation between the 1989 and 2010 excavations

That the 2010 and 1989 excavation areas represent different activity areas on-site is suggested by a comparison of the material culture found: each area shows a distinctive raw material signature, with crypto-crystalline silicas dominating the 2010 area, while

quartzite is more frequent relative to hornfels in the 1989 area than the 2010 area. Patterns of stone reduction are broadly similar, but vastly more cores are present in the 1989 area than in Phases 4-7 of the 2010 areas (the phases which best correlate with the dates from the 1989 area). The comparative lack of cores in the 2010 area suggests that less stone reduction took place here, which is further borne out by quantities of flaked stone: 8615 pieces in phases 4-7 of the 2010 area *versus* nearly 11,000 found in both BLOS-UR and BLOS-LR of the 1989 area (where the 2010 area was comparatively much larger). Numbers of utilised and formal tools further confirm the focus of 1989 on lithic manufacture: more than four times the number of formal tools were found in the 1989 area (n=197) than the 2010 areas (n=43).

Sequences of hearths and preserved (apparently *in situ*) grasses interpreted as bedding in the 2010 area are at odds with the evidence for extensive stone manufacture in the 1989 areas, suggesting that the site was separated into sleeping/eating/fireside and manufacturing areas (Mitchell & Arthur 2012b).

4.7 Grindstones from 1989 *versus* Grindstones from 2010

A relatively low proportion of grindstones (to the total lithic assemblage) was recovered from the 1989 excavations (see Table 4.2), despite the greater total density of lithic material: 0.7% at 9,290 BP; 2.3% at 8950 BP; 0.7% at 8370 BP. Number of grindstones from the 2010 excavations may be compared with this (see Table 4.3).

Table 4.2 Grindstones tabulated for 1989 excavations (data from Mitchell 1993)

	GWA (8370±80 BP)	BLOS-UR (8950±80 BP)	BLOS-LR (9290±90 9970±90 BP)	- Total
Hammerstones	1	2	0	3
Lower Grindstones	1	3	2	4
Ochre stained grindstones	1	0	1	2
Total grindstones	3	5	3	11
Total utilised tools	141	146	232	519
Total formal tools	101	71	25	197
Total tools	142	217	257	716
Grindstones/ total tools	2.1%	2.3%	1.1%	1.5%

(Total grindstones – ochre-stained grindstones)/total tools	0.7%	2.3%	0.7%	1.2%
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Table 4.3 Grindstone counts for the 2010 excavations (data from Mitchell and Arthur 2012; 2014; unpublished excavation data)

	Phase 1/2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8	Phase 9	Phase 10
Total formal and utilised tools	178	48	38	3	4	23	N/A	N/A	N/A
Total un-ochred grindstones	12	2	2	0	0	4	12	12	3
Total ochre-stained grindstones	2	0	1	0	0	0	1	0	0
Grindstone/total tools (%)	6.7%	4.2%	5.2%	0%	0%	17.4%	N/A	N/A	N/A

Table 4.4 Grindstone counts from the 2010 excavations, un-phased MSA assemblages in Trench 61 (Data from Mitchell and Arthur 2012; unpublished excavation notes)

	Upper MSA (Trench 61)	Lower MSA (Trench 61)
Total tools	29	2
Total non-ochre grindstones	2	1
Grindstones/total tools (%)	6.89%	50%

Apart from Phases 1 and 2, which are part of a large total lithic assemblage, the greatest concentration of grindstones occurs in Phases 4 and 7, despite the fact that these are not the phases with the greatest total lithic assemblage: this suggests that in contrast (or perhaps in keeping) with the interpretation that this area of the site was not used in tool production/use at this time, grindstone use was an exception to this role, perhaps reflecting greater domestic role for grindstones than for other kinds of stone tool. That the absence of grindstones in Phases 5 and 6 fits with the general absence of stone tools from this area at this time suggests a change to this pattern, where either grindstone work is absent from this area (and as such perhaps not classed as a domestic activity) and carried out elsewhere on site, or absent altogether. Radiometric dates suggest that Phase 6 corresponds to BLOS-UR, permitting comparison between both the 1989 and

2010 areas of excavation to reveal that grindstone use was nearly absent from the entire site at this time (representing only 0.7% of the lithic assemblage from BLOS-UR). Phase 7 may also correspond to BLOS-UR and, in keeping with the general upswing in lithic proportions, is suggestive of perhaps a different use for this area at this earlier time. Grindstones comprise 17.4% of the assemblage in the 2010 excavation area at this time, dramatically greater than for any period excavated in 1989. Unfortunately due to the absence as yet of comparable dates for grindstone-bearing contexts, this comparison cannot be initiated for any other phase of the 2010 excavations.

As overall lithic counts have not yet been tabulated for phases underlying 7, proportions of grindstones cannot be estimated, but raw numbers appear relatively high. As with Phase 1, however, this may be indicative of a lengthy accumulation of sediments rather than intensified use of plant processing equipment. Phase 10 yielded a small number of grindstones, against a probable lengthy and predominantly geogenic deposit.

From Trench 61 (Table 4.4), rough comparison can be made between upper and lower MSA deposits, where grindstones represent just 6.7% of the upper MSA assemblage but 50% of the lower – this should be contextualised with the information that there are only two tools in the lower assemblage (though one of these is a formally shaped grindstone).

These patterns are further explored, contextualised and discussed in Chapter 7 and in the discussion/conclusion section of this thesis (in which data from residue analysis are integrated), in which I suggest that although for the most part analysis of the 2010 grindstones confirms earlier site interpretations, it also occasionally challenges them.

4.8 Summary

This chapter presented the site of Ha Makotoko and reviewed its location, context, excavation history and palaeoenvironmental data. Information from the two phases of

excavation (1989 and 2010) was compared. The two areas of excavation are considered to have had different functions: the 1989 area predominantly for non-domestic tasks including the manufacture of stone tools; the 2010 area with much less stone tool manufacture and more evidence of domestic activity including hearths and grass bedding. Grindstone tallies for the two areas were compared and found largely to corroborate this interpretation: while grindstones occur in greater quantity in the 2010 area, this is compatible with an interpretation of increased domestic activity, since grindstone processing of foodstuffs could align with this.

Chapter 5. The invisibility of the obvious: towards a typology of grindstones at Ha Makotoko

5.1 Introduction

In Chapter 3, I examined the general neglect of grindstones worldwide, and specifically within southern Africa, exploring the possible reasons and/or justifications for this. I noted that while we could learn and extrapolate a certain amount from the (limited) attention that has been paid to grindstones in southern Africa, our conclusions must be tentative. I suggested that rather than developing novel or innovative study techniques, if the same analytical methodology that is applied as a matter of course to flaked lithics were to be applied to grindstones, we could learn a lot. In this chapter, I attempt to do just that. Taking the corpus of 'grindstones, hammerstones, and introduced rocks' from the 2010 excavations at Ha Makotoko, accompanied by detailed contextual and site information, I analysed them using a simple system: recording dimensions, weight, raw material and morphology (including use-wear visible macroscopically or under low-power microscopy) before using this information to develop a classificatory system, or typology, of the grindstones at Ha Makotoko. This working typology was then cross-referenced with contextual information from the site, results from the related residue studies, and palaeoenvironmental information to further elucidate the grindstone corpus at Ha Makotoko.

5.2 In defence of typology

In the mid-1990s, following a lengthy period of simmering discontent, typology, long considered essential for the study of stone tools, finally fell from grace. Questions were (rightly) posed, particularly within European Middle Palaeolithic studies, as to the relationship between form and function (Binford & Binford 1966), whether the form of a

tool is more to do with a “mental template” (Deetz & Dethlefsen 1965: 196) or its use (and reuse) throughout its life (Dibble 1995): the pertinent question emerges as to whether or not the original manufacturers of a tool would recognise the classification, name, or group given to it by archaeologists (Adams 2002). Dibble (1995) suggested not: that Middle Palaeolithic tools were better seen as products demonstrating a spectrum of reduction, formed through use, rather than discrete design-types reflecting François Bordes’ (1961) system of 63 “tools”.

The main criticism that can be levelled at any typological system (in a southern African context, Janette Deacon’s 1984 typology of the Later Stone Age serves as an analogue) is that the subjective (the formation of criteria for inclusion in a particular group, and the attribution of an item to that group or another) is painted as an objective task (that this attribution is the only possible, plausible, and reasonable option): as Bisson (2000: 6) notes

“The resulting aura of objectivity was [the typological system’s] major attraction; it replaced the muddle of ambiguous categories that had previously hampered inter-assemblage comparisons”

However, rejecting Aristotelian essentialism (Marwick 2008), once we accept the inevitable subjectivity of typology as a concept, it can be rehabilitated as a useful system of analysis. Groups should be based on multiple (rather than singular) criteria (Bisson 2000) and these criteria should be made explicit (Read 1989), nor should a ‘type’ be designated based on (presumed) function – although Lewis and Sally Binford (1966) suggested that artefact form within the Mousterian *was* the result of function (here ‘function’ appears closer akin to ‘purpose’ than ‘use’), it has been observed that many (most?) tools have multiple purposes (Mellars 1996). Of direct relevance to this thesis, for example, some of the items that Dunn (1931) classes as ‘hammers’ are indistinguishable from those classed as ‘mullers, pestles and querns’ – making it impossible to believe that there was no movement between the two categories. Indeed,

if we follow what has been termed “the Philadelphia school” (Hiscock & Attenbrow 2003), through the process of manufacture, use, re-shaping, and re-use all the way to eventual discard, an artefact may move between categories multiple times during its life. Finally, the role of raw material must be emphasised, as discussed by Kuhn (1995) in reference to the Mousterian but also by a variety of authors in what might be termed a materiality or materials approach (Ingold 2000; 2007; 2011; Tilley 2007), where an artefact emerges as the result of interplay between the artisan and the raw material (see also Witmore 2014).

While many authors have emphasised that function and use have as much say in the eventual form of an artefact (as seen by the archaeologist, and as possibly distinct from its original form when freshly made) as design, (Dibble 1995: 307), design and forethought must have an important role to play as well: to remove, or diminish, the design capacity from tool makers is dehumanising, an odd practice for Middle Palaeolithic hominids, but surely ludicrous for MSA and LSA hunter-gatherers all of whom unequivocally belong to *Homo sapiens*.

Although the debate over the utility of typological schemes and subsequent rehabilitation is relevant to all lithic studies (indeed, all material culture studies), it is particularly pertinent in the case of grindstone technology. While a certain degree of pre-use shaping and forethought is demonstrable for agricultural grindstones (as evidenced by ethnoarchaeology and the generally more elaborated forms of archaeological examples that cannot be replicated through experimental studies of use alone), there is less willingness to accept this design in the case of hunter-gatherer grindstones, possibly due to their more amorphous nature. Mike Smith, perhaps one of the only archaeologists to advocate a typological approach to hunter-gatherer grindstones (1988; 2004), notes that there appears to be an unwillingness

“to consider recurrent morphological variability in grindstones – and describe their typology...most work [in Australia] has instead focussed on residues and use polish (so called ‘functional analysis’, as if morphology was not functional)”. (Mike Smith, pers. comm. 12/11/2013).

Thus, residue and use-wear have, perhaps, been embraced by grindstone analysts as a way of determining artefact function without entering into the thorny area of categorisation, classification and typology. To a certain extent, this is laudable: thorough evaluation of the residues and use-wear of individual objects is the only way of determining the specific uses and life-history of that individual object (Fullagar *et al* 2015). The problem lies in extrapolating beyond this information: without a classificatory grouping system, every single artefact in an assemblage must undergo the same analysis (which, as I discuss in Chapter 8, is costly both in terms of labour and money, putting it beyond the budgets of many post-excavation projects) and no generalisations can be made, at either intra- or inter-assemblage levels. There is also the problem that without explicit, detailed typological schemes in the published domain, archaeologists have a tendency to apply murky default mental templates to what an artefact “should” look like – it is pointless to suggest that typology should be done away with because selection and grouping must always play a role in excavation. As I have stated previously, the corpus of material studied here was already subject to some pre-selection based on what excavators thought “grindstones, hammerstones and introduced rocks” looked like. In examining this corpus, I have often agreed, and occasionally disagreed, with initial categorisations of ‘grindstone’ and ‘hammerstone’ (where ‘introduced rock’ represents simply any non-sandstone and apparently unworked pieces of lithic raw material other than sandstone and greater than 2cm), finally coming to the conclusion that they could be improved for the benefit of excavator, post-excavation analyst and audience if we only explicitly described what we mean by them: this is standard practice for other material culture types, so why not grindstones?

5.3 Background work

All this being said, despite the relative absence of typological or morphometric work on grindstones in southern Africa, some studies exist for other regions. Mike Smith's work in Australia has already been mentioned (showing that typological analysis is practicable and useful for less formal, more *ad hoc* tools), while there is more of a wealth of material on grindstones from agricultural societies e.g. (Wright 1992; Adams 2002). Adams' work is particularly useful as it provides her own classificatory schema for the different types of grindstones she encounters in the southwestern United States. As her typology deals with the formal and relatively elaborate grindstones encountered in this region, it cannot be applied directly to other regions, but the methodology she uses in arriving at this typology can: for her "technological approach" she recommends a combination of ethnography/ethnoarchaeology (predominantly gleaned from literature review), experiments, use-wear, classification techniques and excavator descriptions.

These examples constitute applications of typology following what David Clark (1973) has termed a loss of disciplinary innocence (i.e. an archaeology that is critically self-conscious must bear in mind the inherent problems underlying classificatory schema). We might also do well to consider those studies that pre-date this self-conscious phase: early studies did not question the relative subjectivity of their typological groupings, but rather assumed an ontology that naturalised them. Within southern Africa, I refer to two examples in this regard. The first, James Walton's (1953) study of 'pestles, mullers, and querns' from the (then) Orange Free State and Basutoland, is archaeological, while Dunn's (1931) mention of grindstone technology within his ethnographic memoir on *The Bushman* is what we might very loosely term ethnoarchaeology.

Walton's study unquestioningly utilises both contemporary ethnography and foreign terminology (mullers and querns, both of which by their definition assume a certain

purpose of the artefact in question) in classifying the grindstones he discusses. He thus arrives at a classificatory system of grindstones that he associates with distinct groups/technocomplexes: Early Bantu groups (with Iron Age technologies) and the Smithfield industry (an LSA technocomplex thought at the time of Walton's writing to be contemporary with the Wilton, but produced by a different ethnic group (J. Deacon 1974)). There is little evidence of his typology having been adopted by other archaeologists, possibly because of the slightly problematic way in which he relates specific objects to broad regions of both space and time based on an unknown number of examples. Nevertheless, it remains the sole example of a published southern African grindstone typology. Dunn's work is even more brief: consisting of only a few pages in his larger work, he nonetheless uniquely, among late nineteenth century observers and collectors, provides what might be termed a pictorial typology of Bushman, "Hottentot" (Khoekhoe) and "Kaffir" (Bantu-speakers) grindstones and demonstrates quite clearly the difference between the three groups, suggesting that different elements of/priorities for raw material choice, design and use were in play with each, resulting in different forms.

What both of these studies show is the paramount importance of considering not just design and not just use, but rather both in tandem. Bearing this in mind, as well as the general comments on rehabilitating typological schemes discussed above, and factoring information on manufacture of Basotho grindstones (Nic Eoin, unpublished field notes), I now present the working typology I developed for Ha Makotoko's grindstones from the 2010 excavation. A total of 69 grindstones were classified using this typology, from an original corpus of 94 "grindstones, hammerstones and introduced rocks". Every object was measured, weighed, photographed, illustrated, and had observations made on its shape, texture, raw material and any macroscopically (or low-power binocular microscopically) visible residues or usewear, and whether it was whole or fragmented,

before being cross-referenced with contextual and phase information from site excavation data. A number of objects were selected for further residue analysis (the methodology and results of which are discussed in other chapters). Recurrent observations (e.g. shape, concentration of use-wear to a particular face of the object) were grouped to form the basis of the typological categories. Where items did not fit these rough categories, the categories were re-assessed to determine if they warranted alteration or if an additional category needed to be created. Twenty-five objects were eventually discarded as either unused or (where they bore some hallmarks of use as a grindstone) too fragmentary to be classified. Images of all grindstones are presented in Catalogue 1, and a selection of images illustrating each type listed below is presented in section 5.4.1. Morphometrics of each grindstone class are presented in section 5.5 below.

5.4 Description of types

Upper Grindstone Class 1: Elongated or convex shape; facet present; percussive damage; polish (all features should be present with the exception of polish which does not occur on items made from sandstone). See e.g. L177 (Figure 5.1), L147, L182 in Catalogue 1.

Upper Grindstone Class 2: Facet present; percussive damage; polish; convexity (this may be the sign of a developing facet). The majority of features should be present. See e.g. L125 (Figure 5.1), L104, L126 in Catalogue 1.

Upper Grindstone Class 3/Hammerstone: Convexity; percussive damage; areas of polish. See e.g. L140 (Figure 5.2), L129 in Catalogue 1.

It will be seen from this classificatory scheme that only where the development of a facet (from intensive use in abrasive activity) is observed, is an object designated as an

Upper Grindstone *sensu strictu*, as the other features listed may equally pertain to hammerstones.

Lower Grindstone Class 1: All features should be present, including at least one wide, flat face, with a developing sloped concavity in relation to perpendicular faces (which should be convexly curved), percussive damage, polish (again, this will not be present on sandstone artefacts). Sandstone artefacts are less likely to display the same degree of convex curvature to the side of vertical (perpendicular to the flat presumed 'grinding surface') faces as basalt because of the differential nature of sandstone weathering. Finally, while striations (either horizontal and elongated, indicating back and forth movement of an abrasive element, or curved, indicating circular movement of the upper element) may be present, these may be faint/difficult to see against the coarse grain of the raw material, masked by residues, or not present. See e.g. L173 (Figure 5.3).

Lower Grindstone Class 2 : Most features should be present including a wide flat face as above, percussive damage, polish (if artefact is made from basalt), curvature to side, and development of a concavity. See e.g. L115 (Figure 5.4) and L160 in Catalogue 1.

Lower Grindstone Class 3: Flat faces and percussive damage. From this characterisation it will be seen that an item assigned to this class could possibly be part of a higher class but as a fragment that does not preserve the hallmarks of Lower Grindstone of class 1 or 2. See e.g. L116 (Figure 5.4), L107, L152 in Catalogue 1.

All typological classes necessarily mix design and use – thus it is not a hard and fast rule that an item of class 1 reflects greater design input than that of class 3 – rather, an item designated Lower Grindstone class 1 might reflect a) considerable shaping prior to use b) little pre-use shaping but considerable use or c) an equal combination of these two

factors. Where re-shaping has taken place to preserve the original form/use of the artefact, increased evidence of percussive damage/pecking might be visible. Classes 1, 2, and 3 are thus hierarchical, indicating increased formalisation/utilisation. The lower the class, the greater the possibility of multi-purpose use (as with Upper Grindstone Class 3/Hammerstone), as this use may preclude the development of morphologies related to specialised use.

5.4.1 Illustration of grindstone types from the Ha Makotoko archaeological collection

Figure 5.1 L177 (top) is an example of an upper grindstone class 1; L125 (bottom) is an example of an upper grindstone class 2

Figure 5.2 L140 is an example of an upper grindstone class 3/hammerstone

L173

Figure 5.3 L173 is an example of a lower grindstone class 1

Figure 5.4 L115 (top) is an example of a lower grindstone class 2; L116 (bottom) is an example of a lower grindstone class 3

5.5 Morphometrics

Following the presentation of the working typology, morphometric data is factored in and discussed in the manner of general lithic analysis in Table 5.1 to Table 5.6. Prior to typological classification, artefacts were weighed and measured in three dimensions (recorded here as maximum, medium and minimum, but in practice these generally

correlated with length, width and height – because the correct orientation of objects cannot be certain, more objective terms have been used here). Finally, artefacts were assessed as to whether they represented whole (unbroken) objects or fragments.

Table 5.1 Morphometric data for Lower Grindstones class 1 at Ha Makotoko

ID	Maximum dimension (mm)	Medium dimension (mm)	Minimum dimension (mm)	Weight (g)	Whole	Fragment
L113	162.48	114.17	47.7	1953.7	1	
L115	114.2	78.34	31.27	648.1		1
L119	56.64	47.78	29.39	196.9		1
L145	152.5	119.88	89.48	2543		1
L146	190.6	170.6	79.96	5500	1	
L154	59.2	71.18	32.27	244.9		1
L155	119.07	69.47	38.66	622.9		1
L156	178	132.21	38.48	1745.4	1	
L160	58.5	41.22	29.43	108.1		1
L173	280	200	75	6500	1	
L175	85.63	73.49	32.5	417.3	1	
L176	46.8	41.08	39.95	114.9		1
L184	48.35	51.3	32.18	147.4		1
L189	169	111.36	40.63	1104.5	1	
L190	97.5	71.34	45.3	529.5		1
L193	148.44	118.42	82.15	1505.5	1	
Total whole/fragmented objects					7	9
Average weight of whole objects (g)					2675.1	
Average maximum dimension of whole objects (mm)					173.45	
Average medium dimension of whole objects (mm)					131.46	
Average minimum dimension of whole objects (mm)					56.63	

Table 5.2 Morphometric data for Lower Grindstones class 2 at Ha Makotoko

ID	Maximum dimension (mm)	Medium dimension (mm)	Minimum dimension (mm)	Weight (g)	Whole	Fragment
L109	149.85	92.28	52.81	1089.9		1
L110	112.82	53.27	36.06	397.4		1
L112	66.85	58.9	41.88	225.3		1
L116	102.94	85.45	42.77	473.6		1
L122	83.38	57.43	33.09	318.8		1
L123	71.66	49.77	21.04	141.1		1
L134	78.25	46.77	31.49	557.1		1
L150	102.42	86.8	46.07	838.9	1	
L152	131.41	102.85	41.75	854.2		1
L169	45.16	43.68	20.53	60.1		1
L191	132.77	76.5	66.03	1003.1		1
Total whole/fragmented objects					1	10
Average weight of whole objects (g)					N/A	
Average maximum dimension of whole objects (mm)					N/A	
Average medium dimension of whole objects (mm)					N/A	
Average minimum dimension of whole objects (mm)					N/A	

Table 5.3 Morphometric data for Lower Grindstones class 3 at Ha Makotoko

ID	Maximum dimension (mm)	Medium dimension (mm)	Minimum dimension (mm)	Weight (g)	Whole	Fragment
T1	58.03	42.59	43.5	147.8		1
L139	109.43	56.42	32.2	241.6		1
Total whole/fragmented objects					0	2
Average weight of whole objects					N/A	
Average maximum dimension of whole objects					N/A	
Average medium dimension of whole objects					N/A	
Average minimum dimension of whole objects					N/A	

Table 5.4 Morphometric data for Upper Grindstones class 1 at Ha Makotoko

ID	Maximum dimension (mm)	Medium dimension (mm)	Minimum dimension (mm)	Weight (g)	Whole	Fragment
L147	190.1	97.77	50.11	1803.7	1	
L153	74.94	65.58	26.54	211.1		1
L177	101.64	84.74	70.35	656.2		1
L178	49.96	41.9	29.97	112.7	1	
L182	93.9	62.27	46.37	449.4		1
L185	51.71	45.36	25.47	86.6	1	
Total whole/fragmented objects					3	3
Average weight of whole objects (g)					667.67	
Average maximum dimension of whole objects (mm)					97.25	
Average medium dimension of whole objects (mm)					61.67	
Average minimum dimension of whole objects (mm)					35.18	

Table 5.5 Morphometric data for Upper Grindstones class 2 at Ha Makotoko

ID	Maximum dimension (mm)	Medium dimension (mm)	Minimum dimension (mm)	Weight (g)	Whole	Fragment
L101	81.12	54.73	49.5	369.1		1
L103	75.76	45.59	32.85	167		1
L104	59.6	40.98	39.8	116.8		1
L106	57.21	37.08	26.14	63.1	1	
L108	96.7	59.28	28.05	318.5		1
L125	47.73	42.41	32.74	105	1	
L126	55.68	34.46	31.8	76.1		1
L142	41.14	36.64	26.38	65.5		1
L161	67.85	48.49	31.43	112.2		1
L162	32.93	31.97	25.79	44.1	1	
L163	32.35	25.54	21.46	26.1		1
L165	43.73	37.16	27.59	53.5		1
L180	63.11	38.07	29.77	115.6	1	
L181	75.87	68.26	38.31	278.4	1	
L192	58.03	43.5	42.59	147.8		1
Total whole/fragmented objects					5	10
Average weight of whole objects (g)					137.23	
Average maximum dimension of whole objects (mm)					59.25	
Average medium dimension of whole objects (mm)					42.94	
Average minimum dimension of whole objects (mm)					32.28	

Table 5.6 Morphometric data for type Upper Grindstone 3 at Ha Makotoko

ID	Maximum dimension (mm)	Medium dimension (mm)	Minimum dimension (mm)	Weight (g)	Whole	Fragment
L129	57.39	44.89	35.82	145.1		1
L133	67.29	46.41	37.31	139.6		1
L140	66.3	65.52	62.84	412	1	
L151	36.53	81.5	36.51	250.8		1
L167	69.66	92.53	30.35	246		1
Total whole/fragmented objects					1	4
Average weight of whole objects (g)					N/A	
Average maximum dimension of whole objects (mm)					N/A	
Average medium dimension of whole objects (mm)					N/A	
Average minimum dimension of whole objects (mm)					N/A	

Where average weights and dimensions for categories can be compared, we see that class 1 types are heavier and larger than those of class 2 which are, in turn, heavier and larger than those of class 3: this may be an artefact of classification, since larger or more complete objects (note the higher incidence of whole objects in class 1) are more easily assigned to more formal/intensively used categories: for example, the chances of preserving the distinctive facet that I observe as characteristic of Upper Grindstone class 1 are more likely the larger and more complete the artefact in question (whereas a smaller, more fragmented piece is less likely to preserve the required criteria). This observation is borne out by examination of mean object dimensions as well.

5.6 Grindstones contextualised

Following attribution to different typological classes, objects were cross-referenced with context and phase information from excavation data discussed in Chapter 4 (Tables 5.7 and 5.8).

Table 5.7 Grindstone types by phase at Ha Makotoko

	Phases										Total
	1	2	3	4	5	6	7	8	9	10	
Upper Grindstone 1	4										4
Upper Grindstone 2	3		1					6	5		15
Upper Grindstone 3				1				1	2	1	5
Lower Grindstone 1	4	1	1	1			1	1	2	1	12
Lower Grindstone 2							2	4	3	1	10
Lower Grindstone 3	1						1				2
Other	1			1				1			3
Total	13	1	2	3	0	0	4	13	12	3	69

Table 5.8 Grindstone types in contexts without phases at Ha Makotoko

	Upper MSA	Lower MSA
Upper Grindstone 1	1	1
Upper Grindstone 2		
Upper Grindstone 3		
Lower Grindstone 1		
Lower Grindstone 2	1	
Lower Grindstone 3		
Total	2	1

From Table 5.7 it appears that categories indicative of the most formalisation or intensive use are most prevalent in the site's most recent layers: there are four each of types Upper Grindstone 1 and Lower Grindstone 1 in Phase 1. These types correspond most closely with the stylised Basotho grinding implements dating to the nineteenth and twentieth centuries (Nic Eoin, unpublished data). The similarities between these and Lower Grindstones of classes 1 and 2 may be as a result of technological information exchange (recognition, perhaps, with the influx of domesticates on site in this phase, that this style of tool kit was best adapted to their processing). However, against expectations, Upper Grindstones of class 1, similar in appearance to Basotho *litšiloane*, are not restricted solely to the most recent phase, but, surprisingly, crop up in upper MSA layers in Trench 61 in an isolated example, and again in the lower MSA layers (see Table 5.8).

These occurrences indicate that such a formalised type was well within the technological capability of hunter-gatherers using the site from an early date, and does not represent a technological calque from Basotho grindstone users. Alternatively, such technological *savoir-faire* may have been lost, possibly in the absence of need for it in the interim period, though this provokes the question of what changes in subsistence might have occurred during this time, as none are immediately obvious from examination of either palaeoenvironmental data or grindstone residues. Could the increased investment in formalised (or more intensively used – the difference is moot here) grinding technology in the most recent periods on site reflect an intensification of the existing resource base, possibly as the result of competition with the new immigrants to the area indicated by the presence of an Iron Age kraal?

Lower Grindstones of class 1 are not so rare as Upper Grindstones of this class, occurring in all grindstone-bearing phases (except in Trench 61), suggesting that this

shaping may have been more easily facilitated, or necessary for the processing of gathered materials. They are, again, most common in Phase 1.

Upper and Lower Grindstones of class 2 are most common in Phases 8 and 9, which, other than Phase 1 bear the largest grindstone assemblages on-site. In fact, Phases 8 and 1 are mirror images of each other in terms of grindstone typology: where Phase 8 has four of Lower Grindstone class 2, Phase 1 has four of class 1, with very similar overall grindstone yields. This suggests that grindstone use/plant processing was of similar importance in these periods, but that formalised tool-shaping for this purpose was not a priority in Phase 8, unlike Phase 1. The number of Upper Grindstones of class 2 echoes this picture – a similar emphasis on plant processing but without corresponding emphasis on formal tools for that purpose – in Phases 1, 8 and 9, and in general proportions in Phase 9 echo those of Phase 8.

Upper and Lower Grindstones of class 3 are, at first glance, perhaps unexpectedly rare. However, this is more an artefact of classification than of reality: the original corpus of ‘grindstones and hammerstones’ (excluding ‘introduced rocks’) from Ha Makotoko, was, as has been previously stated, the result of pre-selection on the part of the excavators into material that can be broadly termed as looking vaguely grindstone like (as opposed to flaked fine-grained stone). There is little analytical rigour attached to such a categorisation, understandably, given that there is no classificatory scheme to utilise in determining which objects are more grindstone-like than others, existing typologies (J. Deacon 1984; Inskeep 1987) paying little attention to them. Selection, therefore, likely occurs based on how close or far an object appears to be related to some form of idealised grindstone (the fact that this idealised image is perhaps false is also discussed above – I suggest that most excavators will have in mind something that looks more like the Basotho style equipment than even what I have termed Lower or Upper Grindstones of class 1). Thus, Upper and Lower Grindstones class 1 are “most like” the formalised,

idealised image of a grindstone, and Upper and Lower Grindstones of class 3 the furthest from this, closer to those items that were discarded as “unused” based on this typological classification. Therefore the relative absence of items in these categories is not so surprising as at first glance, and emerges as an artefact of research, or rather, one that emphasises the limits of classificatory schemes.

5.7 Observations on raw material

As suggested by Kuhn (1995), Ingold (2007; 2011), Tilley (2007) and others, the characteristics and properties of the raw material to be worked may exercise considerable influence over the final artefact. Ingold (2011: 22-23) sees artefacts not as the consequence of imposition of mental ideas upon material substance, but rather waiting to emerge from the material in question, in collaboration with the human artisan working it. That the different ‘material affordances’ (Gibson 1979; Ingold 2007) of the raw materials used by hunter-gatherers at Ha Makotoko were well understood is clear from a consideration of those used in grindstone manufacture (see Table 5.9 and Table 5.10).

Table 5.9 Raw materials used in grindstone manufacture by grindstone type at Ha Makotoko

	Basalt	%	Sandstone	%	Mudstone	%	Other	%
Upper Grindstone 1	6	100						
Upper Grindstone 2	13	81.25	1	6.25	1	6.25	1	6.25
Upper Grindstone 3	3	75			1	25		
Lower Grindstone 1	11	73	4	27				
Lower Grindstone 2	9	75	3	25				
Lower Grindstone 3	1	50%			1	50%		
Other	1	33%	2	67%				

Table 5.10 Raw materials used in grindstone manufacture by phase at Ha Makotoko

Phase	Basalt	%	Sandstone	%	Mudstone	%	Other	%
1	13	100						
2			2	100				
3			1	50			1	50
4	1	33	2	67				
5								
6								
7	2	50	1	25	1	25		
8	9	50	2	25	1	25		
9	9	50	2	25	1	25		
10	3	100						
Total	37	72.5	10	19.6	3	5.8	1	1.9

As Table 5.10 shows, basalt emerges as the dominant raw material category in all Phases except 2 and 4, both of which are phases with low numbers of grindstones generally, and neither of which contain Upper Grindstone of classes 1 or 2 (Phase 4 contains a single Upper Grindstone of class 3) (see Table 5.7)– the fact that basalt dominates manufacture of these categories (100% of Upper Grindstone class 1, 81.25% of Upper Grindstone class 2) is interesting, suggesting that it was regarded as the best material for this task, or, possibly, the most easily available. Basotho informants from near Ha Makotoko noted that suitable upper grindstones were harder to come by than suitable material for lower grindstones (perhaps given the larger size of the lower grindstones they were regarded as being more easily shaped than upper ones) and were predominantly taken from the riverbed (which yielded basalt cobbles of suitable size for handholding, already naturally weathered and rolled by the river) (Nic Eoin, unpublished field notes).

Grindstone manufacturers at Ha Makotoko apparently realised and took advantage of the natural tendencies of sandstone and basalt to weather in differential forms in their manufacture of upper and lower grindstones (see Table 5.9): Basalt outcrops typically undergo what is known as ‘spheroidal weathering’, liberating rounded basalt blocks that

will be rapidly smoothed and further rounded if transported by rivers, while sandstone's bedded structure promotes a tendency to weather in tabular pieces, especially where it is interbedded with other sedimentary rocks such as mudstone (Chris Doherty pers. comm. 14/01/2015). Furthermore, the dense weight of a basalt upper grindstone could have been advantageous in promoting not only abrasion of processed material but crushing as well. Sandstone and basalt used as a grinding pair will act differently upon the intermediate substance undergoing processing, the upper grindstone crushing, pushing and moving it - and thus traditionally known as the 'active' element - against the 'static' lower grindstone. However, if we take the raw material affordances into consideration, we see that in material terms, the lower grindstone is in fact the active element: human bodily action/gesture pushes the material undergoing processing against it, shearing it against loose grains in the case of sandstone, and vesicles (either natural or as a result of crystal loss from the matrix through percussion/abrasion) in the case of basalt (See also Adams 2002).

5.7.1 Raw material preference and pigment processing

Further differences in raw material preference emerge when macroscopically visible residues are factored in, as indicated by Table 5.11.

Table 5.11 Raw materials used in manufacture of pigment-stained *versus*. non pigment-stained grindstones

	Basalt	%	Sandstone	%	Mudstone	%	Other	%
Red pigment-stained	1	20	4	80				
Other pigment	1	50					1	50
Non-ochre-stained	43	81.1	6	11.3	3	5.6	1	1.8

Sandstone (80% of ochre-stained assemblage) is more frequently found with red-pigment-staining¹⁶ than basalt (25% of ochre-stained assemblage), and while red-

¹⁶ See Appendix B for characterization of these mineral pigments

pigment-stained items contribute 40% to the total sandstone assemblage they contribute approximately one-twentieth of this (2.2%) to the total basalt assemblage. This may have to do with the prevalence of basalt in Upper Grindstone manufacture but is not entirely explained by this, as one ochre-stained lower grindstone is made on basalt. The preferential red/ochre-staining of sandstone artefacts as compared with basalt ones cannot be attributed to utility, neither can it be interpreted through Basotho ethnography, as basalt is equally as likely to be used as a lower grindstone for ochre-processing as sandstone ('Me Malireko Masakale, pers. comm. 13/9/2012), thus it emerges as idiosyncratic human choice. Perhaps the use of sandstone as a lower grindstone for ochre relates to the recognition that it derives from the sandstone itself, or perhaps pigment was mixed on sandstone in recognition of a relationship between the sandstone grindstone and paintings on the wall of the sandstone shelter. Pigment-staining of upper grindstones is isolated to a single artefact: Wadley (2005) suggests that formal upper grindstones would have been less suited to the task of grinding ochreous minerals than coarse-grained flat stones. This may go some way to explaining the relatively low number of ochre-stained grindstones within this assemblage. However if this is the case, why, then is there any evidence of ochre-grinding on grindstones at all? Does it represent a special case? Or was efficiency not prized here?

5.8 Conclusion

While there are problems connected with an unquestioning approach to typology/artefact classification, this chapter shows that with a degree of critical self-consciousness, we can avoid an archaeological equivalent of throwing the baby out with the bathwater: explicit, clearly defined typological schema that privilege neither design nor use but recognise the relationship between both of these aspects in resultant tool form, while also taking into account the role of materiality, are to be preferred to the analytical fudge and confusion that reign in their absence, and permit us to make intra-

assemblage comparisons. It is hoped that eventually application of such a typology at multiple sites will allow us to compare multiple assemblages and examine variation and similarity. At Ha Makotoko, typological classification and analysis shows that manufacturers/artisans had a keen knowledge of raw material affordances and properties, and made decisions based on this knowledge. This analysis also illuminates the fact that formal/intensively used upper and lower grindstones are not solely the preserve of agricultural societies such as the Basotho, but were also utilised by hunter-gatherers in pre-contact contexts. This is probably mostly to do with available raw materials and their affordances, since in pursuit of similar goals, there are a limited number of forms of stone that will emerge from the combination of intentional design and applied use. Nevertheless, it seems likely that manufacturers recognised the different qualities of different raw materials and made use of them accordingly. Further contextualisation of Ha Makotoko's grindstones will be addressed (including a generalised *chaîne opératoire* of their use) in the final chapter of this thesis.

5.9 Summary

This chapter forms the methodological analogue for Chapter 3. Following discussion of the idea that grindstones are a neglected and under-utilised resource within southern Africa, and why this is problematic, it considered how they can be rehabilitated, suggesting that a focus on typology is key. Creating a typology for grindstones at Ha Makotoko necessarily involved consideration of the pitfalls and benefits of typology as applied elsewhere within lithic (but also all other material culture) studies, notably the fact that as objects considerably shaped by use, grindstones must also be considered as part of a spectrum of reduction. Nonetheless, I argue that this is compatible with efforts at typology, and that an explicitly defined attempt at categorisation must always be preferable to the murky definitions and hazy concepts that necessarily exist in its absence. With these ideas in mind, the typology for Ha Makotoko's grindstones was

presented, along with the characteristics of each typological class. This typology was then used to analyse the grindstones at the site. Findings include the fact that raw material choice appears to have been thoughtful, with preferential use of basalt for upper grindstones and lower grindstones, and sandstone used for lower grindstones exclusively, which may correlate with pigment use. The most formalised/heavily utilised types predominate in the most recent phases of occupation, possibly contemporaneous with Basotho occupation of the same area, and possibly as a result of contact or competition with these new migrants. Apart from site-specific information drawn from typological analysis, it is hoped that by applying this working typology to other sites within the Grassland Biome and, eventually, further afield, inter-site assemblage comparisons may be possible, which should further elucidate the role of grindstones in southern African hunter gatherer lifeways.

Chapter 6. Starch analysis of grindstones from Ha Makotoko

6.1 Overview

In determining whether or not grindstones at Ha Makotoko were used to process geophytes, as is suggested by prevailing archaeological thought in southern Africa (see Chapter 2), starch analysis of these artefacts emerges as key, since many underground storage organs are starch-rich. The study of archaeological starch is a growing area of interest in residue analysis and has been widely applied to the study of grindstones. The following sections discuss the production of starch by plants, its diagnostic features, its preservation and risk of contamination, and the utility of starch analysis as a method for archaeologists. Subsequently, a reference collection of known economically useful plants in the region is presented, as are results of starch analysis on 15 grindstones and six sediment samples from Ha Makotoko.

6.2 Production of starch by plants

During photosynthesis (the process by which plants convert energy from sunlight into usable energy for storage within its cells), water is split into hydrogen and oxygen atoms within the plant's chloroplasts. Oxygen is emitted into the atmosphere, and free hydrogen molecules combine with absorbed carbon dioxide to form glucose (a simple sugar). Glucose can then be converted to protein, fat, and complex carbohydrates (cellulose and starch) to serve the plant's energetic needs. Some glucose travels from the chloroplasts to its storage organs, where, within an amyloplast, it converts to starch. This 'reserve' or 'storage' starch remains here until the plant needs energy, at which point it converts back to glucose and travels to other parts of the plant.

Formation of the starch granule starts at a point known as the 'hilum' and is laminar: under normal growth conditions, one layer of starch is deposited by the plant per day (Tester 1997: 166). When the photosynthetic rate is high, 'transitory' starch is also produced, which can be moved around the plant to fulfil energetic needs when it is not undergoing photosynthesis (i.e. when the plant is not exposed to light). Thus, starches are found within almost every kind of plant tissue: seeds, stems, fruits, bark, wood (the young 'sap' wood within a tree, rather than the older 'hard' wood). Storage starch is often found in what are generically termed 'underground storage organs' or 'geophytes' by archaeologists, but which are more specifically known as root tubers, stem tubers, tap-roots, corms, bulbs, and rhizomes.

6.3 Structure and characteristics of starch granules: why starch is useful for archaeologists

Starch granules are built up of units of glucose, formed into two different chains: amylose (an amorphous, unbranched molecule) and amylopectin (branched and semi-crystalline, making up 70-80% of the starch granule) (Tester *et al.* 2004). Growth consists of the laying down of concentric rings of, alternately, amylose and amylopectin. The alternation of amorphous and semi-crystalline materials gives starch its characteristic semi-crystalline structure, which is highly ordered. Because this structure is anisotropic (i.e. the constituting materials of starch have different refractive indices), starch granules are birefringent under polarised light, appearing bright against a dark background. With storage starch (which is the primary concern of archaeologists; transitory starch does not exhibit the same diagnostic-to-type properties), granule size varies from 1 – 100µm and shapes are typically spherical to ellipsoidal (Haslam 2004), although, importantly, these can be damaged/altered by human activity (Tester 1997b; del Pilar Babot 2001; Crowther 2012).

Apart from birefringence, starch is characterised by other qualities that make it useful as an analytical method in archaeology. The first, which also becomes apparent under polarised light, is the exhibition of a rotating 'extinction' or 'maltese' cross that varies with granule type (Gott *et al.* 2006). The centre of the cross is at the hilum of the starch granule and can thus be either centric (e.g. wheat) or eccentric (e.g. potato) according to plant species. Extinction crosses are also exhibited by ooliths, coccoliths, faecal spherulites, some avian/reptile uric acid spheres and some plant calcium oxalates (Haslam 2006). However, all of these materials have much higher refractive indices than starch and are therefore practically invisible in water (Lamb & Loy 2004).

When starch granules come in contact with water, they swell by a small amount in a reversible process. However, when starch is heated in water above a specific temperature (which varies across species, but is typically around 60°C for most plants; Haslam 2004) the hydrogen bonds between amylose chains gradually break down, the granule begins to absorb water and loses many of its diagnostic qualities (such as its birefringence and extinction cross). This process is known as gelatinisation. Not all granules within a given sample will necessarily gelatinise: this may be to do with non-uniform heat transfer across the sample (Crowther 2012). Mechanical (rather than chemical) damage to starch may result in cracking as well as loss of diagnostic criteria such as birefringence or a clear extinction cross (del Pilar Babot 2001). Finally, starch responds in a diagnostic manner to several chemical and/or biological stains. When stained with Iodine-Potassium-Iodide (IKI) solution, pure amylose turns navy blue, pure amylopectin turns reddish, while damaged starch will retain the red stain of Congo red.

