



# Preliminary results of the first lithic raw material survey in the piedmont zones of Kazakhstan

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Received: 20 September 2021 / Accepted: 25 April 2022 / Published online: 19 May 2022  
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## Abstract

The study of raw materials was comprehensively studied in European and African Palaeolithic. However, systematic research of raw material sourcing has not been undertaken for the Palaeolithic of Kazakhstan, such surveys being embedded in reconnaissance works aimed at discovering new Palaeolithic sites. Our work presents preliminary results of the first lithic raw material survey in Kazakhstan. This study distinguishes the geographic patterns of land-use and their correlation with the stone tools from stratified sites. We describe primary and secondary sources of raw materials and compare macroscopically with the lithic assemblages. The survey results show a heterogeneous distribution of raw materials throughout the study regions. Macroscopic observations of lithic assemblages, and data extracted from literature suggest that hominins primarily selected local raw materials. Regional differences in the utilisation of a particular type of raw material which can be observed through the macroscopic examination of the lithic collections are confirmed by survey results.

**Keywords** Pleistocene · Palaeolithic archaeology · Geological maps · Stone tools · Central Asia · Raw material survey

## 1 Introduction

As the study of lithic raw materials has grown in importance, this method has begun to reveal new aspects of technological evolution in Prehistoric communities. In the last few decades, the study of lithic raw materials has tended to focus

on hominin mobility strategies, land-use patterns, and raw material transfer. Specifically, scholars have argued that raw material transport over larger distances is a signature of modern behaviour (Bar-Yosef 2002), corresponding to the extent of territories and social networks of human groups. Examples of such transport behaviour are known throughout the Middle and Upper Palaeolithic of Europe, Africa, the Near East, Australia (Binford 1980; Feblot-Augustins 1993, 2009; Bar-Yosef 2002; Sano 2010; Ekshtain et al. 2017; Frahm and Hauck 2017; O’Leary et al. 2017; Caruana et al. 2019; Ditchfield and Ward 2019; Frahm and Tryon 2019) and some evidence is known in Central Asia (Khatsenovich et al. 2020). In addition, the studies of physical and mechanical properties of rocks can reveal the purposeful raw material selection behaviour of hominins (Domanski et al. 1994; Lerner et al. 2007; Schmidt et al. 2017; Schmidt et al. 2019, 2020), which contributes to the debate on what structured raw material sourcing strategies can be considered to constitute modern behaviour.

To date, raw material sourcing has not been attempted for the Palaeolithic of Kazakhstan. Since the 1950s, local and international teams of archaeologists conducted systematic reconnaissance surveys primarily in southern and eastern Kazakhstan, targeting the discovery of new Palaeolithic

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sites (Alpysbaev 1961a, b, 1972a, 1979; Taimagambetov 1997, 2006; Iovita et al. 2020; Anoikin et al. 2019). These surveys revealed a number of surface lithic scatters, reported as open-air sites which are abundant throughout the country, specifically in the foothills of the Qaratau range (Alpysbaev and Kostenko 1974; Derevianko et al. 2002), Mangyshlaq (Derevianko et al. 1999), and Semisbugu (Medoev 1982). Dating such surface sites is currently impossible and, therefore, they remain understudied. Until now, the age of these sites has been estimated on the basis of stone tool typology, tentatively ranging from the Lower to the Upper Palaeolithic periods. In addition, a few stratified sites containing large assemblages of stone tools have been found in different sedimentary contexts (see details in Alpysbaev 1979; Derevianko et al. 1998; Taimagambetov 2009; Shunkov et al. 2017; Dzhasybaev et al. 2018; Anoikin et al. 2019) and the majority of these have been dated to the Late Pleistocene.

In the available literature (Anoikin et al. 2020; Taimagambetov 2012), the raw materials of these lithic collections have only been briefly described, stating the properties and their availability by site. More systematic works are required to further develop raw material sourcing studies in Kazakhstan. In this study, we sketch the raw material distribution in southern, south-eastern, and eastern Kazakhstan, specifically targeting foothill and piedmont zones of mountain ranges. In addition, we distinguish (1) the geographic use patterns of raw materials and (2) their correlation with the lithic assemblages of the stratified sites. The study is based primarily on surveying outcrops, collecting, and sampling of any potential sources of raw materials, and also on a comprehensive review of the literature.