These diagnostic qualities of starch make its analysis profitable for archaeologists: because plant species exhibit diagnostic differences when exposed to different phenomena and because starch granule morphology is diagnostic to species,

archaeologists have had considerable success in the identification and characterisation of ancient starch residues. It is worth noting, however, that a particular species may include a variety of different starch granule morphologies (and that transitory starch granules are less diagnostic to species). For example, Triticeae exhibit two kinds of starch granule: larger lenticular/disc-shaped granules, as well as smaller spherical ones (See Figure 6.1). For this reason, starch granule morphology should be described at population level for each species, if possible, to minimise the risk of assigning different granule morphologies from the same species to multiple taxa (Torrence *et al.* 2004).

Figure 6.1 *Secale strictum* ssp. *africanum*, displaying the characteristic dual morphology of the Triticeae

Another reason that archaeologists find a valuable analytical method in starch is simply that it is there: starch residues have survived on artefacts for millennia while still retaining their diagnostic qualities: Julio Mercader *et al.* (2009) report sorghum starch on MSA artefacts from northern Mozambique that are at least 105,000 years old. Starch is also able to survive in a wide variety of environments: rainforest (Piperno & Holst

1998), deserts (Fullagar & Field 1997), submerged sites (Piperno *et al.* 2004), cave sites (Barton & Paz 2007) and open air sites (Langejans 2006). Artefacts from museum and private collections (i.e. which have not been freshly excavated) have also been successfully analysed for starch (Barton 2007; Field *et al.* 2009). Starch analysis has been applied to a variety of different artefact classes: grindstones (Liu *et al.* 2010), scrapers (Mercader *et al.* 2008), wooden objects (Field *et al.* 2009), offering a range of possibilities for exploring past plant use.

In her experimental work on the preservation of starch, Langejans (2010) found that the environments which best promoted the preservation of starch were, unsurprisingly, those that promoted the survival of other organic residues: biological decomposition is the main driver of starch decomposition (via microbial or enzyme activity), thus sites with little biological activity are those that will sustain the preservation of organic residues. Langejans notes that this means that open-air sites are not favoured. Sites subject to 'extreme' conditions may be best: arid, waterlogged sites, extremely alkaline or acidic sites, or soils containing heavy metals offer the optimal preservational conditions for residues. There is also some evidence that clayey soils may be beneficial to the preservation of organics, since they may inhibit enzyme activity (Haslam 2004).

Notwithstanding these findings, it must be re-emphasised that in practice, starch has been recovered from a huge variety of environments. One of the major reasons for this, apart from the differential taphonomic conditions of soils, is probably the sheer number of starch grains in what may seem like relatively small samples of living plant tissues: Haslam (2004) points out that 1kg of maize starch is estimated to contain 10^{12} individual starch granules. While we are unlikely to recover this weight of any particular plant resource on archaeological material, we can sub-divide this accordingly: 1 gram of plant residue may be a more realistic amount of expected recovered plant material, or even 1 milligram, respectively containing 10^9 and 10^6 starch grains. In practice,

archaeologists are unlikely to come across anything like these numbers of granules adhering to individual artefacts: we must then conclude that starch *is* very vulnerable to decay, but that the numbers involved are advantageous to the residue analyst. Starch decay is believed to be asymptotic in nature, meaning that decay rates are initially very high (and most of a sample will decay in a very short space of time) but subsequently drop off, perhaps even stabilising (Lähdesmäki & Piispanen 1988), though variably according to plant species (Haslam 2004). All of these factors mean that it is very difficult for the archaeologist to estimate quantities or proportions of living plant tissues processed on artefacts based on remaining residues, since starches are taphonomically variable.

Another reason for the preservation of starch on artefacts may be that the artefacts themselves offer 'micro-environments' favourable to the conservation of starch: the cracks and crevices within artefacts may constitute protective zones for organic residues (Barton 2007). For example, despite minimal quantities of starch in sediment samples from the site of Aguadulce shelter in Panama, Piperno & Holst (1998) recovered granules adhering to artefacts. However, if it is the case that coarse-grained materials are more favourable to the preservation of adhering starch, we should expect starch recovered from fine-grained materials (e.g. obsidian) to be minimal, however starch *has* been successfully obtained from obsidian artefacts (Barton *et al.* 1998). This may suggest that the factors governing the preservation of starch are more variable than anticipated, and may differ according to species, or even individual processed plant samples.

6.4 Contamination

The characteristics that accord starch a long preservational life (e.g. very large numbers of very small granules) also render it vulnerable to contamination. Residue analysts

must be aware when examining starch residues of the possibility of introducing modern contaminants: given the extensive chain of personnel that may come into contact with an artefact from the time it leaves the soil to the analyst's laboratory it may be unrealistic to expect minimal handling of artefacts (although Langejans (2009) recommends that residue analysts be among the first, rather than the last, specialists to engage with artefacts after – and even during – excavation.). Mercader (2009, see supporting methods section) recommends sampling of the laboratory environment in which residue analysis will be carried out in order to identify possible contaminants, and protocol may be followed to minimise contamination (Crowther *et al.* 2014). It is also common practice to analyse sediment samples from sites, with the implication being that if species are found on both artefacts and in bulk sediments then there is a possibility that starches were introduced to the artefact post-depositionally rather than during its use-life. This is problematic, however, as starch found in sediments may still be artefactual and may relate to intentional deposition of flora. Zarillo and Kooyman (2006) recommend analysing sediment samples found directly under living plants in the site's vicinity: if there is starch of a particular plant there, this should flag up as a warning for potential contaminants. In practice this may not be possible, however, unless residue work is explicitly included in research design from the beginning of an excavation. Common sense and good knowledge of time and context should also prevail: as the most common industrial contaminants are domesticated forms of maize, wheat and potato, should these crop up in contexts where their presence flags alarm (e.g. South Africa during the Middle Stone Age), they can be easily dismissed as contaminants. Barton (2007) was able to securely identify and characterise a number of starches on museum artefacts through good knowledge of artefactual context. Thus, although contamination is a danger in any ancient starch research, residue studies can be said to have undergone a sort of disciplinary loss of innocence (*sensu* Clarke (1973: 197) in that

regard, and, with a sense of reflexivity and awareness, the analyst can proceed with caution.

6.5 Grindstones and starch

Grindstones have been hypothesised to offer the ideal preservational environment for starch: the interstices between grains of coarse-grained stone may offer a secluded 'hiding place' for starch (Barton 2007; Langejans 2010). Starch analysis also takes advantage of the fact that *in situ* residues are difficult to study on grindstones, due to their large size and coarse raw material: starches can be extracted from artefacts and applied to slides for microscopy under transmitted light with cross-polarising capabilities.

6.6 Starch analysis in southern Africa

Despite early interest in starch analysis from southern African researchers (Wallace 1996; Williamson 2000), starch work in this region has been minimal. Notable exceptions are either small-scale (Langejans 2006)¹⁷, slightly out of the region under focus (Mercader *et al.* 2008), or unpublished (Henry 2010). The absence is puzzling, given the *avant garde* nature of residue analysis more generally in the sub-continent (Lombard 2004; Lombard & Wadley 2007; Langejans 2010; Henshilwood *et al.* 2011). The lack of work may have to do with the labour-intensity of reference material collection (discussed elsewhere in this thesis and mentioned briefly in Wallace 1996). Other sources of discouragement may be the perceived difficulty of distinguishing between domesticates (Langejans 2006) or the primary reliance upon grindstones as a proxy measure for plant-grinding in general. Nevertheless, previous studies, although sparse, demonstrate collectively and with certainty that starch analysis of grindstones and other artefact types is possible and profitable for southern Africa, given sufficient

¹⁷ Note, however, that although studies are few, both Wallace 1996 and Langejans 2006 focus on grindstones as profitable sources of starch

investment in a reference collection. For this reason, starch analysis is employed in this thesis. Indeed, the assumption that grindstones are associated with the grinding of starchy geophytes was an impetus for pursuing starch analysis of grindstones from Lesotho in the first place.

6.7 Reference Collection Comparison

The taxonomic identification of starch is achieved on a morphological comparative basis, thus it may be said that an identification is only as good as the reference collection that facilitates it: the more diverse the reference collection, the more accurate the identification is likely to be. Because this is the first attempt at starch analysis from Lesotho, the compilation of a reference collection is still only in the preliminary stages, and is restricted to what could be achieved with limited means over a relatively short period of time during the field seasons. Collection of reference species was targeted towards plants likely to have been used by foragers in the area (with an emphasis on geophytes, given the research question in mind), but cannot be termed comprehensive by any means: the shortcomings of field acquisition, lack of botanical identification, and limitations of local Botanical Gardens all come together to limit the possible range of genera identified. For this reason, identifications should be regarded as “cf.” (and may be worth revising in future should expansion of the reference collection be permitted). They are rarely provided to species level, as the possibility of inclusion of multiple species of the same genera was hardly ever possible.

Where possible, species were identified by their Latin binomials and local Sesotho names, although they are recorded in the tables in this chapter by which name they were originally identified and acquired: e.g. *Secale strictum* ssp. *africanum*, rather than

the Sesotho Rogo, and Lematla¹⁸, rather than *Brunsvigia radulosa*. Although identifications were based on population-level starch morphology (as recommended by Torrence *et al.* 2004) the possibility of confusing starches from different genera of the same family (an issue related largely to the taxonomic redundancy of starch types, but which can be further accentuated by the under-representation of taxa. This issue is particularly acute in the sparser areas of the reference collection) is ever present and widely acknowledged limitation of starch analysis (see also Torrence and Barton 2006, Chapter 7).

Section 6.8 lists known uses of the species present. Morphometric information and micrographs of all species in the reference collection are presented in sections 6.9 and 6.10 respectively. As this is the first attempt to establish a starch reference collection not only for Lesotho but the wider Caledon-Maloti/Drakensberg region, it is hoped that these datasets may be of use to future researchers, and to this end, they will be archived accessibly online, through www.paleobot.org (Warinner *et al.* 2011).

¹⁸ To aid clarity, Latin binomials are italicised while Sesotho names are underlined.

6.8 Basotho economic botany and the acquisition of a starch reference collection

6.8.1 Introduction

Although a number of researchers (Wallace 1996; Langejans 2006; Mercader *et al.* 2008; Henry 2010) have carried out research into ancient starch remains in southern Africa, individually compiling reference collections of plants of presumed economic use, to date none of their reference collections have been made available, outside of the occasional micrograph in publications or theses¹⁹. Furthermore, no starch researchers have worked on contexts in Lesotho. Although Wallace's (1996) work at Rose Cottage Cave, approximately 50km from Ha Makotoko could form a useful analogue, the published work contains no photographs. This means that while published sources may offer insight into potentially economically important plants, a study directed at identifying ancient starch in Lesotho must start from scratch with the compilation of a suitable reference collection.

6.8.2 Methods

Criteria for inclusion of plants in the reference collection for starches were based on a number of factors and reflect a number of different aims. The first step was to attempt to identify as comprehensive as possible a list of plant species local to the Metolong catchment (i.e. the area surrounding Ha Makotoko). The Environmental and Social Impact Assessment Report (ESIA) prepared on behalf of the Metolong Authority (SMEC 2008) was invaluable in this regard. Sesotho names for plants on this list were identified primarily through use of Amy Jacot Guillarmod's (1971) *Flora of Lesotho*, which remains the seminal botanical work on Lesotho, with some assistance from Rodney Moffett's

¹⁹ As these micrographs generally show only a single or at most a few starch granules, they are unsuitable for population-level morphometrics and are thus not useful to other researchers except as rough guides.

(2010) *Sesotho Plant & Animal Names and Plants Used By the Basotho* which updates some of Jacot Guillarmod's work. These references also provided uses for many of the plants listed, and where none were listed, Google searches of the relevant plants with the query "uses?" were carried out. These searches provided a number of other sources, usually in the name of shorter papers, and these are listed as and when they are cited in entries on particular plants. The plants identified through these means became targets for the reference collection. Plants known for common economic use elsewhere in South Africa were checked in online botanical databases (primarily <http://www.plants.jstor.org>; <http://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php>, the invaluable database of the Conservatoire et Jardins Botaniques Ville de Genève; and the Southern African National Biodiversity Institute's 'Plants of Southern Africa' online checklist <http://posa.sanbi.org/searchspp.php>) for occurrence in Lesotho. These databases also helped to determine correct botanical nomenclature and weed out rejected synonyms. Additional plants were added based on published sources, including botanical survey, travellers' accounts or macrobotanical work elsewhere in southern Africa (e.g. Burchell 1953; H.J. Deacon 1976; 1993; Letšela *et al.* 2003; Skead 2009).

Finally, two phases of fieldwork were carried out in 2012 and 2014. The primary purpose of these expeditions was to obtain samples of those plants already listed as being of potential or demonstrated importance, the secondary was to interview local residents of the Metolong catchment as to what, in their opinion, were the most economically important wild plants growing in the region. As discussed elsewhere (King & Nic Eoin 2014), due to the nature of material culture and memory, these conversations rarely focussed on the plants alone (although this might have been the initial intention), but expanded to discuss material culture, uses, memories, social histories, and landscape. Approximately 30 plant samples (not all of which yielded

starch) were obtained in the course of 2012's fieldwork, with an additional 20 or so in 2014. These are listed in Table I.1. Fieldwork in 2014 was a more targeted affair: by this point more contextualisation work as to widely known economic plants had been carried out and the collection of samples was driven more by myself than by local people. In 2014 there was also an opportunity to obtain plants from sources outside the Metolong catchment: genera were obtained from Kirstenbosch Botanical Gardens in Cape Town, the National Botanic Gardens of Ireland, the USDA genebank and Dr Christine Sievers of the University of the Witwatersrand generously provided plant samples from her own garden as well as reference collection trips. Finally, where suitable (primarily in the case of widespread domesticates e.g. *Triticum aestivum* and *Zea mays* ssp. *mays*), a number of micrographs in the collection of other researchers (I am grateful to Dr Alison Crowther and Dr Sheehan Bestel for these) were suitable for morphometric analysis.

Table 6.1 Table of plants analysed for the starch reference collection (arranged by family except the Poaceae, which are arranged by tribe)

Family/tribe (if known)	ID	Genus and species (if known)	Sesotho name (if known)	Source	Plant part	Starch present?	Use
Amaranthaceae	RC14	<i>Chenopodium album</i>	<u>Seruo</u>	T. Khesuoe	Leaf/stem	N	D/M/P
Amaryllidaceae	RC9	<i>Boophane disticha</i>	<u>Leshoma</u>	M. Makotoko	USO	N	M/V/P
	RC30	<i>Brunsvigia radulosa</i>	<u>Lematla</u>	H. Seefane	USO	Y	M/C
	RC36	<i>Crinum moorei</i>	<u>Ludutla;</u> <u>mototse</u>	Kirstenbosch	USO	Y	M/C
	RC37	<i>Tulbaghia</i> sp.	<u>Sefothafotha</u> (and others)	C. Sievers	USO	Y	D/M/C
Amaryllidaceae?	RC10	<i>Agapanthus campanulatus</i> ssp. <i>patens</i> ?	<u>Leta-la-phofu</u>	L. Nchakha	USO/stem	N	M
(Poaceae) Andropogoneae	RC38	<i>Miscanthus capensis</i>	<u>Mothala</u>	J. Ralimpe	USO/stem/ leaf	Y	D/M/C
	RC39	<i>Sorghum bicolor</i>	Multiple names	USDA	Seed	Y	D
	RC40	<i>Themeda triandra</i>	<u>Seboku;</u> <u>setjhaba</u>	USDA	Seed	Y	D/M/C
	RC41	<i>Zea mays</i> ssp. <i>Mays</i>	Multiple names	A. Crowther	Seed	Y	D
Araceae	RC42	<i>Zantedescia aethiopica</i>	<u>Mothebe;</u> <u>mohaladitwe</u>	C. Sievers	USO	Y	D/M/C/V
Asparagaceae	RC43	<i>Albuca</i> sp.	Multiple names	C. Sievers	USO	Y	M
	RC44	<i>Eucomis autumnalis</i>	Multiple names	Kirstenbosch	USO	Y	M
	RC45	<i>Merwillia plumbaea</i>	<u>Kgerere</u>	Kirstenbosch	USO	Y	M/V
Asparagaceae?	RC46	<i>Asparagus</i> sp.?	<u>Rethe-la-ntja</u>	J. Ralimpe	USO/Stem/ Leaf	Y	D/M
Asteraceae?	RC1	<i>Berkheya</i> sp.?	<u>Mohatollo</u>	L. Thame	Leaf/stem	N	M
	RC12	<i>Gazania</i> sp.?	<u>Tsikitlana</u>	L. Thame	Root/stem/ leaf	N	D/M/C
Asteraceae?	RC18	<i>Haplocarpha scaposa</i> ?	<u>Papetloane 1</u>	M. Masakale	Root	N	M
	RC34	<i>Haplocarpha scaposa</i> ?	<u>Papetloane 2</u>	H. Seefane	Root	N	M
Brassicaceae	RC33	<i>Lepidium capense</i>	<u>Qhela</u>	T. Khesuoe	Leaf/stem	N	D

Family/tribe (if known)	ID	Genus and species (if known)	Sesotho name (if known)	Source	Plant part	Starch present?	Use
Caprifoliaceae?	RC31	<i>Scabiosa columbaria?</i>	<u>Selomi</u>	H. Seefane	Root	N	M
Convolvulaceae?	RC29	<i>Ipomoea crassipes?</i>	<u>Maime</u>	H. Seefane	Root	N	D/M
	RC57	<i>Ipomoea crassipes?</i>	<u>Maime 2</u>	J. Ralimpe	Root	N	D/M
Cucurbitaceae	RC58	<i>Citrullus lanatus</i>	Multiple names	L. Nic Eoin	Seed/fruit	N	D
Cyperaceae	RC58	<i>Cyperus</i> sp.	<u>Lepeka? 2</u>	C. Sievers	USO	N	D/M/C
	RC61	<i>Cyperus involucratus</i>	Multiple names	NBGD	USO	Y	D/M/C/V
Cyperaceae?	RC28	<i>Cyperus</i> sp.?	<u>Lepeka 1</u>	H. Seefane	USO	Y	D/M/C
(Poaceae)	RC47	<i>Eragrostis capensis</i>	Multiple names	USDA	Seed	Y	D
Eragrostideae	RC48	<i>Eragrostis curvula</i>	Multiple names	USDA	Seed	Y	D
Fabaceae	RC49	<i>Vigna radiata</i>	<u>Lehloli</u>	S. Bestel	Fruit	Y	D/M/C
Geranaceae?	RC11	Multiple genera	<u>Khoara</u>	M. Makotoko	USO	Y	D/M/V
Gunneraceae	RC50	<i>Gunnera perpensa</i>	<u>Qobo</u>	C. Sievers	USO	Y	D/M
Hypoxidaceae?	RC6	<i>Hypoxis</i> sp. (<i>rooperi</i>)?	<u>Moli</u>	M. Makotoko	USO	Y	M
Iridaceae	RC60	<i>Gladiolus dalenii</i>	<u>Kgahla; kgahla ea kgolo</u>	NBGD	USO	Y	M/D/C
	RC59	<i>Moraea spathulata</i>	<u>Leloele; teelee-ea-noka</u>	NBGD	USO	Y	D/M/C
	RC51	<i>Watsonia wordsworthiana</i>	<u>Kgahla</u>	Kirstenbosch	USO	Y	D/V/C
Lamiaceae?	RC19	<i>Ajuga ophrydis?</i>	<u>Senyarela</u>	L. Thame	Leaf/stem/root	N	M
Malvaceae?	RC5	<i>Malva</i> sp.?	<u>Tika motse</u>	L. Thame	Leaf/stem/root	Y	D/M
	RC17	<i>Hermannia</i> sp.?	<u>Seletjane</u>	M. Masakale	Root	N	M/C
	RC20	<i>Hermannia geniculata?</i>	<u>Selepe</u>	M. Masakale	Root	N	M/C
Myrtaceae	RC3	<i>Eucalyptus</i> sp.	<u>Bleikom</u>	L. Thame	Leaf/stem	N	M
(Poaceae) Paniceae	RC52	<i>Echinochloa colona</i>	Multiple names	A. Crowther	Seed	Y	D
Rubiaceae?	RC22	<i>Pentanisia prunelloides?</i>	<u>Setima mollo</u>	M. Masakale	Root	N	M
Rubiaceae?	RC53	<i>Kohautia</i> sp.?	<u>Morokolo poli</u>	M. Masakale	USO	Y	D/M
Solanaceae	RC21	<i>Solanum</i> sp.	<u>Thola</u>	M. Masakale	USO	Y	M
(Poaceae) Triticeae	RC54	<i>Hordeum capense</i>	<u>Ditse ba ntja; leboya</u>	USDA	Seed	Y	D?

Family/tribe (if known)	ID	Genus and species (if known)	Sesotho name (if known)	Source	Plant part	Starch present?	Use
	RC55	<i>Secale strictum</i> ssp. <i>africanum</i>	<u>Rogo</u> (and others)	USDA	Seed	Y	D
	RC56	<i>Triticum aestivum</i>	<u>Koro</u> (and others)	A. Crowther	Seed	Y	D
Xanthorroaceae	RC4	<i>Aloe striatula</i>	<u>Seholobe</u>	L. Thame	Leaf/stem/ root	N	M/C
Unknown	RC7	Multiple possibilities	<u>Hloenya</u>	M. Malireko	USO	Y	M
	RC35	Unknown	<u>Lenyoka</u>	H. Seefane	Root/stem/ leaf/seed	N	M
	RC25	Unknown	<u>Machacha-metsa</u>	M. Masakale	Root/stem	Y	M
	RC16	Multiple possibilities	<u>Moferefere</u>	L. Thame	Leaf/stem/ root	N	D/M
	RC33	Unknown	<u>Mofoka tiali</u>	H. Seefane	USO	Y	M
	RC15	Unknown	<u>Moratoe 1</u>	M. Masakale	Root	N	M
	RC26	Unknown	<u>Moratoe 2</u> "male"	H. Seefane	Root	N	M
	RC27	Unknown	<u>Moratoe 3</u> "female"	H. Seefane	Root	N	M
	RC13	Multiple possibilities	<u>Mosala-suping</u>	M. Masakale	Root	N	D/M/C
	RC23	Multiple possibilities	<u>Poho-tsehla</u>	M. Masakale	USO	Y	D/M
	RC32	Unknown	<u>Sehloko</u>	H. Seefane	Leaf/stem/root	N	M/C
	RC8	Unknown	<u>Selai</u>	M. Masakale	Root/stem	N	D
	RC24	Multiple possibilities	<u>Tsoene</u>	M. Masakale	Leaf/stem/ root	N	M

For Table 6.1, the following sources supplied plant samples primarily identified by their Linnaean taxonomic designations: Dr Sheehan Bestel, University of Exeter; Dr Alison Crowther, University of Queensland; Kirstenbosch Botanical Gardens, Cape Town; National Botanic Gardens,

Dublin (NBGD); Dr Christine Sievers, University of the Witwatersrand; United States Department of Agriculture Genebank (USDA). Sesotho translations of names were sourced from Moffett's (2010) and Jacot-Guillarmod's (1971) glossary of Sesotho plant names.

The following sources supplied plant samples primarily identified by their Sesotho names: 'Me Malireko Masakale and Ntate Hlenyane Seefane.

The following sources supplied plant samples primarily identified by their Sesotho names on expeditions in the Metolong catchment. Where Linnaean taxonomic designations are listed for these plants (without a question mark), the author was able to confirm the match between the Sesotho and Latin names through reference to photographs of type specimens: Ntate Tseliso Khesuoe, Ntate Makhobalo Makotoko, Ntate Lefaso Nchakha, Ntate Joseph Ralimpe, Ntate Libe Thame.

Question marks in the 'Family/tribe' and 'Linnaean name' columns denote uncertainty as to attribution: this is because in these cases, plants were identified by their Sesotho name alone and the author was unable to confirm their Latin names through photographic comparison. Linnaean names were assigned where Moffett (2010) or Jacot-Guillarmod (1971) offered only one attribution of genus or family for the plant in question, but these should be accepted with caution.

Where no genus or family is listed for a Sesotho-named plant, it is hypothesised that the Sesotho name given is a regional name not known elsewhere.

Where 'multiple names' are listed for a particular plant, these are listed in full in individual entries on plants and their uses, see below.

Uses:

D: dietary

M: medicinal/magical (these are not separated)

P: pesticidal

V: Veterinary medicine

C: Crafting/material culture.

6.8.3 Details, including uses, of plants sampled for the starch reference collection

Amaranthaceae

Chenopodium album, seruoe. Jacot Guillarmod (1971) notes this as a common pot herb, particularly when young, although it may also be used as a decoction to treat worms, or distributed around sleeping areas to deter bed bugs. Moffett (2010) suggests that while *C. album* is used dietarily, the medicinal/pesticidal uses listed by Jacot Guillarmod refer to another species of *Chenopodium*, *C. schraderianum*. The leaves may be eaten fresh or dried (van Wyk & Gericke 2000).

Amaryllidaceae

Boophane disticha. Also written as 'Boophone'. leshoma. The common English name of "poison bulb" is perhaps a misnomer, as knowledgeable herbalists in the Metolong catchment explained that the bulb of *Boophane* functions more as a sedative than as a poison although it is certainly toxic (Ntate Lefaso Nchackha, pers. comm., 17/9/12). This is confirmed by van Wyk & Gericke (2000:156). *Boophane disticha* is probably the best known of southern African medicinal/magical plants, and since information is relatively plentiful as compared with other useful plants (van Wyk *et al.* 1997; van Wyk & Gericke 2000; Ellenberger 2003; Mitchell & Hudson 2004; Steenkamp 2005) I will mention only the presumed and demonstrated antiquity of use in southern Africa. H.J. Deacon (1976) notes that *Boophane* sp. remains have been found in Holocene storage pits, while its use by Bushmen in tipping arrows for use in hunting is well established and possibly of great antiquity. See for example the following passage from Burchell's account of his 1822-24 travels in southern Africa

"Near Aakaap²⁰ [near Griquatown, now Grikwastad, Northern Cape] Plants of *Amaryllis toxicaria*²¹ were in many places very abundant, their bluish, undulated leaves, rising out of the ground, and spreading in the form if a fan, rendered them remarkable and conspicuous; but their flowers had long since passed away, and here and there only could now be seen the short dried stalks. This plant is well known to the Bushmen, on account of the virulent poison contained in its bulb. It is also known to the Colonists and Hottentots, by the name of *Gift-bol* (Poison-bulb). This *poison* is obtained by inspissating the milky juice, either by the heat of the sun, or, as I was told, by boiling. It is mingled with the venom of snakes, or a large black species of spider of the genus *Mygale*, and forms a half-viscous, gummy compound..." (Burchell 1953: 372)

In Lesotho specifically, the importance of *B. disticha* may be of great antiquity, as demonstrated by a possible identification of a rock art panel depiction of a plant (rare in southern African rock art cf. Ellenberger 2003) with *B. disticha*. Although the possibility that this is *Brunsvigia radulosa* (known as lematla in Sesotho, see below) has been raised by Ellenberger (2003), this has been dismissed by Pearce (2008) who regards both the specific appearance of *B. disticha* and its demonstrated importance in Bushman cosmologies as making it a more likely candidate (Mitchell & Hudson 2004).

In the Metolong catchment, the importance of *B. disticha* (and furthermore, the perceived impossibility of confusing it with *B. radulosa*) was confirmed (Ntate Lefaso Nchakha, pers. comm. 17/9/2012), and further outlined by Jacot Guillarmod who notes medicinal/ritual uses in initiation rituals as well as – somewhat alarmingly, given reports of its toxicity (Steenkamp 2005; Cheesman 2013) – a role for “scooped out bowl...used by herders as a pot for warming milk” (Jacot Guillarmod 1971: 416).

Given the obvious importance of *B. disticha* in both Basotho and Bushman cosmologies, obtaining samples of this plant for inclusion in the starch reference collection was prioritised. Unfortunately, however, multiple samples failed to yield starch. While it is possible that *B. disticha* does not store starch, but rather inulin, this is not discussed in

²⁰ Near Griquatown (now Grikwastad, Northern Cape)

²¹ That Burchell is referring to *Boophane disticha* is suggested by the use of the Afrikaans term ‘gif(t)bol’ and confirmed by J.G. Baker in an 1897 entry in *Flora Capensis* where it is noted that *Amaryllis toxicaria* is a rejected synonym for *B. disticha*

the pharmaceutical or botanical literature (Lee Cheesman, pers. comm. 1/10/2014). Given the perceived importance of this plant, future researchers would be advised to try further samples, or to attempt identification through other means

Agapanthus campanulatus ssp. *patens* (?) leta-la-phofu. Although this plant was identified by its Sesotho, rather than Latin, name, detailed photographic comparison suggests that its translation to *A. campanulatus* (Jacot Guillarmod 1971) is accurate. Its Sesotho name translates as “eland’s saliva”, possibly in reference to the sticky sap that exudes from the roots when cut which are, superficially at least, very similar in appearance to the trails of saliva displayed by an eland after it has been felled by hunters, or (more likely according to Ntate Lefaso Nchakha, pers. comm. 17/9/12) its emetic qualities when ingested. Because of the latter quality, Ntate Nchakha noted that it could be used to expel poisons. Jacot Guillarmod (1971:410) lists three uses: treatment of neonatal suborrheic dermatitis (known colloquially as ‘cradle cap’); in initiation of ‘doctors’; and as a wash or lotion for newborns

Brunsvigia radulosa, lematla. Again, samples of this plant growing in the wild were compared with multiple photographs, confirming the identification of lematla (which translates as “the strong one”) with *B. radulosa*. Ellenberger (2003) regards *B. radulosa* as a more likely candidate for the depiction at Thaba Bosiu, but this is disputed by others (Mitchell & Hudson 2004; Pearce 2006). It does, however, play a prominent role in Basotho herbal medicine, as indicated by its common name. Jacot Guillarmod (1971) notes its use in pregnancy and delivery, in the preparation of bones for divination, and as a sealant for clay pots. Ntate Nchakha noted that although lematla was less important in folk medicine than leshoma, it was still of relatively important use. He observed that like *leshoma*, *lematla* is toxic and should not be ingested. It is used mostly in charms and when burnt its smoke may be inhaled to ease lung complaints. Ntate Hlenyane Sefane (pers. comm. 14/9/2012) confirmed the importance of lematla and added that it could

be used as a charm to control lightning, which is a desirable power among traditional healers. On analysis, samples of the bulb were found to yield plentiful starch.

Crinum moorei. ludutla or mototse. Listed as an economically important plant by Letšela *et al.* (2003), van Wyk & Gericke (2000:124) note the use of *C. bulbispermum* in treatment of cold and tuberculous lymphadenopathy. Jacot Guillarmod (1971:421) and Moffett (2010:263) confirm this, and note its use also as a charm in preventing evil and to promote flow of breast milk. A sample of *C. moorei* yielded plentiful starch.

Tulbaghia alliacea, sefothafotha or moelela. Known as ‘wild garlic’ in English²² (van Wyk & Gericke 2000: 63), this plant is used in Lesotho as a pot herb when young, and as a love charm/topical unguent (Jacot Guillarmod 1971:456), this latter use in spite (or perhaps because) of its extremely pungent odour. A sample of *T. alliacea* yielded plentiful starch.

See also http://pza.sanbi.org/sites/default/files/info_library/tulbaghali.pdf (Accessed 28/4/2015).

(Poaceae) Andropogoneae

Miscanthus capensis, mothala. Also known as *Miscanthus sorghum*. The rhizomes may be chewed (Moffett 2010:286) and have a sweet taste (personal observation), while the grain is regarded as a ‘famine food’ (van Wyk & Gericke 2000: 9; Moffett 2010: 286). Jacot Guillarmod (1971:441) notes an indeterminate medicinal use, also that it makes a good thatching grass. Plentiful starch was yielded by the sample obtained.

Sorghum bicolor, botalane, mofoka, mokgotho, moroho, mosothi, mothulo, pakollane, seboyane, sekgobane, seqhobane. The sheer number of Sesotho names for this plant

²² Note that this is different from the plant known as wild garlic in Europe and Asia, which is *Allium ursinum*. The smell is not dissimilar, however.

hints at its ubiquity in Basotho life: as one of the major crops in the country it is consumed on a daily basis. In the absence of detailed macrobotanical (or indeed microbotanical) work for Lesotho, the date of arrival for sorghum cannot be pinpointed exactly, but in line with its accepted spread alongside Bantu farmers elsewhere in southern Africa, is assumed to have accompanied Bantu-speaking farmers into Lesotho (Mitchell & Whitelaw 2005). Hunter-gatherers in what is today Lesotho might conceivably have encountered sorghum elsewhere, prior to the influx of farmers and establishment of the region as a political territory, but any presence of sorghum at Ha Makotoko presumably post-dates the arrival of Bantu-speaking farmers to the area.

Themeda triandra, seboku, setjhaba. *T. triandra*-dominated grassland is one of those listed in Staples and Hudson's (Staples & Hudson 1938) binomial system of Lesotho grasslands, the other being *Festuca caprina*. *T. triandra*-dominated grassland is found in all biomes of Lesotho, including the foothills biome in which the Metolong catchment is located. It is noted as being sweet and palatable, usually occurring on northern slopes at lower elevations (Kobisi & Kose 2003). Accordingly, it is most commonly used to graze animals, but also as thatching grass (Jacot Guillarmod 1971: 455), medicine (Moffett 2010: 302), and famine food (Ruskin 1999).

Zea mays ssp. *mays*, borocho, dihomane, jalo, lehakwane, lehomo, lehkwa, lepolanka, mamainwa, matlolwa ke tweba, motamo, poone.

As with *Sorghum bicolor*, the multitude of common Sesotho names for maize sheds light on the importance of this crop in everyday Basotho life. Maize arrived in Africa with Portuguese sailors following the "Columbian Exchange" of the sixteenth century (McCann 2001; Crosby 2003). Identifying the date of maize's arrival in Lesotho (and to a lesser extent, areas of South Africa, although McCann (2001:251) notes that maize had certainly not arrived in the Cape prior to 1652) is difficult in light of the lack of micro- or macro-botanical work, and some work in areas of South Africa has relied on arguably

unsatisfactory proxy methods (i.e. conflation of presence of grindstone with maize-grinding (Huffman 2006). Maize does appear to have been a staple in Lesotho by at least the mid-nineteenth century (McCann 2001), with the missionary Eugène Casalis observing large fields of it at the foot of Thaba Nchu in 1833 (Germond 1967: 26). The identification of maize starch in some contexts at Ha Makotoko was problematic given maize's common role in modern-day manufacturing and industry: maize starch is an extremely common contaminant and can be difficult to separate from archaeological starch (Crowther *et al.* 2014). However, given that maize is extremely unlikely to have been encountered by hunter-gatherers in the area until the last few centuries, it is regarded as contamination in all but the most recent layers (uppermost contexts at Ha Makotoko bear clear evidence of the shelter's recent historical use by Basotho and herd animals. Given this, the presence of maize is very much expected).

Araceae

Zantedeschia aethiopica, mahaladitwe, mothebe. According to Moffett (2010:306), the ground roots are prepared to ward off malignant spirits (known as *thokolosi*, presumably derived from the Zulu *tokoloshe*), used as [yellow-green, according to Jacot Guillarmod 1971: 458] dyestuff, the leaves eaten as a pot herb and also to treat wounds, rheumatism and gout, and the rhizomes boiled to treat bronchitis or fed to cattle. Samples of *Z. aethiopica* revealed plentiful starch, but as is characteristic for certain members of the aroid family, plentiful raphides (elongate calcium oxalate crystals which facilitate transfer of toxins to predators in order to inhibit consumption cf. Crowther (2009)).

Asparagaceae

Albuca sp., mototse, nkoko-phiri, sualilale, tsuha-liliale, khapumpu, morotoana-phookoana, sesepa-sa-linoha. *Albuca* sp. is used for exclusively medicinal/magical purposes in Lesotho, as a preventative charm, to treat constipation (as an enema) in

infants, and wounds in cattle (Jacot Guillarmod 1971: 307). Moffett lists further, more specific uses, but as some confusion relates to the lumping of multiple species of *Albuca* with *Ornithogalum* sp. (Martinez-Azorin *et al.* 2011) they are not listed here.

Eucomis autumnalis, khapumpu [this appears to be the generic name for the genus, but see use of this name for *Albuca* sp. which may suggest that the name refers to the family, *sensu lato* at least], kgato, maboni, mathebethalebale, mohale wa marumo. The underground storage organ of *E. autumnalis* is regarded as poisonous and is thus used with care for multiple medicinal/magical uses in Lesotho with purposes ranging from hangover cure to treatment for syphilis (van Wyk & Gericke 2000: 126). It may be combined with *Zantedeschia* sp. in certain treatments (Moffett 2010: 270, 306).

Merwillia plumbaea [previously known as *Scilla natalensis*], kherere. As with other genera of Asparagaceae listed above, uses of *Merwillia plumbaea* in Lesotho are exclusively medicinal, magical or veterinary. Moffett (2010:286) notes the toxicity of the bulb and a number of uses corresponding to the above categories, but also that a decoction made from the bulb may be used to wash clothes. Jacot Guillarmod (1971: 451) confirms these uses and further notes that despite its toxicity the bulb may be combined with food as an aperient or laxative. Van Wyk & Gericke (2000:202) suggest that the plant functions as a significant analgesic and antimicrobial.

Asparagus sp.?, rethe-la-ntja. The common Sesotho name can best be rendered in English as “dog’s testicles”²³, probably due to the shape of the plant’s underground storage organ [Ntate J. Ralimpe, pers. comm. 17/4/2014]. Jacot Guillarmod (1971:414) lists multiple uses for *Asparagus* spp., ranging from charms and initiation preparations to eye-wash and other medicinal concoctions. Moffett (2010) confirms these and also

²³ Albeit without the idiomatic meaning of the corresponding English slang.

that the young shoots are frequently eaten. Ntate Ralimpe told me that the rhizomes may also be eaten raw, and I was able to observe that they have a pleasantly sweet flavour, not dissimilar to cultivated asparagus (*A. officianalus*). It should also be noted that a number of other plants appear to correspond to this Sesotho name (see Chapter 3)

Asteraceae

Berkheya sp.?, mohatollo. According to Moffett (2010:257), *mohatollo* may refer to *B. montana* (of which an infusion of the roots may be used to reduce inflammation, or to prevent witchcraft) or *B. onopordifolia* (which is used similarly). The sample obtained yielded no starch but this may be because inulin content in the Asteraceae is reportedly high (Hardy 2010: 669).

Gazania sp.?, tsikitlana. Moffett (2010) and Jacot Guillarmod (1971) both list multiple species of the genus *Gazania* exclusively as corresponding to the Sesotho name noted when the plant sample was obtained, with uses ranging from dietary (the flowers are eaten) to medicinal (headache cure, digestive aid) and magical (exorcism of evil spirits) to crafting (fibres from the plant can be made into clothing). No starch was present in the sample.

Haplocarpha scaposa?, papetloane. Multiple samples of this plant were provided by different sources, both of whom used it in medicinal/magical preparations – ‘Me Malireko Masakale (pers. comm. 18/9/12) listed as a useful ingredient in treating stomach ailments while Ntate Hlenyane Seefane (pers. comm. 19/9/12) noted that it could be used in gynaecological medicines and as a charm to prevent lightning. These uses accord reasonably well with Moffet’s (2010:275) equation of the plant with *H. scaposa*, which mirror and expand on Jacot Guillarmod’s (1971:431-432).

Brassicaceae

Lepidium capense, qhela. Qhela was listed by six sources in the Metolong catchment as among the most common wild food plants (known as moroho in Sesotho) both in terms of use and ubiquity. Photographic comparison suggests a good match between the Latin name suggested by both Jacot Guillarmod (1971) and Moffett (2010), both of whom list exclusively dietary use for the plant. For the purposes of this project, the confirmation by sources in the Metolong catchment ('Me Bela Nthunya pers. comm. 15/9/12; Ntate Tseliso Khesuoe pers. comm. 13/9/12; 'Me Malireko Masakale pers. comm. 13/9/12) that the plant is generally ground prior to use is interesting, but unfortunately since multiple samples of the plant did not yield starch, there is little chance of tracing it using the methods applied here.

Caprifoliaceae

Scabiosa columbaria?, selomi. Moffett (2010: 296) and Jacot Guillarmod (1971: 450) list multiple uses for *Scabiosa columbaria* which is the only plant they identify as corresponding to selomi. Uses include preparations of the roots and leaves as treatment for indigestion, gynaecology, and skin ailments. No starch was present in the sample obtained.

Convolvulaceae

Ipomoea crassipes?, maime. *I. crassipes* is the only plant identified as maime by either Jacot Guillarmod or Moffett. Van Wyk & Gericke (2000:90) note the plant as both a water source and a famine food. Uses of maime in Lesotho are largely medicinal although the root is also chewed as an appetite suppressant (Jacot Guillarmod 1971: 436; Moffett 2010:280).

Cucurbitaceae

Citrullus lanatus, kaate, lehapu, mokakawane, mokopuntja, qhomo, qhoomo, qootho, thomo, tjoko, tjoto. According to van Wyk & Gericke (2000:38) *Citrullus* sp., commonly

known in English as ‘tsamma’ or ‘tsamma melon’ is found throughout Asia and Africa, where it is known as a Kalahari water source. A sample of this fruit was obtained when the plants were observed growing wild (and plentifully) in the foothills above the town of Roma, Lesotho. Although van Wyk & Gericke (2000) discuss multiple dietary uses of *C. lanatus* aside from its role as water source (hardly useful in water-rich Lesotho), a group of small boys who accompanied me as I took a sample of the plant laughingly dismissed the idea of consuming it as food and demonstrated instead its primary use (to them): as a football. This use is confirmed by Jacot Guillarmod (1971:418) and Moffett (2000:260) who also describe its use as a charm. No starch was found in either the flesh or seeds of the sample obtained.

Cyperaceae

Cyperus sp.? lepeka?. Two species of possibly the same plant were obtained throughout the course of research, the first in 2012 from Ntate Hlenyane Seefane, who referred to it as lepeka, which is one of multiple names listed by Moffett (2000:264) for *Cyperus* sp. The second sample of possibly the same plant was contributed by Dr Christine Sievers who listed it as *Cyperus* sp. but not *C. usitatus*. Further confusion stems from the fact that micrographs of each sample reveal starch in the sample labelled lepeka but not in the *Cyperus* sample. *Cyperus* sp. (including *C. usitatus* and *C. fulgens*), known commonly by the Afrikaans “uintjies” are considered to be economically useful plants by southern African bushmen (van Wyk & Gericke 2000:86-87). Both *C. usitatus* and *C. fulgens* have edible corms, and are described by European travellers as most commonly prepared by roasting them in embers although occasionally dried and ground (Stow 1905; Burchell 1953)

Cyperus spp. have also been identified as bedding in MSA layers at Sibudu, indicating that not only is their use widespread, but of great antiquity (Sievers 2011; Wadley *et al.* 2011). Various non-dietary uses are listed by Moffett (2010:264-365) and Jacot

Guillarmod (1971), ranging from crafting (the fibre used for weaving and rope-making), anti-diarrheals (which may caution against over-consumption as food). Moffett notes that *C. usitatus* may be ground prior to use.

A third sample of *Cyperus*, *C. involucratus*, was obtained from the National Botanic Gardens in Dublin. As *C. involucratus* is native to KwaZulu-Natal (however, although undocumented, plausible within Lesotho), no Sesotho name directly applies to it, nevertheless, given the uncertainty as to the attribution of the other samples of Cyperaceae within the reference collection, *C. involucratus* may act as a guide to similarities within the genus.

(Poaceae) Eragrostideae

Eragrostis capensis, baroa. *Eragrostis* sp. is discussed further in the phytolith chapter. Species of *Eragrostis* have been consumed throughout Africa for millennia, most notably the species *E. tef* which is now a common domesticate (D'Andrea 2008; Radomski & Neumann 2011). Vinnicombe (2009) records oral testimony of witnesses to the grinding and consumption of *Eragrostis curvula* “moseka” by Bushmen at Sehonghong in the eastern highlands of Lesotho (and see Chapter 2). Given that *moseka* (*E. curvula*) is the species noted in this regard, it is interesting that the Sesotho name for the species *E. capensis* should be “Baroa” (which translates directly as ‘people of the bow’, and is used by Basotho to refer to Bushmen (Stow 1905:31)) which would seem to suggest some association between the plant and Bushmen. Yet neither Moffett (2010:269) nor Jacot Guillarmod (1971:315) record dietary use of *E. capensis* by Basotho: admittedly this does not necessarily mean that it might not have been consumed by Bushmen but given that *E. curvula* is noted as a “famine food” it seems odd that *E. capensis* should not be. Instead, only charm use is recorded. Although starch was yielded by samples of both types of *Eragrostis* seed, granules were very small and lacking in birefringence – it is doubtful whether it would be recognised archaeologically as starch and for this reason

phytolith evidence might be a more reliable means of detecting *Eragrostis* in the archaeological record.

Eragrostis curvula, moseka. See *Eragrostis capensis*.

Fabaceae

Vigna radiata, lehloli. Neither Jacot Guillarmod (1971: 457) nor Moffett (2010:305) record a non-medicinal use for *V. radiata* (instead suggesting that it seems to work as a poultice in drawing out infection from a wound) but van Wyk & Gericke (2000:30) note it as an important food plant throughout rural southern Africa and residents of the Metolong catchment cited it as an important craft plant, using it for thatching and weaving: customarily, the *sethebe* (known as *motseme* elsewhere in Lesotho), a small mat placed in front of a grindstone to catch overspill, was woven from lehloli ('Me Bela Nthunya, pers. comm. 15/9/12).

Geraniaceae

Geranium caffrum?, *Monsonia biflora?*, *M. brevirostrata?*, *Pelargonium bowkeri?*, *P. caffrum?*, *P. grossularioides?*, *P. reniforme?*, khoara. Various genera within the Geraniaceae are suggested as Jacot Guillarmod (1971:345) and confirmed by Moffett (2010: 21) as corresponding to khoara. Jacot Guillarmod lists no uses for *G. caffrum*, however Moffett (2010:272) lists it as a treatment for stomach complaints. *M. biflora* and *M. brevirostrata* are both used to treat stomach complaints and to bathe sore eyes (Jacot Guillarmod 1971: 442). Moffett (2010:286-287) confirms these uses and adds that *M. biflora* is also administered to cows and to treat snake-bite. Jacot Guillarmod (1971:444-445) notes *P. bowkeri* and *P. reniforme* as used medicinally, and additionally that "the Bushmen are said to have made a porridge of the dried roots [of *P. bowkeri*] for their babies". These uses are confirmed by Moffett (2010:290).

Gunneraceae

Gunnera perpensa, qobo. *Gunnera* sp. was noted as an important medicinal plant by 'Me Bela Nthunya (pers. comm. 15/9/12) who also observed that as it grew within the Metolong catchment only along the banks of the Phuthiatsana river, it would likely become a casualty of the impending dam completion. The potency of *Gunnera perpensa* is confirmed by Jacot Guillarmod (1971), Moffett (2000), and van Wyk & Gericke (2000) who list it as a treatment for many gynaecological ailments as well as headaches and male impotence. Moffett (2000:274) also confirms a personal communication from Christine Sievers (22/4/2014) that *Gunnera* root is also used to make beer. See also http://pza.sanbi.org/sites/default/files/info_library/gunnerapers.pdf (Accessed 28/4/2015)

Hypoxidaceae

Hypoxis hemerocallidea?, moli. A sample of moli was provided by Ntate Makhobalo Makotoko, and the association of this plant with *Hypoxis* sp. supported not only by its appearance but by the statement by 'Me Malatlatsa Makotoko that this was "African potato" (pers. comm. 15/9/12). Van Wyk & Gericke (2000:146) associate *H. hemerocallidea* alone with this common English name and list a variety of medicinal uses, primarily associated with anecdotal evidence for its role as an anti-inflammatory. These uses are confirmed by Moffett (2010: 280) who also lists a number of charm uses. See also http://pza.sanbi.org/sites/default/files/info_library/hypoxisradix.pdf (Accessed 28/4/2015)

Iridaceae

Gladiolus dalenii, kgahla, kgahla e kgolo. Moffett (2010:273) and Jacot Guillarmod (1971:430) list a number of uses for *G. dalenii*²⁴, including dietary consumption of the

²⁴ formerly sub-divided into *G. dracocephalus* and *psittacinus*, before being lumped together as *G. natalensis*, a name which has now been rejected in favour of *G. dalenii* (<http://www.ville-ge.ch/musinfo/bd/cjb/africa/details.php?langue=en&id=21195> accessed 26/1/2014))

corms, a treatment for swollen feet, rope manufacture, anti-diarrhoeal and as one of the ingredients in the medicine horn (*lemaka*) of a *sangoma*.

Moraea spathacea, leloe, teele ea kgolo

Although a Sesotho name for *Moraea* sp. is listed by Moffett (2010:287) as kgahla e nyenyene, reflecting its perceived similarity to other genera within the Iridaceae, specific names for *M. spathacea* are leloe, teele ea kgolo (where kgolo means 'big') (Moffett 2010: 287) while Jacot Guillarmod (1971:325) also has teele ea noka (where noka indicates 'by the river'). Documented uses are in rope-making, while the corms of other species of *Moraea* are eaten and used in veterinary medicine.

Watsonia wordsworthiana, kgahla. As indicated by the shared name for both plants, *Watsonia* sp. is not differentiated from *Gladiolus* sp. within Lesotho, and as Moffett (2010:305) and Jacot Guillarmod (1971:457) record, uses are similar: *Watsonia* sp. is listed as a veterinary treatment, foodstuff and rope material. Hilary Deacon (1976) discusses various *Watsonia* sp. as a Holocene food staple at Melkhoutboom, although without information as to its preparation aside from an inference that since grindstones occur at the site some of the plants may have been ground, while other authors have pervasively assumed its association with grindstones (see Chapter 2).

Lamiaceae?

Ajuga ophrydis?, senyarela. Senyarela is translated solely as *Ajuga ophrydis* by Moffett (2010:252) and Jacot Guillarmod (1971: 397), and listed as a treatment for gynaecological disorders by both, with additional charm and medicinal uses listed by Moffett. No starch was present in the sample provided.

Malvaceae?

Malva sp.?, tika motse. Tika motse is listed as a name for multiple species of *Malva* by Moffett (2010: 285) and Jacot Guillarmod (1971:254) (as is mosala suping, see below),

both of whom list medicinal uses as an anti-inflammatory, while dietary use is noted as widespread elsewhere in the world, see e.g. Tukan *et al.* (1998). Starch was observed in the sample provided.

Hermannia sp.?, seletjane. Moffett (2010:278) lists seletjane as a name for at least five species of *Hermannia*, some of which have no recorded uses, while others are used to aid digestion, in charms, and to repair pots. Jacot Guillarmod (1971:434) confirms these uses and adds that *Hermannia depressa* may be used to treat burns. Starch was not observed in the sample provided.

Hermannia geniculata?, selepe. 'Me Malireko Masakale (pers. comm. 18/9/12) listed selepe as a charm for expulsion. In contrast to seletjane, only *H. geniculata* is listed as a possible synonym for selepe, the uses of which correspond to those listed for seletjane (as seletjane is also a possible name for *H. geniculata* and both samples were given by the same person, it might be parsimonious to argue that the seletjane sample here represents a species of *Hermannia* other than *H. geniculata*). Neither seletjane nor selepe yielded starch.

Myrtaceae

Eucalyptus sp., bloekom. This plant was identified by its local name, but given that this name is evidently derived from the Afrikaans for various species of *Eucalyptus* sp., and that this was confirmed by photograph, the equation of *Eucalyptus* sp. with bloekom seems secure. Although use of *Eucalyptus* sp. for medicine is widespread in Lesotho (Moffett 2010:270; Ntate Libe Thame pers. comm. 14/9/12), it is certainly not a native species (van Wyk & Gericke 2000:218) and as such is not a particularly useful addition to a reference typology aimed at exploring hunter gatherer plant use. In any event, the sample did not yield starch.

(Poaceae) Paniceae

Echinochloa colona, jwang ba masimo, bohomo ba didiba, jwangnyana ba mehlaka, leholo la dipere, mabele a dinonyana, motlepere. Although Moffett (2010) lists no uses for *Echinochloa* sp. (and Jacot Guillarmod does not list it at all), van Wyk & Gericke (2000:9) note that multiple species were regarded as famine foods in times of drought. As such, it may be regarded in the same light as *Eragrostis* sp. as having similar potential in a hunter-gatherer diet.

Rubiaceae

Pentanisia prunelloides?, setima mollo

P. prunelloides is the only Linnaean name listed for the plant known as setima mollo in Lesotho (Moffett 2010:290; Jacot Guillarmod 1971: 400) which has a wide range of medicinal uses, including one confirmed by 'Me Malireko Makotoko (pers. comm. 18/9/12), as a treatment for stomach ailments. According to 'Me Bela Nthunya (pers. comm. 15/9/12) setima mollo is always ground prior to use, which might make it a good candidate for recovery from an archaeological grindstone, but unfortunately the sample did not yield starch.

Kohautia amatymbica? morokolo poli

Although morokolo poli occurs as a prefix in the local names of members of the Vitaceae (*Rhoicissus* sp. being known as morokolo poli o moholo), *Kohautia amatymbica* is the only species known as morokolo poli alone, the name translating loosely as “goats’ droppings”, in reference to the shape of the bulbous roots (Ntate Joseph Ralimpe, pers. comm. 20/4/2014). Despite noting that “no vernacular names seem to have been recorded” van Wyk & Gericke (2000:90) note that edibility of the fleshy roots and Moffett (2000:282) multiple medicinal and charm uses.

Solanaceae

Solanum sp.? thola

Jacot Guillarmod (1971:333) lists *S. aculeatissimum*, *S. lichtensteinii*, and *S. supinum* as possible candidates for thola, which Moffett (2010:300) confirms. Unlike their better known cousins, *S. tuberosum* or *S. lycopersicum*, use of any species known as thola appears to be solely medicinal, including widespread use as a toothache remedy (van Wyk & Gericke 2000:211). Additionally, 'Me Malireko Masakale (pers. comm. 18/9/12) noted that *thola* would “keep people quiet” although whether she meant as a sedative or as a charm is not known.

(Poaceae) Triticeae

Hordeum capense, ditse ba ntja, leboya

Although neither Moffett (2010:279) nor Jacot Guillarmod (1971) record any known uses for *H. capense*, a sample was sought for the reference collection both as an indigenous species of Triticeae and in light of the fact that other wild Poaceae are known to have been used as famine foods in Lesotho. The southern African National Biodiversity Institute records *H. capense* as being present in Lesotho (<http://www.ville-ge.ch/musinfo/bd/cjb/africa/details.php?langue=en&id=52187> accessed 4/11/14)

Secale strictum ssp. *africanum*, rogo?

While *Secale cereale* (common rye) is known as rogo in Sesotho, there is no local name recorded for *Secale strictum* ssp. *africanum*. A sample of this grass was sought for the same reason as *H. capense*, however *S. strictum* is not known from Lesotho, although it is found elsewhere in southern Africa: Skead (2009: 70) includes an account by the traveller John Barrow from April 1798 on observing what is probably *S. strictum* ssp. *africanum* in the Roggeveld (the name deriving from the Afrikaans word for rye) and notes that

“Loxton (1973:75) states that this wild rye or wilde rog is the only true rye...indigenous to South Africa and is confined to the Roggeveld, the name indicating that it was once abundant in this region”.

Identification of archaeological starch granules with this species then, can be read in two possible lights: firstly, that although *Secale strictum* ssp. *africanum* is no longer present in Lesotho, in earlier times it was, possibly because of climatic difference such as the more arid conditions prevailing in the Pleistocene. Secondly, that identification may be misleading: it may suggest that while an identification with this species is incorrect, an unknown Triticeae is present. Thus identifications of *S. strictum* ssp. *africanum* should always be regarded as tentative, and critically assessed: cross-referenced with dates (if the species has been confined in recent times to areas outside of Lesotho, it is unlikely to have been present).

Triticum aestivum, koro, mankale, motanyatsane, teluntsu.

Although common bread wheat, *T. aestivum*, is not native to Lesotho, accounts suggest that by the mid-nineteenth century, vast quantities were being grown in the country for export to the newly-discovered diamond mines in Kimberly, South Africa. McCann (2001:261) notes that by

“...1873 alone, Basutoland exported 8,000 metric tons of grain...Export figures by 1893 had more than doubled to include 11,600 tons of wheat”.

Thus it is eminently feasible that nineteenth century hunter-gatherers in the Metolong area (present along the Phuthiatsana at least as late as the 1840s/1850s according to Arbousset 1991) would have encountered wheat through contact with Basotho farmers, as Stephen Gill (pers. comm. 1/12/14) notes the plausibility that it was being grown in this area at that time.

Xanthorroaceae

Aloe striatula, seholobe

Identified by its local name, the identification of the sample with *Aloe striatula* was confirmed through photographs. Moffett (2010:253) lists it as used as a digestive aid

and wound treatment, while Jacot Guillarmod (1971: 412) lists it as a preparation in tanning skins or hides

Unknown family or unidentified by Linnaean/Latin taxonomic name, possibilities in multiple families/genera

Hloenya, possibly *Dicoma anomala* (Asteraceae) or *Teedia Lucida* (Scrophulariaceae)

Three local sources ('Me Malireko Masakale, 'Me Bela Nthunya, Ntate Hlyenane Seefane) listed hloenya as an important medicinal plant, with 'Me Nthunya (pers. comm. 15/9/12) noting that it was always ground prior to use, and 'Me Masakale (pers. comm. 18/9/12) describing it as used in stomach ailments. Because the sample obtained was dried prior to use, it was not possible to compare it with photographs to achieve a Linnaean identification. For *D. anomala*, Jacot Guillarmod (1971:423-424) lists a wide variety of medicinal uses (also some veterinary uses), including use as a treatment for multiple stomach ailments, all of which are confirmed by Moffett (2010:266). For *T. lucida*, Jacot Guillarmod (1971) does not list any uses, while Moffett (2010:302), lists two: treatment for blood pressure and diabetes. Given the wide variety of noted uses could the reference to hloenya as an important medicinal plant by local informants lend support to its identification at Metolong as *D. anomala*?

Lenyoka

Ntate Hlenyane Seefane provided a sample of a plant known as lenyoka, describing it as a useful medicinal plant, but no identification could be made with a Latin name. No possible homonyms are listed by either Jacot Guillarmod or Moffett, and the closest possible entry, lenoku, is listed as "unknown plant" by both authors (Jacot Guillarmod 1971: 356, Moffett 2010:36).

Machacha metsa

‘Me Malireko Masakale provided a sample of this plant, describing it (pers. comm. 18/9/12) as a useful medicinal plant in treatment of stomach ailments. However there are no listings for it in either Jacot Guillarmod or Moffett. The prefix ‘machacha’ may related to the mountain Machache, located near the Phuthiatsana, River and a commonly-cited landmark. If so, this might suggest this name is local only to the area, which may be why it is not listed in either of the plant dictionaries consulted.

Moferefere

Possibilities for moferefere are *Epilobium hirsutum* (Onagraceae), *Lycium horridum* or *L. tenue* (Solanaceae), or *Senecio asperulus* (Asteraceae). *E. hirsutum* is listed as having dietary and magical uses (Moffett 2010:268), *L. horridum* medicinal uses (Moffett 2010: 284), *L. tenue* none, and *S. asperulus* multiple medicinal uses, including relief of cold and flu symptoms (Moffett 2010:298).

Mofoka tiali

Ntate Hlenyane Seefane listed the underground storage organ of this plant as an important medicinal constituent, but neither Jacot Guillarmod nor Moffett list the name.

Moratoe

‘Me Malireko Masakale and Ntate Hlenyane Seefane both noted this plant as an important medicinal/charm component, with ‘Me Masakale (pers. comm. 18/9/12) noting that it was used as a charm and attract people to the user. Both informants described it as having both male and female variants, neither of which yielded starch. The local name is not listed in Jacot Guillarmod or Moffett, and photographic identification was not possible as the samples obtained were dried.

Boraginaceae or Malvaceae

Lithospermum cinereum? *Malva parviflora?* *Malva verticillata?* Mosala suping

‘Me Malireko Masakale provided the sample of this plant, the local name of which corresponds to three possible Latin names, according to Jacot Guillarmod (1971:379). While ‘Me Masakale (pers. comm. 18/9/12) listed the plant as a charm to prevent expulsion, this does not correspond particularly well with the uses for *Malva* spp. or *Lithospermum* sp. listed by Jacot Guillarmod (which are similar – *Lithospermum* sp. being used as a pot herb and to treat broken limbs, and *Malva* spp. used to repair broken pots and broken limbs, cf. Jacot Guillarmod 1971: 439; 440). Moffett (2010:285) adds a number of further uses for both species of *Malva*: as an emetic and to treat tapeworms, treatment for dysmenorrhea, and as a charm for grief. As for *Lithospermum* sp., Moffett (2010:284) adds only that an infusion of the roots is used to wash after a funeral.

Apocynaceae?, Phytolaccaceae?

Poho tšela is listed as a local name for *Pachycarpus rigidus*, *Xysmalobium undulatum* (both Apocynaceae) and *Phytolacca heptandra* (Phytolaccaceae).

‘Me Malireko Masakale, who provided the sample from her store of dried pharmacopeia, informed me (pers. comm. 18/9/12) that poho tšela was used to treat stomach ailments. Ntate Joseph Morema (pers. comm. 14/9/12) told me that the plant grew by the river (and as such will be affected by the Metolong Dam). Jacot Guillarmod (1971:444) notes the following uses for *Pachycarpus rigidus*: dietary (with the leaves, stem and rootstock all being edible) and medicinal (to treat colic or sneezing). All of these uses are confirmed by Moffett (2010:289). While Jacot Guillarmod (1971:458) lists only dietary use for *Xysmalobium undulatum*, a wide variety of medicinal uses are listed by Moffett (2010:306) including treatment for colic, other stomach ailments and wounds, and as a decongestant. Van Wyk & Gericke (2000:136) note its widespread medicinal use. As for *Phytolacca heptandra*, Jacot Guillarmod (1971:446) states (somewhat confusingly) “the plant is said to be edible, but the fruits are never eaten, even, apparently, by birds; the root is said to be poisonous”. Moffett (2010:291) lists a preparation of the ground root

as a treatment for stomach pains and venereal disease, as a vermicide, and also that it is “used to get rid of an enemy”. Whether this refers to charm use or simply to the toxic nature of the plant if ingested is unknown.

Euphorbiaceae?

Seholoko

Jacot Guillarmod (1971:395) suggests *Elyonurus argenteus* (Poaceae, Andropogoneae), *Euphorbia clavaroides* or *Euphorbia inaequilatera* (both Euphorbiaceae) as Linnaean identifications for sehloko. Moffett (2010:98) confirms these and lists additionally another species of the Andropogoneae, *Andropogon schirensis*. Given that the sample provided (by Ntate Hlenyane Seefane) bore no resemblance at all to any Andropogoneae (this was clearly not a grass), only Euphorbiaceae are considered here: the sample corresponds better with *E. clavaroides* than *E. inaequilatera* but I list uses of both. Jacot Guillarmod (1971:428) notes that *E. clavaroides* may be used “to prepare bird lime”, as a gum chewed by children, to reduce swelling in feet, and with *Berkheya onopordifolia* to treat leprosy, while *E. inaequilatera* is used as a soothing treatment for nursing mothers. Moffett (2010:271) confirms these uses and adds that *E. inaequilatera* once dried and powdered may be used to treat heart disease. F. Krauss, travelling near the Groot River in 1839 noted that the flesh of *E. inermis* (which he referred to as *E. caput-medusae*) was eaten by farmers (quoted in Skead (2009: 84).

Selai

Selai was listed as a common food plant by several informants (including ‘Me Malireko Masakale, pers. comm. 13/9/12 and Ntate Joseph Morema, pers. comm. 14/9/12) who noted that it grew by the river, and would thus be jeopardised by the dam. No entry in either Jacot Guillarmod (1971) or Moffett (2010) corresponds to it. The sample did not yield starch.

Dipsacaceae?, Asteraceae?, Apiaceae?

Tšoene

Cephalaria attenuata (Dipsacaceae), *Helichrysum fulgidum* (Asteraceae), and *Pimpinella caffra* (Apiaceae) are suggested by Jacot Guillarmod (1971:407) as synonyms for this plant, while Moffett (2010: 276) confirms these and lists also further species of both Asteraceae (*Helichrysum aureum*) and Dipsacaceae (*Cephalaria decurrens*; *C. oblongifolia*). *H. aureum* has no recorded use and *H. fulgidum* is used in bathing sore eyes (Jacot Guillarmod 1971: 432; Moffett 2010:276). *C. attenuata* is used in various charms including expulsion of spirits (Jacot Guillarmod 1971:418; Moffett 2010:259), *C. decurrens* and *C. oblongifolia* have no recorded uses (Moffett 2010:259). Finally, *P. caffra* is used to expel intestinal parasites and evil spirits (Jacot Guillarmod 1971:446; Moffett 2010: 291). 'Me Malireko Masakale's information (pers. comm. 18/9/12) that tšoene is used to protect one's compound conforms reasonably well with either *C. attenuata* or *P. caffra*.

6.9 Morphometrics of the starch reference collection

Material for the starch reference collection was collected as described in section 6.8 above. Small pieces of material (c. 1cm³) were immersed in a solution of 70% ethanol and water, prior to grinding with a pestle and mortar, mounted and viewed on slides as per the archaeological material (see Appendix C). The criteria used in the morphometric analysis followed those listed in Torrence and Barton (2006).

Table 6.2 Morphometric characteristics of the starch reference collection

Name	Shape	Hilum	Vacuole/ Fissure	Lamellae	Maximum length range (um)	Minimum length range (um)
Amaryllidaceae						
<i>Crinum moorei</i>	Ovate	Highly eccentric	1. Absent (68.3%) 2. Straight fissure (12.2%) 3. Vacuole (14.6%) 4. Vacuole and fissure (4.88)	1. Faint (65.9%) 2. Absent (34.1%)	11.82-24.38	7.32-14.68
<u>Lematla</u>	1. Kidney (65.1%) 2. Round (20.9%) 3. Ovate (14%)	Centric	Absent	Absent	7.74-31.64	6.39-26.43
<i>Tulbaghia</i> sp.	1. Irregular tear/pear shape (87.5%) 2. Ovate (10%) 3. Round (2.5%)	Slightly eccentric	Absent	Absent	5.28-18.34	3.71-11.35
(Poaceae) Andropogoneae						
<i>Miscanthus capensis</i>	Round	Centric	1. Absent (87.2%) 2. Vacuole (12.8%)	Absent	3.66-10.36	3.27-9.71

Name	Shape	Hilum	Vacuole/ Fissure	Lamellae	Maximum length range (um)	Minimum length range (um)
<i>Sorghum bicolor</i>	Polyangular	Centric	1. Absent (61.4%) 2. Straight fissure (29.5%) 3. 3-pronged fissure (6.8%) 4. Vacuole (2.3%)	Absent	8.41-24.88	6.46-18.69
<i>Themeda triandra</i>	1. Polygonal (58.1%) 2. Round (41.9%)	Centric	1. Vacuole (53.5%) 2. Absent (44.2%) 3. Straight fissure (2.3%)	Absent	4.53-12.15	4.3-11.09
<i>Zea mays</i> ssp. <i>mays</i>	Polyangular	Centric	1. Fissure (40%) 2. Absent (37.2%) 3. Vacuole (22.8%)	Absent	8.2-17.14	6.2-15.37
Arecaceae						
<i>Zantedeschia aethiopica</i>	Polyangular	Centric	1. Absent (93.2%) 2. Straight fissure (6.8%)	Absent	3.27-13.15	3.2-11.73
Asparagaceae						
<i>Albuca</i> sp.	1. Round (63.5%) 2. Ovate (37.5%)	1. Centric (72.5%) 2. Slightly eccentric (27.5%)	1. Absent (97.5%) 2. 3-pronged fissure (2.5%)	1. Absent (90%) 2. Faint (10%)	6.48-20.61	5.43-17.77
<i>Eucomis autumnalis</i>	1. Clamshell (97.73%) 2. Oval (2.27%)	Highly eccentric	Absent	1. Absent (95.45%) 2. Faint (4.5%)	7.15-17.98	5.33-13.86
<i>Merwillia plumbaea</i>	Round	Centric	Absent	Absent	3.79-7.81	3.69-6.9
<i>Rethe la ntja</i>	1. Bell (51.2%) 2. Round (46.5%) 3. Kidney (5.1%)	Centric	1. Absent (72.1%) 2. Straight fissure (18.6%) 3. Vacuole (9.3%)	Absent	3.11-13.74	3.06-13.07

Name	Shape	Hilum	Vacuole/ Fissure	Lamellae	Maximum length range (um)	Minimum length range (um)
Convolvulaceae?						
<u>Maime</u>	1. Round (79.4%) 2. Ovate (20.6%)	Centric	Absent	Absent	2.89-9.59	2.5-8.64
Cyperaceae						
<i>Cyperus involucratus</i>	Polygonal – angular	Centric	Absent	Absent	2.71-5.57	3.49-6.29
<i>Cyperus sp.</i>	1. Ovate (72.73%) 2. Round (27.27%)	Centric	Absent	Absent	3.2-9.7	2.84-6.53
<i>Lepeka</i>	1. Round (52.3%) 2. Ovate (34.1%) 3. Bell (13.6%)	Centric	1. Vacuole (65.9%) 2. Absent (15.9%) 3. Dimple (18.2%)	Absent	3.47-11.2	2.78-9.95
(Poaceae) Eragrostideae						
<i>Eragrostis capensis</i>	Polygonal – angular	Centric	Absent	Absent	2.91-5.3	2.39-5
<i>Eragrostis curvula</i>	Polygonal – angular (97.2%) Ovate (2.8%)	Centric	Absent	Absent	2.39-5.09	1.83-4.41
Fabaceae						
<i>Vigna radiata</i>	1. Round 2. Oval-kidney	Centric	Straight fissure (66.6%) Straight fissure 65.4%		8.95-18.16 12.45-28.58	8.95-16.92 11.83-22.71
Geranaceae?						
<u>Khoara</u>	1. Round (64.3%) 2. Ovate (35.7%)	Centric	Absent	Absent	5.12-11.02	4.16-9.8
Gunneraceae						
<i>Gunnera perpensa</i>	Ovate	Highly eccentric	Absent	1. Strong (56.1%) 2. Absent (43.9%)	10.66-31.55	7.05-16.85
Hypoxidaceae?						
<u>Moli</u>	1. Round (65.1%)	Centric	Absent	Absent	3.14-10.3	2.94-7.59

Name	Shape	Hilum	Vacuole/ Fissure	Lamellae	Maximum length range (um)	Minimum length range (um)
	2. Ovate (25.6%) 3. Sub-round (2.3%)					
Iridaceae						
<i>Gladiolus dalenii</i>	Polygonal – rounded	Centric	Absent	Absent	2.32-6.04	3.02-7.83
<i>Moraea spathulata</i>	1. Irregular (56.8%) 2. Oval (43.2%)	Centric	1. Straight fissure (20.5%) 2. Absent (79.5%)	Absent	5.95-21.96 4.45-15.21	7.495-25.48 5.15-22.88
<i>Watsonia wordsworthiana</i>	1. Bell (50%) 2. Round (25%) 3. Polygonal (15.9%) 4. Polyangular (9.1%)	Centric	1. 3-pronged fissure (77.3%) 2. Absent (22.7%)`	Absent	5.97-23.87	5.17-21.1
Malvaceae?						
<u>Tika motse</u>	Bell	Slightly eccentric	Straight fissure	Absent	6.73-9.28	5.17-7.71
(Poaceae) Paniceae						
<i>Echinocloa colona</i>	Polyangular – irregular	Centric	Absent	Absent	4.27-12.73	2.77-11.91
Rubiaceae?						
<u>Morokolo poli</u>	1. Round (85%) 2. Ovate (15%)	Centric	1. Absent (75%) 2. 3-pronged fissure (25%)	Absent	6.13-23.18	5.69-18.83
Solanaceae?						
<u>Thola</u>	Polygonal/irregular	Centric	Absent	Absent	3.77-7.39	2.54-7.54
(Poaceae) Triticeae						
<i>Hordeum capense</i>	1. Ovate (77.3%) 2. Round (20.5%) 3. Sub-round (2.2%)	Centric	1. Dimple (54.5%) 2. Absent (45.5%)	Absent	4.16-10.13	2.52-7.37
<i>Secale strictum</i> ssp. <i>africanum</i>	1. Oval-round (large) 2. Round-bell (small)	Centric	1. Absent 2. Dimple (59.2%)	Absent	10.48-24.66 3.46-9.96	9.13-23.81 2.94-7.86

Name	Shape	Hilum	Vacuole/ Fissure	Lamellae	Maximum length range (um)	Minimum length range (um)
<i>Triticum aestivum</i>	1. Large round-ovate (24.4%) 2. Round-bell shape (75.5%)	Centric	1. Absent (66.9%) 2. Vacuole (33.1%)	Absent	1. 14.32-28.9 2. 3.82-9.45	1. 12.93-28.1 2. 4.39-7.55
Zoysieae						
<i>Sporobolus fimbriatus</i>	Polyangular	Centric	Absent	Absent	2.37-5.58	1.91-5.02
Unknown family or tribe						
<u>Hloenya</u>	Kidney	Centric	Absent	Strong	23.52-25.53	17.42-21.19
<u>Machacha metsa</u>	1. Round (71.4%) 2. Bell (14.3%) 3. Irregular (9.5%) 4. Kidney (2.4%) 5. Ovate (2.4%)	1. Centric (97.6%) 2. Highly eccentric (2.4%)	1. Absent (81%) 2. Dimple (14.2%) 3. Straight fissure (4.8%)	Absent	4.37-13.23	3.35-9.54
<u>Mofoka tiali</u>	1. Ovate (86.1%) 2. Round (6.9%) 3. Kidney (4.7%) 4. Sub-round (2.3%)	1. Centric (83.7%) 2. Slightly eccentric (16.3%)	Absent	Absent	7.19-34.76	6.4-27.17
<u>Poho tšela</u>	Round	Centric	1. Straight fissure (90.4%) 2. Vacuole (9.5%)	Absent	6.55-14.21	4.83-14.21
<u>Sehloko</u>	1. Oval (94.1%) 2. Polyangular (5.9%)	Centric	Absent	Absent	3.6-7.55	2.62-5.66
<u>Selepe</u>	1. Polygonal (63.6%) 2. Round (27.3%) 3. Bell (9.1%)	Centric	1. Dimple (52.3%) 2. Vacuole (40.9%) 3. Absent (6.8%)	Absent	3.11-12.36	3.53-11.23

6.10 Catalogue of images from the starch reference collection

Images from the starch reference collection (section 6.9) are presented here, ordered by family/tribe.

Amaryllidaceae

RC 36: *Crinum moorei*

RC 30: *Lematla* (*Brunsvigia radulosa*)

RC 37: *Tulbaghia* sp.

(Poaceae) Andropogoneae.

RC *Miscanthus capensis*

RC 39: *Sorghum bicolor*

RC 40: *Themeda triandra*

Areaceae.

RC 42: *Zantedeschia aethiopica*

Asparagaceae

RC 43: *Albuca* sp.

RC 44: *Eucomis autumnalis*

RC 45: *Merwillia plumbaea*

RC 46: *Rethe la ntja*

Convulvulaceae

RC 29: *Maime*

Cyperaceae.

RC 45: *Cyperus involucratus*

RC 28: *Lepeka*

Eragrostideae

RC 47: *Eragrostis capensis*

Geranaceae

RC 11: Khoara
Gunneraceae.

RC50: *Gunnera perpensa*

Hypoxidaceae

RC 6: Moli

Iridaceae

Gladiolus capensis

Moraea spathacea

RC 51: *Watsonia wordsworthiana*

Rubiaceae.

RC 53: Morokolo poli

Solanaceae

RC 21: Thola

(Poaceae) Triticeae.

RC 54: *Hordeum capense*

RC 55: *Secale strictum* ssp. *africanum*

Family/Tribe uncertain/unknown.

RC 7: Hloenya

RC 29: Maime

RC 33: Mofoka tiali

RC 53: Morokolo poli

RC 23: Poho tšela

RC 32: Sehloko

RC 20: Selepe

6.11 Starch analysis as applied to grindstones from Ha Makotoko

15 grindstones from a range of contexts dating from the earliest Middle Stone Age at Ha Makotoko up to most recent occupation layers were analysed in the course of this project.

The grindstones selected were: L101, L108, L109, L110, L116, L139, L140, L145, L147, L152, L173, L181, L189, L193 and T1. Their dimensions and other features are described in Chapter 5. Several were also analysed for pigment (see Appendix B) and phytoliths (Chapter 7) in order to determine if the presence of one type of residue might correlate inversely or directly with the presence of another substance. As I discuss in Chapter 2, this does not, of course, constitute the total number of possible uses to which the putative grindstones were put. The main aim in examining starch residues on putative grindstones from Ha Makotoko was to explore whether or not they had been used in geophyte processing (Cable 1984; Mitchell 1996; Wadley 2000).

6.12 Illustrations of grindstones analysed for starch

This section (Figure 6.2 to Figure 6.12) presents illustrations of those grindstones analysed for starch, with their different surfaces (separated where possible during analysis) labelled, as well as locations for spot samples.

Figure 6.2 Grindstones L101 and L108 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

L109

Figure 6.3 Grindstone L109 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

Figure 6.4 Grindstones L110 and L116 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

Figure 6.5 Grindstones L139 and L140 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

L145

(Clockwise from left perpendicular side): C; A; D; B. Not visible: E and F

A, with E and F perpendicular to longest sides

Figure 6.6 Grindstone L145 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

Figure 6.7 Grindstones L147 and T1 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

Figure 6.8 Grindstone L152 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

L173

8

Figure 6.9 Grindstone L173 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

L173

L181

Figure 6.10 Grindstones L173 (continued) and L181 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

L189

Figure 6.11 Grindstone L189 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

L193

Figure 6.12 Grindstone L193 with surfaces labelled. Circles denote the location of spot samples. Scale bar measures 5cm.

6.13 Method

The method of analysis followed was adapted from that used by Carol Lentfer, Michael Therin and colleagues from the Australian Museum (Lentfer *et al* 2002), and developed and modified in communication with Alison Crowther (University of Queensland). Full details are listed in Appendix C and I will note here only that due to concern for contamination (following Crowther *et al* 2014), a full range of control measures was followed in the course of analysis to eliminate (where possible) and isolate (where elimination was not possible) contaminants: this included the preparation and analysis of blank or ‘negative control’ (‘NC’) samples processed with all archaeological samples to isolate laboratory-derived contamination. Conversation with the excavators of Ha Makotoko led me to be reasonably confident that objects to be analysed for starch had been minimally handled in advance of analysis. This is further discussed in the case of individual grindstones. Prepared slides were scanned at 200x magnification using a Brunel Instruments SP400 microscope with polarising capacity. Bodies identified as starch (via features outlined in Section 6.3 above) were examined at 400x and photographed using a ScopeTek microscope camera. Images were processed using ScopePhoto and ImageJ software. Morphometric characteristics were observed and documented both directly (i.e. using the microscope) and indirectly on examination of the photographs. These characteristics were then inscribed on a recording form (see Figure 6.13 below).

Ha Makotoho Grindstones
2147 - second round

* shading suggests quality

Artefact no. + tag	SG	Cond	Type	2D/3D shape	Size (LxWxB)	Hilum	Vacuole/ Fissure/ Damage	Lamellae	Cross	Comment Drawing
L147 WBA5 400x	1	R		round	10.66 11.73 11.37	C	—	—	90° flared	
L147 WBA5 400x	2	R		oval/boxy	11.81 9.82	C	—	—	90°	
L147 WBA5 400x	3	D?		round	17.76 18.12	C	fissure @ hilum	Y, faint	90° w/ slightly bent arms	
L147 WBA5 400x	4	D		amorphous	28.43 20.60	—	Amorphous starch, possibly prismatic	poss. faint	no, but birefringent	
L147 WBA6 400x	1	R		round/poly	11.72 10.66	C	long fissure @ hilum	1, faint?	no xp photo (w/ing?)	
L147 WBA1 400x	1	D		round/square	14.56 15.98	C	translucent, pitting @ centre? (see xp)	—	90° loss of clarity	
L147 WBB1 400x	1	D		round	11.72 11.72	C	translucency, loss of birefringence, cracks/fissures	—	60° not quite 90° faint	
L147 WBB1 400x	2	R		round	9.24 8.17	C	—	v. faint?	90° slightly bent arms	
L147 WBB3 400x	1	R		round	9.95 10.30	C	fissure @ hilum	—	90° slightly refracted	
L147 WBB4 400x	1	R		round	10.30 10.66	C	"	—	"	
L147 WBB4 400x	2	R		round	9.59 8.88	C	"	—	"	
L147 WBB6 400x	1	R		round	7.46 6.39	C	—	—	90° quite clear	
L147 WBB6 400x	2	R		round/oval	10.80 8.17	C	fissure @ hilum	—	90° slightly refracted	
L147 WBB6 400x	3	R		oval	7.46 6.39	C	—	—	90°	
L147 US3A 400x	1	R		round	10.66 11.37	C	—	—	90° clear	
L147 US3A 400x	2	R		"	10.21 9.59	C	fissure @ hilum	—	90° thin	

Figure 6.13 Sample recording form for archaeological starch

Features documented included condition (damaged or raw/native), shape (two- or three-dimensional), dimensions, location of the hilum, presence of a vacuole, fissure, or damage, presence of lamellae, description of the extinction cross, and, finally a brief sketch drawing. This information was then copied into an Excel spreadsheet and compared with morphometric and photographic information from species within the reference collection (see sections 6.9 and 6.10).

This method resulted in the identification of many archaeological starches to genera present in the reference collection (See Table 6.4 to Table 6.7 below), but also illuminated a number of types which were not present: these are designated 'NRC 01', 'NRC 02' (etc.) where 'NRC' is 'not present in reference collection'. Table 6.4 to Table 6.7 below also detail where archaeological starches were not identifiable: either because

they were obscured by other bodies on the slide, or because of damage (where this was identifiable as gelatinisation, this is also noted).

Finally, the presence of a recurring non-starch body was also recorded: following consultation with members of the 'Phy-talk' list-serv (a mailing list permitting conversation between researchers interested in phytoliths and other microbotanicals) and follow-up with Prof. Gerald Carr of Oregon State University, a morphotype initially thought to represent damaged starch (due to its prominent lamellae, ragged edges, birefringence and tendency to stain with Congo Red) is tentatively characterised as a cystolith (Figure 6.14). Cystoliths are calcium carbonate deposits within lithocyst cells of the leaves of certain plants, most commonly found within the Urticaceae, Moraceae and Cannabaceae (Watt *et al.* 1987). They are understudied in terms of their archaeobotanical potential (although see Piperno 2006) but may form useful proxies.

Figure 6.14 *Boehmeria* sp. (Urticaceae) cystolith courtesy of Gerald Carr (left); possible cystolith from grindstone L116 at Ha Makotoko (right).

6.14 Grindstones and sediments contextualised

Table 6.3 presents contextual information on each grindstone and sediment sample analysed.

Table 6.3 Phase, date, and contextual information for sediments and grindstones sampled for starch

Grindstones	Context	Phase, date, and contextual information
L101	(052)	Phase 9, >40,100±230BP, largely geogenic and present across entire excavation area, includes diagnostic MSA artefacts
L108	(190)	This context is interpreted as being the same as (052)
L109	(120)	Phase 8, minimum age of 25,000BP, Terminal Pleistocene sediments.
L110; L116	(109)	Phase 8 (see above). (109) is an extensive linear deposit with a large concentration of bone.
L139	(091)	Phase 7, pre-Woodlot Oakhurst, 10,060±30 BP. Context comprises an extensive and thick white ashy layer derived from hearth activity
L140	(012)	Phase 3, Final LSA/Woodlot, later Holocene. Predominantly aeolian deposit with some anthropogenic input
L145	(023)	Phase 4, Woodlot, 9110±30 BP. Composition similar to that of (012)
L147	(202)	Unphased (in area 61 rather than main area), dating to between 28,690±90 BP – 39,620±210BP. This deposit is interpreted as the natural fill of a pit.
L152	(186)	Unphased, as with (202). This deposit is from the fill of a small pit or hollow
L173	(177)	Unphased, possibly early Holocene, this context is interpreted as the fill of a small pit apparently intentionally dug for the deposition of L173 and some burnt mammalian bone
L181	(002)	Phase 1. This phase represents the most recent LSA/Historic occupation of the site, with dung in layer indicative of a recent date.
L189	(002)	See above
L193	(141)	Phase 1. See above, but this context also contains both LSA diagnostic artefacts and Later Iron Age pottery.
T1	(001)	Phase 1. This context is from the site's surface dust

6.15 Characterisation of starch from Ha Makotoko grindstones

Table 6.4, Table 6.5, Table 6.6, and Table 6.7 show the starch counts for each grindstone analysed. A note on labelling: where possible (during dry and wet brushing steps, and during spot sampling), discrete surfaces of artefacts were studied separately and labelled 'A', 'B', 'C' etc. 'US' refers to 'Ultrasonication' and therefore represents the entire artefact (as this step follows brushing stages, placing the artefact into an ultrasonic water bath and studying the residue in the water). These discrete surfaces are depicted in illustrations in section 6.12. 'NC' represents 'Negative Control', the blank control

sample analysed alongside each artefact in order to determine if contamination of samples had occurred during laboratory analysis. 'All samples' is used as code where no sample from the grindstone yielded starch: this is to aid legibility and does not signify that the grindstone in question was not subject to the same procedures as others. An asterisk (*) is used to denote a case where a starch granule is interpreted as contamination (usually due to the presence of maize or wheat in an unfeasibly early context, see section 6.8.3 for dates for the earliest occurrences of these species in the region). A total of 229 starch granules and 7 possible cystoliths were encountered on the grindstones analysed.