## 2 Study areas

The study areas of the present study have been chosen to complement the goals of the PALAEOSILKROAD (PSR) project, which aims to discover new Palaeolithic sites in different geological and geomorphic contexts in Kazakhstan, and to test the hypothesis that Pleistocene dispersals correlated with climatic pulses during the last Glacial Cycle (ca. 110,000–15,000 years ago). These study areas are located within the Inner Asian Mountain Corridor of Kazakhstan (henceforth, IAMC), the terms introduced by Frachetti (2012) to define a group of mountain ranges that covers most of the Central Asian states. The IAMC stretches from Uzbekistan in the south, through Kazakhstan and Kyrgyzstan to Mongolia to the north-east. The geographical position of the area has played an important role in the hominin occupation and probably further dispersal to Northern and Eastern Asia (Li et al. 2019; Zwyns et al. 2019; Iovita et al. 2020).

Approximately 211,500 km<sup>2</sup> (or 47%) of the IAMC lies in the territory of modern day Kazakhstan (Cuthbertson

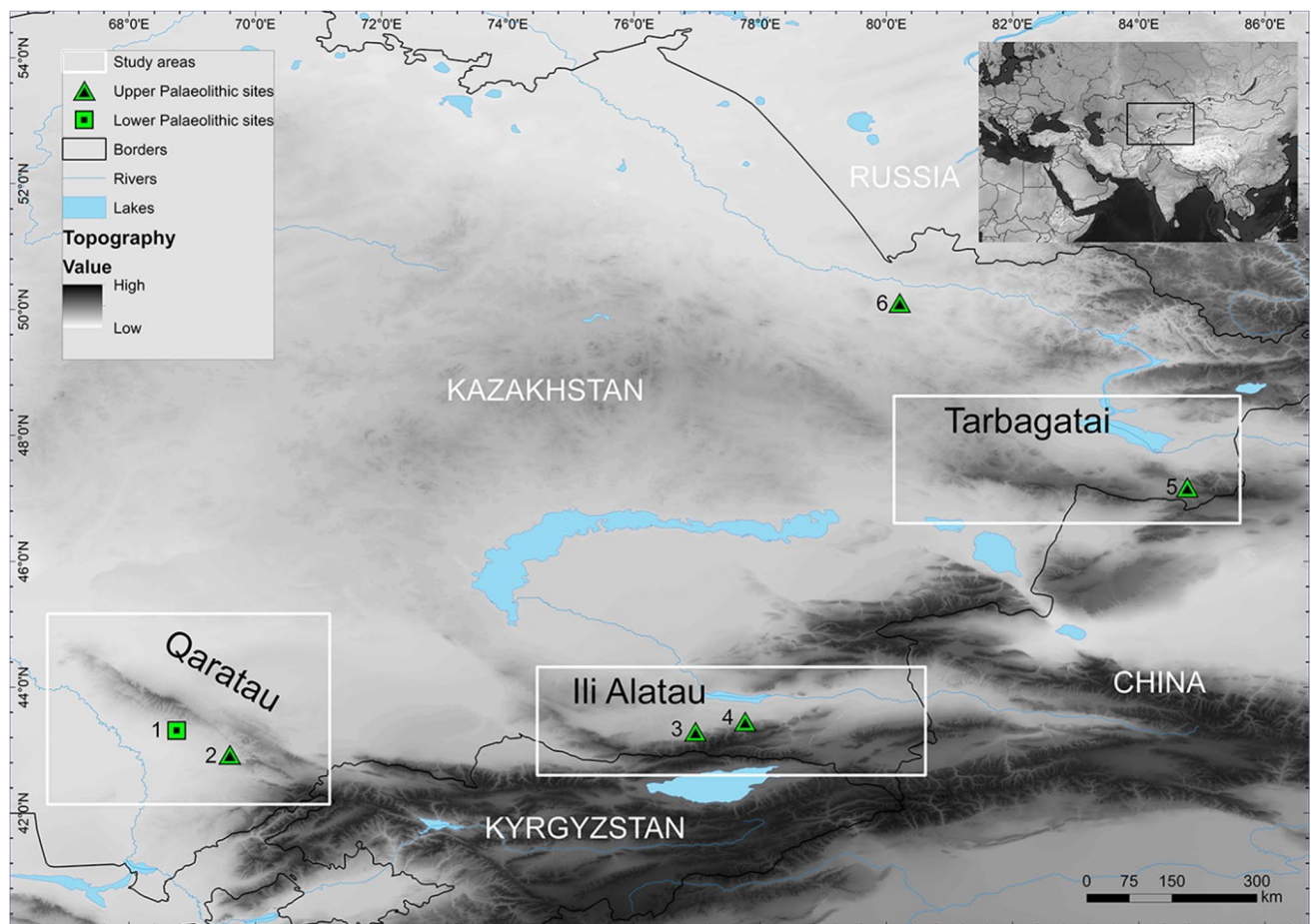
et al. 2021). We primarily focused on the Kazakh portion of the IAMC that is comprised of the Qaratau, Ili Alatau and Tarbagatai mountain ranges (Figs. 1, 2, 3) described below from west to east. These are also the most promising areas to retrieve data concerning raw material distribution, as most of the known stratified Palaeolithic sites are located within them.