Table 6.4 Starch characterised on L101, L108, 109, L110, and L116, presented in alphabetical order according to family, except in the case of the Poaceae which are sub-divided according to tribe.

	L101	L108					L109					L110	L116					Total
	All samples	US	A	B	C	NC	US	A	B	C	NC	All samples	US	A	B	C	NC	
Amaryllidaceae																		
<i>Crinum moorei</i>																		0
<u>Lematla</u>																		0
<i>Tulbaghia</i> sp.																		0
Poaceae (Tribe: Andropogoneae)																		
<i>Miscanthus sorghum</i>																		0
<i>Sorghum bicolor</i>																		0
<i>Themeda triandra</i>																		0
<i>Zea mays</i>		1*																1*
<i>Sorghum</i> sp. or <i>Zea</i> sp.																		0
Arecaceae																		
<i>Zantedeschia aethiopica</i>																		0
Asparagaceae																		
<i>Albuca</i> sp.																		0
<i>Eucomis autumnalis</i>																		0
<i>Merwillia plumbaea</i>																		0
<u>Rethe la ntja</u> (<i>Asparagus</i> sp.)																		0
Convolvulaceae																		
<u>Maime</u> (<i>Ipomoea</i> sp.)																		0
Cyperaceae																		

	L101	L108					L109					L110	L116					Total
	All samples	US	A	B	C	NC	US	A	B	C	NC	All samples	US	A	B	C	NC	
<i>Cyperus involucratus</i>																		0
<i>Lepeka</i> (<i>Cyperus</i> sp.)																		0
Andropogoneae: Eragrostideae																		
<i>Eragrostis capensis</i>																		0
<i>Eragrostis curvula</i>																		0
Fabaceae																		
<i>Vigna</i> sp.																		0
Geranaceae																		
<i>Khoara</i>							1											1
Gunneraceae																		
<i>Gunnera perpensa</i>																		0
Hypoxidaceae																		
<i>Moli</i> (<i>Hypoxis</i> sp.)																		0
Iridaceae																		
<i>Gladiolus dalenii</i>																		0
<i>Moraea spathacea</i>																		0
<i>Watsonia wordsworthiana</i>									1				1					2
Poaceae: Paniceae																		
<i>Echinochloa colona</i>																		0
Rubiaceae																		
<i>Morokolo poli</i> (<i>Kohautia</i> sp.)																		0
Solanaceae																		
<i>Thola</i> (<i>Solanum</i> sp.)																		0
Poaceae: Triticeae																		

	L101	L108					L109					L110	L116					Total
	All samples	US	A	B	C	NC	US	A	B	C	NC	All samples	US	A	B	C	NC	
<i>Hordeum capense</i>									1									1
<i>Secale strictum</i>																		0
<i>Triticum aestivum</i>								3			1							4*
cf. <i>Triticeae</i>		1			1			*			*							2
Family/Tribe uncertain/unknown																		
<u>Hloenya</u>																		0
<u>Hloenya</u> or <u>Lematla</u>																		0
<u>Maime</u>																		0
<u>Maime/Merwillla/Moli/Miscanthus</u> sp.																		0
<u>Mofoka tiali</u>																		0
<u>Poho tšela</u>																		0
<u>Sehloko</u>																		0
<u>Selepe</u>																		0
Not in reference collection																		
NRC O1																		0
NRC O2																		0
NRC O3																		0
NRC O3A																		0
NRC P1																		0
NRC P2																		0
NRC R1																		0
NRC R2																		0

	L101	L108					L109					L110	L116					Total
	All samples	US	A	B	C	NC	US	A	B	C	NC	All samples	US	A	B	C	NC	
Unidentified starch																		0
Unidentified gelatinised starch		2			1				1									4
Unidentified other damaged starch									1									1
Other bodies																		
Cystolith														1				1
Total	0	4	0	0	2	0	1	3	4	0	1	0	1	1	0	0	0	17

Table 6.5 Starch characterised on L139, L140, L145, L147, and L152, presented in alphabetical order according to family, except in the case of the Poaceae which are sub-divided according to tribe.

	L139				L140				L145	L147				L152					Total
	US	A	B	NC	US	A	B	NC	All samples	US	A	B	NC	US	A	B	C	NC	
Amaryllidaceae																			
<i>Crinum moorei</i>																			0
<i>Lematla</i>					1														1
<i>Tulbaghia</i> sp.												1							1
Poaceae: Andropogoneae																			
<i>Miscanthus sorghum</i>																			0
<i>Sorghum bicolor</i>																			0
<i>Themeda triandra</i>						1						1							2
<i>Zea mays</i>																			0
<i>Sorghum</i> sp. or <i>Zea</i> sp.																			0
Arecaceae																			
<i>Zantedeschia aethiopica</i>		1				1													2
Asparagaceae																			
<i>Albuca</i> sp.					2														2
<i>Eucomis autumnalis</i>																			0
<i>Merwillia plumbaea</i>																			0
<i>Rethe la ntja</i> (<i>Asparagus</i> sp.)															1				1
Convolvulaceae																			
<i>Maime</i> (<i>Ipomoea</i> sp.)																			0
Cyperaceae																			

	L139				L140				L145	L147				L152					Total
	US	A	B	NC	US	A	B	NC	All samples	US	A	B	NC	US	A	B	C	NC	
<i>Cyperus involucratus</i>																			0
<u>Lepeka</u> (<i>Cyperus</i> sp.)																			0
Poaceae: Eragrostideae																			
<i>Eragrostis capensis</i>																			0
<i>Eragrostis curvula</i>																			0
Fabaceae																			
<i>Vigna</i> sp.																			0
Geranaciae																			
<u>Khoara</u>											1								1
Gunneraceae																			
<i>Gunnera</i> sp.																			0
Hypoxidaceae																			
<u>Moli</u> (<i>Hypoxis</i> sp.)																			0
Iridaceae																			
<i>Gladiolus dalenii</i>																			0
<i>Moraea spathacea</i>																			0
<i>Watsonia wordsworthiana</i>					1		4												5
Rubiaceae																			
<u>Morokolo poli</u> (<i>Kohautia</i> sp.)											1	2							3
Solanaceae																			
<u>Thola</u> (<i>Solanum</i> sp.)																			0
Poaceae: Triticeae																			
<i>Hordeum capense</i>																			0
<i>Secale strictum</i>		1																	1

	L139				L140				L145	L147				L152					Total
	US	A	B	NC	US	A	B	NC	All samples	US	A	B	NC	US	A	B	C	NC	
<i>Triticum aestivum</i>																			0
cf. <i>Triticeae</i>		1												1					2
Family/Tribe uncertain/unknown																			
<u>Hloenya</u>																			0
Hloenya or Lematla																			0
<u>Machacha metsa</u>											1								1
<u>Maime</u>																			0
<u>Maime/Merwillla/Moli/Miscanthus sp.</u>										1	1								0
<u>Mofoka tiali</u>																			0
<u>Poho tšela</u>										1									1
<u>Sehloko</u>																			0
<u>Selepe</u>																			0
Not in reference collection																			
NRC O1																			0
NRC O2																			0
NRC O3																			0
NRC O3A																			0
NRC P1																			0
NRC P2															1				1
NRC R1					2														2
NRC R2																			0
Unidentified starch						1					1	2					1		5
Unidentified gelatinised starch																			0

	L139				L140				L145	L147				L152					Total
	US	A	B	NC	US	A	B	NC	All samples	US	A	B	NC	US	A	B	C	NC	
Unidentified other damaged starch												1					1		2
Non starch bodies encountered																			
Cystolith			1		1	1	1												4
TOTAL	0	3	1	0	7	4	5	0	0	2	5	7	0	1	2	0	2	0	39

Table 6.6 Starch characterised on L173, L181, L189 presented in alphabetical order according to family, except in the case of the Poaceae which are sub-divided according to tribe.

	L173							L181	L189					Total
	A	B	C	D	E	F	NC	All samples	US	A	B	C	NC	
Amaryllidaceae														
<i>Crinum moorei</i>						1								1
<u>Lematla</u>														0
<i>Tulbaghia</i> sp.										1				1
Poaceae: Andropogonaceae														
<i>Miscanthus sorghum</i>														0
<i>Sorghum bicolor</i>														0
<i>Themeda triandra</i>	1		1									1		3
<i>Zea mays</i>	2*		2*			1*								5*
<i>Sorghum</i> sp. or <i>Zea</i> sp.										0				0
Areaceae														
<i>Zantedeschia aethiopica</i>														0
Asparagaceae														
<i>Albuca</i> sp.														0
<i>Eucomis autumnalis</i>														0
<i>Merwillia plumbaea</i>														0
<u>Rethe la ntja</u> (<i>Asparagus</i> sp.)										1				1
Convolvulaceae														
<u>Maime</u> (<i>Ipomoea</i> sp.)														0

	L173							L181	L189					Total
	A	B	C	D	E	F	NC	All samples	US	A	B	C	NC	
Cyperaceae														
<i>Cyperus involucratus</i>														0
<i>Lepeka</i> (<i>Cyperus</i> sp.)														0
Poaceae: Eragrostideae														
<i>Eragrostis capensis</i>														0
<i>Eragrostis curvula</i>														0
Fabaceae														
<i>Vigna</i> sp.														0
Geranaceae														
<i>Khoara</i>							1							0
Gunneraceae														
<i>Gunnera perpensa</i>														0
Hypoxidaceae														
<i>Moli</i> (<i>Hypoxis</i> sp.)														0
Iridaceae														
<i>Gladiolus dalenii</i>														0
<i>Moraea spathacea</i>														0
<i>Watsonia wordsworthiana</i>					1	3								4
Poaceae: Paniceae														
<i>Echinochloa colona</i>														0
Rubiaceae														
<i>Morokolo poli</i> (<i>Kohautia</i> sp.)														0
Solanaceae														
<i>Thola</i> (<i>Solanum</i> sp.)														0

	L173							L181	L189					Total
	A	B	C	D	E	F	NC	All samples	US	A	B	C	NC	
Poaceae: Triticeae														
<i>Hordeum capense</i>									1					1
<i>Secale strictum</i>	2		1			1			7			1		12
<i>Triticum aestivum</i>								3*			1*			4*
cf. Triticeae		1			1				75		2	1		80
Family/Tribe uncertain/unknown														
<u>Hloenya</u>														0
<u>Hloenya or Lematla</u>	1D													1
<u>Maime</u>														0
<u>Maime/Merwillla/Moli/Miscanthus</u> sp.														0
<u>Mofoka tiali</u>														0
<u>Morokolo poli</u>										2	1`			3
<u>Poho tšela</u>	1													1
<u>Sehloko</u>														0
<u>Selepe</u>														0
Not in reference collection														
NRC O1														0
NRC O2														0
NRC O3		2	1		1						1			5
NRC O3A					1	1								2
NRC P1														0
NRC P2														0

	L173							L181	L189					Total
	A	B	C	D	E	F	NC	All samples	US	A	B	C	NC	
NRC R1														0
NRC R2	1													1
Unidentified starch	1					1								2
Unidentified gelatinised starch	11													11
Unidentified other damaged starch						1					2			3
Other bodies														
Cystolith	1								1	1				3
Total	21	2	7	0	3	1 1	0	0	83	5	6	3	0	159

Table 6.7 Starch characterised on T1 and L193 presented in alphabetical order according to family, except in the case of the Poaceae which are sub-divided according to tribe.

	T1	L193									Total
	All samples	US	A	B	C	D	E	F	G	NC	
Amaryllidaceae											
<i>Crinum moorei</i>											0
<i>Lematla</i>											0
<i>Tulbaghia</i> sp.											0
Poaceae: Andropogonaceae											
<i>Miscanthus sorghum</i>											0
<i>Sorghum bicolor</i>											0
<i>Themeda triandra</i>											0
<i>Zea mays</i>											0
<i>Sorghum</i> sp. <u>or</u> <i>Zea</i> sp.			3								3
Arecaceae											
<i>Zantedeschia aethiopica</i>											0
Asparagaceae											
<i>Albuca</i> sp.									1		1
<i>Eucomis autumnalis</i>											0
<i>Merwillia plumbaea</i>											0
<i>Rethe la ntja</i> (<i>Asparagus</i> sp.)											0
Convolvulaceae											
<i>Maime</i> (<i>Ipomoea</i> sp.)											0
Cyperaceae											
<i>Cyperus involucratus</i>											0
<i>Lepeka</i> (<i>Cyperus</i> sp.)											0
Poaceae: Eragrostideae											
<i>Eragrostis capensis</i>											0
<i>Eragrostis curvula</i>											0
Fabaceae											
<i>Vigna</i> sp.			1								1
Geranaceae											
<i>Khoara</i>											0
Gunneraceae											
<i>Gunnera perpensa</i>											0
Hypoxidaceae											
<i>Moli</i> (<i>Hypoxis</i> sp.)											0
Iridaceae											
<i>Gladiolus dalenii</i>											0
<i>Moraea spathacea</i>											0
<i>Watsonia wordsworthiana</i>											0
Poaceae: Paniceae											
<i>Echinochloa colona</i>											0
Rubiaceae											
<i>Morokolo poli</i> (<i>Kohautia</i> sp.)											0

	T1	L193									Total
	All samples	US	A	B	C	D	E	F	G	NC	
Solanaceae											
<u>Thola</u> (<i>Solanum</i> sp.)											0
Poaceae: Triticeae											
<i>Hordeum capense</i>											0
<i>Secale strictum</i>											0
<i>Triticum aestivum</i>											0
cf. Triticeae		2	1	1		1			1		6
Family/Tribe uncertain/unknown											
<u>Hloenya</u>											0
<u>Hloenya</u> or <u>Lematla</u>											0
<u>Maime</u>											0
<u>Maime/Merwillla/Moli/Miscanthus</u> sp.											0
<u>Mofoka tiali</u>			1	1							2
<u>Poho tšela</u>		1									1
<u>Sehloko</u>											0
<u>Selepe</u>											0
Not in reference collection											
NRC O1		1									1
NRC O2											0
NRC O3											0
NRC O3A											0
NRC P1					1						1
NRC P2											0
NRC R1							1				1
NRC R2											0
Unidentified starch									1		1
Unidentified gelatinised starch									2		2
Unidentified other damaged starch											0
Other bodies											
Cystolith				2							2
Total	0	6	6	4	1	1	1	0	5	0	24

6.16 Discussion of individual grindstones

Where micrographs of starches are presented, these are always (unless stated otherwise) in the format of plane light (left) and cross-polarised light (right), under 400 x magnification. Contextual information is provided for each grindstone in Table 6.3 above, and a Harris Matrix illustrating the stratigraphic relationship between contexts may be found in Chapter 4.

L101 is interpreted as an upper grindstone, class 2, and was completely blank, including its control sample.

L108 is interpreted as a lower grindstone, class 2, and yielded two granules of Triticeae starch (**Figure 6.15**), which fit within the population morphometrics for both *Secale strictum* ssp. *africanum* and *Triticum aestivum* and are thus assigned to family alone. While its control sample was blank, given the age of the grindstone's context, these Triticeae starches are regarded as possible contaminants, perhaps from the excavation process. Alternatively, it is possible that *Secale strictum* ssp. *africanum*, a native southern African subspecies of rye, grew in the area during the Pleistocene, although it does not do so now (see section 6.8.3). Three unidentifiable starch granules were also recovered.

Figure 6.15 cf. Triticeae starch (contamination?) from L108

L109 is interpreted as a lower grindstone, class 2 and revealed a single granule each of Khoara (Figure 6.16), *Watsonia* sp., and *Hordeum* sp. (Figure 6.17), one gelatinised body, and one unidentifiable starch granule. The control sample was not blank and contained one granule of *Triticum aestivum*, while a further three *T. aestivum* granules were recovered from surface 'A'. For this reason (and given the age of grindstone's context), all granules of *Triticum* recovered are regarded as contamination. While *Watsonia* sp. and Khoara each have medicinal in addition to edible uses, *Hordeum* sp. has no recorded medicinal properties. While the *Watsonia* sp. granule was recovered from the ultrasonicated sample, four of the others (*Khoara*, *Hordeum* sp. and the two unidentified granules) derived from surface B, which could conceivably have formed a working surface, thus these starches could be derived from use.

Figure 6.16 Khoara from L109

Figure 6.17 (From top to bottom) *Watsonia* sp (note mechanical damage to top left side of granule); *Hordeum* sp. granule from L109, possibly damaged.

L110 is interpreted as a lower grindstone, class 2 and was completely blank, including its control sample.

L116 is interpreted as a lower grindstone class 2, and yielded one granule of *Watsonia* sp. from the ultrasonicated fraction (Figure 6.18). Its control sample was blank.

Figure 6.18 (From top to bottom) *Watsonia* sp. starch from L116; Possible cystolith from L116

L139 is interpreted as a lower grindstone class 3 and yielded one granule of *Zantedeschia* sp., and one granule each of *Triticum aestivum* and (tentatively) *Secale strictum* ssp. *africanum* (Figure 6.19). While the control sample was blank, the age of the artefact suggests that the *Triticum aestivum* granule is contaminant derived (ex-laboratory) and in light of this, perhaps the characterisation of *Secale* sp. should be revised: however, the morphometric characteristics of the granule fit better within the range for *Secale* sp.. *Zantedeschia* sp. has both edible and medicinal uses. All starch granules derived from surface A, which is interpreted as a possible working surface.

Figure 6.19 (From top to bottom) cf. Triticeae; *Zantedeschia* sp.; possible *Secale* sp. starch from L139 L140 is interpreted as an upper grindstone class 3/hammerstone, and yielded one granule each of *Lematla* (Figure 6.20), *Themeda triandra*, *Zantedeschia* sp. (Figure 6.21) and an unidentifiable starch. Two granules of *Albuca* sp. (Figure 6.21) and five of *Watsonia* sp. (Figure 6.22) were present as were two of a type which is not present in the reference collection (NRC R1). The control sample was blank. While the artefact was separated into two functional surfaces during starch sampling, due to the spherical shape of the object, these were arbitrary, and as such, the surfaces 'A' and 'B' should probably be interpreted together. While *T. triandra*, *Zantedeschia* sp. and *Watsonia* sp all

have potential dietary and medicinal uses, *Lematla* and *Albuca* sp. are used solely medicinally within Basotho economic botany. If the use of this grindstone to apparently process medicinal plants was consistent throughout its lifetime this might indicate that the separation between dietary and medicinal plant grinding as practiced by Basotho today also existed in hunter-gatherer practices at Ha Makotoko. The presence of starches from four geophytes on this spherical artefact could be consistent with inferences from experimental literature in Chapter 2 which suggest that the morphology of a spherical, hammer-shaped upper grindstone is more likely to result from processing (i.e. pounding) geophytes rather than the morphology of a *tšiloane*-type upper grindstone.

Figure 6.20 *Lematla* granule from L140

Figure 6.21 From top to bottom) *Themeda triandra*; *Zantedeschia* sp.; *Albuca* sp. from L140

Figure 6.22 *Watsonia* sp. from L140

L145 is interpreted as a lower grindstone class 1 and was completely blank, including its control sample.

L147 is interpreted as an upper grindstone class 1 and yielded one granule each of *Tulbaghia* sp., *Themeda triandra*, *Khoara* (Figure 6.23), *Machacha metsa*, *Poho tšela*; two of *Watsonia* sp. (Figure 6.24); and three of *Morokolo poli* (Figure 6.25) as well as three unidentifiable starch granules. The control sample was blank. The plant types identified from starches are variously edible and medicinal (see section 6.8.3). Starch granules were found fairly equally on both surfaces of the artefact separated during starch extraction (with five on surface A, seven on B and two in the ultrasonicated fraction) suggesting that, if the starches are processing-derived, the artefact was used equally on both sides. Unfortunately the distal end of the artefact could not be separated during analysis, which might have yielded more precise information on how the artefact was used (as a pestle or as a grinder, for instance).

Figure 6.23 (From top to bottom) *Tulbaghia* sp.; *Themeda triandra* and *Khoara* from L147

Figure 6.24 (From top to bottom) *Machacha metsa*, *Poho tšela*; *Watsonia sp.*, from L147

Figure 6.25 Morokolo poli, from L147

L152 is interpreted as a lower grindstone class 2 and yielded one granule each of Rethe la ntja (Figure 6.26) and *Triticum* sp. (Figure 6.27). One granule of a type not in the reference collection was found (NRC P2), one granule of unidentifiable starch, and one granule of damaged starch (Figure 6.27). The control sample was blank, but the *Triticum* sp. granule is probably contaminant-derived (ex-laboratory). Although the overall starch yield for L152 was low, it is worth noting that the broken side of the artefact (B) yielded no starches, while sides A and C (both intact) did, which suggests that even if the non-Triticeae starch was not derived from processing activity, it derived from contact pre-deposition.

Figure 6.26 Rethe la ntja from L152

Figure 6.27 (top to bottom): cf. Triticeae; NRC P2; and unidentified damaged starch from L152

L173 is interpreted as a lower grindstone class 1 and yielded one granule of *Crinum* sp. (Figure 6.28) , two of *Themeda* sp., four of *Watsonia* sp., one damaged²⁵ granule of either

²⁵ See section 6.3 for criteria for recognizing damaged starch

Hloenya or Lematla (in this case indistinguishable because of damage), and one of Poho tšela (Figure 6.29). Of types not included in the reference collection, there are four granules of NRC 03, two of NRC 03A, and one of NRC R2 (Figure 6.30). A further two granules of unidentifiable starch were recovered, as well as 11 granules of gelatinised starch (Figure 6.31) and one of damaged starch. Five granules of *Zea* sp. were recovered, which given the age of the artefact, must be regarded as contamination-derived, as must four of Triticeae (not distinguishable to genus). The attribution of four granules to *Secale* sp. should be regarded as tentative, but fits better than an identification with *Triticum* sp.. L173 is one of the largest grindstones encountered. While it can be confidently asserted that it was not contaminated during the laboratory process (as the control sample was blank), because of its size it was not placed in an enclosed ‘finds bag’ by excavators and must thus have been more vulnerable to contamination than smaller objects analysed, all of which were bagged. Of the six non-contaminant plants potentially identified through starch analysis on L173, all have medicinal uses, and two/three have solely medicinal uses: *Crinum* sp., Hloenya, and Lematla. This could mean that L173 was used to process non-dietary plants: further support for a processing role could come from the fact that the two sides of the object interpreted as working surfaces (A and F) yielded the highest number of starches (20 and 11 respectively).

Figure 6.28 *Crinum* sp from L173

Figure 6.29 (From top to bottom) *Themeda triandra*; *Watsonia* sp.; *Hloenya/Lematla* (indistinguishable here) from L173

Figure 6.30 (From top to bottom) NRC O3; NRC O3A, NRC R2 from L173

Figure 6.31 (From top to bottom) NRC 02; a cluster of gelatinised granules from L173. IKI stain is visible in the unpolarised photo.

L181 interpreted as an upper grindstone class 3 and was blank, including its control sample.

L189 is interpreted as a lower grindstone class 1 and yielded one granule each of *Tulbaghia* sp. *Themeda* sp., and *Rethelantia* (Figure 6.33); two of *Watsonia* sp.; three of *Morokolo poli* (Figure 6.34); one of NRC 03; and two unidentified damaged starches. Finally, 91 Triticeae starches were identified, 75 of which were part of a large cluster (note that these 75 represent only those individual granules within the cluster that could be identified and counted, though the cluster was in fact much larger, see Figure 6.32). The population level morphometrics for these 75 granules fit equally with *Secale* sp. or *Triticum* sp. Eight of the remaining 16 Triticeae granules (not part of the cluster)

were assigned to *Secale* but as with all other identifications to this genus, this should be regarded as tentative. The presence of Triticeae is not regarded as contamination: the control sample was blank, and as is discussed in the account of the starch reference collection, given the age of the grindstone, it is plausible that *Triticum aestivum* would have been available to persons occupying Ha Makotoko at the time of use (see section 6.8.3). Thus, the Triticeae starches are here regarded as use-related, although the cluster derives from the ultrasonicated fraction rather than a working surface. Edible plants predominate in this sample.

Figure 6.32 cf. Triticeae cluster from L189

Figure 6.33 (From top to bottom) *Tulbaghia* sp ; *Themeda triandra*; *Rethe la ntia* from L189

Figure 6.34 *Watsonia* sp (top); *Morokolo Poli* (bottom) from L189

T1 is interpreted as a lower grindstone, class 3, and was completely blank, including its control sample.

L193 is interpreted as a lower grindstone, class 1 and yielded three granules of *Sorghum* sp. or *Zea* sp. (indistinguishable²⁶), one of *Vigna* sp. or other Fabaceae (Figure 6.35), one of *Gunnera* sp., six Triticeae, two *Mofoka tiali* (Figure 6.36), one of *Poho tšela*, and three of types not included in the reference collection (one each of NRC 01, NRC P1, NRC R1, Figure 6.37, Figure 6.38). There were also two obscured starch granules and two

²⁶ Note that as with distinguishing members of the Triticeae (e.g. *Secale* sp. and *Triticum* sp.) from one another, differentiation between *Sorghum* sp. and *Zea* sp. (both Andropogoneae) can also be difficult (Langejans 2006). Here, it was sometimes possible to distinguish between the two genera using morphometric information, but sometimes impossible (e.g. where a granule shared features common to each genus, and fell within the range of dimensions overlapping both genera). When this occurred, granules are identified as '*Sorghum* sp./*Zea* sp.'.

gelatinised granules. As with L189, the presence of Triticeae (and in this case of *Sorghum* sp. and *Zea* sp. too) is not regarded as contamination-derived due to the clean control sample and the age of the artefact (see section 6.8.3). All plants identified are edible, while some have additional medicinal uses within Basotho economic botany, with the exception of *Mofoka tiali*, of which little is known other than that it is used medicinally. Starches were most frequent on probable working surfaces (A and G — as these were sampled for phytoliths also, results of the two methodologies can be directly compared, see Chapter 7).

Figure 6.35 *Zea* sp. or *Sorghum* sp. cluster; *Vigna* sp from L193

Figure 6.36 (From top to bottom): *Gunnera* sp.; cf. Triticeae; Mofoka tiali from L193

Figure 6.37 From top to bottom: Poho tšela; NRC 01, NRC P1 from L193,

Figure 6.38 NRC R1 from L193

6.17 Characterisation of starch from Ha Makotoko sediments

In accordance with what is now fairly standard practice among starch analysts (Torrence & Barton 2006; Zarrillo & Kooyman 2006) and as discussed above, 5g sediment samples from grindstone-yielding contexts at Ha Makotoko were also analysed for starch: this has the dual function of controlling for contamination and may also reveal insights into plant procurement and processing strategies. Comparison of grindstone starch and sediments offers the possibility of exploring these patterns. As with sediments processed for phytoliths, samples were not available for every context. All samples were processed alongside a control sample: since these samples were blank in all cases, they are mentioned only here, in brief. Table 6.8 (presenting 347 starch granules and 10 cystoliths) follows the format used for grindstone analysis.

Table 6.8 Starch analysed from sediments at Ha Makotoko in order of age (left to right), alphabetically according to family, except for the Poaceae which are subdivided into tribes.

	[120]	[091]	[052]	[023]	[002]	[002] Hearth	Total
Amaryllidaceae							
<i>Crinum moorei</i>	0	0	0	0	9	1	10
<i>Lematla</i>	0	0	0	0	2	2	4
<i>Tulbaghia</i> sp.	0	0	0	2	2	1	5
Poaceae: Andropogoneae							
<i>Miscanthus sorghum</i>	0	0	1	0	1	0	2
<i>Sorghum bicolor</i>	0	0	0	0	32	31	63
<i>Themeda triandra</i>	0	1	0	0	5	6	13
<i>Zea mays</i>	0	0	1*	0	40	66	109
<i>Sorghum</i> sp. or <i>Zea</i> sp.	0	0	1	1	4	6	15
Aracaceae							
<i>Zantedeschia aethiopica</i>	0	0	0	0	2	0	3
Asparagaceae							
<i>Albuca</i> sp.	0	1	0	0	3	1	5
<i>Eucomis autumnalis</i>	0	0	0	0	0	0	0
<i>Merwillia plumbaea</i>	0	0	0	0	0	0	0
<i>Rethe la ntja</i> (<i>Asparagus</i> sp.)	0	0	2	2	2	1	9
Convolvulaceae							
<i>Maime</i> (<i>Ipomoea</i> sp.)	0	0	0	0	0	0	0
Cyperaceae							
<i>Cyperus involucratus</i>	0	0	0	0	0	0	0
<i>Lepeka</i> (<i>Cyperus</i> sp.)	0	0	0	0	1	0	2
Poaceae: Eragrostideae							
<i>Eragrostis capensis</i>	0	0	0	0	0	0	0
<i>Eragrostis curvula</i>	0	0	0	0	0	0	0
Fabaceae							

	[120]	[091]	[052]	[023]	[002]	[002] Hearth	Total
<i>Vigna</i> sp.	0	0	0	0	0	1	1
Geranaceae							
<u>Khoara</u>	0	0	0	0	4	1	7
Gunneraceae							
<i>Gunnera</i> sp.	0	0	0	0	6	0	6
Hypoxidaceae							
<i>Moli</i> (<i>Hypoxis</i> sp.)	0	0	0	0	0	1	1
Iridaceae							
<i>Gladiolus dalenii</i>	0	0	0	0	0	0	0
<i>Moraea spathacea</i>	0	0	0	0	0	0	0
<i>Watsonia wordsworthiana</i>	0	0	1	1	3	4	10
Poaceae: Paniceae							
<i>Echinochloa colona</i>	0	0	0	0	2	0	2
Rubiaceae							
Morokolo poli (<i>Kohautia</i> sp.)	0	0	0	0	0	1	1
Solanaceae							
<i>Thola</i> (<i>Solanum</i> sp.)	0	0	0	0	1	0	1
Poaceae: Triticeae							
<i>Hordeum capense</i>	0	0	0	0	0	0	0
<i>Secale strictum</i>	2	1	0	1	0	0	4
<i>Triticum aestivum</i>	0	0	0	0	0	0	0
cf. Triticeae	0	0	0	0	0	1	1
Family/Tribe uncertain/unknown							
<u>Hloenya</u>	0	0	0	0	0	2	2
<u>Hloenya or Lematla</u>	0	0	0	0	0	0	0
<u>Machacha metsa</u>	0	0	0	0	2	0	2
<u>Maime</u>	0	0	0	0	0	0	0
Maime/Merwillla/Moli/ <i>Miscanthus</i> sp.	0	0	0	0	1	1	2

	[120]	[091]	[052]	[023]	[002]	[002] Hearth	<i>Total</i>
<u>Mofoka tiali</u>	0	0	0	0	2	3	5
<u>Poho tšela</u>	0	1	1	1	6	9	20
<u>Sehloko</u>	0	0	0	0	2	0	2
<u>Selepe</u>	0	0	1	0	0	0	1
Not in reference collection							
NRC O1	0	0	0	0	4	3	7
NRC O2	0	0	0	0	3	2	5
NRC O3	0	0	0	1	0	0	1
NRC O3A	0	0	0	0	0	0	0
NRC P1	0	0	0	0	0	1	1
NRC P2	0	0	0	0	1	2	3
NRC R1	0	0	0	0	0	0	0
NRC R2	0	0	0	0	0	0	0
Unidentified starch	1	2	0	2	9	3	18
Unidentified gelatinised starch	0	0	0	0	0	0	0
Unidentified other damaged starch	0	0	0	0	3	0	4
Cystolith	0	0	0	0	2	8	10
TOTAL	3	6	8	11	154	158	357

6.18 Comparing sediments and grindstones

Again, contextual information is provided for the sediment samples in Table 6.3 above, with further information in Chapter 4.

Context (120) yielded only three starch granules: one of unidentifiable starch, and two of *Secale* sp.. The fact that preservation of starch is more extensive on L109, which derives from this context, may be indicative of a preservational micro-environment associated with the grindstone's surface, while at least three of the starches on the grindstone do not occur in the sediment.

Context 091 yielded six granules: one each of *Themeda* sp., *Albuca* sp., *Secale* sp., and Poho tšela, and two of unidentifiable starch. L139, which came from this context, preserved less starch than the surrounding sediment

Context 052 yielded eight granules: one each of *Miscanthus* sp., *Watsonia* sp. and Poho tšela, two of Rethe la ntja, and one each of *Zea* sp. and *Sorghum* sp./*Zea* sp.. Given the date of this context, the granules of *Zea* sp. and *Sorghum* sp./*Zea* sp. are probably contaminant-derived. L101, which came from this context, was blank, while L108 (from context 190 which is the same as 52) preserved Triticeae and unidentified starches.

Context 023 yielded 11 granules: one each of *Sorghum* sp./*Zea* sp. (interpreted as contamination, given age of the deposit), *Watsonia* sp., *Secale* sp. (as for *Sorghum* sp./*Zea* sp.), Poho tšela, and a type not included in the reference collection (NRC 03); two of *Tulbaghia* sp., Rethe la ntja, and unidentifiable starches. L145 derives from this context and was completely blank.

Context 002 (Hearth), yielded 150 starch granules: one each of *Crinum* sp., *Tulbaghia* sp., *Albuca* sp., *Rethe la ntja*, *Vigna* sp., *Khoara*, *Moli* cf. Triticeae, *Maime/Merwillla/Moli/Miscanthus* sp., *Morokolo Poli*, and NRC P1 which is not in the reference collection; two of *Lematla/Hloenya*, NRC 02, and NRC P2; three of *Mofoka tiali* and NRC 01; four of *Watsonia* sp.; six each of *Themeda* sp. and *Sorghum* sp./*Zea* sp.; nine of *Poho tšela*; 31 of *Sorghum* sp. and 66 of *Zea* sp. Given the presence of dung in this context (signifying Basotho, and thus agriculturalist, occupation of the site), the presence of *Zea* sp. and *Zea* sp./*Sorghum* sp. is not regarded as contaminant-derived.

Context 002 yielded a total of 152 starch granules: one each of *Miscanthus* sp., *Lepeka*, *Thola*, *Maime/Merwillla/Moli/Miscanthus*, and one of a type not included in the reference collection (NRC P2). Two granules each of *Lematla*, *Tulbaghia* sp., *Zantedeschia* sp., *Rethe la ntja*, *Echinochloa* sp., *Machacha metsa*, *Mofoka tiali*, and *Sehloko*; three of *Albuca* sp., *Watsonia* sp., NRC 02, and unidentified damaged starch; four of *Sorghum* sp./*Zea* sp., *Khoara* and NRC 01; five of *Themeda* sp.; six of *Gunnera* sp. and *Poho tšela*; nine of *Crinum* sp. and unidentifiable starches; 32 of *Sorghum bicolor*; 40 of *Zea*. Given the presence of dung in this context, the presence of *Zea* sp. and *Zea* sp./*Sorghum* sp. is not regarded as contaminant-derived. L189 and L193 derived from this context, with L189 yielding a cluster of Triticeae. L189 and L193 also display starches not found in the underlying sediment: *Morokolo poli* (L189) cf Fabaceae and *Gunnera* sp. (L193). Although *Gunnera* sp. is a geophyte found on only L193 and not in the sediment, in general (002) has more evidence for geophyte starch than the two grindstones analysed from it: 25 granules of seven species, with 4 and 2 granules respectively of five species on L189 and L193.

6.19 Discussion of starch recovered from grindstones and sediments at Ha Makotoko

6.19.1 Low yields: poor preservation?

An easily observable trend is that starch yields increase towards the present: the uppermost contexts (and artefacts derived from them) display the most starch. An explanation for this — and indeed the relatively low yield of starch from grindstones at Ha Makotoko in general — might simply be that starch does not preserve well in general, or at all in early contexts: an exception to this may be L109 which preserves more starch than its surrounding sediment, possibly as a case of a preservational micro-environment (Barton 2007). However this belies information from south-central Africa, where preservation of starch 100,000 years old has been noted (Mercader 2009). It is also at odds with information as to the quality of zooarchaeological preservation at the site, which is good (Mitchell & Arthur 2012). As noted in Section 6.3, Langejans (2010) observed experimentally that starch preserved best in conditions that promoted preservation of other organic residues. At Ha Makotoko, organic residues such as animal fats have been noted in MSA (post-40,000BP) contexts at the site (Lombard 2012): thus I conclude there is no reason to cite bad preservation of starch in early contexts at the site as being responsible for the low yields of starch encountered on either artefacts or sediments, with the caveat that there probably remains more we do not know about the archaeological preservation of starch than what we do know (Haslam 2004).

6.19.2 Greater yields in later contexts: influx of domesticates?

Instead, it is argued here that the greater yield of starch from later contexts is partially due to the influx of starchy domesticates such as wheat, maize, and sorghum, for which grinding is broadly recognised as a common and efficient method of processing. But this is not the entire story, as with both grindstones and (more so) sediments, the yield of

geophyte starch also increased towards the present: note, for example, the nine granules of *Crinum* sp. starch recovered from the (002) hearth context. In contrast, the earliest context sampled (120) yielded only three starch granules, and the earliest grindstones – L101, L108, L109, L110 yielded minimal starch. One explanation for this disparity might be that no plant processing was taking place at Ha Makotoko in the earliest occupation layers, but phytolith data (see Chapter 7) suggests otherwise: L101 and L108 were both sampled for phytoliths and the differential percentages of grass inflorescence phytoliths on surfaces of these objects suggests that they were being used to process plants. The fact that starch yields for these objects are so low suggests perhaps simply that grindstones were not used extensively to process starchy plants. In fact, only one grindstone, L189, evidences extensive processing of such taxa. The fact that these starches are characterised as Triticeae might explain this pattern: prior to the arrival of domesticated cereals in Lesotho, the grass seeds that were being processed may not have been particularly starchy. Evidence of this was seen in the reference collection, for example, *Eragrostis* spp. are known ethnographically to have been ground and used by foragers in Lesotho, and for which the phytolith evidence offers tentative support, but neither seed displays starch granules with dimensions greater than 5.3µm (see micrographs in section 6.10). At such a size, granules would be vulnerable to loss during processing or could simply be overlooked by the analyst.

6.19.3 Grindstones and geophytes

Grindstones appear to have been occasionally, rather than extensively, used to process geophytes: L140 and L173 both evidence processing of geophytes among other plants, however, given that all have medicinal uses (and some are edible) these are interpreted as perhaps indicating grinding of geophytes/other plants for exclusively medicinal rather than dietary purposes, which fits with Thornton-Barnett's (2013) ethnoarchaeological predictions. This interpretation may be factored into a consideration of the most frequently occurring geophytes: *Watsonia* sp. totals 11

granules on four artefacts, however nine of these derive from L140 and L173, while I believe it may be possible to interpret the single-grain occurrences on L109 and L116 as non-processing related, see below. An equivalent number of granules ($n = 10$) was recovered from sediment contexts, but unfortunately those from which L140 and L173 derive could not be compared due to a lack of sediment samples. Where sediment samples *can* be compared, e.g. for L189 and L193 with Context 002, geophyte starch in sediment outnumbers that on the grindstones: 25 granules of seven different genera in context (002) *versus* four and two granules respectively from five different genera for L189 and L193.

6.19.4 Contamination: ancient and modern

While negative controls within the laboratory can assist in the identification of contamination from the analytical procedure itself, it cannot eliminate the possibility of external contamination such as from the excavator or during transit. Following e.g. Zarrillo & Kooyman (2006), the standard procedure is to screen sediments for comparison based on the premise that starches found on artefacts that also occur within underlying sediments are the result of cross-contamination. But this is somewhat unsatisfactory for several reasons: sediment samples may not have been obtained from directly beneath the artefact, and artefacts may 'contaminate' sediments rather than *vice versa* (Beck & Torrence 2006). In fact, ancient (as opposed to modern) 'contamination' may be responsible for the transfer of many apparently 'archaeological' starches: all that is needed is for a past individual working with one type of plant matter in one way to abandon that task and begin to process another type of plant matter with a grindstone to ensure a contamination route from task A to task B. Thus the association of starch with 'working surfaces' on grindstones is important (and another argument for typological assessment). As alluded to above, where *Watsonia* sp. starch occurs as single granules on L116 and L109, these are not on working surfaces, and could thus conceivably have resulted from contamination. But this is unlikely to be a hard and fast

rule: I interpret the Triticeae starches on L189 as use-derived despite the fact that they occurred in the ultrasonicated fraction, given the lack of evidence for other contamination and the large size of the cluster. Thus I suggest that starches be interpreted contextually: factoring in single granule or cluster status, presence of known contaminants, damage, relation to working surfaces, with the caveat that often we can describe them as possibly or probably use-related, but rarely definitely.

On the subject of damage, analysts (del Pilar Babot 2001; Perry *et al.* 2006) have regarded mechanical damage to starch granules as a potential hallmark of plant processing, and del Pilar Babot (2001; 2006; see also Figure 4.16 in Beck and Torrence 2006) has shown with experimental data how this manifests. The lack of routine damage to starch granules on implements from Ha Makotoko (although there are some cases of damage, see e.g. Figure 6.17) may thus indicate against a link between grindstones and geophytes here. However, given that the studies of mechanical damage to starches have largely been carried out with tools analogous to those used in agricultural societies and with domesticated plants, one wonders if the less intensive processing indicated by experimental studies of hunter-gatherer grindstones might in turn lead to less intensive damage of wild plants.

6.20 Conclusion

Based on the sample in question (which at 25% of the total grindstone corpus may be regarded as representative of the site), use of grindstones in processing starchy plants at Ha Makotoko is not extensive, although it appears to have increased with time. The fact that this trend also occurs in sediments suggests that taphonomic factors may be in play and responsible for possibly poor preservation of starch in all but the uppermost layers at the site. On the other hand, the fact that phytolith data recovered from the earliest grindstones at site indicate siliceous plant processing suggests cultural choice between siliceous and starchy plants more underlies this pattern (see Chapter 7).

Starch granules of *Themeda triandra* occasionally occur on grindstones, which might further support a role for grass processing, although it should be noted that many grasses may not be so easily detected, as with the case of *Eragrostis* spp.. The presence of significant quantities of Triticeae starch on a late grindstone (L189) at Ha Makotoko may thus represent the new occupation of an existing niche: grasses are still being ground, but these grasses are now domesticated “starch balloons” (Martin Jones, pers. comm. 26/6/2014), rather than less starchy wild cereals. The relative lack of *Sorghum* sp. or *Zea* sp. on grindstones at the site, while they are present in the sediments may confirm i) that the grindstones were not used by Basotho occupants of the shelter (who would, presumably have had easy access to these crops, and also a need to process them) and/or ii) that the episode of Triticeae processing on L189 is as a unique moment of forager-farmer contact in the Ha Makotoko sequence.

In contrast to assertions elsewhere, that hunter gatherer grindstones are principally associated with either geophytes or medicinal plants, the evidence I have presented shows that this was not the case at Ha Makotoko. Although geophytes and medicinal plants were being brought to site, as evidenced by starch in sediments, they were only occasionally being ground on the grindstones investigated, and the evidence for processing of other plants is as convincing. Other methods of preparation for geophytes may thus be indicated. However, there does appear to be some correlation between grindstones (in two instances – L140 and L173) and *medicinal* geophytes, which would provide a logical reason for grinding them (see Chapter 2 and also Thornton-Barnett 2013). The case of L140, compared with other artefacts interpreted as more formal upper grindstones suggests that linkage of grindstones with geophytes does not explain the morphology of such more formal objects — from the literature discussed in Chapter 2, the processing of geophytes would be unlikely to result in the development of a facet on an upper grindstone, thus even if some small role for grindstones in geophyte

processing can be supported, it cannot be extended to all morphologies, particularly those that appear more formal in nature.

6.21 Summary

This chapter began by reviewing starch analysis and its utility to archaeology, particularly as it relates to grindstone analysis. Starch analysis provides a means of testing the first hypothesis presented and critiqued in Chapter 2, that grindstones in southern Africa were predominantly used to process geophytes. As geophytes are generally starchy plants, starch analysis provides the ideal means of testing this. The analysis made use of a reference collection predominantly based on economically useful geophytes (with other additions) local to the region surrounding Ha Makotoko, with contributions from local people. However, because this project pioneers starch analysis in Lesotho (and as such had no background material other than gazetteers of local useful plants) the reference collection was less comprehensive than is considered ideal. Given the investment of time into the creation of this reference collection, the archaeological sample was, as a result, relatively small: 15 artefacts and six sediment samples. In general, starch yields from the artefacts were also small, with five completely blank (as well as low counts from four sediment samples). Part of the reason for this may simply be that starch does not preserve from the earliest occupation layers at Ha Makotoko, but this is at odds with the preservation of other organic residues from layers dated to approximately 40,000BP. Another possibility (that should be factored in with results from phytolith analysis) is that grindstones were not being used to process starchy plants at this time. Indeed, given the low overall yields and lack of separation of grindstone surfaces (i.e. starch granules may occur on all surfaces of the artefact, including those broken post-depositionally, rather than being confined to working surfaces) it is possible that at least some of the grindstones preserving starch were not used to process this starch, but rather came into contact with the starch via

contamination²⁷ or from surrounding sediments. Nevertheless, since typological analysis suggests that at least some of them were used to process plants (starchy or otherwise) it seems parsimonious to argue that at least some of the starch encountered could be use-derived. I use this information in analysing the composition of starch assemblages on the individual artefacts: in many cases adhering starches had both possible edible and medicinal uses, but in two cases (L140 and L173) starches deriving from plants that are not considered edible but are used in medicine within Basotho society were encountered. I interpret these grindstones as having been used predominantly for the processing of medicinal, rather than dietary, plants, at least in their most recent use. As for the geophyte hypothesis, it is impossible to extrapolate from a small sample at one site to the wider region, but geophyte starches in the reference collection occurred in no great quantity on the artefacts, and occasionally in greater quantity in the sediments. I suggest, therefore, that at Ha Makotoko geophytes were *not predominantly* (but possibly occasionally) processed by grindstones, and that the primary function of grindstones at Ha Makotoko was something else. Following the review in Chapter 2, it may have been grass seeds. The fact that one grindstone (L189) evidenced use in *Triticum aestivum* processing may support this, as a domesticated cereal might have seemed akin to a wild grass to those used to processing them, as is perhaps indicated by occasional *Themeda triandra* granules. Whether or not the grindstones at Ha Makotoko were used to process grasses as well or instead of starchy geophytes is addressed in the next chapter.

²⁷ Here I separate “ancient” (transfer of plant starch to an artifact not used to process it at some point prior to deposition) from “modern” (transfer of –generally modern domesticate – starch to grindstones during/post excavation) contamination

Chapter 7. Phytolith analysis of grindstones and sediments

from Ha Makotoko

7.1 Overview

In this chapter I discuss the rationale, methodology and results of a pilot project investigating the usefulness of phytolith analysis in understanding the uses of grindstones at Ha Makotoko. This follows on from Chapter 2's review of the case for grass seed consumption in southern Africa. While archaeologists have considered the contribution of grass seeds to hunter gatherer diet in this region to have been minimal, if not non-existent, this is at odds with ethnographic evidence which suggests that grass seeds may have been important resources for hunter gatherers in this region. I propose that phytolith analysis of grindstones is a vital step in examining these arguments.

7.2 Production of phytoliths and utility to archaeologists

Many higher plants take up monosilicic acid from the soils in which they root, depositing it throughout their cells as they grow. These silica particles are inorganic and thus taphonomically robust and, when the plant dies, may be deposited into the soil. Piperno (2006: 5) refers to phytoliths as "possibly the most durable terrestrial fossils known to science". Because the silica takes on the shape of the intra- or extra-cellular context in which it is deposited while the plant grows, phytoliths are diagnostically identifiable to plant type on a morphological basis, and are thus also useful plant fossils for scientific research. That they were observed by Darwin on the voyage of the *Beagle* is often noted by analysts, but it was not until the 1970s that their archaeological utility was observed (Shillito 2013). Since then, they have been recognised as a valuable source for archaeological understanding of both human plant use and palaeoenvironments, as

they are far more robust than plant macroremains or other microfossils such as starch (Gott *et al.* 2006; Shillito 2013).

Shillito (2013) notes that archaeological exploration of phytoliths can be divided into broad areas according to regional context, with a focus in the Americas on the origins and domestications of maize and other staple crops (del Pilar Babot & Apella 2003; Pearsall *et al.* 2004; Lusteck & Thompson 2007; Ranere *et al.* 2009), and in the Near East a focus on the major crops of wheat and barley, as well as non-food plants (Rosen & Weiner 1994; Albert *et al.* 2000; Power *et al.* 2014). Regional foci exist also in Australasian and East Asian contexts (D. Hart & Wallis 2001; Fullagar *et al.* 2008; Liu *et al.* 2014). In southern Africa, phytolith research has tended to focus on palaeo-environmental reconstruction (Scott 2002; Rossouw 2009; Mercader 2009; Parker *et al.* 2011) rather than on the human use of plants.

Examination of phytoliths on artefacts (including grindstones) is relatively limited compared to studies focusing on sediments, but there is enough presence within the literature (particularly from the Americas) to confirm that it can be a profitable avenue of analysis in identifying human use of plants (especially that relating to processing activity), rather than palaeoenvironmental reconstruction alone (del Pilar Babot & Apella 2003; Pearsall *et al.* 2004; Lusteck & Thompson 2007; Fullagar *et al.* 2008; Ranere *et al.* 2009; T.C. Hart 2011; Power *et al.* 2014). It is evident from the literature that analysis of phytoliths to demonstrate human use of plants is minimal in African contexts whether from sediments or artefacts (Henry 2010; Radomski & Neumann 2011) and in southern African contexts, including Lesotho, analysis of phytoliths on artefacts is non-existent.

7.3 The Sample

Six artefacts were chosen for a pilot study to explore how useful phytolith analysis could be to an understanding of grindstones, at Ha Makotoko, and how this compared with starch analysis. The overarching question in this chapter is whether or not Poaceae (grass) phytoliths were being processed at Ha Makotoko, as evidenced by phytolith analysis. The choice of artefacts for sampling was based on three concerns: whether or not they had yielded starch (i.e. if there was prior indication of a processing role), their date, and whether a sediment sample of surrounding context could be obtained – this was available in all but one case. Although this sample size of six artefacts may appear small, these six artefacts were sub-divided in a manner common to starch analysis (where separate samples are taken from each surface of the artefact, method which allows isolation and location of working surfaces) but, to my knowledge, not practiced in phytolith analysis of grindstones. Thus the total number of phytolith samples studied was 28, plus a further three sediment samples. A final note on sampling, which follows the convention used for starch in the previous chapter, is that while the system of designating surfaces as ‘A’, ‘B’, ‘C’ is explained below, all samples labelled ‘US’ (ultrasonicated) refer to the fact that these sample were derived from the entire artefact being immersed in ultrapure water inside a container, which was in turn placed in an ultrasonic bath. ‘US’ samples thus represent residues from the entire artefact as a whole, and may be compared against individual surface samples: this represents a useful control in determining use and was used in all but two samples (L173 was too large to be immersed in the available ultrasonic bath, and the US sample for L181 was entirely consumed by starch analysis). By the same token, in labels, the term ‘WB’ occasionally prefixes ‘A’, ‘B’ etc. (as in the phytolith graphs) and indicates that this sample was obtained by ‘wet brushing’ the surface in question.

7.3.1 Contextual and typological information on the samples

As a guide to contextual information on the grindstones discussed here, a section drawing and Harris Matrix of grindstones and contexts may be found in Chapter 4.

L101 derives from Context 052 which is part of the Middle Stone Age phase at Ha Makotoko – the uppermost layer (overlying 052) of this phase is dated to 40100 ± 230 BP (UGAMS-8988) (Mitchell and Arthur 2014). L101 had been sampled for starch, but found to be blank, so investigation as to whether a lack of starchy plant processing might be correlated with a presence of siliceous starch processing was desirable. L101 is interpreted as an upper grindstone class 2 (see Figure 7.1)

L108 derives from Context 190 which was later determined to be the same as Context 052, putting it in the MSA phase of the site's occupation. L108 had yielded a small amount of starch. L108 is interpreted as an upper grindstone class 2 (see Figure 7.1).

L122 also derives from Context 052 and had not previously been sampled for starch. It thus acted as a control on whether previous processing for starch might influence phytolith yield. L122 is interpreted as an upper grindstone class 2 (see Figure 7.2).

L173 derives from Context 177 and was previously sampled for starch and ochre. Given the lack of evidence for extensive starchy plant processing, the fact that those starches present were from plants with medicinal uses (in one case exclusively so) and the presence of ochre, it was hypothesised that this might suggest evidence that hunter-gatherers practiced the same separation of grindstones used for dietary plants and medicinal plants/ochre as contemporary Basotho ('Me Malireko Masakale, pers. comm. 13/9/2012). L173 represents an interesting case of a formal grindstone (lower grindstone class 1, see Figure 7.3 and Figure 7.4), heavily powdered with ochre, inside a

pit (Context 183, filled with the deposit 177) apparently specifically dug for its deposition and that of a number of burnt mammal bones underlying it. Dates are awaited to confirm its age, but it is thought to be considerably older than the deposits surrounding it, dating possibly to the early Holocene.

L181 derives from Context 002, part of the uppermost phase at Ha Makotoko – this context is known as the ‘dung crust’, reflecting its composition of bovine and caprine origin dung, the result of historical use of the shelter as a kraal. Diagnostic Later Stone Age artefacts (Mitchell and Arthur 2012) suggest that ‘grindstone-like’ material here could also be *ex situ* LSA in origin. Comparisons of hunter-gatherer and Basotho-style grindstones (see Chapter 5) also suggest that these artefacts are not historic examples of Basotho grindstones. L181 was sampled for starch, but found to be blank. L181 is interpreted as an upper grindstone class 3 (see Figure 7.2)

L193 derives from Context 141 – this is from outside the main area of excavation, but is within a dung layer (Charles Arthur, pers. comm. 14/05/2014) suggesting a historical date. L193 was sampled for starch and yielded a moderately high amount. L193 is interpreted as a lower grindstone class 1 (see Figure 7.5).

7.3.2 Determining possible ‘working’ surfaces

Observations of gross morphology and use-wear under low-power microscopy were used to determine possible working surfaces for plant processing, in order to provide contextual information for the phytolith counts.

L101: The surface designated ‘A’ is slightly curved (indeed the shape of the object is not unlike that of a contemporary Basotho *tšiloane* (upper grindstone), albeit broken) and

displays pocking/pitting consistent with grinding activity, but also some instances of natural weathering on basalt (Chris Doherty pers. comm. 12/2/2014).

L108: Surfaces designated 'A' and 'B' are both flat (A is slightly concave), with extensive pitting/pocking on A, and less extensive but more concentrated pitting/pocking on B, along with some striations. Both surfaces display white residues that appear unrelated to use and may possibly be a weathering product. C is a lateral surface (i.e. perpendicular to the long surfaces), with evidence of breakage.

L122: 'B' has extensive breakage scars covering its face, while 'A' appears intact and covered in pocking/pitting as well as some dark staining. 'C' is a broken face.

L181: 'A' is slightly convex and 'B' is flatter. There is little obvious pocking/pitting, although animal hairs and plant fibres adhere to 'B'.

L193: 'A', 'B', 'C', 'D', 'E' are all scars upon one 'side' of the artefact. Their individual surface areas were large enough to warrant (and facilitate) separation during processing. 'A' displays pocking/pitting and some lateral polish. 'F' represents a broken surface perpendicular to 'A-E' and 'G'. 'G' suggests a heavily abraded surface, with shallow, wide pits, supported by the development of a concavity, rising steeply towards one lateral edge, (the side closest to 'E'); this is reminiscent of the concavity that develops upon Basotho grinding technology following prolonged use.

Figure 7.1 Illustrations of grindstones L101 and L108 with labelled surfaces. Scale bar measures 5cm.

L122

L181

Figure 7.2 Illustrations of grindstones L122 and L181 with labelled surfaces. Scale bar measures 5cm

L173

Figure 7.3 Illustration of grindstone L173 with labelled surfaces. Scale bar measures 5cm

Figure 7.4 Surface 'F' of L173. Scale bar measures 5cm

L193

Figure 7.5 Illustration of grindstone L193 with surfaces labelled. Scale bar measures 5cm

7.4 Method

Samples were processed for phytoliths following a methodological protocol based on those documented by Chandler-Ezell & Pearsall (2003), Horrocks (2005) and Madella *et al.* (1998). The first two of these protocols provide for “piggyback” processing of multiple microfossils, including starch and phytoliths, whereas most phytolith protocols involve stages which would damage starch granules. The last protocol (Madella *et al.* 1998) utilises sodium polytungstate ($\text{Na}_6[\text{H}_2\text{W}_{12}\text{O}_{40}]$) as a heavy liquid.

For this study, all but one artefact had previously been analysed for starch. Samples with specific gravities of greater than 1.8 had been left behind following heavy liquid separation and set aside, while the lighter fraction had been analysed for starch. Some phytoliths have specific gravities of less than 1.8 (Adrian Parker, pers. comm. 19/04/2014), in which case they should appear on ‘starch’ slides. This heavier fraction was rinsed in ultrapure water and centrifuged a number of times prior to proceeding with the phytolith protocol (see Appendix D). The single artefact not previously processed for starch, L122, was brushed with a wet toothbrush to remove residues, separating different surfaces, and then ultrasonicated. Processing then proceeded as outlined in the protocol in Appendix D, skipping the initial rinsing step.

Following processing, 500µl ethanol was added to each sample, and 200 µl was pipetted on to slides. The extract was allowed to dry under cover, before coverslips were mounted with Entellan®, a fixed mount. This was then allowed to dry and slides were scanned under high-power microscopy at 400x magnification. Phytoliths were counted to 300 on each slide, except where density of phytoliths was considerably less than this, in which case a second slide was mounted. Phytoliths were measured, their two-

dimensional (and where possible, three-dimensional) morphology described, photographed, and their topography and any surface features described.

7.5 Phytolith typology

Following the observation of samples under high-power microscopy, morphotypes were recorded in keeping with the International Code for Phytolith Nomenclature (Madella *et al.* 2005), with occasional modifiers.

Observed types were then cross-referenced with high-quality reference collection photographs from Lloyd Rossouw's (2009) PhD dissertation, which surveys southern African grasses, and characterised before further cross-referencing with databases of plants currently found in Lesotho from Amy Jacot Guillarmod's (1971) ethnobotanical survey of Lesotho and the website of the Conservatoire et Jardins Botaniques Ville de Genève, which comprises an index of 196,884 species of African plants (<http://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php>).

A final cross-referencing step was to identify which plants had been observed in the Metolong Dam Environmental and Social Impact Assessment (ESIA) (SMEC 2008). It is recognised that hunter-gatherers are likely to have collected plants from a wider radius than their immediate surroundings. However, in the case of potentially non-anthropogenic deposition of phytoliths (due to aeolian action, for example), it seems probable that a higher proportion of riverside than more remote plants would be represented. Finally, any recorded economic use of possibly identifiable plants was noted: primary sources included Jacot Guillarmod (1971), van Wyk & Gericke (2000), and a variety of more single-use literature derived from Google and Google Scholar searches. These are cited in the text as and when they were used.

Before listing the types identified in this study, a brief note on the redundancy of morphotypes is warranted. Phytolith types are often perceived as diagnostic to plant sub-families: e.g. the ‘saddle’ type as diagnostic to the Chloridoideae. However, in reality, one morphotype may be found in a number of different plant species across several sub-families (as will be seen below). For this reason, it was considered essential to cross-reference the presence of a particular type in a species with further information on its presence in Lesotho and along the Phuthiatsana river as a form of control.

7.5.1 List of types

The following list describes the identified types from the archaeological phytolith assemblages and where they appear in grass sub-families (as listed and depicted in Rossouw 2009), cross-referencing them according to what grows (today) both in Lesotho in general, and along the Phuthiatsana River in the vicinity of Ha Makotoko specifically. Recorded uses are also discussed. The scale bar in each photograph is equal to 20µm.

Figure 7.6 Type 0201

0201: Bilobate. Convex lobes, flattened ends (Figure 7.6).

Redundant across several sub-families, particularly the Panicoideae and Chloridoideae, however, if weighting is given to species present in the ESIA, this morphotype is twice as common in the former than the latter (Table 7.1). Of the species present in Lesotho, *Aristida congesta*, *Cymbopogon plurinoides*, *Setaria* sp., *Sporobolus fimbriatus* and *Themeda triandra* are noted as edible, *Elionurus muticus* as medicinal and *Enneapogon scaber* and *Setaria* sp. in craft use (Jacot Guillarmod 1971; van Wyk & Gericke 2000). It

may be inferred from *Themeda triandra*'s dominance in grassland around Ha Makotoko that this is the most likely candidate for this type, but this is supposition and the high level of redundancy across sub-families suggests equifinality at best.

Table 7.1 Type 0201

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in Metolong ESIA
Aristidoid	1	1	1
Chloridoid	8	5	2
Ehrhartoid	3	3	-
Panicoid	9	6	4
Total	21	15	7

Figure 7.7 Type 0203

0203: Bilobate in the form of two saddles joined by a shank (Figure 7.7).

Among southern African grasses generally, this morphotype is more dominant in Chloridoideae (3 species *versus* 2 in Panicoideae) but of species present in Lesotho, Panicoideae dominate, with two present in the ESIA (*versus* one for Chloridoideae) (Table 7.2). Of these the rhizome of *Imperata cylindrica* (Panicoideae) is said to be edible and *Trichoneura grandiglumis* (Chloridoideae) is used for medicinal/magical purposes (Jacot Guillarmod 1971).

Table 7.2 Type 0203

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoid	3	1	1
Panicoid	2	2	2
Total	5	3	3

Figure 7.8 Type 0205

0205: Bilobate. Two convex lobes with a shank not more than a third of overall length (Figure 7.8)

Although this morphotype is present in one Pooid species, this is not native to Lesotho, leaving the Panicoideae and Chloridoideae as more likely candidates (Table 7.3). Although three species of the Panicoideae in which it occurs grow in Lesotho, *versus* one for Chloridoideae, only one Panicoid and one Chloridoid species each are present in the ESIA. Furthermore as two of the Panicoid genera (*Panicum* sp. and *Sorghum* sp.) represented in Lesotho are cultivars (and likely introduced), further support may be lent to the identification of either *Heteropogon contortus* (Chloridoideae) or *Setaria* sp. (Panicoideae) with this morphotype where it occurs in earlier dated contexts. *Heteropogon contortus* is eaten by baboons (Norton *et al.* 1987) while *Setaria* sp. is used in contemporary Basotho crafting and also as a famine food (Jacot Guillarmod 1971; van Wyk & Gericke 2000).

Table 7.3 Type 0205

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoideae	2	1	1
Panicoideae	3	3	1
Pooid	1	-	-
Total	6	3	1

Figure 7.9 Type 0206

0206: Bilobate with cleft lobes (Figure 7.9).

Although this morphotype does not occur within species in the ESIA (Table 7.4), it is found in three Lesotho grass species of which two, *Digitaria eriantha* (Panicoideae), and *Enneapogon scaber* (Chloridoideae), have recorded craft uses and one (*Cymbopogon plurinoides* – Panicoideae) is recorded as eaten by baboons (Jacot Guillarmod 1971).

Table 7.4 Type 0206

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoid	3	1	-
Panicoid	3	2	-
Total	6	3	0

Figure 7.10 Type 0207

0207: Bilobate with concave lobes with concave ends (Figure 7.10)

This morphotype appears in multiple species across three sub-families: the Chloridoideae, Panicoideae and Ehrhartoideae and thus cannot be described as diagnostic to any particular sub-family (Table 7.5).

Table 7.5 Type 0207

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoid	4	3	2
Ehrhartoid	1	1	-
Panicoid	5	4	2
Total	10	8	4

Figure 7.11 Type 0208, taken from McClung de Tapia & Adriano-Morán (2012), Figure 2

0208: Bilobate with convex lobes and a shank greater than one third of its total length (Figure 7.11).

This morphotype is found only within the Aristidoideae and can thus be held as diagnostic to the sub-family. Only one species (*A. congesta*) is found in the ESIA (Table 7.6) and its use is unknown. However, the stem of *A. stipoides* is eaten by Basotho (Jacot Guillarmod 1971) and C.A. Smith (1966) notes the consumption of *A. brevifolium* by hunter-gatherers in Namaqualand which may indicate the edibility of *A. congesta*.

Table 7.6 Type 0208

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Aristidoideae	1	1	1
Total	1	1	1

Figure 7.12 Type 0209

0209: Bilobate with ‘peanut’ shape: lobes are not fully distinct from shank (Figure 7.12).

Although this morphotype appears widespread across the Chloridoideae, all but one occurrence are in the Danthionioideae tribe, which is not present in Lesotho (Table 7.7). The morphotype is also present in the Ehrhartoideae which are not present in the ESIA but do grow in Lesotho (*Ehrharta calycina*, *Ehrharta thunbergi*), however there are no recorded uses by humans. *Eragrostis* sp. (Chloridoideae) however has a wide variety of uses, in crafts, medicine and as food (although this is very far from the scale of consumption of the species *E. tef*, in Eritrea and Ethiopia). Significantly it is noted, in an oral history account, as being ground and eaten by late nineteenth-century Bushmen at Sehonghong shelter, eastern Lesotho (Vinnicombe 2009).

Table 7.7 Type 0209

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoideae	6	1	1
Ehrhartoideae	2	2	-
Total	8	3	1

Figure 7.13 Type 1902

1902: Cone/conical rondel (Figure 7.13)

This morphotype is present only in one species of Ehrhartoideae, *Ehrharta ramosa*, which is absent from the ESIA but present in Lesotho, and for which no uses are recorded (Table 7.8).

Table 7.8 Type 1902

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Ehrhartoideae	1	1	-
Total	1	1	0

Figure 7.14 Type 0703

0703: Cross with quadrilateral symmetry, convex lobes (Figure 7.14).

This morphotype is diagnostic to the Panicoideae (Figure 7.14), of which two species (*Cymbopogon plurinoides* and *Panicum coloratum*) are present in Lesotho, but only the former in the ESIA. *C. plurinoides* is eaten by baboons, and *P. coloratum*'s place in the millet family may hint as to its edibility (Jacot Guillarmod 1971).

Table 7.9 Type 0703

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Panicoideae	2	2	1
Total	2	2	1

Figure 7.15 Type 0704

0704: Cross with quadrilateral symmetry, indistinct lobes (Figure 7.15).

While this morphotype is present in five sub-families, the Bambusoideae and Pooideae species in which it occurs are not found in Lesotho, leaving six plausible species across the Chloridoideae, Ehrhartoideae and Panicoideae (Table 7.10). Of these, one species each of both Chloridoideae and Panicoideae grow along the river valley. *Cymbopogon plurinoides* (Panicoideae), as noted above, is eaten by baboons, and *Harpochloa falx* (Chloridoideae) is recorded in craft use (Jacot Guillarmod 1971).

Table 7.10 Type 0704

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Bambusoideae	1	-	-
Chloridoideae	7	3	1
Ehrhartoideae	1	1	-
Panicoideae	2	2	1
Pooideae	1	-	-
Total	12	6	2

Figure 7.16 Type 0705

0705: Cross with quadrilateral symmetry, squared-off lobes (Figure 7.16 Figure 7.16).

Three species in which this morphotype occurs grow in Lesotho, but none along the Phuthiatsana (Table 7.11). These are: *Leersia hexandra* (Ehrhartoideae), *Sorghum bicolor* and *Panicum coloratum* (Panicoideae). The edibility of Panicoid genera has already been noted, but local varieties of *L. hexandra* are recorded as edible in South America (Roosevelt 2000: 465).

Table 7.11 Type 0705

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Bambusoideae	1	-	-
Chloridoideae	1	-	-
Ehrhartoideae	1	1	-
Panicoideae	3	2	-
Total	6	3	0

Figure 7.17 Type 0801

0801: Quadrilaterally symmetrical cross, but not equilateral (Figure 7.17).

Although this morphotype does occur in the Ehrhartoideae (*E. longiflora*), it is outnumbered 3:1 by species of Chloridoideae within Lesotho (Table 7.12), so it seems

parsimonious to argue that at Ha Makotoko this would also be the case. However, no use is recorded for either *Diplachne fusca* or *Catalepsis gracilis*. *Enneapogon scaber* is used in crafting by Basotho (Jacot Guillarmod 1971).

Table 7.12 Type 0801

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoideae	7	3	-
Ehrhartoideae	1	1	-
Total	8	4	0

Figure 7.18 Type 0802

0802: Cross with bilateral symmetry (Figure 7.18).

As with 0801, although this morphotype is present in two sub-families in Lesotho (Table 7.13), in one sub-family (Panicoideae) it outnumbers the occurrences in the other sub-family (Chloridoideae) to such a degree as to render it highly likely that occurrences at Ha Makotoko represent predominantly (if not exclusively) examples from the Panicoideae. It occurs in *E. scaber* (Chloridoideae, with use discussed above) and in *Brachiaria serrata*, *Miscanthus sorghum*, *Setaria* sp. and *Panicum stapfianum*. Dietary use of the first three is widely confirmed (Jacot Guillarmod 1971; van Wyk & Gericke 2000), and it is probable that most species of *Panicum* are edible. There is thus good reason to suppose that where this morphotype occurs in Ha Makotoko samples, the plant in question was being consumed.

Table 7.13 Type 0802

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoideae	4	1	-

Panicoideae	5	4	3
Total	9	5	3

Figure 7.19 Type 1601

1601: Papillae (Figure 7.19).

This type occurs only within *Ehrharta longiflora* (Table 7.14) for which there are no known recorded uses, although it may have possible use as bedding or animal fodder.

Table 7.14 Type 1601

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Ehrhartoideae	1	1	-
Total	1	1	0

Figure 7.20 Type 1801

1801: Polylobate with parallel lobes (Figure 7.20).

In Lesotho this morphotype appears to be distinct to *Trachypogon spicatus* (Panicoideae), which is recorded as used in thatching (Brink & Achigan-Dako 2012) (Table 7.15).

Table 7.15 Type 1801

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Arundinoideae	1	-	-

Panicoideae	3	1	1
Total	4	1	1

Figure 7.21 Type 1802

1802: Polylobate with staggered lobes (Figure 7.21).

In Lesotho this morphotype appears unique to *Melica racemosa*, for which no uses are recorded although again, use in bedding might be arguable (Table 7.16).

Table 7.16 Type 1802

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Pooideae	1	1	1
Total	1	1	1

Figure 7.22 Type 1901

1901: 'Two-spike' rondel (Figure 7.22).

Although this morphotype occurs in four sub-families within Lesotho, Chloridoideae species pre-dominate (Table 7.17). *Stipagrostis namaquensis* (Aristoideae) is edible, as are the rhizomes of *Phragmites australis* (Arundinoideae), while *Arundinella nepalensis* (Panicoideae) has recorded medical/magical uses. Of the Chloridoideae, there are no recorded uses for *Chloris* sp., or *Diplachne fusca*, while *Pentaschistis ancifolia* has

recorded medicinal/magical use and *Eragrostis capensis* is, as already discussed, probably edible based on analogies with other *Eragrostis* species (Jacot Guillarmod 1971).

Table 7.17 Type 1901

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Aristidoideae	1	1	1
Arundinoideae	1	1	1
Chloridoideae	6	5	3
Panicoideae	1	1	-
Total	11	9	5

Figure 7.23 Type 1906

1906: wavy-topped rondel (Figure 7.23).

Within Lesotho, this morphotype appears to be diagnostic to *Helictotrichon hirtulum* (Pooideae) (Table 7.18). Although there are no recorded uses for *Helictotrichon* sp., as a member of the Avenae (Oat) tribe, its seeds may be edible.

Table 7.18 Type 1906

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoideae	2	-	-
Pooideae	1	1	1
Total	3	1	1

Figure 7.24 Type 1907

1907: 'Volcano' type rondel, with a base longer than its top and gently concave sides (Figure 7.24).

This morphotype occurs in three species found within the ESIA, *Phragmites australis* (Arundinoideae), *Helictotrichon hirtulum* and *Melica racemosa* (Pooideae), for which the uses are recorded above (Table 7.19).

Table 7.19 Type 1907

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Arundinoideae	1	1	1
Panicoideae	1	-	-
Pooideae	4	2	-
Total	6	3	3

Figure 7.25 Type 2001

2001: Saddle shape, with thick viscous margins (Figure 7.25).

With this morphotype present in seven species within Lesotho, and four within the ESIA, attribution to the Chloridoideae seems reasonable, despite its presence in *Arundinella nepalensis* (Panicoideae) (Table 7.20). Of the Chloridoideae it occurs in *Brachypodium flexum*, *Tetrachne dregei*, *Tragus berteronianus*, *T. koelerioides*, *Chloris virgata*, *C.*

pycnothrix, *Eragrostis bicolor*, and *Harpochloa falx* (the last four of which are found in the ESIA). *Brachypodium* sp. has been identified on Upper Palaeolithic grindstones in Europe and associated with dietary use (Revedin *et al.* 2010), *Tetrachne dregei* has medicinal uses (Jacot Guillarmod 1971) while evidence for use of the others is listed above. There is no information available on use of *Tragus berteronianus* other than that it is grazed by animals of the Turkana in northern Kenya (Morgan 1981).

Table 7.20 Type 2001

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoideae	7	7	4
Panicoideae	1	1	-
Total	8	8	4

Figure 7.26 Type 2002

2002: Saddle with distinct upper and lower margin (Figure 7.26).

This morphotype is found solely within the Chloridoideae, in a dozen species within Lesotho and six in the ESIA (Table 7.21). These are *Chloris gayana*, *C. dactylon*, *Eragrostis denudata*, *E. obtusa*, *Harpochloa falx*, *Microchloa caffra* (all in the ESIA), *Eleusine coracana*, *Enneapogon scaber*, *Eustachys paspaloides*, *Fingerhuthia africana*, *Pogonarthria squarrosa*, and *Tragus racemosus*. Of those for which uses have not yet been listed, *Eustachys paspaloides* and *Microchloa caffra* have no recorded uses, *Eleusine coracana* is consumed as a grain in Lesotho (Jacot Guillarmod 1971), and *Pogonarthria squarrosa* has been recorded in Zambia and Nigeria as having medicinal use (http://plants.jstor.org/upwta/2_694 accessed 3/4/2015).

Table 7.21 Type 2002

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoideae	16	12	6
Total	16	12	6

Figure 7.27 Type 2003

2003: Saddle with distinct surrounding margins (Figure 7.27).

Within Lesotho, this morphotype is diagnostic to Chloridoideae (Table 7.22), present in *Chloris gayana*, *Eragrostis chloromelas*, *Eragrostis micrantha*, *Pentaschistis colerata* and *Sporobolus fimbriatus* (*P. colerata* is the only species of these not present in the ESIA). *P. colerata* has recorded craft and medicinal use, and the grain of *S. fimbriatus* is recorded as edible (Jacot Guillarmod 1971).

Table 7.22 Type 2003

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Bambusoideae	1	-	-
Chloridoideae	8	5	4
Pooideae	1	-	-
Total	10	5	4

Figure 7.28 Type 2201

2201: Sinuous trapeziform (Figure 7.28).

This morphotype is redundant across three sub-families, but predominates in the Panicoideae and Pooideae (Table 7.23), being present in *Bromus commutatus*, *B. rigidus* *Festuca eliator* (all Pooideae), *Helictotrichon hirtulum* (Panicoideae), *Melenis repens* (Panicoideae), *Poa annua* (Pooideae) (all in the ESIA) and *Brachypodium flexum*, *Paspalum distichum* (both Panicoideae), *Schismus barbatus* (Chloridoideae) more widely in Lesotho. Of those whose use has not been listed above, the seeds of most species of *Bromus* are believed to be edible (Duke 2000: 52), all parts of *Melinis repens* are eaten by baboons, *Festuca* sp. has recorded craft usage in Lesotho (Jacot Guillarmod 1971), *S. barbatus* has recorded medicinal use in Egypt (Heneidy & Bidak 2004), but *P. annua* and *P. distichum* have no recorded uses.

Table 7.23 Type 2201

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoideae	5	1	-
Panicoideae	5	4	2
Pooideae	6	4	4
Total	16	9	6

Figure 7.29 Type 2202

2202: Trapeziform with concave sides, wider base than top (Figure 7.29).

Again, this morphotype is redundant across several sub-families, eight present in Lesotho (Table 7.24): *Bromus pectinatus*, *Festuca scabra* (both Pooideae), *Imperata cylindrica*, *Melica racemosa* (both Panicoideae), *Trichoneura grandiglumis*

(Chloridoideae), (all in the ESIA), *Antheophora pubescens*, *Digitaria eriantha* (both Panicoideae), and *Schismus barbatus* (Chloridoideae). *T. grandiglumis* has recorded magical/medicinal use by Basotho, *D. eriantha* craft use (Jacot Guillarmod 1971) and *A. pubescens* no known use.

Table 7.24 Type 2202

Sub-family	Species in Rossouw (2009)	Of which present in Lesotho	Of which present in ESIA
Chloridoideae	5	2	1
Panicoideae	6	3	1
Pooideae	4	3	3
Total	15	8	5

7.6 Interpretation of phytoliths

Figure 7.30 Differential production of phytolith morphotypes by different plant parts. Illustration by Alice Williams

Following Harvey & Fuller (2005) and as illustrated in Figure 7.30 I attempted to determine which plant parts were represented by the phytolith sample: if grasses were being processed, it would be expected that inflorescence phytoliths (rather than those

deriving from leaves, for example) would predominate²⁸. This analysis was achieved by grouping identified types by the part of the plant from which they derive, e.g. elongate psilate and tracheids from the culm, echinates and dendriforms from inflorescences and then compiling tables. Not all recorded types are diagnostic to plant part, hence the presence of 'unidentified' types in each table. In each case, using information on use-wear and gross morphology as presented in section 7.3.2, likely working surfaces were determined.

Following on from Harvey and Fuller (2005), if inflorescence proportions can be regarded as a proxy for presence of grass seeds, where the likely working surface correlates with the highest proportion of grass inflorescence phytoliths (as compared with the object's other surfaces), I consider that this is consistent with a role for that surface in grass seed processing. Chi-square tests were carried out for each object, comparing the inflorescence phytolith yields on each surface, in order to determine if the observed patterns (where working surface was correlated with highest proportion of inflorescence phytoliths) were statistically significant.

Although they cannot be compared in the same way as the surface samples (given that they derive from multiple, aggregated surface samples), US (ultrasonicated) samples represent a total artefactual sample and thus constitute useful tools in rough comparison of artefact surfaces and 'background samples': I suggest that US samples are more useful as controls/background for artefacts than the more commonly used contextual sediment samples, since we cannot be sure that these sediment samples were derived from directly underneath an artefact, however where possible, sediment samples were also compared.

²⁸ It has been noted (Power *et al.* 2014) that grain does not produce phytoliths – inflorescence phytoliths come rather from husks. While phytolith analysis of agricultural contexts might encounter a separation of husks and grain, it seems unlikely that hunter-gatherers encountering wild grasses would find it efficient or even possible to separate grain from husks prior to grinding.

For each sample (31 in all) following the presentation of plant part proportions, proportions of phytolith types diagnostic to grass taxa (as discussed in section 7.5.1) are presented using bar charts and then discussed. Once again, sediment and ultrasonicated samples (where available) are used for background comparison, against which individual surface samples are compared. Not all the phytoliths counted are diagnostic to grass taxa: inflorescence phytoliths, for example, while they can tell us about the part of the plant represented, may not be informative as to the type of plant in question. Because of this, the number of diagnostic phytoliths counted (visible on the bottom left of each bar chart) fluctuates between samples.

7.6.1 Sediment samples from Ha Makotoko

The proportions of plant parts in sediment samples are arguably most useful as baselines against which to compare the corresponding proportions from the artefactual samples (Table 7.25 to Table 7.27).

Table 7.25 Phytolith counts and percentages for plant parts in context (052)

052		
Plant part represented	Count	%
Culm	12	4
Hair	3	1
Inflorescence	18	6
Leaf	252	84
Undiagnostic	15	5
Total	300	100

Table 7.26 Phytolith counts and percentages for plant parts in context (002)

002		
Plant part represented	Count	%
Culm	36	12
Hair	3	1
Inflorescence	27	9
Leaf	207	69
Undiagnostic	27	9
Total	300	100

Table 7.27 Phytolith counts and percentages for plant parts in context (002 Hearth)

002 Hearth		
Plant part represented	Count	%
Culm	12	4
Hair	6	2
Inflorescence	27	9
Leaf	192	64
Undiagnostic	63	21
Total	300	100

As regards specific morphotypes, again, these tables are most useful as comparatives for the artefactual samples, but we can also observe that Context 052 shows a spread of morphotypes, with no one type reaching higher than 15%. Highest percentages occur for types 0201, 0209, 2002, and 2003 suggestive of a make-up of Panicoideae (as

suggested by 0201 which may represent *Themeda triandra*), Ehrhartoideae or Panicoideae e.g. *Eragrostis* sp. (as suggested by 0209), and Chloridoideae (as suggested by 2002 and 2003). (002) shows high proportions of 1907 (possibly either *Phragmites australis*, *Helictotrichon hirtulum* or *Melica racemosa*) and 2002 (again suggestive of a heavy contribution of Chloridoideae). (002 Hearth) differs from the surrounding (002) although proportions of 2002 remain high (Chloridoideae), 1907 is much lower, and 0201 (probably Panicoideae) is higher.

Figure 7.31 Morphotypes represented in sediment samples from contexts 052 (top) and 002 Hearth (bottom). See 7.5.1 for key to morphotypes

Figure 7.32 Morphotypes represented in sediment samples from context 002. See Section 7.5.1 for key to morphotypes

7.6.2 Artefactual samples from Ha Makotoko

L101: Support for surface A as used in processing siliceous material is evident from comparison of the tables (Table 7.28, Table 7.29): the highest proportion of inflorescence phytoliths (10%) in this group of samples occurs here, *versus* 8% in US1, 2% in WBB, 0% in WBC, and 6% in (052).

Table 7.28 Phytolith counts and percentages for plant parts in L101

L101	US1		WBA		WBB		WBC	
Plant part represented	Count	%	Count	%	Count	%	Count	%
Culm	36	12	27	9	24	8	24	8
Hair	15	5	12	4	45	15	27	9
<i>Inflorescence</i>	24	8	30	10	6	2	0	0
Leaf	171	57	195	65	180	60	192	64
Undiagnostic	54	18	36	12	45	15	57	19
Total	300	100	300	100	300	100	300	100

Table 7.29 Phytolith counts and percentages for plant parts in context (052)

052		
Plant part represented	Count	%
Culm	12	4
Hair	3	1
Inflorescence	18	6
Leaf	252	84
Undiagnostic	15	5
Total	300	100

Use of a chi-square test shows that the difference between the inflorescence counts on L101's surfaces (discounting US1 and the sediment sample 052) is statistically significant. With two degrees of freedom (df), the chi square (χ^2) gives a value of 42²⁹. The two-tailed p-value is < 0.0001 which is much smaller than the standard significance level of 0.05, thus there are significant differences between the surfaces, and the fact that WBA has the highest remainder (o-e) of 18, suggests that the significant difference observed in the chi-square is due to this.

L101 derives from Context 052 (Figure 7.31) which shows a spread of morphotypes, with no single type reaching a proportion of greater than 15%. By contrast, L101 (Figure 7.33, Figure 7.34) shows high levels of morphotype 2002 in all samples, reaching as much as 27.59% in US1. However, the flat face, A, shows a drop in 2002 (down to 12.5%), and a rise in 1901 (to 13.3%) – this may be important given that the proportion of 1901 is no more than 7.14% in any other sample. The high proportion of 2002 is suggestive of phytoliths deriving predominantly from the Chloridoideae. If the range of species for which 2002 and 1901 are diagnostic is considered, we see that *Diplachne fusca*, *Pentaschistis ancifolia*, *Stipagrostis namaquensis* and *Phragmites australis* are not types in which 2002 occurs, suggesting that they may be unique to surface A.

²⁹ Where the equation $[(o-e)^2]/e=\chi^2$ is used. o is the 'observed count' and e is the 'expected count'

Figure 7.33 Morphotypes represented on L101 US1 (top); WBA (middle); WBB (bottom). See Section 7.5.1 for key to morphotypes

Figure 7.34 Phytolith morphotypes represented on L101 C. See Section 7.5.1 for key to morphotypes

L108 derives from Context 190 which is the same as Context 052 (Charles Arthur pers. comm. 14/05/2014). As with L101, support for A as a grinding surface may be drawn from the proportions of inflorescence phytoliths in each sample: 7% (WBA) versus 3% (US1) and 4% (WBB and WBC) (Table 7.30). However, given that at 6%, inflorescence proportions in 052 (Table 7.31) are higher than some of the artefact surfaces it emerges that although the underlying context is stratigraphically equivalent to Context (052), it may be compositionally different, and as a result may not function well as a control.

Table 7.30 Phytolith counts and percentages for plant parts, L108

L108	US1		WBA		WBB		WBC	
Plant part represented	Count	%	Count	%	Count	%	Count	%
Culm	27	9	27	9	30	10	33	11
Hair	9	3	3	1	9	3	3	1
<i>Inflorescence</i>	9	3	21	7	9	3	12	4
Leaf	180	60	189	63	165	55	201	67
Undiagnostic	75	25	60	20	87	29	51	17
Total	300	100	300	100	300	100	300	100

Table 7.31 Phytolith counts and percentages for plant parts in sediment sample from 052, repeated

052		
Plant part represented	Count	%
Culm	12	4
Hair	3	1
Inflorescence	18	6
Leaf	252	84
Undiagnostic	15	5
Total	300	100

Comparing artefact surfaces alone, the difference between L108's surfaces is not statistically significant ($\chi^2=5.57$, $p=0.1345$). Given the low counts here on all surfaces, however, it may be that statistical testing is not appropriate for this sample: although differences between the surfaces do not emerge as statistically significant, this could be the result of very low-intensity plant processing, or poor preservation. This is further discussed in section 7.7 below.

As with L101, 2002 remains the most common morphotype, and is fairly stable across the three samples, ranging from 17-19%. 0201 is also relatively high, ranging from 9.68-15.33%. (Figures 10.35, 10.36). A shows a jump in proportion of 2003, compared to US1 and C, but surface B has even more of this type. If A was being used to process siliceous material, perhaps the grindstone then rested on top of more of this material, which would explain why A does not show a distinctive signal of phytolith types: the most noticeable increase in surface A is the number of 1907 which is associated with *Phragmites australis*, *Helictotrichon hirtulum*, and *Melica racemosa*. On the other hand, given that WBA is not significantly different from other surfaces in terms of inflorescence counts, the lack of distinct signal of phytolith types for WBA might further suggest that it was not used to process grass seeds.