*The Qaratau range* is a horn of the Tien Shan mountain system located in the southern part of Kazakhstan and extending about 450 km towards the north-west and south-east. It is sometimes divided into Lesser and Greater Qaratau separated by 25 km of relatively flat lands. In terms of lithology, the Qaratau range consists of carbonate beds and uplifted limestone. There are a number of Palaeolithic finds in the piedmont zones, which have been known since the 1950s (Alpysbaev 1961a, b, 1972a, b, 1979). The most significant ones are Valikhanova (Alpysbaev 1979; Taimagambetov 1990), the chronology of which spans 43.5 – 9 ka (Fitzsimmons et al. 2017), and the Qoshqorgan-Shoqtas complex dated to 500 – 90 ka by ESR method (Derevianko et al. 2000; Derevianko 2006). The abundant evidence for occupation in and around the Qaratau range makes this area especially interesting as a focus of raw material study, which has the potential to shed light on the wider land-use patterns and tool-use decisions of hominins.

*The Ili Alatau* is a portion of the Tien Shan mountains located in the south-eastern part of Kazakhstan. The main bedrock consists of the volcanic granitoid lithology from the Devonian period, and the areas comprised of carbonate beds are located in the south-eastern portion of the range. The foothills contain thick deposits of loess, the thickness of some areas reach up to 700 m (Dodonov 2007). Surveying exposed loess sections is the most promising technique in terms of locating new Palaeolithic sites in this region. Previously, two Upper Palaeolithic stratified loess sites (Maibulaq and Rahat) have been located and studied by local and international teams of archaeologists (Taimagambetov 2009; Fitzsimmons et al. 2017; Ozherelyev et al. 2019).

*The Tarbagatai range* is located on the border of the East Kazakhstan with north-western China and stretches 300 km from west to east. The lithology of the beds is comprised of volcanic rocks, primarily granites and diorites, and fine-grained shale outcrops are distributed in some areas. The stratified Upper Palaeolithic site of Ushbulaq is located in the eastern portion of our study area making it particularly interesting for further systematic survey.

Because these areas cover a large territory (more than 2000 km from west to east), which includes much of the area of the IAMC in Kazakhstan, they provide an opportunity to address several research questions relating to hominin occupation and dispersal through the region.



**Fig. 1** Known stratified Lower and Upper Palaeolithic sites in Kazakhstan, illustrated in relation to the major topography of the study areas. 1) Qoshqorgan-Shoqtas complex. 2) Valikhanova, 3) Maibul'aq, 4) Rahat, 5) Ushbulaq, 6) Shul'binka. Data sources:

Global Administrative areas (GADM) (Hijmans 2012), vector and raster map data from Natural Earth ([www.naturalearthdata.com](http://www.naturalearthdata.com)) and Shuttle Radar Topography Mission (SRTM) Version 4 (Jarvis et al. 2008)