Figure 7.35 Phytolith morphotypes represented in L108 US1 (top); WBA (middle); WBB (bottom). See Section 7.5.1 for key to morphotypes

L122 also derives from Context 190. Proportions of inflorescence phytoliths (Table 7.32) are greatest for WBA (4% versus 2-3% for the other three samples), but chi-

square testing ($\chi^2=2$) shows no statistical significance ($p=0.3679$) between the surfaces. As with L108, however, just as we should avoid over-interpreting results with low statistical significance, we should be wary of under-interpretation as well: low statistical significance may be the result of low sample size (possibly reflecting poor preservation or low-intensity activity).

Table 7.32 Phytolith counts and percentages for plant parts on L122

L122	US1		WBA		WBB		WBC	
Plant part represented	Count	%	Count	%	Count	%	Count	%
Culm	57	19	27	9	33	11	39	13
Hair	3	1	6	2	3	1	3	1
<i>Inflorescence</i>	6	2	12	4	9	3	6	2
Leaf	183	61	195	65	174	58	195	65
Undiagnostic	51	17	60	20	81	27	57	19
Total	300	100	300	100	300	100	300	100

Morphotype 2002 remains high across L122 (17.39-25%) but 1907 and 0209 are also high across the four samples with ranges of 11-17% and 9-26% respectively (Figure 7.36, Figure 7.37). The rise in proportions of 1907 suggest an increase in Arundinoideae and Pooideae (specifically *Phragmites australis*, *Helictotrichon hirtulum* and *Melica racemosa*) at the expense of Chloridoid species, while 0209 might represent an increase in species of Ehrhartoideae or *Eragrostis*.

Figure 7.36 Phytolith morphotypes represented in L122 US1 (top); WBA (bottom). See Section 7.5.1 for key to morphotypes

Figure 7.37 Phytolith morphotypes represented in L122 WBB (top) and WBC (bottom). See Section 7.5.1 for key to morphotypes

L173: Comparing the percentages of inflorescence phytoliths (Table 7.33) it does not appear as though any one surface was subject to siliceous plant grinding: A,C,D, and F contain 6% inflorescence phytoliths, with 3% in B and 5% in E. Although unfortunately neither sediment sample nor US sample was available for this object, I suggest that these balanced proportions show that L173 was not used to grind siliceous plants, despite the concavity and use-wear it bears.

Table 7.33 Phytolith counts and percentages for plant parts on L173

L173	WBA		WBB		WBC		WBD	
Plant part represented	Count	%	Count	%	Count	%	Count	%
Culm	51	17	30	10	33	11	60	20
Hair	3	1	3	1	6	2	3	1
<i>Inflorescence</i>	18	6	9	3	18	6	18	6
Leaf	189	63	213	71	168	56	150	50
Undiagnostic	39	13	45	15	75	25	69	23
Total	300	100	300	100	300	100	300	100

L173 continued	WBE		WBF	
Plant part represented	Count	%	Count	%
Culm	39	13	42	14
Hair	12	4	12	4
<i>Inflorescence</i>	15	5	18	6
Leaf	177	59	153	51
Undiagnostic	57	19	75	25
Total	300	100	300	100

Results from chi-square testing confirm the lack of statistical significance in difference between the surfaces of L173, where the observed value (o) on surfaces WBA and WBF (most likely candidates for working surfaces) is 18 in both cases. The expected value (e) for all surfaces is 16, with five degrees of frequency. This gives a result for χ^2 of 4.185, and a p-value of 0.521. Given that even a rough glance at the inflorescence counts for each surface suggests little difference between the surfaces, and that the counts here are higher than for other grindstones sampled, I suggest that the low statistical significance between L173's surfaces is in this case meaningful, rather than the result of low sample size or low-intensity activity.

As regards specific morphotypes (Figure 7.38; Figure 7.39), there are differences in percentages, but the pattern (of which morphotype is present in greatest or least proportion) is the same throughout: 1907 dominates, with smaller amounts of 2002 and 2003 as well as 0209 and 2202: this suggests a composition of *Phragmites australis*/*Helictotrichon hirtulus* and *Melica racemosa* with considerable contribution of Chloridoideae (represented by 2002, 2003 and 0209). 2202 is redundant across multiple families.

Figure 7.38 Phytolith morphotypes represented in L173 WBA (top); WBB (middle); WBC (bottom). Although not pictured, for WBA, n=102; for WBB n=116; for WBC n=94. See section 7.5.1 for a key to morphotypes

Figure 7.39 Phytolith morphotypes represented in L173 WBD (top); WBE (middle); WBF (bottom). For WBD, n=94; for WBE, n=116; for WBF, n=102. See Section 7.5.1 for key to morphotypes

L181 As with L173, based on inflorescence percentages, L181 cannot be supported as used in siliceous plant grinding: there is a higher proportion of inflorescence phytoliths in the underlying sediment of Context 002 (9%) (Table 7.35) than on the artefact (2% on WBA and 3% on WBB) (Table 7.34) which argues against a processing role.

Table 7.34 Phytolith counts and percentages for plant parts on L181

L181	WBA		WBB	
Plant part represented	Count	%	Count	%
Culm	24	8	15	5
Hair	15	5	6	2
<i>Inflorescence</i>	6	2	9	3
Leaf	177	59	207	69
Undiagnostic	78	26	63	21
Total	300	100	300	100

Table 7.35 Phytolith counts and percentages for plant parts in context (002) repeated

002		
Plant part represented	Count	%
Culm	36	12
Hair	3	1
Inflorescence	27	9
Leaf	207	69
Undiagnostic	27	9
Total	300	100

Furthermore, the proportions of morphotypes present are not suggestive of differential use of surfaces, and are in keeping with the 'background' levels of phytoliths present in the sediments: Context 002 (Figure 7.32) shows high proportions of 2002 and 1907 (both about 25%), while samples WBA and WBB (Figure 7.40) are similar in their relative proportions: high counts of 2002 (both about 27%) and similar levels of 0201, 0205, 1907 and 2003, all about 10%.

Figure 7.40 Phytolith morphotypes represented in L181 WBA (top); WBB (bottom) See Section 7.5.1. for key to morphotypes

L193

Based on percentages of inflorescence phytoliths (Table 7.36), a strong case can be made for L193 in grinding siliceous plants, with G containing more than twice the number of inflorescence phytoliths than the other seven L193 samples. L193 derives from Context 141 which was not available for sampling but as a 'dung' layer, the underlying sediment may be relatively similar in composition to (002).

Table 7.36 Phytolith counts and percentages for plant parts on L193

L193	US1		WBA		WBB		WBC	
Plant part represented	Count	%	Count	%	Count	%	Count	%
Culm	9	3	42	14	33	11	12	4
Hair	9	3	15	5	9	3	15	5
<i>Inflorescence</i>	9	3	3	1	12	4	3	1
Leaf	177	59	186	62	183	61	195	65
Undiagnostic	96	32	54	18	63	21	75	25
Total	300	100	300	100	300	100	300	100

L193 continued	WBD		WBE		WBF		WBG	
Plant part represented	Count	%	Count	%	Count	%	Count	%
Culm	6	2	12	4	12	4	36	12
Hair	12	4	6	2	3	1	3	1
<i>Inflorescence</i>	9	3	9	3	12	4	27	9
Leaf	192	64	219	73	213	71	207	69
Undiagnostic	81	27	54	18	60	20	27	9
Total	300	100	300	100	300	100	300	100

Evaluating the statistical significance differences between surfaces, χ^2 emerges as 34.14, with $p < 0.0001$, suggestive of very strong differences between the artefact's surfaces. This can be ascribed to WBG, as this surface has the highest residual (o-e) value of 12.43, thus WBG can be strongly supported of having been used to process siliceous plants.

The proportions of 2002 are the greatest of any artefact, ranging from 25-46%, suggestive of a high contribution of Chloridoideae to this context (Figures 7.41-7.43). Proportions of 1901 are also relatively high across the eight samples, (although two samples contain no 1901), especially in F (20%) and G (16%). G contains the highest proportion of 2002 phytoliths (46.39%) and the second highest proportion (after F with 20%) of 1901, at 16%. This might suggest that if G is a processing surface, the material processed might include morphotypes 1901 and 2002. Possible candidates are *Chloris* sp. and *Eragrostis* sp. and if a further inferential leap may be made (in assuming that whatever material being processed is dietary), *Eragrostis* sp. seems a likely.

Figure 7.41 Phytolith morphotypes represented in L193 US1 (top); WBA (middle); and WBB (bottom) See Section 7.5. for key to morphotypes

Figure 7.42 Phytolith morphotypes represented in L193 WBC (top); WBD (middle); and WBE (bottom). See Section 7.5.1 for key to morphotypes

Figure 7.43 Phytolith morphotypes represented in L193 WBF (top) and WBG (bottom)

See Section 7.5.1 for key to morphotypes

7.7 Discussion

7.7.1 Processing grasses at Ha Makotoko

If the proportion of inflorescence phytoliths can be taken as a guide to likely use in grinding grasses, the ‘working surfaces’ of two artefacts, L101 and L193 were used as such, with strong statistical significance. There were also other notable correlations with the side with highest proportion of inflorescence phytoliths: in L101 WBA a drop of

2002 and increase of 1901; and in L193 the highest proportion of 2002 and second-highest proportion of 1901.

L108 and L122 have greater counts of inflorescence phytoliths on those surfaces interpreted as 'working', however the differences between the observed and expected counts here were not statistically significant at a confidence level of 0.05 (particularly in the case of L122). However, this might still be consistent with low-intensity grass seed processing, or possibly poor preservation, particularly in the case of L108: we should be wary of positing too much importance to statistical significance where sample size is low. Examining phytolith types diagnostic to grass taxa reveals other trends which might support a differential role for WBA on both L108 and L122: for L108 WBA the highest count of type 2003; in L122 WBA high counts of 2002 and 0209, although again these are less dramatic.

L181 and L173 appear not to have been used in grinding siliceous plants: in the case of L181 this may represent a simple case of confusing a naturally weathered cobble (which was interpreted as an upper grindstone class 3, indicative of the lowest level of confidence in this attribution) with a grindstone, although macroscopically adhering animal hairs may suggest an alternative role for this object other than plant processing. L173 is more puzzling as it bears all the hallmarks of a formal grindstone, and was heavily powdered with red ochre which may have been ground on it. However, Basotho ethnobotany and information from starch analysis help to interpret the lack of inflorescence phytoliths: Basotho keep separate those grindstones used for grinding dietary plants and those used for grinding medicinal plants or ochre – from examination of L173, it seems that this prohibition/separation may be of great antiquity.

7.7.2 Chronological trends?

There does not seem to be any noticeable trend or difference between the artefacts relating to age. Although it is possible, for example, that historic-period artefacts might have been used to process Panicoid crops (maize or sorghum) perhaps obtained through interactions with Basotho farmers, there is no evidence of that here. Indeed except for L181 no sample shows a sizeable proportion of Panicoideae (and L181 appears not to have been used in grass seed processing). This is in contrast to results from starch analysis which indicate processing of domesticates (wheat) late in the Ha Makotoko sequence, and also the presence of domesticates (maize and sorghum) within the upper layers onsite. Thus, the absence of Panicoideae phytoliths on artefacts from these layers (e.g. L193) could be interpreted as indicating that consumption of wild (as opposed proportionally to domesticated, rather than wholesale) grasses continued to dominate into more recent periods, with grinding of domesticated grasses only an occasional event. Alternatively, it might indicate that such grindstones are *ex situ* in origin, and were disturbed from earlier deposition events. On the subject of age, the very early date (c. 40KBP) for the statistically significant representation of grass inflorescences on the working surface of L101 should be noted.

7.7.3 Comparing starch and phytolith yields

As regards the correlation between the presence/absence of starch on artefacts and the presence/absence of phytoliths, two grindstones (L101 and L108) displayed little or no evidence of starchy plant processing but possible (definite, in the case of L101) evidence for siliceous plant processing, while L193 displayed evidence for siliceous plant processing but also some evidence for starchy plant processing. L181 was devoid of starch, but also appears not to have been used to process siliceous plants, while L122 was not sampled for starch but evidence for siliceous plant grinding was not statistically significant. L173 yielded starch but no evidence for use in siliceous plant processing.

Based on these results it appears that while a lack of starch may correlate with the presence of inflorescence phytoliths, it is not always the case (this is common sense: some artefacts interpreted as grinding stones may have been completely unused as such, or not used in plant processing). However since starch sampling does not appear to affect phytolith yield, the 'piggyback' dual analytical method is validated.

7.7.4 Grass families represented

Chloridoideae predominate in the phytolith assemblage. This may reflect the fact that a number of morphotypes are redundant across the Chloridoideae (more so than with other sub-families) or that they constitute the most numerous sub-family of southern African grasses, with Rossouw (2009) listing 71 species (*versus* 43 Panicoideae). However, if we pull in another strand of evidence, namely that the inflorescence phytolith proportions indicate grinding of seeds, and if we assume that the purpose of this processing was dietary consumption, then the identification of specific morphotypes could be narrowed down to those with known dietary/medicinal uses. Thus, the known dietary role in Lesotho (for both Bushmen and Basotho) of *Eragrostis* spp. helps to support the genus as a possible candidate for phytolith production (and plant processing) on both L193 and possibly L122, while *Pentaschistis* sp. and *Sporobolus* sp. are candidates for L108. Finally L101 may have been used to process *Stipagrostis* sp., or again *Pentaschistis* sp.: intriguingly while the former is regarded as edible in Lesotho, *Pentaschistis* is used only in medicine/magic.

Additionally, this information can be cross-referenced with evidence derived from other methods. Usewear on the artefacts sampled for phytoliths (Section 10.3) indicates a correlation between suitably ergonomic grinding surfaces, visible wear and patterns in phytolith distribution. This can be further correlated with evidence from starch analysis and the evidence for grass processing may explain why starch yields from numerous

objects were so low: grass seeds may not be very starchy, or difficult to distinguish from starch analysis due to e.g. low birefringence (See Chapter 6)

7.8 Conclusion

Overall, it should be borne in mind that this study represents no more than a pilot investigation: only six artefacts and three contexts (yielding a total of 31 phytolith samples) were analysed, and more artefacts should be sampled for phytoliths before any firm conclusions as to the general purpose of artefacts of such type in southern Africa can be drawn. However, the results discussed here indicate that phytolith analysis can be a profitable avenue of enquiry in understanding the use of plants by southern African hunter-gatherers, and that a connection can be made between macrolithic artefacts and grass-grinding activity: these are in fact grindstones (*sensu stricto*), and thus bely assertions (Parkington 1991; H.J. Deacon 1993; Sealy 2006) that grasses were not important contributors to southern African hunter-gatherer diets and support ethnohistorical accounts arguing the contrary. However, we should bear in mind H.J. Deacon's (1993) suggestion that hunter-gatherers did not process grasses with any great degree of efficiency or in huge quantity. These results should also be interpreted with reference to discussions on the (in)efficiency of grass collection in Chapter 2, such that an "inefficient" or low-efficiency task may still be regarded as worthwhile, and efficiency should not be seen as a binary construct: the low overall proportions of grass inflorescence phytoliths present on the grindstones make more sense if this is borne in mind, as do those grindstones which display higher inflorescence phytolith counts on 'working' surfaces but where these differences are not statistically significant.

7.9 Summary

This chapter addresses the discussion in Chapter 2 as to whether grass seeds could have contributed to hunter gatherer subsistence in southern Africa, particularly within the

Grassland Biome. This idea is in keeping with ethnographic and historical information both in southern Africa, Australia and elsewhere, feasibility from an optimal foraging perspective (i.e. that suitable edible grasses exist in the vicinity of the site), and Basotho economic botany, but contrasts with accepted archaeological opinion (e.g. H.J. Deacon 1993; Sealy 2006). Moreover, the potential contribution of plants following C₄ photosynthetic pathways to hunter gatherer diets has been considered minimal at most (See Chapter 8).

I employed a method suggested by Harvey and Fuller (2005) which divides phytoliths into the plant parts from which they derive. I coupled this with a method common in starch analysis, but apparently unpractised in phytolith analysis, that separates artefacts into different surfaces. Where concentrations of inflorescence phytoliths were highest on surfaces estimated from morphology/use-wear to be used (compared with other surfaces and underlying sediments), I suggest that the grindstone was used in processing siliceous plants. Four out of six grindstones corresponded to this pattern, although only two grindstones displayed statistically significant differences between the number of inflorescence phytoliths on their grinding surface and other surfaces. The two grindstones with statistically significant levels of inflorescence processing come from both extremes of the Ha Makotoko sequence: the earliest MSA on-site, and the latest LSA. Inflorescence counts were never particularly high, which may suggest a low-intensity or low-efficiency processing of grass seeds. Despite its appearance as a formalised/intensively used grindstone, L173 showed no evidence for the presence of phytolith inflorescences, despite starch analysis yielding evidence of a possible role for it in medicinal plant processing.

An attempt was made to characterise the composition of phytolith assemblages on grindstones, although it should be understood that this cannot be done in the same way as for starch analysis, since phytolith morphologies are often redundant across plant taxa. Nevertheless, if we accept high concentrations of inflorescence phytoliths on

working surfaces as evidence of grass seed processing, it is most parsimonious to assume that such activity involved orally consumed plants: as such, potential contributors to phytolith assemblages can be narrowed down from a wider range to those with known dietary or medicinal uses such as *Diplachne fusca*, *Eragrostis curvula*, *E. capensis*, *Pentascistis lancifolia*, *Sporobolus fimbriatus*, *Stipagrostis namaquensis* and *Phragmites australis*. These candidates predominantly follow C₄ photosynthetic pathways, with one C₃ example (*P. australis*³⁰) also present.

If grindstones were used to process wild grasses, even if in a low intensity way, archaeologists must rethink interpretations of gathered materials consumed by hunter gatherers, for instance, the presence of large concentrations of grass interpreted as bedding on site: it seems parsimonious to argue that rather than having a sole function, in light of the phytolith results from Ha Makotoko, seeds might first have been removed from grass to be used as bedding and eaten, thus making more efficient use of resources collected off-site and introduced to it. This idea is further examined in the concluding chapter of this thesis.

³⁰ Note however that in Lesotho it is the rhizome of *P. australis* that is commonly regarded as edible, which may rule it out here.

Discussion

8.1 Introduction

This chapter starts by synthesising and exploring the major results of the thesis, then discusses how successfully the aims and objectives outlined in the introduction were achieved, as well as how far we can extrapolate from the results at Ha Makotoko. The methodology as a toolkit for grindstone analysis is then evaluated. The size and nature of both the archaeological tool sample and the residue samples are discussed. Following this, suggestions for further research are made. Themes arising from the results are then addressed: an account is given of both the place of the grindstone in Basotho society based on ethnographic work and the inferred place of the grindstone in hunter-gatherer society based on both the functional analysis at Ha Makotoko as well as findings from elsewhere in southern Africa. *Chaînes opératoires* are used as visual aids in illustrating how grindstones were used at Ha Makotoko based on the results from functional analysis. Next, the idea of gatherers and grasses is considered, since as Chapter 2 points out, this is an idea that has received mostly negative responses in southern African archaeology to date. Finally the thesis concludes by questioning what impact the results presented here have on our conception of hunter-gatherer lifeways at Ha Makotoko and within the wider Grassland Biome of southern Africa.

8.2 Synthesis of archaeological findings

Table 8.1 summarises findings on grindstones by context, comparing this with contextual information from the 2010 final excavation report (Mitchell & Arthur 2012).

Table 8.1 Table synthesising data from Ha Makotoko grindstones, set against context, in phase order. Artefacts and sediments subjected to residue analysis are written in bold. Note that data on pigment analysis of the Ha Makotoko grindstones are presented in Appendix A

Phase	Dates	Contexts	Excavation report	Grindstones	Sediments
1	Final LSA/Modern. Modern date from Square 54, 58 (UGAMS-8983)	(001), (002) , (004), (141)	Recent Basotho use indicated by dung, maize cobs and kraal, as well as plastic (Mitchell & Arthur 2012: 21). Pottery as deep as (141) is LIA. Hearth in (002),	L177, T1 , L175, L176, L178, L180, L181 , L182, L183, L184, L185, L186, L189, L193 . Starch analysis: Triticeae starch (and some miscellaneous starches) on L189, T1 blank, L193 miscellaneous starches including maize & sorghum. Phytoliths: L181 appears to be unused. L193 shows use in grass processing, possibly <i>Chloris</i> sp. and <i>Eragrostis</i> spp.	Starches: Dominated by maize and sorghum, but also miscellaneous wild species. Hearth sediments in (002) broadly similar to rest of (002) Phytoliths: High proportions of morphotypes 2002 and 1907
2	Final LSA	(018-020), (076), (003), (021),	Prolonged accumulation (Mitchell & Arthur 2012). (021) is wall of a kraal, ochre-stained	L146, L174, L194 Pigment: L146 and L194 analysed – similarities between L194 pigment and that used in paintings of polychrome eland at the site.	
3	Final LSA	(012)	Majority of artefacts are later Holocene, with some early Holocene artefacts, possibly due to erosion of underlying sediments	L140 , L160 Starch: L140 shows a small range of wild taxa, possible use as medicinal grindstone	
4	Later Oakhurst (Woodlot) 9110±30 BP	(023)	Youngest <i>in situ</i> early Holocene sediments. <i>In situ</i> hearth and patches of burning (charcoal and burnt grass) possibly derived from earlier	L144, L145 , L148, L151 Starch: L145 is blank	Starch: very little – 11 granules in total including three contaminant granules

	(UGAMS-8984) at top of phase		hearths, either swept out or previously <i>in situ</i> .		
5	Later Oakhurst (Woodlot)	-	Series of small hearths, one with multiple use	No grindstones	
6	Later Oakhurst (Woodlot) 9320±30 BP (UGAMS-8985) equivalent to top of BLOS-UR (9290±90 BP, Pta-5204)	-	Topped by a large hearth, multiple use, overlying aeolian sands including eroded hearth material. Earlier part of phase includes <i>in situ</i> hearths which are associated with grass-rich areas interpreted as bedding material.	No grindstones	
7	Oakhurst (Pre-Woodlot) 10,060±30 BP (UGAMS-8986) 9970±90 BP (Pta-5205)	(091)	Topmost sediments include high charcoal and plant fibre content (burnt grass and twigs). Underlying this are earlier hearths. Corresponds to base of BLOS-UR Layer, suggesting Phase 7 began accumulation at start of Holocene.	L123, L154, L139 Starch: L139 yielded only one artefactual granule, of <i>Zantedeschia</i> sp. as well as some contaminated granules	Low starch: six granules, including one of Triticeae type.
	Robberg	Trench 52		-	-

	12,580±35 BP (UGAMS-11594)				
8	Minimum age of 25,000 BP (UGAMS-11595) from Area 61, and 28,700 BP (UGAMS-11598), date of latest MSA	(030), (074), (116), (120), (109), (119) A. 61 (184)	Terminal Pleistocene sediments. Accumulating sediments begin to show increased geogenic input (principally contributed by weathering of surrounding sandstone). (056) appears to have accumulated under very diff. circumstances to overlying layers – could this signify a climatic event? Last Glacial Maximum/Younger Dryas?	L163, L164, L161, L167, L169, L155, L109 , L110 , L106, L142, L162 (L152) L109 had 5 starch granules and 3 Triticeae granules (probably contaminant given presence in negative control sample) L110 was blank.	(120) yielded little starch: three granules of which two are Triticeae which must be contamination
9	Top of phase dated to 40,100±230 BP (UGAMS-8988).	(192), (172), (200), (052), (190) Trench 61 (202)	Increased evidence of anthropogenic deposits compared to Phase 8, but still considerable geogenic input. Two hearths (060, 065), used briefly, rather than repeatedly (see early Holocene hearths). Grass bedding also present (083), as well as storage/sleeping hollows filled with grass. (173) There is also a refuse dump (172).	L129, L133, L126, L115, L101 , L122 , L108 , L104, L107, L117, L112, L125, (L147) L101 no starch, used in grass grinding – numerous edible taxa possible. L122 possible grass grinding use, <i>Eragrostis</i> sp. is a candidate. L108 yielded 2 contaminant starches and 3 unidentifiable ones, and was used in grass grinding – <i>Pentastichis</i> sp. or <i>Sporobolus</i> sp.	(052) Phytoliths: spread of morphotypes Starch: eight granules, spread of wild taxa and two modern <i>Sorghum</i> sp./ <i>Zea</i> sp. granules
10		(078)	Rests directly on bedrock.	L103, L118, L119, L134	

			Largely geological in origin, but reasonably high artefact frequency. Probable lengthy accumulation during mid Upper Pleistocene		
2a	(Called Phase 1b in final Metolong Report)	(177),	Possibly just part of Phase 2 in Area 61, (177) is the fill (mostly aeolian sand but with eight burnt mammal bones and a crypto-crystalline silica flake) of a pit (183), apparently intentionally dug for the deposition of L173. Lack of dung/hair in pit suggest possible earlier Holocene age – this context currently undergoing dating.	<p>L173</p> <p>Processed for pigment, starch and phytoliths.</p> <p>Starch – several wild taxa including possible non-dietary ones (medicinal grindstone use?), but also contaminants.</p> <p>Phytoliths – no evidence for use in grass grinding. Presence of haematite suggests this could be medicinal/special purpose grindstone</p>	Sediment sample not available.

I now present two tables summarising the botanical information obtained from analysis of grindstones (Table 8.2) and sediments (Table 8.3) at Ha Makotoko. The necessary contextual information can be cross-referenced from Table 8.1 above.

Table 8.2 Summarised botanical information for grindstones from Ha Makotoko. * designates likely contamination

ID	Phase	Starch	Phytoliths
L101	9	None	Chloridoideae; <i>Diplachne fusca</i> ; <i>Pentaschistis ancifolia</i> ; <i>Stipagrostis namaquensis</i> ; <i>Phragmites australis</i>
L108	9	Triticeae: <i>Secale</i> sp? <i>Triticum</i> sp*; unidentified starch	Low intensity use: <i>Phragmites australis</i> ; <i>Helictotrichon hirtulum</i> ; <i>Melica racemosa</i>
L109	8	<i>Khoara</i> ; <i>Watsonia</i> sp; <i>Hordeum capense</i> ; <i>Triticum</i> sp*	N/A
L110	8	None	N/A
L116	8	<i>Watsonia</i> sp.	N/A
L122	9	N/A	Low intensity use: Arundinoideae; Pooideae; <i>P. australis</i> ; <i>H. hirtulum</i> ; <i>M. racemosa</i> ; <i>Eragrostis</i> sp.
L139	7	<i>Zantedeschia</i> sp; <i>Triticum</i> sp?*; <i>Secale</i> sp?	N/A
L140	3	<i>Lematla</i> ; <i>Themeda triandra</i> ; <i>Zantedeschia</i> sp; <i>Albuca</i> sp; <i>Watson asp.</i> Unidentified starch	N/A
L147	Unphased	<i>Tulbaghia</i> sp.; <i>Themeda triandra</i> ; <i>Machacha metsa</i> ; <i>Poho tšela</i> ; <i>Morokolo poli</i> ; <i>Watsonia</i> sp.	N/A
L152	Unphased	<i>Rethe la ntja</i> ; <i>Triticum</i> sp.*; Damaged starch; unidentified starch	N/A
L173	2a	<i>Crinum</i> sp; <i>Watsonia</i> sp; <i>Themeda triandra</i> ; <i>Hloenya/lematla</i> ; <i>Poho tšela</i> ; <i>Zea</i> sp*; <i>Triticum</i> sp*; <i>Secale</i> sp? Unidentified starch; gelatinised starch	Unused. Possible background composition of Chloridoideae. <i>P. australis</i> ; <i>H. hirtulum</i> ; <i>M. racemosa</i>
L181	1	None	Unused. Similar make up to context (002)
L189	1	<i>Tulbaghia</i> sp; <i>T. triandra</i> ; <i>Watsonia</i> sp; <i>rethe la ntja</i> ; <i>Morokolo poli</i> ; unidentified starch; <i>Triticum aestivum</i>	N/A

ID	Phase	Starch	Phytoliths
L193	1	<i>Sorghum/zea</i> , cf. Fabaceae; <i>Gunnera</i> sp.; <i>Triticum</i> sp.; <u>Poho tšela</u> ; <u>Mofoka tiali</u>	Chloridoideae. <i>Chloris</i> sp. <i>Eragrostis</i> sp.
T1	1	None	N/A

Table 8.3 Summarised botanical information for sediments from Ha Makotoko. * designates likely contamination

ID	Phase	Starch	Phytoliths
120	8	Unidentified starch; <i>Secale</i> sp	N/A
91	7	<i>Themeda triandra</i> ; <i>Albuca</i> sp.; <i>Secale</i> sp.; <u>Poho tšela</u> ; unidentified starch	N/A
52	7	<i>Miscanthus capensis</i> ; <i>Watsonia</i> sp. <u>Poho tšela</u> ; <u>Rethe la ntja</u> ; <i>Zea/Sorghum</i> sp.*	Panicoideae; Erhartoieae; Chloridoideae; Pooideae
23	4	<i>Sorghum/zea</i> sp*; <i>Watsonia</i> sp.; <i>Tulbaghia</i> sp; <i>Secale</i> sp.; <u>Poho tšela</u> ; <u>Rethe la ntja</u> ; unidentified starch	N/A
002 Hearth	1	<i>Crinum</i> sp; <i>Tulbaghia</i> sp.; <i>Albuca</i> sp.; cf. Fabaceae; <i>Triticum</i> sp.; <i>Watsonia</i> sp; <i>Themeda triandra</i> ; <i>Sorghum/Zea</i> sp; <u>Rethe la ntja</u> ; <u>Khoara</u> ; <u>Moli</u> ; <u>Maime/merwillia</u> ; <u>Morokolo poli</u> ; <u>Lematla/hloenya</u> ; <u>Mofoka tiali</u> ; <u>Poho tšela</u>	Chloridoideae; <i>P. australis</i> , <i>H. hirtulum</i> ; <i>M. racemosa</i>
002	1	<i>Miscanthus</i> sp; <i>Tulbaghia</i> sp; <i>Zantedeschia</i> sp; <i>Echinochloa</i> sp; <i>Albuca</i> sp; <i>Watsonia</i> sp; <i>Sorghum/zea</i> sp; <i>Themeda</i> sp; <i>Gunnera</i> sp; <i>Crinum</i> sp; <i>Sorghum</i> sp; <i>Zea</i> sp. <u>Lepeka</u> ; <u>Thola</u> ; <u>Maime/Merwillia</u> ; <u>Lematla</u> ; <u>Rethe la ntja</u> ; <u>Machacha metsa</u> ; <u>Mofoka tiali</u> ; <u>Sehloko</u> ; <u>Khoara</u> ; <u>Poho tšela</u> ; unidentified starch;	Chloridoideae; Panicoideae

8.2.1 Grindstone results in full

The information on grindstones and sediments in tables 8.1 and 8.2 is now presented in full with interpretive information. The Harris Matrix (Figure 4.4.) in Chapter 4 can also

be used to contextualise information on the stratigraphic relationship between the grindstones and their sedimentary contexts.

L101 yielded no starch, but is consistent with use in inflorescence processing of grass seeds. The differences between different surfaces have been shown to be statistically significant, with this significance apparently predominantly due to the disparity between surface 'A' and the other surfaces, suggestive that A was used as a working surface for processing grass seeds. If these seeds can be presumed to be economically useful in nature, identifications of *Diplachne fusca*; *Pentaschistis ancifolia*; *Stipagrostis namaquensis*; *Phragmites australis* are consistent with the phytolith morphotypes observed. The underlying sediment, context (052) yielded starch from known dietary plants *Miscanthus capensis*; *Watsonia* sp. Poho tšela; Rethe la ntja; as well as *Zea/Sorghum* sp. which is likely contaminant in nature. A background composition of Panicoideae, Ehrhartoieae; Chloridoideae; and Pooideae is suggested by phytolith analysis. L101 is an upper grindstone class 2 from the earliest dated phase at Ha Makotoko, c. 40100±230 BP (UGAMS-8988).

L108 yielded Triticeae starch which might be either *Secale strictum* ssp. *africanum* or *Triticum aestivum*. While *Secale strictum* ssp. *africanum* is native to South Africa, it grows today only in the Roggeveld, far west of Lesotho (See Chapter 6). If it is occurring in pleistocene sediments at Ha Makotoko, this would suggest that palaeoclimates differed substantially to those of the present day. This is possible, however an identification of *Triticum aestivum* (due to contamination) might be more likely. Three unidentified starch granules were also obtained. The phytolith results suggested that the working surface 'A' might have been used in grass processing due to the presence of the greatest number of inflorescence phytoliths on this surface, but the differences between the surfaces are not statistically significant: this may suggest that a) the difference in

inflorescence phytolith yields are not significant or b) that the numbers are too low to be statistically manipulated but this surface was used for low-intensity processing. If the grindstone was used in grass seed processing, the morphotypes present are consistent with *Phragmites australis*, *Helictotrichon hirtulum* and *Melica racemosa*. L108 derives from context (190) which was unavailable for sampling but part of the same overall context as (052) and as such, of a similar age. It is interpreted as an upper grindstone class 2.

L109 yielded starch from Khoara, *Watsonia* sp., and *Hordeum capense*, all of which are edible plants, as well as unidentifiable starch and some gelatinised (cooked) starch, but also some contaminant *Triticum aestivum*. It was not processed for phytoliths. L109 is a lower grindstone class 2, and derives from context (120) which contained only unidentified starch and some possible *Secale strictum* ssp. *africanum*. This dates L109 to phase 8, which has a minimum age of 25,000 BP (UGAMS-11595). L109 is a lower grindstone class 2.

L110 yielded no starch, and was not sampled for phytoliths. It was interpreted as a lower grindstone class 2, deriving from context (109), which is part of phase 8, giving it the same minimum age as **L109**.

L116 yielded only *Watsonia* sp. starch, and was not sampled for phytoliths. It is a lower grindstone class 2 from context (109) which has already been discussed in the case of L110.

L122 was not sampled for starch, but was possibly consistent with use in grass seed processing, although the differences between surfaces were not statistically significant. I interpret this issue in the same light as **L108** such that this does not prove L122 was *not*

used in grass seed processing, but here this identification is even more tentative given the low overall counts. Arundinoideae and Pooideae phytoliths are indicated for this grindstone. If the grindstone was used to process useful grasses this might be narrowed down to *P. australis*, *H. hirtulum*, *M. racemosa* and *Eragrostis* sp.. L122 is a lower grindstone class 2, from context (052) which has already been discussed in the case of L101.

L139 yielded *Zantedeschia* sp., starch as well as either *Triticum aestivum* or *Secale strictum* ssp. *africanum* (see above) but was not sampled for phytoliths. L139 is a lower grindstone class 3 from context (091) which yielded starch from *Themeda triandra*, *Albucca* sp.; *Secale strictum* (which might indicate that the Triticeae granule on L139 was in fact *Secale strictum* and thus archaeological rather than contaminant) Poho tšela, and some unidentified starch. This grindstone dates to phase 7 at Ha Makotoko, the oldest LSA on site with absolute dates of 10,060±30 BP (UGAMS-8986) and 9970±90 BP (Pta-5205).

L140 yielded lematla, *Themeda triandra*, *Zantedeschia* sp., *Albucca* sp., and *Watsonia* sp. starch, as well as some unidentified granules. It was not processed for phytoliths. As noted in Chapter 6, all the identified starches have medicinal uses, while lematla and *Albucca* sp. have solely medicinal uses within Basotho economic botany, which may suggest a role in primarily medicinal plant processing for L140, interpreted as an upper grindstone class 3/hammerstone. It derives from context (012) which was not available for sampling but which is part of phase 3 on site, the beginning of the final LSA, possibly the early Holocene.

L145 yielded no starch, and was not processed for phytoliths. A lower grindstone class 1, it derives from context (023), which did yield *Sorghum/zea* sp. starches

(contaminant), *Watsonia* sp., *Secale strictum* ssp. *africanum*, *Tulbaghia* sp. poho tšela, rethe la ntja, and some unidentified starch. Context (023) is part of later Oakhurst (Woodlot) phase 4 on site, dating to the early Holocene.

L147 yielded *Tulbaghia* sp., *T. triandra*, *Watsonia* sp., Machacha metsa, Morokolo poli and Poho tšela starches, but was not processed for phytoliths. An upper grindstone class 1, it derives from context (202), which is unphased (as it occurs in Trench 61), but which has a minimum date of 28690±90 BP (See Figure 4.4).

L152 yielded contaminant *Triticum aestivum* starch, as well as rethe la ntja, unidentified starch and damaged starch. It was not processed for phytoliths. It is a lower grindstone class 2 from context (186) which is also unphased, but like L147 derives from the area in Trench 61 with a minimum date of 28690±90 BP (See Figure 4.4). Its sediment sample was not available for analysis.

L173 yielded starches from plants that are all known to have medicinal uses in Basotho economic botany: *Crinum* sp., *Watsonia* sp., *T. triandra*, *Secale strictum* ssp. *africanum*, hloenya/lematla, poho tšela, as well as unidentified starch, gelatinised starch, and contaminant *Zea mays* and *T. aestivum* granules. As with L140, some of these plants have solely medicinal uses (*Crinum* sp, hloenya/lematla). The interpretation of L173 as having been used predominantly to process medicinal plants is substantiated by findings from phytolith analysis which showed a background signal of Chloridoideae, but no evidence (statistically significant or otherwise) that one surface was preferentially used to process grass inflorescences. In addition, L173 was also stained with ochre (see Appendix B), and derives from an apparently special depositional context, accompanied by burnt mammalian bone in an unphased (2a) pit possibly dating

to the early Holocene (see Figure 4.4). No sediment sample was available from this pit for analysis. L173 is a lower grindstone class 1.

L181 was not sampled for starch but yielded phytoliths very similar to its sedimentary context of (002), predominantly Panicoideae and Chloridoideae. Like L173, there was little difference in terms of inflorescence phytolith yield between the different surfaces of the artefact, and as such it does not appear to have been used in grass seed processing. It is a lower grindstone class 3.

L189 yielded a large amount of Triticeae starch, which is consistent with both *T. aestivum* and *S. strictum* ssp. *africanum*. However, due to the age of the artefact (from context (002), phase 1, the most recent phase on site), I suggest that an identification with *T. aestivum* is more likely, and consistent with information that wheat was being grown around Ha Makotoko at this time (see Chapter 6). In addition to this large yield, *Tulbaghia* sp., *T. triandra*, *Watsonia* sp., morokolo poli and rethe la ntja were found, as well as some unidentified starch. The underlying sediment (002) was also rich in starch, and this is listed in full in table 8.3 above. L189 is a lower grindstone class 1.

L193, also a lower grindstone class 1, yielded *Sorghum* sp. and *Zea* sp. starch. This is probably artefactual rather than contaminant, given L193's age (dating to phase 1) and the fact that its surrounding context (002) is also rich in these species. Additionally, it yielded cf. Fabaceae, *Gunnera* sp., cf. Triticeae, mofoka tiali and poho tšela as well as unidentified and gelatinised starch. As with L101, this grindstone displayed statistically significant differences between inflorescence counts on its different surfaces, with the greatest difference attributable to surface WBG, a likely working surface. Thus, an interpretation of L193 as a grass-seed grinder seems warranted. As regard specific species, with a background of Chloridoideae, *Eragrostis* sp. seems likely. Such phytoliths

were also found in the underlying sediment of (002) and (002 Hearth), as well as some Panicoid species. This is consistent with the starch results for these sediments (see table 8.3 above).

T1, a lower grindstone class 3, yielded no starch and was not processed for phytoliths. The composition of its underlying sediment, context (002) is presented above.

8.3 Summary of major results by chapter

I now turn to results from each chapter. **Chapter 2's** review of literature, relating to 'what hunters gathered' in the Grassland Biome and southern Africa more generally, concluded that the oft-cited connection between geophytes and grindstones was possibly based on shaky ethnohistorical evidence and logical implausibility. I then observed that by contrast to the 'geophyte hypothesis', the case for grass seed consumption by hunter-gatherers, so often dismissed by southern Africanist archaeologists, was in fact both logically plausible and backed up by suitable ethnographic information (i.e. derived from hunter-gatherers rather than pastoralists). **Chapter 3's** major finding from the literature was that despite use as archaeological proxies, hunter-gatherer grindstones are products of more complex behaviour than this use would suggest, given, for example, their common use as grave goods. This argues against use of them as simple proxies for plant-processing, which may be why the graphs presented at the end of the chapter, plotting grindstone density at sites within the Grassland Biome, failed to identify strong trends in use over time, but rather pointed to site-specific idiosyncrasy. In fact, the major finding of **Chapter 3** is that the current state of analysis of grindstones in southern Africa does not really allow for meaningful comparison.

Chapter 4 turned to the case study for this thesis, Ha Makotoko, and compared contextual and spatial information for the grindstones derived from the 1989

excavations against those derived from the 2010 excavations which form the subject of functional enquiry in this thesis. Differences in material culture between the 1989 and 2010 excavation areas point to differential use of space from at least the Holocene at Ha Makotoko (as the 1989 excavations uncovered only Holocene deposits, the Pleistocene material excavated in 2010 cannot be compared). This is suggestive of division into 'manufacturing' (the 1989 area as indicated by greater amounts of lithic debitage) and 'domestic' (the 2010 as indicated by hearth activity and the presence of grass "bedding") areas of the site. Grindstones appear to fit into this pattern: the 1989 area lacks grindstones, but they are present in phases 4 and 7 in the 2010 area's 'domestic' region. This, to me, suggests strongly that not only did grindstones have domestic connotations at this time in Ha Makotoko's sequence, but that the grass "bedding" they are near was intended as food as well as/rather than bedding alone. The picture is, however, complicated given that grindstones are absent from the 'domestic' area in phases 5 and 6 on site, arguing against a completely straightforward association between grindstones and 'the domestic': the role of grindstones may have been changeable.

The functional analysis component of the thesis begins with **Chapter 5** when a working typology of Ha Makotoko's grindstones is presented. The major benefit of typology is that formalisation of design and intensity of use can be measured and classed, but also that intra-assemblage comparison is permitted, allowing extrapolation from one member of a typological class to another. At Ha Makotoko such typological classification allowed me to observe that basalt was the preferred raw material for grindstone manufacture, but that sandstone grindstones were preferentially stained with ochre. It also showed that more formal grindstones were not confined to upper layers on site, but occurred deep into the Middle Stone Age sequence. It also, as noted in section 8.4 below, cautions against a simplistic linkage between grindstone morphologies and particular functions. In other words, grindstones are not straightforward proxies for behaviours.

Chapter 6 used starch analysis as a method of evaluating the linkage between geophytes and grindstones discussed in Chapter 2. Across 15 grindstones and six sediment samples I found not only that starchy plants were not extensively processed at Ha Makotoko, but that geophyte starch in sediment outnumbered that on grindstones, suggesting that although geophytes were being consumed at site, they were not predominantly processed by grindstones beforehand. Thus I suggest that at Ha Makotoko, if we can extrapolate from 25% of the total grindstone corpus, the linkage between grindstones and geophytes is not supported. There were other interesting results however: starch granules of domesticates which may reasonably be interpreted as non-contaminate in nature occur in both the uppermost sediments and the most recent grindstones, suggesting that hunter-gatherers occasionally incorporated such domesticated grasses into their diets (which may be important to consider in the debate about wild grass seed consumption by hunter gatherers). Cross-referencing with typological information was also beneficial here: a hammerstone/upper grindstone of class 3 (the most informal type) was associated with solely medicinal plants (including medicinal geophytes), while more formal upper grindstones (such as L147) had no such linkage. Such a comparison is tentative pending incorporation of further samples, but potentially consistent with predictions made from experimental work in the literature (presented in Chapter 2) such that upper grindstones with facets are more likely to be associated with hard material (e.g. siliceous grass seeds) than softer plant tissue (e.g. grass seeds). This is further supported by the case of L173, which despite its appearance as a most formal lower grindstone, preserved only medicinal starches and ochre (see Appendix B) rather than food-related plant starches. This might support Thornton Barnett's (2013) claim that LSA grindstones at Erfkroon were used to process medicinal, rather than dietary, plants.

Chapter 7 presented a project designed to test the hypothesis also set out in Chapter 2 that hunter-gatherers did not routinely consume grass seeds. Results from a six-

grindstone, three-sediment sample phytolith study supported the logical and ethnohistorical argument that grass seeds *were* incorporated into hunter-gatherer diets in this region. Comparison of artefact surfaces showed that in four out of six grindstones, the surface morphologically consistent with the hallmarks of grinding (i.e. pronounced concavity on the lower grindstone examples, pronounced convexity or facet on the upper grindstone examples) also showed the highest yield of inflorescence phytoliths derived from grass seeds. Two cases (L101 and L193) showed statistically highly significant differences between their respective surfaces, which analysis of Chi-square results suggest is the product of the surface with the highest remainder: in both cases the working surface. The case of L101 should be especially noted, given that this grindstone is from a layer dated to c. 40,000 BP. While the other two cases (L108 and L122) were not statistically significant, I cautiously suggest that this could be due to low-intensity grass seed processing (which would be consistent with the ethnohistorical and experimental record) and should be tested with more samples before any firm conclusions can be drawn. Two grindstones (L173 and L181) showed no such difference between inflorescence counts on their multiple surfaces: in the case of L173 this is consistent with the starch and pigment findings such that this grindstone was primarily used in medicinal plant and pigment processing rather than food production. In the case of L181 I suggest that this shows the danger of relying on typology (or indeed any method) alone to interpret the function of an artefact, and that this supports the use of a multi-method toolkit in grindstone analysis. Finally, interpreting the presence of individual morphotypes from Lloyd Rossouw's (2009) grass phytolith reference collection, I suggest that given the positive correlation between working surfaces and inflorescence counts, this information can be used to combat phytolith redundancy and narrow possible candidates represented down to those with known dietary use. These are: *Diplachne fusca*, *Eragrostis curvula*, *E. capensis*, *Pentaschistis lancifolia*, *Sporobolus fimbriatus*, *Stipagrostis namaquensis* and *Phragmites australis*.

8.3.1 Achievement of aims and objectives

As stated in the introduction, the overarching aim of this thesis was to show the potential of grindstones to reveal hitherto obscured facets of hunter-gatherer lifeways in southern Africa. This was to be achieved by taking insights from other regions and contexts but testing them holistically for the first time in southern Africa, developing a methodological toolkit for grindstone analysis. I believe that this aim has been achieved, and this closing chapter of the thesis will go on to take a more interpretive look at the 'gatherer' in southern Africa (and what the grindstone has to contribute to this identity) following evaluation of more specific thesis objectives.

As shown in section 8.2 above, Chapter 2 achieved a comprehensive review of the current state of knowledge of gathered materials in the Grassland Biome. It also provided two of the primary hypotheses to be tested later in the thesis: that grindstones were predominantly used to process geophytes, and that they were not predominantly used to process grass seeds. Chapters 6 and 7 directly addressed these questions, finding that at Ha Makotoko a link between dietary geophytes and grindstones could not be supported, but that a link between grindstones and grass seeds could. Of course, we must be wary of extrapolating from small sample sizes (as section 8.5 below discusses) but pending further results I believe these chapters fully evaluated these hypotheses. In the case of the starch analysis, the compilation of a starch reference collection of known economically useful plants from Ha Makotoko and the wider Biome was essential, and it is to be hoped that the data gathered may contribute to future analysis. The second set of specific objectives was to prove that the current state of grindstone analysis in southern Africa masks the complexity of their relationship with those that used them, and as such a new toolkit should be used to explore them. Chapter 3 laid out the complexity of this relationship and also presented graphs illustrating how no straightforward trends over time (intensity for instance) could be proven, but rather than site-specific sequences were in evidence. Chapter 5 then employed typological

analysis to show the benefit of such an exercise (i.e. much more information can be revealed) and used it to explore classes of grindstones at Ha Makotoko, showing that through use of typology, grindstones could be compared across the sequence.

This thesis drew together methods established in other contexts and regions of the world, in attempt to test them in a southern African context in order to answer questions directly generated from the southern African archaeological record. It shows that these methods can be integrated profitably for use on hunter-gatherer grindstones in this region, and, when tested at the site of Ha Makotoko, reveals that prevailing wisdom within the regional archaeological literature is not supported by grindstone assemblage here. It would be foolish to try to project the Ha Makotoko results too far out from the site, but I suggest that if the methodology outlined here is adopted and applied at other sites, we may find further support for the conclusions outlined in this thesis.

8.4 Evaluating the methodology: a tool kit for grindstone analysis

Four methods of functional analysis were used to assess grindstones from Ha Makotoko, directed by a literature review identifying the specific questions to be asked. These were: typology; analysis of starch; phytoliths and pigments (see Appendices A and B).

Table 8.4 Residue analysis methods used for Ha Makotoko grindstones. All artefacts were typologically assessed.

ID	Starch	Phytoliths	Pigment
T1	X		
L101	X	X	
L106			X
L108	X	X	
L109	X		
L110	X		
L116	X		
L122		X	
L139	X		
L145	X		
L147	X		
L146			X
L152	X		
L157			X

ID	Starch	Phytoliths	Pigment
T1	X		
L101	X	X	
L106			X
L108	X	X	
L109	X		
L110	X		
L173	X	X	X
L181	X	X	
L185			X
L189	X		
L193	X	X	
L194			X

These methods worked well for the targeted questions in mind which were predominantly directed at plant processing strategies (this is why the results from pigment analysis are presented in Appendix B rather than the main body of the thesis). Of course, other methods of residue analysis could have been profitably used (see section 8.6) and it is to be hoped that they may be used in grindstone analysis in southern Africa in the future. Typology, however, I regard as crucial for any grindstone analysis, as it alone permits comparison intra- and inter-assemblage. At Ha Makotoko, for instance, it suggested that form does not necessarily correlate with function: we must not presume that ‘formal’ grindstones are necessarily indicative of particular kinds of plant processing, but rather use cues from morphology to direct our micro-residue analyses. L173 might have been thought to have been used in food production, as suggested by experimental results discussed in Chapter 2, but microbotanical analysis revealed no such role. Similarly, the upper grindstone class 3/hammerstone L140 shows evidence of use in medicinal plant processing, despite an unprepossessing appearance. Thus form can be used to guide the kinds of analysis to be used, but should not be used as shorthand.

Ideally, post-excavation projects would subject all materials to a full suite of residue analyses, but this is unlikely to happen given constraints of cost and time, particularly outside of research environments: the project at Ha Makotoko, as discussed in Chapter

4, was initiated ahead of construction of the Metolong Dam, which limited both time and funding available. Instead, goal-oriented methods should be used: if general exploratory residue analysis is considered desirable, following typological assessment, lower-level starch and phytolith analyses could be carried out, e.g. identifying inflorescence phytolith proportions alone (which quickly assesses whether an artefact was used in grass processing), coupled with analysis of ultrasonicated starch samples in order to determine the presence of starch. Given the stepwise nature of starch analysis, spot samples and dry and wet brushing steps would have to be executed before the artefact was ultrasonicated if any intention to examine these subsequently was held. Should starch be indicated, and it was felt desirable, analysis of specific surface samples could then be entered into. For more specific questions such as whether or not grindstones were used to process edible or medicinal plants, more detailed characterisation is necessary than presence or absence of microbotanicals, and this is largely dependent on development of a suitable reference collection, which, as shown in Chapter 6, is an entire project in itself.

I suggest then, that although this toolkit worked well for Ha Makotoko, future projects adapt to the questions provoked by individual sites and context, adding or removing methods accordingly.

8.4.1 Controls

Following the recommendations of Crowther *et al.* (2014), for starch analysis, negative controls processed in the laboratory should be regarded as mandatory, otherwise the possibility of contamination originating in the laboratory cannot be eliminated. Given the potential for contamination of such large objects as grindstones (see for example my discussion of the possible handling of L173 in Chapter 6) the elimination of as much of this risk as possible is vital. However, I am not convinced of the utility of sediment samples as comparative controls (with the notion that where plant types occur in the sediment and on the grindstones they indicate that the grindstone starch derived solely

from contact with the sediment). Firstly, it is just as possible for a grindstone with plant material on it to pass starch into the surrounding sediment following deposition as *vice versa* (and see discussion of potential starch pathways in Beck & Torrence 2006). Secondly, general context sediment samples, as were available for this thesis, emerged as not particularly useful as controls. Despite the relatively high level of spatial control offered by single context recording, we may still encounter situations whereby a sediment sample from one corner of a context is the only comparative sample for a grindstone from the opposite corner of the context, perhaps as much as a metre away. If any kind of spatial division of activity was practised during the deposition of this context, the sample becomes useless as a control (and moreover no certainty can attach to this). Where a sediment sample can be obtained from directly beneath an artefact, as is recommended by residue analysts working with other methods (Langejans 2010), it offers a better comparative, but this is only possible where excavators anticipate a programme of residue analysis, which they may not do at the time of excavation. I suggest that the aggregation of surfaces (as identified through ultrasonicated bulk samples) via the surface control method advocated in this thesis may offer a better form of informal control, but where possible, discrete surfaces from a given artefact may be compared statistically and correlated with typological and morphological information to provide formal controls, as suggested in Chapter 7.

Finally we must remember that while laboratory contamination can be (to an extent) isolated or eliminated, there is far less scope for controlling ex-laboratory (i.e. excavation) contamination sources. Here, little can be done other than cautioning excavators to avoid touching objects unnecessarily, but communication is invaluable in identifying and isolating contamination from this source.

8.5 What's missing: on sample size in archaeological residue analysis

“The presence of starch grains alone does not make a seed-grinder, and a few grindstones with starch remains does not make a seed based economy”
(Smith 2004: 174)

While Smith makes a valid point, that we should be wary of making assumptions based on a small number of artefacts, we should be even warier about making assumptions based on no artefacts at all, as has previously been the case in southern Africa. Additionally, while researchers are right to critique extrapolations based on a small sample size, we must be realistic about the feasibility and labour intensity of residue analysis. Smith (2004) cites two papers which make conclusions based on entire assemblages: Fullagar and Field 1997 (25 artefacts) and Balme *et al* 2001 (49 artefacts). It should be noted, however, that these analyses did not involve taxonomic characterisation of residues: while microresidues were identified according to category (e.g. starch; phytoliths; ochre), they were not individually characterised. Furthermore, even these bulk identifications may be misleading. Fullagar and Field (1997:303), for example, note that "the presence of phytoliths and starch grains is indicative of siliceous and starchy plants respectively". This is accurate insofar as some species such as domesticated grasses from the Triticeae will produce both phytoliths and starches, but it is not necessarily indicative of *processing* of these types of plants: most sediment, anthropogenic or otherwise, will contain phytoliths. Kealhofer *et al* (1999) employ controls to account for this, but these do not adequately allow discussion of artefactual/contaminant phytoliths as the control sample in question derives from sediment shed by the artefact inside its finds bag. As a result, this control will have phytoliths from all over an artefact in it, including those contracted through depositional, rather than use-related, practices (i.e. those adhering to non-working surfaces). While this sediment may act as a general control, it cannot isolate use-related phytoliths which is better achieved through separation of different artefact surfaces.

Except where general exploration of residue potential of an assemblage as outlined in section 8.4 is mandated, I suggest that more comprehensive analysis of a smaller number of artefacts is better than use of one method on a wider corpus. In the course of this thesis I have struggled with justifying the sample size in question: in addition to carrying out typological assessment with low-power binocular microscopy on the entire sample of 95 original “Grindstones, Hammerstones, and Introduced Rocks”, 20 “grindstones”, or about one-third of the reduced sample, were subjected to more intensive microscopic/spectroscopic residue analysis (See Table 8.4).

Additionally, sediment samples from six contexts containing analysed grindstones were screened for starch, and three of these were also screened for phytoliths. When we couple the total number of these samples with the number of samples from each individual grindstone, a total of 116 samples was microscopically analysed in the course of this project (73 artefactual starch samples including one negative control sample per artefact; 28 artefactual phytolith samples; six pigment samples, six sediment starch samples; three phytolith starch samples). As I discuss below, the aim of this project was not necessarily to comprehensively identify all uses for grindstones at Ha Makotoko, but rather to carry out a pilot project at this site in order to develop a methodology for application elsewhere in southern Africa. As such, while small, the sample size adequately demonstrates trends within the Ha Makotoko sequence which can be further evaluated by extrapolating the methods used to further samples and further sites.

8.6 Suggestions for further research

It is immediately apparent to anyone embarking on a review of the gathered record within southern Africa that what we do not know far outweighs what we do. Knowledge of which species were utilised is heavily biased towards the few sites which have had comprehensive programmes of archaeobotanical analysis, and overreliance on often unsuitable ethnohistorical accounts. How far, for example, can we realistically stretch

macrobotanical findings from the Western Cape to other regions, or practices of San or Khoekhoe groups across other ethnic groups? While sites such as Sibudu are salutary examples of what can be done (e.g. thorough investigations of “bedding” via micromorphological, microbotanical, experimental and macrobotanical work), we cannot simply extrapolate from them: comparisons, diversity and new data must be promoted through renewed and concerted effort into the archaeobotanical analysis of hunter-gatherer deposits.

The importance of comprehensive botanical reference collections to this effort cannot be overemphasised. In fact, without them there is no possibility of success. Effort must be made to acquire materials for all kinds of archaeobotanical analysis: for macrobotanicals, starches, phytoliths, parenchyma, charcoal, pollen, and perhaps new microbotanical possibilities such as the cystoliths discussed in Chapter 6. Accompanying the acquisition of reference material, we need detailed information on economic uses, but also identification by both local users and botanical taxonomists. It should be remembered that such records can be of use to source communities as well, and should, in accordance with good practice be jointly archived (e.g. Nic Eoin *et al.* 2013). This thesis functions as a reminder in this regard: time for analysis of archaeological samples was limited by the necessity of identifying, collecting and preparing reference material, while identification, of starches in particular, was limited by the size of the reference collection meaning that all identifications must be regarded as tentative pending additions to it. Thus widescale macrobotanical analysis and creation of comprehensive reference collections emerge as the first and most general priority for future research.

As regards the specific remits of this thesis, while the questions addressed would certainly have benefitted from the methods just discussed, particularly the idea of grass bedding as possibly representing food use as well as bedding/floor cover, the simple addition of further samples (both from Ha Makotoko and then further afield) analysed according to the same methods used would also be beneficial in order to confirm the

patterns I have tentatively identified. Further testing of lower grindstone types to confirm whether low starch yields are generally accompanied by increased evidence for inflorescence processing and whether pigment grinding is ever accompanied by evidence of food plant grinding are examples of this.

The analysis of pigment on grindstones would benefit from the incorporation of infra-red spectroscopy to confirm tentative characterisations, while experimental samples could also be created to determine what the intermediate step between grindstone processing of pigment and its use in rock art (as identified by the different size of pigment granules sampled from each) might be.

Following (or alongside) reference collection, the key step for advancing knowledge beyond what I have been able to say in this thesis is in application of the multi-method toolkit for grindstone analysis to other sites using the typological method in order to compare them.

Finally, it should be remembered that the ethnohistorical record is indicative of other uses for grindstones than plant and pigment processing: insect grinding and ostrich eggshell bead shaping, for instance (Stow 1905). These functions could be interrogated through analysis of fatty acids or biochemical stains perhaps following some of the methods utilised by others (Yohe *et al.* 1991; Malainey 2007; Matheson & Veall 2014; Fullagar *et al.* 2015; Stephenson 2015).

8.7 Themes for discussion

This section explores the themes emergent from the conclusions presented in section 8.2 above: firstly, the idea of ‘gatherers and grasses’, followed by presentation of the role of the grindstone in Basotho society in Lesotho today, then finally the surmised role of the grindstone to the hunter-gatherer occupants of Ha Makotoko.

8.7.1 Gatherers and grasses?

“The direct use of C₄ plants as food by humans is a very recent phenomenon”
(van der Merwe & Tschauner 1999)

“Some of the Bushman tribes collected considerable quantities of grass-seeds which were pounded, boiled, and eaten like grain. It would appear that the practice of collecting these seeds for winter store was almost universal before the peace of the country was destroyed by the irruption of the stronger races into it” (Stow 1905: 58)

Recent papers have debated whether C₄ isotopic signatures in southern African hominins are derived from the consumption of C₄-plant eating bovids or direct consumption of C₄ plants themselves, with a predominant focus on earlier hominins (Peters & Vogel 2005; Lee-Thorp *et al.* 2012; Sponheimer *et al.* 2013; Fontes-Villalba *et al.* 2013). For Anatomically Modern Humans (see Footnote 31) there has been less discussion, but Sealy (2006) states that there is no evidence for Holocene Cape hunter-gatherer consumption of grasses at all, and that they may have had no need to supplement their diets with such low-energy foodstuffs, given the prevalence of shellfish as an easily-gathered resource for those close to the coast. However, I would argue that in this case, absence of evidence really does not constitute evidence of absence, especially given that isotopic analysis is incapable of differentiating between human consumption of C₄ grasses *versus* human consumption of C₄ grass-eating bovids. To my mind, the case for grass consumption by southern African hunter-gatherers (and outside marginal environments, *contra* H.J. Deacon 1993) is clearly established by the ethnographic and historical evidence detailed in Chapter 2: the possibility of acquiring seeds from harvester ant nests, the oral testimony of a witness to hunter-gatherer processing of moseka (*Eragrostis* sp., probably *curvula*) at Sehonghong, more general ethnohistorical accounts (Stow 1905; Dunn 1931), and information from Basotho economic botany as to the edibility of many grass species as fallback/famine foods all point to their consumption within a broad-spectrum diet by hunter-gatherers. The logical argument and opportunity for the consumption of grasses exists as well:

arguments as to the inefficiency or low-energy return of grass seed harvesting are dismissed by Australian case studies (which show that grass seeds provided a major economic contribution to Australian hunter-gatherer diets), while interpreting grass deposits as bedding at various southern African sites is simply not parsimonious – is it likely that hunter-gatherers would dismiss such a potential food source when it was already being brought onsite? Viewing these grasses as edible is not at odds with their interpretation as bedding. However, even where the association (to my mind, at least) between grass “bedding” and grindstones is clear, archaeologists appear to have chosen to ignore it: at Tienfontein 7, for example, Leslie Brooker (1980) comments on a deposit of “bedding” (composed of *Themeda triandra*, *Eragrostis* sp, and *Ehrharta* spp., with *Eragrostis* sp. forming the dominant component) overlain by large stones including one “which had served for a short time as a grindstone” (Leslie Brooker 1980: 39), yet she goes on (1980:39) to state that

“the plant food remains indicate a gathering pattern utilising corms and bulbs reminiscent of a geophyte-based plant food economy recorded from sites in the eastern Cape (H.J. Deacon 1976)”.

At no point is the idea of grass as food entertained, despite the fact that the species are edible and her note that inflorescences were virtually absent (but for two) in the deposit: could this not suggest that inflorescences had been stripped for processing – it seems odd that inflorescences would have been removed for any other reason, and the presence of two anomalous ones suggests that the grasses were gathered during their flowering period.

In addition to these logical arguments and ethnographic demonstrations, I believe that phytolith and starch analysis of Ha Makotoko grindstones offers support for this hypothesis: the evidence that grindstones across the sequence (from the MSA into the latest LSA) were used to process grass inflorescences is coupled with only weak support

for the grinding of geophytes but some evidence that starchier grasses (such as *Themeda triandra*) did occasionally come into contact with grindstones. A focus on grass-processing could also help to explain the lack of starch on early grindstones at Ha Makotoko: many siliceous grasses do not have strong starch signatures. The presence of a sizeable cluster of wheat starch on one recent hunter-gatherer grindstone (L189) only strengthens this argument to my mind: a new occupant (energy-rich, starchy grass) into an existing niche (the processing of local wild grasses) rather than a completely new component of subsistence.

Regarding the idea that C₄ grasses specifically were not consumed by humans until very recently³¹, while the Ha Makotoko evidence offers some support to contradict this (and isotopic evidence suggests that C₄ grasses were being brought on to site, see Roberts *et al* 2013), the ethno-historical record offers even more. A glance at Peters & Vogel's (2005) list of some African plants with C₄ signatures known to be used as food reveals that many of them are those listed above: *Cyperus* sp., *Brachiaria* sp., *Cynodon* sp., *Echinochloa* sp., *Eragrostis* sp., *Imperata* sp., *Miscanthus* sp., *Sporobolus* sp., *Stipagrostis* sp., *Themeda* sp..

The size of the contribution of C₄ plants to hunter-gatherer diets cannot be estimated by the methodology I have used, and unfortunately is not estimable via isotopic analysis either. All that can be said is that C₄ edible plants grow in the vicinity of Ha Makotoko, are ethnographically and historically known to have been consumed by agriculturalists and hunter-gatherers, and appear to have been consumed in antiquity as well. As Peters and Vogel note, when they began their research they believed it would show that C₄

³¹ The “recent date” referred to by van der Merwe and Tschauner (1999:509) refers to the domestication of C₄ grass species in the transition to agriculture. We encounter a problem here with equating temporality with cultural/societal progression: van der Merwe and Tschauner evidently regard the recent past as being populated by agriculturalists, and are not discussing contexts/regions in which hunter-gatherers also populate this period, e.g. Lesotho in the nineteenth century.

plants had contributed considerably more to hunter-gatherer diets than had previously been entertained within the literature, but were forced to conclude that this was, in fact, unlikely to have been a sizeable presence. What they do show, however, is that C₄ plants must have contributed at least partially to the isotopic signature observed, and this cannot therefore be entirely the product of consuming of C₄-eating bovinds. Instead they suggest for a potential δ^{13} isotopic signature of 30% C₄ contribution, 5% might come from C₄ plants, and the other 25% from species consuming those plants (5% invertebrates, 5% bird eggs/nestlings, 5% micromammals and reptiles, 5% smaller ungulates, 5% larger ungulates) (Peters and Vogel 2005). This seems a reasonable supposition, and fits well with my interpretation of grass-processing at Ha Makotoko as certainly a component of diet, but likely not to have been a major staple. It does seem time, however, for archaeologists in southern Africa to factor in the likely contribution of at least some C₄ grasses to modern human, non-agriculturalist, diets.

This would be very much in keeping with what we know of incorporation of wild grass and other small-seeded resources into hunter-gatherer diets elsewhere (see Torrence and Barton 2015), both ethnographically from Australia (Cane 1989) and North Africa/the Levant (Harlan 1967; 1989; 1992) as well as archaeologically in Australia (Smith 1988; 2004; Fullagar & Field 1997; Fullagar *et al* 2015), the Levant (Weiss *et al.* 2008; 2015; Snir *et al.* 2015a; 2015b); Europe (Revedin *et al.* 2010) and elsewhere in Africa (Mercader 2009; Henry 2010). Evidence of small-seed processing at these sites have been perceived as episodes, or events: for example, Snir *et al* (2015b) discuss their findings of wild wheat and barley at Ohalo II as a niche construction event preceding the Neolithic proper by some 13,000 years, and discussion of similar results at other sites globally receive similarly 'episodic' treatment. I suggest that this is because widescale contextualisation (i.e. more 'events' at more sites) is still growing, and the dataset is still relatively small. But the Ha Makotoko results simply take their place on a continuum of what are broad, and likely adaptive, trends, rather than punctuated episodes in what is

not necessarily the transition to agriculture in all locations, but rather increasing intensification of existing resource bases. Is this ‘niche construction’ prior to the Neolithic³²? Or is it perhaps merely intensification of an existing niche that has existed throughout human/hominid history, as suggested by analysis of early hominid diets (e.g. Peters & Vogel 2005; Lee-Thorp *et al.* 2012; Sponheimer *et al.* 2013; Fontes-Villalba *et al.* 2013)? As such there is every reason to believe that as the southern African dataset is expanded, more and more hunter-gatherer sites will join Ha Makotoko with early evidence of grass seed processing: the c. 40,000 years BP date for the grindstone L101’s evidence of grass inflorescence (i.e. seed) processing will likely be exceeded.

8.7.2 Grindstones in Basotho society

“Build a grindstone into the walls of your house, it will make it strong”
(‘Me Malireko Masakale, pers. comm. 13/9/2012)

In much of Lesotho today, the grindstone (or *leloala*) remains of paramount purpose (Figure 8.1). Even in areas such as Metolong, where mechanised mills have replaced the need to use grindstones for preparing food (except for occasional wild plant processing), the grindstones remain, on doorsteps, as doorstops, as mnemonics for the stories everyone can recount about their mother’s or grandmother’s grindstone. Where grindstones are still used, in Sekhutlong-sa-Lineo in southern Lesotho for instance, they are not just mnemonics but living material culture, vital aspects of technology, for, without them, people would not eat. One woman informed me that her mother (who is head of household, and, as such has many other concerns) would grind maize or sorghum for hours before every meal to produce sufficient grain for her family of six, i.e. three to six hours per day. Women using personal grindstones, or larger central ones owned by the entire village, need to be efficient and rhythmic in their work. As such, they are mesmerising to watch as they push and pull the *tšiloane* back and forth on the

³² And note that for southern Africa a Neolithic has only been posited (and disputed) based on pastoralism (Sadr 2003; Hobart 2004; Smith 2005, McGranaghan 2015) rather than plant-use.

leloala, using the *tšiloane* and sometimes a hand to push the grain to the top platform of the lower grindstone to check its consistency, before pushing it off onto the mat made of sacking or *Vigna munda* stems until there is enough of it to be made into maize porridge or beer. The efficiency and rhythm of the womens' movement is a skilful, whole-body dance of action and gesture that is not instinctive (as I found when I tried it), but learned: women typically began their apprenticeship with grindstones before puberty and could spend their whole lifetimes practising the rhythms required, possibly even with the same lower grindstone (although more often a woman acquires a new grindstone on her marriage) throughout, as a stout piece of basalt can last a generation or more (Delgado-Raack & Risch 2009). Grindstones go through cycles of resharpening and rejuvenation and many *litšiloane* until they break (or are simply exhausted) and are either discarded or repurposed for use as a doorstop, ornamental feature, building material (in a kraal or a house) or medicinal grindstone. No matter what the ultimate purpose, they also act as reminders of past ways of life or the past people who used them, and what they used them for: with the flooding of the Metolong Dam and the subsequent loss of raw material sources for grindstone manufacture, the practice is likely to cease completely in that region, with the remaining grindstones no longer functioning as mnemonics, and dwindling to the status of the enigmatic hunter gatherer grindstones found inside rockshelters like Ha Makotoko. Apart from the vital relationship between grindstones and subsistence, there is also the role of the grindstone in the tool kit of the traditional healer or *ngaka chitja* (herbalist)³³ who uses a smaller grindstone, often a broken *leloala*, with a fist sized, spherical *tšiloane* (typically just a river cobble) to process medicinal plants and other compounds such as fat or bone, before mixing these together to form medicines or charms. Curiously, the grinding

³³ Technically a *ngaka chitja* is distinct from a *ngaka ea litaola* (diviner) but in practice the roles may be combined, and occasionally the Zulu term *sangoma* (diviner) may be used. Curiously the Zulu counterpart for herbalist, *inyanga*, is rarely, if ever heard.

equipment used by traditional healers is not subject to mythologising, despite the best hopes of the curious graduate student. Nevertheless, as with grindstones used for food (which appear, by contrast, to have deeper connotations of domesticity and importance) the equipment used by healers exists as a transformative tool that has the power, when combined with skilful human action (and patience!), to alter something of low significance – river fish fat, wild leaves or tubers, raw grains – into something much more: food, medicine, magic.

Figure 8.1 *Chaîne opératoire* of Basotho grindstone use

8.7.3 Grindstones in hunter-gatherer society

For hunter-gatherers in Lesotho, we lack direct voices to inform us about grindstones, and must fall back on material culture as mnemonic, interpreting it to work out the place of the grindstone in society. I think, though, that we can extrapolate some of the symbolism grindstones might have had based on analogy with their place in Basotho

life, as well as the contexts in which hunter-gatherer grindstones have been found (Figure 8.2). The first is that they appear to have been connected with domestic activity: grindstones occur in far greater quantity in the area at Ha Makotoko interpreted as a domestic area (fires, food preparation, bedding) than in the area interpreted as a manufacturing zone where stone tool production appears to have dominated. Thus grindstones (possibly despite their status as stone tools) appear to have had predominately domestic associations. This pattern appears perpetuated at other sites where grindstones accompany grass deposits interpreted as bedding (e.g. Tienfontein 7, Sehonghong).

There are exceptions to this pattern: not all the grindstones at Ha Makotoko were simply discarded where they were probably used, following breakage or abandonment. At least one (L173) was specially deposited, after being used to process ochre and medicinal plants. I suggest that this deposition might echo the use of grindstones in hunter-gatherer burials in southern Africa. Discussing the burial at Pitsaneng, which was accompanied by a grindstone, Hobart (2003: 152) notes the following:

"Historical descriptions of Bushman burials tell that burial under a cairn of stones was the most common system employed (Barrow 1806:246; Dornan 1909: 444; Bleek 1928:35); the body was placed in a shallow hollow facing towards the east (Theal 1910:50), covered with stones, and then a flat stone of about 30 cm in diameter was placed on the top (Dunn 1931:47)"

Hobart appears to interpret the stone (which is approximately the size of L173) as just that: a stone, nothing more, and places no importance on the fact that at Pitsaneng it was a grindstone. It is possible that use of a grindstone in this instance was solely utilitarian (e.g. it was the right size), but this is at odds with Wadley's (1997) survey of Holocene Cape burials which found that grindstones were the second most commonly deposited grave good: elsewhere in southern Africa, grindstones appear to have been specifically chosen to accompany burials. In light of this, I think it no accident that the Pitsaneng burial is accompanied by a grindstone, nor that an ochreous grindstone was apparently

ritually deposited at Ha Makotoko: Stow (1905:126) quotes Thomas Arbousset as noting that in some areas, Bushmen were not buried under cairns of stones but were smeared with ochre (Stow 1905:126).

Is the fact that the Cape grindstones accompany burials of all sexes and ages significant? Does it argue against my interpretation of grindstones as conative of domesticity? Not necessarily, as I will argue below. Does the ochre on L173 make it a different case, more like the painted stones deposited at Boomplaas perhaps, or hybridising elements of burial practice as detailed by Arbousset?

I suggest that the role of grindstones in Basotho society as important transformational tools was echoed in hunter-gatherer societies: neither always connative of domesticity or ritual, grindstones were united in their ability to turn one thing into another: a great power for such a seemingly mundane object. But as Pierre Lemonnier (2012) notes on just this subject, seemingly mundane objects may be of great power and importance to their users and makers, even if they appear not to realise this! I suggest that the use of grindstones in grass processing is a case in point. Archaeologists who have commented on the unprepossessing nature and lack of gustatory appeal of wild grasses are not necessarily wrong: grass seeds may not have been a first choice food for hunter-gatherers, who, at odds with modern conceptions of a 'Paleo Diet' (Cordain 2012 but see also Milton 2000) would likely have prized high-fat, high-flavour, sweet, salty, juicy or *umami* foodstuffs. However, grass seeds may have been a necessary foodstuff and provider of essential calories, or just something with which to fill the stomach on hungry days. Yet gathering a handful of grass seeds and eating them is not an appealing prospect. Use of a grindstone, though, is a means (a transformative technology) of turning such low-appeal, yet ubiquitous fodder, into a high(er)-nutrition porridge or flour, through patience, a little elbow-grease, and the presence of mind to gather the seeds (easily done, while out on the foraging round, and if grass was to be brought back

to camp for use as bedding, why not extract the maximum potential from it?). With a grindstone, non-food can be turned into food, just as minerals can be abraded and ground to bright powder for bodies, hafting and art, and plants and other ingredients (minerals, animal products) can become medicine or magic. Grindstones used to process foods and medicines/magic might have been kept separate, but this might simply have been for practical reasons rather than any prohibition/pollution concept: grindstones of different functions might still have been united under the umbrella of transformational tool, and I believe this is the key to their role in burial elsewhere in the sub-continent, and possibly within the pit at Ha Makotoko. The specific powers and affordances of different raw materials were recognised, which might go some way to explaining why sandstone grindstones are more often stained than basalt ones. We must also remember the power of any material culture as mnemonic (and as demonstrated for grindstones by Basotho stories of parents' and grandparents' use of them). Within the grindstone journeys and different places could be encapsulated (see O. Harris 2009 for the object as an assemblage of places), the place from whence the lower grindstone material came (the cave, the river, further afield), coupled with the place from whence the upper grindstone material came (possibly successive upper grindstones), then the gathered materials processed on it – a stand of particularly tasty grass seeds further away than usual; a potent medicinal geophyte found nearby or on a more distant mountain slope; ochre from the cave floor or further away. Each time the grindstones were used, a new memory would attach to them, with prowess perhaps attaching to the person who fed their family well, or ground minerals for paint. We must remember also the transformative power of the grindstone in producing portable materials: grass seeds or geophytes turned to meal or flour could be easily transported in a bag to ensure food for travelling days.

Figure 8.2 *Chaîne opératoire* of grindstone use at Ha Makotoko: gathered materials are in red, assumed purpose/function in orange, and terminations to the sequence in purple. Comments in italics ask questions about the human choice and actions underlying the operational steps

8.8 Conclusion: What this awl means³⁴ for hunter-gatherers

A focus on the gathered invites an examination of the material culture used to achieve such activities. Similar studies could perhaps be envisioned of sedimentary contexts, adzes, bored stone digging weights, or even the digging sticks themselves, where they survive, but I suggest that is the grindstone (or rather pairs of grindstones, for although they generally separate in the archaeological record, they must function together in life) that has the most potential of any object to reveal what hunters gathered, and what they did with this material. Although not all the fruits of all gathering activities are connected with grindstones (indeed, I have suggested that some oft-linked ones, i.e. geophytes, are less connected than widely thought), the ones that are may be obscure or even invisible outside of this focus: grass-processing for instance. Although the logical conditions for grass-grinding by hunter-gatherers in this region exist (vast stands of edible wild grasses; the need to process grass seeds to make them a viable foodstuff), as well as appropriate ethnographic analogies (oral testimonies, use of wild grasses by farmer communities) and circumstantial evidence (grindstones in association with deposits of edible grasses), only microbotanical evidence of grindstones can reveal whether they were directly used for such an activity. The results of the Ha Makotoko study suggest that at least some were, while typological analysis suggests that others may have been (based on features unlikely to arise from processing of softer materials such as geophytes). The related lack of evidence for intensive geophyte processing as well as the corresponding lack of existing logical or ethnographic analogies together with circumstantial evidence and the absence of other likely candidates for grindstone use leads me to suggest that use in grass-processing might partially explain the ubiquity of grindstones within southern Africa. This is not to say either that grass was intensively processed, or that other materials were not processed at all: starch analysis at Ha

³⁴ With apologies to Janet Spector (1991)

Makotoko reveals processing of edible and medicinal starchy plants, for instance, while the pigment analysis merely confirms the macroscopically visible evidence for mineral processing. However I believe that grass-processing was an important role for grindstones in MSA and LSA contexts, one that laid the foundation for the incorporation of occasional domesticates more recently: wheat was detected in this analysis (L189) as well as smaller amounts of maize and sorghum (L189 and L193), which also occur in sediments.

8.8.1 Gatherers with grasses?

I do not wish to overstate the case for grasses in hunter-gatherer diets, but given the almost total lack of (positive) attention the idea has previously received in southern Africa, some positive reinforcement is necessary, and therefore I turn now to thoughts on what this means for our conceptions of hunter-gatherers within southern Africa. Going hand-in-hand with debunking of the geophyte hypothesis (I see no reason to disagree fundamentally with Hilary Deacon's concept of the geophyte as a staple food, merely that it has been overstated and that it is unlikely to explain the presence of large numbers of grindstones) is that simplistic accounts of the lack of independent domestication of plants in southern Africa must be eliminated: contrary to Marshall & Hildebrand (2002) a situation where reliance on geophytes and lack of interest in wild grasses failed to establish conditions for domestication did not exist. Evidence that hunter-gatherers did interest themselves in wild grasses requires that we rethink (once again!) what it meant to be a gatherer in southern Africa. Terminological re-assessment has been discussed elsewhere for decades (D.R. Harris & Hillman 1989; Harlan 1992; Terrell *et al.* 2003; Barton & Paz 2007; Denham *et al.* 2007; Barker 2009) and as Barker (2009:72) succinctly puts it:

"The complexity of the lifeways represented in the ethnographic and ethnohistoric record... is hidden within simple terms such as 'foragers' and 'small-scale agriculturalists'"

Based on the material discussed in this thesis, specifically the probable low-intensity of hunter-gatherer grass processing, which might not entail storage, I see no reason to overhaul “hunter-gatherer” or, rather “gatherer” as a term, but we do need to remember that this term does not imply simply picking up foodstuffs from the landscape as though in a supermarket, and absolutely not in terms of a “provisions spreadsheet” as suggested by Terrell *et al.* (2003), but rather sophisticated engagement and interaction with surrounding species and materials – in this sense, we should envision a symmetrical ontology which sees the hunter-gatherer as a construct of humans and the resources (plant, animal, mineral) consumed (see also Ingold 2000: 59 for a complementary but 'asymmetrical' view). Each actant affects the other – plant/animal availability, edibility; raw material affordances, properties, availability; human management through gathering, deposition, and even fire (H.J. Deacon & Wurz 2005; Skead 2009). That it is the way in which the lifeway is practised, rather than the necessary elements it includes (e.g. domesticates), which differentiates this from a farmer lifeway is evidenced by the way at Ha Makotoko in which wheat was, in one of the most recent contexts, processed on grindstone L189 in exactly the same way as wild grasses were 40,000 years previously on grindstone L101³⁵. I suggest that the lifeway formed through the kind of interaction between actants I discuss above is negotiated and made possible through manufacture and use of technology such as grindstones which end up encapsulating and memorialising the nature of this lifeway and the relationships it implied, both literally through the presence of residues but metaphorically as the meeting place between the actants.

8.8.2 The Gatherer

I would like to end by thinking about what grindstones tell us about the people who made and used them, in other words, the ‘gatherer’, followed by one last consideration

³⁵ By which time wheat would almost certainly have been available in Lesotho and even grown in the vicinity of the site (see Chapter 2)

of the grindstone itself. Adopting what might be termed loosely practice theory or performativity via the archaeology of gender and identity, but which really harks back to Mauss' (1973) idea that technology encapsulates the people who use and make it, we know that: a person using a grindstone is not, at that moment, hunting – can we thus term them a gatherer? If they are not hunting, that may eliminate those who hunt. This may suggest possibly women, maybe children and perhaps also less physically agile members of society, such as the elderly. At Ha Makotoko we know that these users maintained a separation between medicinal and dietary plants, and that pigment might be ground with medicinal plants. They knew how to turn a low-energy but widely available resource (wild grasses) into a high-energy, portable, storable foodstuff. If they were doing so, they must have applied skilled and possibly learned bodily actions and gestures to the process of achieving this. Skill and knowledge applied also to the acts of gathering both resources-to-be-processed, such as minerals for pigment and edible and medicinal plants and the resources for grindstone manufacture. The raw materials so used were differentiated with some preference for pigment processing on sandstone, maybe for symbolic or ritual reasons. Finally, the people who used this technology placed importance on it, possibly due to its transformative ability (which in reality was the result of their own relationship with it) and because of this, saw it as worthy of ritual or symbolic deposition in one case. Elsewhere in southern Africa, it would be incorporated into burials of men, women and children which would someday hint to remote descendants the importance of this technology.

8.8.3 The Grindstone

“Technology is society made durable”, writes Bruno Latour (1991:103): material culture stabilises and reinforces relations between people. A seemingly mundane object such as a grindstone could make the difference between hunger and a full belly, and its presence in daily life memorialise occasions when it did just that, a promise of things to come – either metaphorically or literally, what could be more stabilising than that? It might also

transform plants to medicine, or pigment to magic. As Latour (1991; 2007) reminds us, it is not the grindstone itself that has the transformative effect (although to an observer it may seem this way), but rather the network between the human makers and users of the grindstone, the gesture/action in play, the stone itself and its properties (vesicles within the basalt, detaching quartzite crystals from the sandstone). Perhaps also some overseeing spirits or ancestors, along with the wild plants or minerals help enact the transformation, but the grindstone itself is the nexus where these other actants come together, and functions as the mnemonic for the transformation once they have departed: for this reason it was memorialised. I cannot in good conscience advocate an interpretation of the past that focuses on things as equal in importance to people, but I do advocate an approach which reminds us how humans might have negotiated their relationships with other humans (feeding them, for instance) by using and making things without which those relationships would be impossible. In applying elements of a symmetrical archaeology, actor-network, object-focussed approach, we can see that things truly make worlds, and that seemingly mundane objects such as grindstones may be vitally and vibrantly important for the people who make and use them, and, as such, live in those worlds.

Appendix A: What hunters gathered (mineral pigments)

A.1 Overview

This appendix deals with another key element of southern African gathered resources: mineral pigments. In the same way that plants exist as standing resource patches, so do mineral outcrops, and as such I class them together as gathered resources. Moreover, pigmented grindstones are frequently encountered within southern African archaeological deposits. While there is some debate as to the nomenclature that archaeologists should use when referring to these residues, I refer here to minerals such as haematite, goethite, jarosite, ilmenite, kaolinite, gypsum, and manganese as ‘pigment’, since no matter the final use of the minerals in question, they are pigments in the strictest sense in that they are materials that change the colour of reflected or transmitted light as the result of wavelength-selective absorption. Thus, although the term ‘pigment’ or ‘mineral pigment’ may be seem connotative of specific use as a colourant, I use it here. Where these pigments are red and yellow in colour, the term ‘ochre’ is used. While the specific nature of ochre is discussed in Appendix 2, which presents results of characterisation studies of pigment on grindstones from Ha Makotoko; it is used *sensu lato* at this point in the thesis.

A.2 Uses of mineral pigment

The use of mineral pigment in prehistory has been the subject of warm debate by Palaeolithic archaeologists, probably because colour staining is seen by many as a proxy for symbolic capacity in hominids: ‘ochre’ figures in McBrearty and Brooks’ (2000) checklist of modern human behavioural signatures. A role for ochre has been claimed in hide-working (Wadley 2005; Webley 2005; Dubreuil & Grosman 2009), body paint (Mellars 2010; Roebroeks *et al.* 2012), and hafting (Pawlick 2004; Hodgskiss 2006; Lombard 2007) as well as rock art. While a role for pigment in hide-working and body

paint can only be hypothesised or its possibility established experimentally, archaeological evidence of pigment use in both rock art and hafting is demonstrated not only throughout southern Africa, but at the case study site for this thesis, Ha Makotoko. As such, I discuss the role of mineral pigments in these activities.

A.3 Rock Art

One of the most tantalising potential roles for ground ochre in prehistory is its use in art. Southern Africa has one of the most celebrated traditions of parietal art in the world, dating at least as far back as Marine Isotope Stage 3, as evidenced by Apollo 11 rockshelter in Namibia, which has secure radiocarbon dates of 27,500-25,500 BP³⁶ (Wendt 1976). Unfortunately, dating rock art proper is notoriously difficult (Pettitt & Pike 2007; Bonneau *et al.* 2011) due to the problems inherent in dating inorganic substances (such as ochre) and the caveats relating to dating of even organic substances (such as charcoal). However, advances in dating stratigraphically positioned weathering products and improved understanding of site formation processes show promising results for the future of rock art chronologies (Goodall *et al.* 2009). Evidence of ground ochre on grindstones from securely dated archaeological contexts cannot be regarded as direct evidence for its use in rock art, but through compositional analysis and comparison with rock art pigment from the same geographic regions, we may be able to better consider it as a possibility (Nic Eoin & Bonneau 2014).

The importance of mineral compounds in southern African rock art cannot be overemphasized: indeed, some ethnographic reports suggest that a particular pigment may have dictated image content/composition rather than *vice versa*. The Bleek and Lloyd archive includes a story ("The girl of the early race of people, who married a Baboon") told by |Han#kass'o, a /Xam Bushman, in 1878, in which a girl said

³⁶ Strictly speaking this is not evidence of parietal, but rather mobiliary, art, as the paintings are on seven rock spalls in a sedimentary context. However, the discovery does prove that figurative art, making use of similar imagery and of similar chemical composition to modern rock art, dates at least as far back as the early LSA.

"It is //hara [black specularite] therefore I think I shall draw a gemsbok with it.' Her companion replies "It is tó [red haematite] therefore I shall draw a springbok with it (BC 151 A2 1 093).

If this importance of colour is consistent throughout southern African (pre)history, it is high time pigment encrusted grindstones were subject to comprehensive compositional analysis – as yet, such studies are rare (Henshilwood *et al.* 2011; Nic Eoin & Bonneau 2014; Scadding *et al.* 2015).

Perhaps more than any other proposed role for prehistoric mineral pigments, their use in rock art highlights the interplay between symbolism and function. In southern Africa, European settlers and travellers were struck by the extent of Bushman rock paintings, and much of the ethnographic record as documented by the colonial establishment (as late as the middle of the twentieth century) focuses on the composition, meanings, and execution of rock art. Rare interviews with those involved in the production of the art serve as an invaluable resource for those interested in its composition. These ethnographic anecdotes provide information as to the context of painting, how the composition of a painting was decided, the specific pigments to be used, where these might be obtained, and how pigments were prepared.

As Christol (1911: 6) notes, southern African rock art is primarily composed of a circumscribed colour palette of red-brown, yellow, black and white tones, and this is supported by the more rigorous survey of Lewis-Williams and Dowson (1989) who also note that there seems to be some correlation between geographical region and colour palette (while admitting that this may be a preservational bias, as red is a more persistent shade than white or black). Marion How, whose grandfather was a missionary to the BaPhuthi chief Moorosi, interviewed a younger son of Moorosi, named Mapote. Mapote claimed to have painted with Bushmen, and gave How an account of the pigments used in rock art and their significance. He showed her a pigment known as *Qhang Qhang* (which may be related to the supernatural being known as *Qhang*, occasional user of a Mantis avatar (Lloyd 1889)) which "glistened and sparkled, whereas

the ochre was just a dull earthy substance [in comparison]" (How 1962: 34). This reddish, sparkling pigment may have been a form of specular haematite, and, according to Mapote, was dug out of basalt mountains, and could be obtained some distance away. *Qhang Qhang* was regarded as a powerful medicine by Bushmen and apart from being used in painting, was also said to ward off hail and lightning, and could be used to join the frontal bones of babies. Mapote recounted that it had to be

"specially prepared at full moon out of doors by a woman who heated it until red hot in a dung or other fire. The rich red pigment was then ground between two stones" (1962: 35).

How sent a sample of *Qhang Qhang* for analysis by the South African Council for Scientific and Industrial Research (although she does not note who performed the research, nor what method was used to characterise it), who informed her that it consisted of "haematite, Fe_2O_3 (red), mixed with hydrated iron oxides, e.g. limonite and goethite (yellow)" (How 1962: 35).

Mapote executed some paintings for How at her home (see Figure A.1.1), and made use of white, brown and yellow pigments as well as *Qhang Qhang*. Mapote referred to the white pigment as *phepha* and thought it was the same as that used by girls to smear their bodies at initiation rites. Analysis of *phepha* by the same methods as that used for *Qhang Qhang* suggested that it was composed of a powdered white clay containing SiO_2 , Fe_2O_3 (possibly Al_2O_3), CaO , MgO , and sulphate. Mapote told How that a number of binders could be used with the white clay, all whitish, milky plant fluids. Those he listed included *Asclepia gibba* (known as Motsoko oa Baroa), *Eulophia hians* (Rete la ntja³⁷),

³⁷ Rete la ntja is also used to refer to species of *Asparagus* within the Metolong catchment, and the species of plant with this common name within the starch reference collection is certainly not of the Orchidaceae family and was verified using photographs as being *Asparagus* sp.. Given the fact that the common name is descriptive – as discussed in Chapter 6, it refers to the shape of the bulb being akin to the testicles of a dog – it seems plausible that a range of other plants might be so-named: indeed, Moffett (2010:93) lists *Asclepias* sp. and *Euphorbia* sp. as well as *Eulophia hians* and *Asparagus* sp. as corresponding to this name

Parapodium sp. (Sehloko³⁸) and *Costatum* sp. (Sehlama poli). For the brown tones, Mapote listed a number of different substances, known as *Moking/mokiling/shalaone*, *Motlako*, and *Pharohloana* respectively, all of which, according to How, were kinds of black earth used in pot decoration. Mapote also made use of a yellow pigment, called *Keketse*. Though he did not make use of them in the paintings he made for How, he suggested that another white pigment (*Mokoetla*) could be used, as well as bluish-white (*ekama*) and black (*ebilo*). He himself used a mixture of charcoal and water for black tones, and made use of fresh blood to bind *Qhang Qhang* (eland blood was preferred, but How, unable to obtain fresh eland blood, offered him ox blood), as only fresh, uncoagulated blood, would serve as a binding agent. Interestingly, *Qhang Qhang* was the only pigment to be mixed with blood.

Figure A.1.1 The panel that Mapote executed for Marion How, now held in the Origins Centre of the University of the Witwatersrand (photo courtesy David Pearce)

On the subject of binders in rock art pigment, (Rudner 1983: 14) comments that most ethnographic accounts are based on “doubtful primary information”, second – or even third-hand information. She casts doubt on the veracity of Mapote’s information

³⁸ This plant is not known to Moffett (2010) by this name, but rather as Sehamelapoli, while Jacot Guillarmod (1971) and Moffett both have Sehloko as referring to multiple plants from the Andropogoneae and Euphorbiaceae.

(particularly as regards use of fresh blood as a binding agent), given that he is merely a “Sotho³⁹ informant who saw Bushmen painting” (Rudner 1983: 15). Her own experimental work suggests that the time it takes for blood to coagulate can be extended through a number of practices, thus blood as a binding agent may not necessarily have come from a fresh kill. She discusses the likelihood of use of various other potential binding agents, and the authenticity of reports which claim their use, including urine, animal fat, stomach liquid, water, and plant sap. Rudner (1983:17) states that from her experimental experience, plant sap is difficult to extract from those flora listed in the ethnographic literature, and that despite its prevalence as a reported binder in said literature, most of these accounts are based on hearsay. However, one wonders whether it may not be necessary to give some credence to an idea expressed so frequently. The plant sap as binder hypothesis also receives support from more recent compositional studies of compounds: using Raman spectroscopy, both Prinsloo *et al.* (2008) and Arocena *et al.* (2008) found oxalic acid in pigment compounds from KwaZulu-Natal, which they suggest may have originated in plant sap. In light of Rudner’s doubts over the veracity of ethnographic reports, it may be worth noting that other binding agents she rules out as having a very limited basis in truth, such as egg and (to a limited extent, given that she acknowledges that it has been known to be mixed with ochres for other purposes by recent hunter-gatherer groups) fat, have also been tentatively identified in compositional studies (Prinsloo *et al.* 2008).

Compositional studies of rock art (van Rijssen 1990; Arocena *et al.* 2008; Prinsloo *et al.* 2008; Tournié *et al.* 2011; Bonneau *et al.* 2012) have led to increased understanding of the pigments used in southern African parietal art. They confirm forms of haematite as the most common pigment, as well as use of goethite (yellow, or after heating, red), calcite, gypsum, kaolinite (all white pigments), and amorphous carbon and manganese

³⁹ In fact, as a son of Moorosi, Mapote was a MoPhuthi rather than a MoSotho (Rachel King, pers. comm.).

(black). In Chapter 8, composition of mineral compounds adhering to grindstone surfaces is analysed and the hypothesis that grindstones were used to process rock art pigment further evaluated.

A.4 Mineral pigments in hafting

Mineral pigments, specifically limonite in the form of iron oxides and iron hydroxides were used in hafting stone tools as least as far back as the Middle Stone Age, if not before (Lombard 2006; Wadley 2010a). Although the incorporation of ochre into hafting compounds is acknowledged as possibly aesthetic (and by no means at odds with any more utilitarian characteristics) (Lombard 2006; Wadley 2006), its role in facilitating efficacy of adhesives is now well established (Hodgskiss 2006; Lombard 2006; Lombard 2007). Incorporation of ochre into an adhesive mix aids in combining other materials, and promotes hardening: experimental studies using *Acacia karroo* gum as an adhesive found that it adhered well, but remained brittle and occasionally crumbled. Addition of ochre and beeswax made the adhesive more pliable and easier to use (Lombard 2007).

At Ha Makotoko, ochre particles have been observed in presumed hafting residues on a 40,000 BP stone point. However these particles were so small that it was impossible to determine whether or not the ochre actually formed part of the adhesive, or was the result of accidental contact (Lombard 2012: 20): as Lombard observes elsewhere, the latter could easily transfer ochre particles to another object (Lombard 2006). In view of the fact that the practice of adding ochre to adhesive mixtures used in hafting is both pervasive and widespread throughout the MSA in southern Africa (Lombard 2007) it seems plausible that it might have occurred at Ha Makotoko as well, and the existence of a number of ochre-stained grindstones at the site suggests that ochre was being ground for a particular purpose.

A.4 Mineral extraction and processing

Experimental studies exploring the purported functions of ochre (hafting, use as pigment, hideworking) suggest that in many cases the mineral had first to be ground to

a form of powder (Wadley 2005; Chambers 2010; Hodgskiss 2010; Rifkin 2012). Use-wear analysis of ochreous nodules also confirms that many archaeological specimens were subject to the kind of abrasive wear described by the experimental studies (e.g. Henshilwood *et al.* 2009). It is also demonstrated, however, that utilized ochreous nodules, or 'crayons' were not uniformly used thus (see (Rifkin 2012 for a discussion of alternative forms of use). However, unprocessed ochre is of less interest for the present work and I do not discuss it further here. The processing of ochre in order to extract powder may allow us to estimate the value and importance of ochre in antiquity: extraction of even a small amount of ochre powder is extremely labour intensive. Rifkin (2012) states that 79 minutes of grinding haematite produced only 49.1 grams of powder. Rifkin (2012:18) also provides useful experimental data on how much powder might be necessary for use in hide-working (2.1kg for a medium-sized antelope hide) and corresponding equations as to the length of time necessary to produce this much haematite (estimated at 55.3 hours). Unfortunately, functional analyses of archaeological specimens of ochreous grindstones are few, but those that have been performed suggest that ochre was not always processed on its own: Dubreuil and Grosman's (2009) use-wear study, when compared with experimentally and ethnographically derived data, suggested that ochre on Natufian basalt grindstones had been processed in conjunction with a greasy substance, while Henshilwood *et al.*'s 2011 study used mineralogical spectroscopy and chemical analysis to show that mammal bone was crushed and processed in association with ochre at Blombos.

The *chaîne opératoire* of ochre powder production has not been fully considered by any researcher to date, but experimental and archaeological data may be combined to deliver some preliminary insights. Findings of ochre-stained cemented ash at Sibudu suggest that these may have been used as work surfaces for grindstones involved in the production of ochre powder, and that these grindstones took the form of small (40-130

mm) sandstone slabs recovered from the layers in which the ochreous hearth features occur (Wadley 2010b). Wadley's (2005) experimental work suggests that coarse-grained flat stones are more suitable for the processing of ochre than rounded classic 'upper grindstones'⁴⁰, and that the most user-friendly way of producing ochre powder creates artefacts of the much-vaunted 'crayon' shape that are commonly regarded by researchers as evidence for symbolic use of ochre (D'Errico 2008).

⁴⁰ A combination of typological and functional analyses of ochreous grindstones could be used to assess whether this experimental claim stands up archaeologically: at Ha Makotoko only one upper grindstone type is pigmented, with a white pigment which appears to be gypsum (see Appendix B)

Appendix B Characterising mineral pigments at Ha Makotoko

B.1 Introduction

This section deals with the mineral residues macroscopically visible on a number of grindstones at Ha Makotoko discussed in Appendix A. Although ‘ochre’ was used in a looser sense in that appendix to discuss red or yellow coloured pigment, in this chapter it refers to

“a rock or a coloured earth, whose colour comes from an iron oxide compound (either hydrated or not), such as limonite, goethite or haematite. An ochre pigment therefore contains mainly silicon, aluminium or iron...Ochres are formed by weathering and degradation of rocks, and reflect the composition of the rock from which they arise” (Bonneau *et al.* 2012: 291–292).

In southern Africa, deposits of red ochre have been linked to degradation of Clarens Formation sandstone (Watts 2002), the geological material of which Ha Makotoko is composed (Johnson *et al.* 2006; Mitchell & Arthur 2014).

In Appendix A I examined the proposed and established uses for pigment in the southern African archaeological record. Despite this interest, and my observation that one of the few features of grindstones that are generally regarded as worthy of note is whether they are ochre-stained, to date few studies have characterised grindstone pigment (see Henshilwood *et al.* (2011) but see also Nic Eoin & Bonneau (2014) which details some of the work in this appendix, as well as Scadding *et al.* (2015) for an approach from an Australian context). Given that the techniques used in characterisation of rock art pigment are becoming well established in the region (Prinsloo *et al.* 2008; Tournié *et al.* 2011; Bonneau *et al.* 2012) and are, as this chapter discusses, in many cases directly applicable to grindstone analysis, it is to be hoped that

this will change. In that vein, this chapter presents the results of a pilot study in the characterisation of pigment from grindstones excavated at Ha Makotoko.

B.2 Methodological overview

In examining all ‘grindstones, hammerstones and introduced rocks’ from Ha Makotoko, observations included notes on their appearance/presence of visible residues. Initially (following macroscopic observation alone) it was thought that a relatively high number (29) were pigment-stained, but upon binocular microscopic observation and consultation with a geologist (Chris Doherty of the Research Laboratory for Archaeology and the History of Art (RLAHA), University of Oxford) it was found that in several cases the raw material had undergone rubification due to thermal alteration or was naturally reddish, as in the case of sandstone or dolerite, while the cortex of Lesotho basalt may also have a reddish tinge upon occasion. This is partially due to the fact that iron from the “red beds” of the Elliot Formation (named for their iron-imparted reddish colour) occasionally migrates across the border with the overlying Clarens Formation (Johnson *et al.* 2006). It should be noted that given that, these artefacts were to be subject to residue analysis, they were not washed prior to examination, and were thus covered in reddish-brown sediment, which further obscured any pigment adhering to their surfaces.

Following binocular microscopy, which eliminated 23 objects completely, six objects proceeded to subsequent stages of analysis.

Figure B.2.1 L106, 5cm scale. Yellow residue is visible toward lower left corner of artefact

Figure B.2.2 L146 with red pigment visible on surface, 5cm scale

At this point residue samples from each artefact were extracted using forceps and a scalpel, applied to a carbon stud and further coated with carbon for scanning electron microscopy. Samples were then viewed and secondary electron images taken within the Scanning Electron Microscope (SEM) prior to Energy-dispersive X-ray Spectroscopy (EDX) on a Jeol 5910 with an Oxford Instruments INCA 300 energy dispersive analytical system. Both of these tasks were completed at RLAHA. Samples of red pigment were then mounted on glass slides and underwent Raman spectroscopy at Art Access Research Ltd.

Figure B.2.3 L157, 5cm scale. Red pigment visible toward bottom left and top right of object.

Fourier transform infrared (FTIR) spectroscopy would also have been desirable (in keeping with the protocol established by (Bonneau *et al.* 2012) but was not possible due to time/facility constraints. But for some modification due to the logistics of working

with different objects, as well as instrument/laboratory availability, the protocol in general followed that of Bonneau *et al.* (2012) and as detailed in Nic Eoin & Bonneau (2014). The advantage of mirroring this methodology was that it allowed pigment retrieved from grindstones to be directly compared with that from rock art at Ha Makotoko.

B.3 Methodological specifics

While SEM-EDX protocol in residue analysis is very well established (Mansure-Franchomme 1983; Jose-Yacaman & Ascencio 2000; Pawlick 2004), Raman spectroscopy is less well known, although now common in rock art analysis (Edwards *et al.* 1998; van der Weerd *et al.* 2004; Goodall *et al.* 2007; Prinsloo *et al.* 2008; Goodall *et al.* 2009; Tournié *et al.* 2011). For this reason, its underlying principles are briefly detailed here.

Raman spectroscopy is based on how light reacts when it comes into contact with a sample. When a sample is irradiated with a monochromatic beam, most of it is absorbed, reflected or transmitted by the sample. A small fraction interacts with the sample and is mostly scattered elastically (a process known as Rayleigh scattering) and is not informative as to the specific composition of the sample matter, however, an even smaller fraction scatters inelastically at energies below or above those of the Rayleigh photons, and 'Raman' photons of different frequencies to that of the incident radiation are consequently emitted, reflecting the composition of the sample and expressed as peaks in a spectrum of wave number (which is the inverse of the wavelength, plotted on the X-axis) and intensity (plotted on the Y-axis) (Cariati & Bruni 2000; Smith & Clark 2004).

Raman spectroscopy offers molecular specificity, non-destructive sampling, *in situ* analysis (especially with the increasing portability of newer instruments; Tournié *et al.*

2011), and high spatial and spectral resolution, and enjoys growing popularity with researchers analysing pigments. It can be used on both organic and inorganic compounds (and mixtures thereof; Edwards *et al.* 1997) and, unlike FTIR, is unaffected by contact with glass, water or air (Derbyshire & Withnall 1999). However, like some other spectroscopic techniques, it is subject to quantification problems. Moreover it cannot be used on most pure metals, and can be frustrated by natural fluorescence, as well as the absorption of scattered light by the sample, although this can be combated by use of either very high or very low wavelength lasers which provide an exciting line outside the electronic absorption bands of the pigment. Raman also has problems detecting manganese, as the heat generated by the laser may alter the sample, although use of X-ray diffraction (XRD) or a near Infra-red laser can combat this (Cariati & Bruni 2000; Smith & Clark 2004). Nevertheless, it meets all the criteria necessary for analysis of this sample, where the research question focussed on characterisation of the red pigments.

The Raman microscope used here is housed at Art Access Research Ltd, and is a Bruker Raman Senterra system equipped with a microscope and a CCD (charge-coupled device) detector. The pigment samples were excited with a near infrared laser of 785nm length and a power of 10mW. Each spectrum was recorded using resolutions of 9-15cm⁻¹ (low resolution) and 3-5cm⁻¹ (high resolution), and collected in the spectral range between 80 and 3500cm⁻¹. Each spectrum was collected over five minutes.

Figure B.2.4 L173, red pigment visible towards left side, 5cm scale

B.4 Sample presented for further analysis

As mentioned above, six artefacts were selected for further analysis by SEM/EDX. As well as four artefacts (L146 (Figure B.2.2), L157 (Figure B.2.3), L173 (Figure B.2.4) and L194 (Figure B.2.6)) which appeared to be red ochre-stained, one artefact (L106, Figure B.2.1) was stained with a yellow substance, thought possibly goethite (iron hydroxide) and another, L185 (Figure B.2.5), was heavily covered in a white product (thought, following Bonneau *et al.* 2012, possibly to be calcite, gypsum or white clay). As discussed in Chapter 5, three of the red ochre-stained artefacts are made of sandstone (L146, L157, L194) and one (L173) is basalt. L185 is also basalt, while L106 is an unknown, finer-grained raw material.

Figure B.2.5 L185 with white pigment visible, 5cm scale

Figure B.2.6 L194 with pigment visible on upper surface, 5cm scale

A final typological note: L194 does not conform to the typology established in Chapter 5. Its place in the wall of a kraal within the rock shelter may suggest that it is of Basotho, rather than hunter-gatherer origin, although it might represent re-use. However, despite

its lack of conformity to forms of lower grindstone discussed in this thesis, this would not preclude its being used as an *ad hoc* lower grindstone (perhaps not for plant processing) prior to use as building material. Analysis of its adhering residues casts more light on its use, see below.

B.5 Scanning electron microscopy

Scanning electron micrographs and selected EDX spectra are presented here with a discussion of the results obtained for each artefact.

L106

An area of yellowish pigment thought possibly to be goethite was macroscopically visible on L106, and a sample of this was subjected to SEM/EDX analysis (Figures B.7 and B.8).

Figure B.2.7 SEM photo of L106 pigment showing location of spectrum 2

Figure B.2.8 EDX spectrum, L106 spectrum 1

Figure B.2.9 L106 EDX spectrum, spectrum 2

Figures B.8 and B.9 show high levels of silicon in all EDX spectra, with moderate aluminium, small amounts of potassium and calcium and low levels of iron – the iron

might indicate goethite ($\text{FeO}(\text{OH})$). The high concentration of silicon suggests the contribution of soil/sediment to the sample.

L146

Two samples were taken from L146, the first (L146.1, Figures B.10, B.11) of the more intense red pigment, and the second (L146.2, Figures B.12 to B.15) a raw material sample from a less bright area.

Figure B.2.10 L146.1 SEM photo showing location of spectrum 1

Figure B.2.11 L146.1 EDX spectrum

As with L106, high peaks of silicon point to the origin of the sample from an excavated deposit, while potassium and sodium indicate clay (Figure B.11). The iron may be a degradation product as shapes typical of haematite flakes are not indicated by the SEM photo (Figure B.10 and see also Figure B.20).

Figure B.2.12 L146.2 SEM photo showing location of spectrum 2

Figure B.2.13 L146.2 EDX Spectrum 2

Figure B.2.14 L146.2 EDX Spectrum 3

Figure B.2.15 L146.2 EDX spectrum 7

L146.2 EDX spectrum 2 (Figure B.13) shows high concentrations of silicon and calcium, indicating clay, which is also indicated by the mixture of potassium and sodium (with low peaks of iron probably present as a degradation product from the sandstone) in

spectrum 7 (Figure B.15). Spectrum 3 (Figure B.14) indicates the presence of alkali feldspar from concentrations of aluminium, sodium, silica, calcium and potassium confirming the raw material as sandstone. The higher concentrations of iron in L146.1 are absent.

L157

Figure B.2.16 L157.1 SEM photo showing location of spectrum 2

Figure B.2.17 L157.1 EDX spectrum 2

Figure B.17 shows that as with all other samples, levels of silicon are high, while aluminium, magnesium, phosphorus, calcium and iron are all present in decreasing quantities

Figure B.2.18 L157.2 SEM photo showing location of spectrum 1

Figure B.2.19 L157.2 EDX Spectrum 1

L157.2 (Figure B.18) was taken from a black pigment adhering to the surface of the object. Figure B.19 shows that the composition is of calcium, smaller amounts of silicon, phosphorus and potassium as well as carbon, indicative of charcoal.

L173

Two samples were taken from L173, samples L173.1 (Figures B.20 to B.22) and L173.3 (Figures B.23 to B.25), both from patches of pigment.

Figure B.2.20 L173.1 SEM photo showing location of spectrum 1, white boxes indicate bodies characteristic of haematite

Figure B.2.21 L173.1 EDX spectrum 1

Figure B.2.22 L173.1 EDX spectrum 4

L173.1 Spectrum 1 (Figure B.21) shows small amounts of iron present, but also aluminium and silicon, as well as potassium and magnesium. In this case the magnesium is probably linked to the underlying raw material, which is basalt (while the other elements indicate the presence of clays). This is confirmed by spectrum 4 (Figure B.22), which shows high levels of manganese, which may also be linked to the very high concentration of iron, suggesting that this is a haematite (Fe_2O_3) flake (see also areas indicated in Figure B.20).

Figure B.2.23 L173.3 SEM photo showing location of spectrum 1 with location of spectrum 4 indicated by smaller white box

Figure B.2.24 L173.3 EDX spectrum 1

Figure B.2.25 L173.3 EDX spectrum 4

L173.3 (Figures B.23 to B.25) is similar in composition to L173.1 as indicated by the levels of potassium, magnesium and iron (the last two are once again linked here) – that the levels of iron are lower for L173.3 EDX spectrum 1 (Figure B.24) than L173.1 EDX spectrum 4 (Figure B.25) is explained by the fact that the former spectrum does not pinpoint a haematite flake.

L185

One sample of the white pigment from L185 was analysed by SEM-EDX.

Figure B.2.26 L185 SEM photo showing location of spectrum 2

Figure B.2.27 L185 EDX spectrum 2

That the white pigment on L185 is likely composed of gypsum is indicated by Figures B.26 and B.27: in the former, the long sherds characteristic of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) are present, while the EDX spectrum shows high levels of calcium and sulphur.

L194

Three samples from L194, two of red pigment (L194.1 Figures B.28, B.29; L194.2 Figures B.30, to B.32) and one of a white substance/underlying raw material (L194.3 Figures B.33, B.34) were subjected to analysis.

Figure B.2.28 L194.1 SEM photo showing location of spectrum 4

Figure B.2.29 L194.1 EDX spectrum 4

Iron is strongly indicated in L194.1 (Figures B.28, B.29), as are silicon and aluminium (once again reflecting the contribution of the site's sediments to the pigment on the surface of objects)

Figure B.2.30 L194.2 SEM photo showing location of spectrum 4. Haematite flakes are indicated by the white boxes

Figure B.2.31 L194.2 EDX Spectrum 4

Figure B.2.32 L194.2 EDX spectrum 5

L194.2 shows higher concentrations of iron than L194.1 (see Figure B.31), perhaps due to the presence of intact haematite flakes within sample (Figure B.30), while spectrum 5 (Figure B.32) indicates titanium. Calcium, potassium, silicon and chlorine (possibly present as a weathering product) are also present.

Figure B.2.33 L194.3 SEM photo showing location of spectrum 1

Figure B.2.34 L194.3 EDX spectrum 1

L194.3 (Figures B.33, B.34) shows much lower amounts of iron, but higher amounts of potassium and calcium, indicative of feldspar, probably from the sandstone raw material of which the object is composed.

B.5.1 Discussion of results from SEM-EDX analysis

SEM-EDX analysis suggests the presence of iron-related red pigments in four objects:

L146, L157, L173 and L194, with evidence of haematite flakes in the latter two. The yellow pigment on L106 is characterised as most likely goethite, while L185's white pigment is probably gypsum (calcium sulphate). Gypsum is known to have been used as a white pigment within southern African rock art (Bonneau *et al* 2012) and its presence here may suggest a role for L185 in pigment processing. A high occurrence of clay minerals in all samples points to the origin of all pigments as derived from sediments, while in some samples clues are given to the raw material composition of the underlying artefacts: manganese points to basalt in the case of L173; feldspars and quartz (respectively) points to sandstone in the cases of L146 and L194.

B.6 Raman spectroscopy

Following SEM-EDX analysis, four artefacts with red pigment attached were analysed with Raman spectroscopy. Spectra were compared with markers for red ochre/haematite (peaks at 220cm^{-1} , 226cm^{-1} , 286cm^{-1} , 294cm^{-1} , 402cm^{-1} , 406cm^{-1} , 491cm^{-1} , 601cm^{-1} and 612cm^{-1} (Stuart 2007; Bonneau *et al.* 2012)) and Raman spectra obtained from rock art at Ha Makotoko (A. Bonneau unpublished data; Nic Eoin and Bonneau 2014) in order to determine if the pigment in question was a) haematite/ochre related and b) related to neighbouring rock art. Spectra are presented for each artefact with a discussion of the results for each artefact.

L146

Figure B.2.35 Composite Raman spectra for L146.1

Peaks for haematite are absent from these spectra (Figure B.35), indicating that neither haematite nor red ochre were responsible for the 'pigment' adhering to the surface of L146 sample 1. This indicates that the concentrations of iron within the sample as detected by EDX must have been in forms other than haematite or red ochre: further analysis is required to identify in what form the iron occurs here.

L157

Figure B.2.36 Composite Raman spectra for L157

Strong peaks at 205cm^{-1} and 465cm^{-1} in Figure B.36 are indicative of quartz, but no markers for ochre or haematite are present, despite the presence of iron in the EDX spectra derived from this pigment sample.

L173

Figure B.2.37 Composite Raman spectra for L173 sample 1

Strong peaks visible in Figure B.37 at 222cm^{-1} , 286cm^{-1} , 401cm^{-1} and 604cm^{-1} indicate haematite.

L194

Figure B.2.38 Composite Raman spectra for L194.1

The strongest peak in Figure B.38, visible at 147cm^{-1} , is indicative of the presence of anatase, while weaker peaks at 223cm^{-1} , 293cm^{-1} and 410cm^{-1} suggest the presence of iron oxides, possibly a mixture of red ochre and haematite.

B.6.1 Discussion of Raman spectra

In all cases except L157 the indications of the SEM/EDX analysis appear to be confirmed: in the case of L146 markers for ochre do not appear, while L173 and L194 show clear indicators that haematite/ochre is present, with anatase present in L194 as well (which sheds light on the occurrence of titanium visible in the EDX spectra). L157 is more problematic: while quartz is indicated by both the Raman spectra and the EDX spectra, there is no sign of the iron indicated by the EDX in the Raman spectra.

L173 and L194 appear to indicate two different types of haematite, as evidenced by the different peaks appearing in each, as well as the presence of anatase in L194 but not L173. This is unsurprising given their different contexts, with L194 deriving from Phase 2, and L173 likely to be of a much earlier date.

B.7 General discussion

B.7.1 Comparison with rock art

A panel featuring three polychrome eland from Ha Makotoko was analysed using the methods outlined above by Adelphine Bonneau (Nic Eoin and Bonneau 2014), with the red pigment producing the following SEM/EDX and Raman spectra (Figures B.39, B.40):

Figure B.2.39 SEM photo of rock art red pigment from Nic Eoin and Bonneau 2014

Figure B.2.40 EDX spectra of rock art red pigment from Nic Eoin and Bonneau 2014.

Figure B.2.41 Raman spectrum from red pigment sample at ARAL 175 from Nic Eoin and Bonneau 2014

Strong markers appear at 293cm^{-1} and 410cm^{-1} in Figure B.41, suggesting a similarity with the red pigment on L194. However anatase is absent (indicating perhaps that the anatase derives from sediment. Other differences emerge when SEM/EDX and binocular microscopy are factored in: granules in the rock art pigment are much finer-grained than those found on L173 and L174. In the case of L194, this suggests that the artefact was used as a grindstone (despite its shape, which does not concur with the types identified in Chapter 5) rather than as a canvas, so to speak: the coarser grains on L194 suggest that pigment was being processed there. While the gypsum-based pigment on L185 was not compared directly with analogous rock art pigment, given that we know gypsum to be a common component of white pigment in rock art (Arocena *et al.* 2008; Tournié *et al.* 2011) it is at least possible that L185 might have been used to process

pigments for use in parietal art. Finally, although Raman spectroscopy is capable of identifying minerals from organic compounds which might have been used as binding agents in paint, such as whewellite from plant sap (Arocena *et al.* 2008), none of these were identified in the grindstone pigment samples, suggesting that if the grindstones were used to process pigment for use in rock art paint, that either binders must have been introduced at a later stage or have totally degraded.

A hitherto unexplored avenue for detecting whewellite is, in fact, microbotanical analysis: calcium oxalate (i.e. whewellite) crystals known as raphides are commonly encountered in microbotanical samples and are known to indicate aroid plants (Bradbury & Nixon 1998; Crowther 2009a; Crowther 2009b), but although one of the grindstones analysed for pigment was also analysed for microbotanical remains (L173), calcium oxalate crystals were not observed here nor in any of the other grindstones examined for microbotanical residues.

B.8 Conclusion

“Ochre-stained” grindstones are regarded as noteworthy by seemingly all archaeologists within southern Africa. Indeed, we might go so far as to say that they are the only grindstones regarded as interesting. There is similar (arguably greater) interest in characterising the ochres and red pigment used in rock art, hafting, and recovered in sediment. However, there has been hitherto little interest in characterising the red pigment on grindstones (Henshilwood *et al.* 2011) and seemingly none at all in linking any of these areas of use together. Experimental studies exist on the processing of ochre (Wadley 2005; Hodgskiss 2010; Rifkin 2012) but this has yet to follow through into characterisation of archaeological material. Characterisation of pigment on grindstones and comparative studies linking this characterisation to possible uses (hafting, hideworking, rock art) are essential to understanding the *chaînes opératoires* of pigment use in southern African (indeed, global) contexts. Although the material here must be regarded as a pilot study given the small number of objects studied it points the way for

further research: worthy of note is the fact that macroscopically evident “pigment” may turn out not to be pigment at all, as in the case of L146. Thus it emerges that microscopic and spectroscopic characterisation is essential to differentiate between pigment and breakdown products, and it seems possible that in the past, grindstones have been mislabelled as ochre-stained, given the absence of such techniques. The low-intensity signal produced by objects which have been subject to deposition within sediment (compared with more intense signal from ‘pure’ rock art pigments) also warrants attention: could pre-treatment protocols improve this? Also indicated are intriguing hints as to the use of pigment and changes in recipes over time: as indicated by the Raman spectra, L173 and L194 feature quite different pigments, with L194 very similar to that used in the neighbouring rock art. Comparison of these two pigments (from L194 and the rock art) indicates possible differences in the *chaînes opératoires* of processing, or perhaps presence in the same *chaîne opératoire*, but with distances and other steps (e.g. sieving, further crushing) in between. Comparison of provenance might further enlighten this.

Appendix C: Starch extraction protocol

Information on the development of the protocol may be found in Chapter 6. All consumables were first sterilised by boiling them in Milli-Q water for 10 minutes and air-drying under cover.

1. Dry Brushing

i) Prepare a number of weigh trays (note: during routine laboratory tests, these were found not to contain starch and are thus used unsterilised) corresponding to the number of sides of the artefact. Label each of these according to the sides of the artifact (e.g. DBA, DBB, DBC etc)

ii) Using a sterile, dry toothbrush, gently brush any sediment adhering to one side of the artefact into the correspondingly labeled tray

iii) Using a fresh toothbrush and a new tray for each side, repeat this procedure until all sides of the artifact have been brushed.

iv) Pour dried sediment into a correspondingly labeled 50ml centrifuge tube with lid for each side. Add Milli-Q water until tubes are all level (for centrifuging).

v) Centrifuge at 2500 revolutions per minute (rpm) for 5 minutes.

vi) Decant and discard supernatant down to 5ml. Repeat step v)

vii) Pipette and discard supernatant down to cone.

viii) At this point, either proceed with heavy liquid separation, or prepare sterile, labeled slides, then pipette 60µl -100µl residue per slide onto the corresponding slide. Scan as per spot sampling, see below.

2. Spot sampling

i) Label slides 'SSA' (Spot Sample A), 'SSB', 'SSC' etc.

ii) With a pipetter, pipette up to 100µl Milli-Q water on to the first sample spot (SSA) 20µl at a time, agitating with the pipette tip, and drawing off the residue to the

slide. Depending on how porous the raw material of the artefact is, the amount of water may need to be increased.

iii) Repeat for the number of sample spots.

iv) Apply coverslips with clear nail polish, then scan slides under a transmitted light microscope with cross-polarising capability. Once slides have been scanned, typically at 200x magnification (increasing magnification to 400x if necessary), they can be stained with Iodine-Potassium-Iodide (IKI) to verify the presence of starch, if necessary.

3. Wet Brushing

i) Label weigh trays with the sides to be sampled (WBA, WBB, etc).

ii) Using a fresh sterile toothbrush for each side, gently scrub each side with the toothbrush, rinsing with Milli-Q water from the wash bottle. Position the artefact such that the resultant runs off into the corresponding weigh tray. Try to keep the resultant from running off onto another side of the artifact, but this may be difficult. Continue this until the water runs clear.

iii) Pour the resultant from each weigh tray into labeled centrifuge tubes with lids. Add Milli-Q water to each tube until they are level.

iv) Centrifuge at 2500rpm for five minutes

v) Decant and discard supernatant down to 5ml, then repeat step iv)

vi) Pipette supernatant down to cone of tube

vii) At this point, either proceed with heavy liquid separation (see below), or prepare sterile, labeled slides and scan for starch (see Dry Brushing)

4. Ultrasonication

i) Place artefact in a sterile beaker or finds bag, and immerse in Milli-Q water.

ii) Place beaker/bag into an ultrasonic bath, such that the water in the bath comes half way up the beaker/bag.

iii) Ultrasonicate for five minutes.

- iv) Hold artefact over beaker/bag and allow run off.
- v) Decant liquid in beaker/bag into sterile, labeled (US1, US2, etc) tubes.
- vi) Centrifuge at 2500rpm for five minutes
- vii) Decant and discard supernatant to 15ml and repeat step v) with more of the liquid from the original beaker (this step is inserted in attempt to limit the number of samples and waste of consumables, since much more resultant is produced from the ultrasonication step than any other). Repeat step vi)
- viii) Repeat steps vi) and vii) until all resultant from original beaker has been processed.
- ix) Pipette off and discard liquid to halfway down the cone of the centrifuge tube, and allow to dry in oven overnight.
- x) Either proceed with heavy liquid separation or prepare sterile, labeled slides, add 500µl Milli-Q water to the centrifuge tube, agitate, then pipette 60-100 µl residue to each slide and scan for starch.

Heavy liquid separation

In practice, most samples require heavy liquid separation because of the large amount of other material (phytoliths, plant parenchyma cells etc) that occur alongside starch. Heavy liquid separation with sodium polytungstate (SPT) removes most of these, but conserves starch.

Native starch granules have a sg of around 1.5, thus they should sink when placed in pure water, but will float if placed in a SPT solution with a specific gravity higher than 1.5. Use of heavy liquid separation in two consecutive stages — at specific gravities of 1.3 (lighter than starch) and 1.8 (heavier than starch) — means that starch can be conserved, and most other plant bodies discarded.

- i) Prepare two solutions of SPT solution, one at 1.3 sg and the other at 1.8.
- ii) Prepare centrifuge tubes containing resultant from dry brushing, wet brushing, and ultrasonication. Add SPT to all tubes, raising the liquid level to 10ml.
- iii) Centrifuge at 2500rpm for 10 minutes

- iv) Decant and discard⁴¹ supernatant. This step removes those bodies lighter than starch.
- v) Add 5ml SPT at 1.8 sg to each tube. Centrifuge at 2000rpm for 10 minutes. Decant supernatant (containing starch) into fresh, sterile tubes labeled 'starch'.
- vi) Fill the new 'starch' tube to 50ml with Milli-Q water. Centrifuge at 3000rpm for 10 minutes. Decant and discard two-thirds of the supernatant. This rinses the SPT from the starch.
- vii) Repeat step vi) three times (with the centrifuge at 3000 rpm for 5 minutes for the first repetition; 2500 rpm for 3 minutes for the second; 2000 rpm for 3 minutes for the third), decanting and discarding two-thirds of the supernatant for recycling each time.
- viii) When the last centrifuging step is complete, pipette out the remainder of the supernatant down to half-way down the cone of the centrifuge tube. Dry in an oven (<35°C to avoid gelatinising any starch) overnight.
- ix) When dry, add 500µl Milli-Q water to each tube, and agitate with a sterile pipette tip for each tube. Pipette out 60-100µl residue onto each sterile, labeled (according to the tube it came from) slide. Scan for starch at 200x magnification, increasing to 400x if necessary.

⁴¹ For recycling: SPT is expensive, but can be recycled through filtering and evaporation theoretically an infinite number of times

Appendix D: Phytolith extraction protocol (following starch extraction)

Information on the development of the protocol may be found in Chapter 7.

1. Rinse Sodium Polytungstate (SPT) from samples by adding Milli-Q water to 50ml, centrifuge at 3000 revolutions per minute (rpm) for 3 minutes. Repeat this.
2. Add 10ml calgon (Sodium hexametaphosphate) to each sample tube and leave overnight.
3. Add water to 50ml, shake and centrifuge at 3000 rpm for 3 minutes, decanting supernatant and repeat twice.
4. Add 10ml 33% Hydrogen Peroxide (H_2O_2) to each sample and allow to react for 10 minutes. Add water, cap and shake. Rinse by centrifuging at 2000 rpm for 2 minutes, decanting and discarding supernatant. Repeat this three times.
5. Add 10ml 5% Hydrochloric acid (HCl) and place in hot water bath until no further reaction observed.
6. Rinse by adding water and centrifuging at 2500 rpm for 2 minutes. Decant and discard supernatant. Repeat twice.
7. Add 8ml SPT at a specific gravity of 2.3, centrifuge at 3000 rpm for 5 minutes, decanting supernatant to a new tube labelled 'phytolith'. Repeat this step.
8. Rinse the new phytolith tubes by adding Milli-Q water to 45ml and centrifuging for 5 minutes at 3000 rpm. Decant and discard two thirds of the supernatant. Repeat twice, pipetting out remaining liquid down to cone, and allow to dry in oven overnight.

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Catalogue 1: Grindstone illustrations

T1

A

B

C

L101

A

B

C

L102

L103

L104

L106

L107

L108

A

B

C

L109

L110

A (top), C (sides)

B (top), C (sides)

L112

L113

L115

L116

A (middle), C (sides)

B

L119

L122

A

B (polished)

C

L123

L125

L126

L129

L133

L134

L139

L140

L142

L154

L143

L144

L145

(Clockwise from left perpendicular side): C; A; D; B.

Not visible: E and F

A, with E and F perpendicular to longest sides

L146

B

L146

L147

A

B

L153

L150

L151

L152

A (top)

B

C

L155

L157

L160

L161

L162

L163

L165

L167

L175

L173

L177

L178

L180

L181

L182

L184

L185

L189

A

B

C

L190

L191

L192

L195

L197

L193

L194