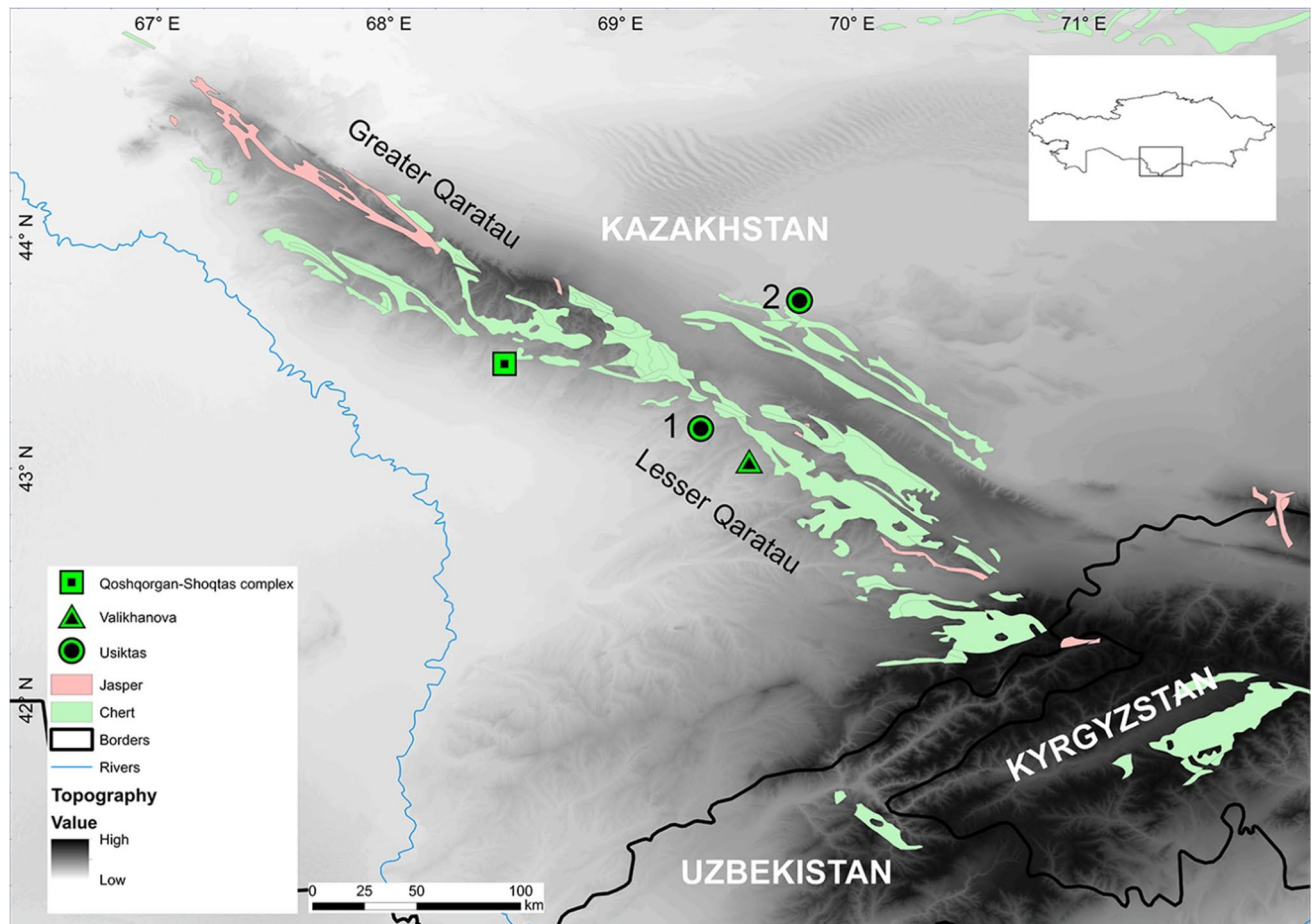
### 3 Survey

A major task for creating any raw material database is having a wide range of samples from potential sources that can be compared with archaeological lithic assemblages. In order to acquire these samples, we undertook a series of field surveys with the aim of locating and characterising raw material sources, and distinguishing regional variations. The exploratory raw material survey, and collection of geological samples were both conducted as a part of the PSR project's fieldwork during the 2018 and 2019 seasons (Iovita et al. 2020; Namen et al. 2020). For the recognition, and locating of potential raw material sources, georeferenced and digitized Soviet geological maps (1:200 k and 1:500 k), as well as lithological data from the ArcGIS platform developed by the Centre for Russian and Central EurAsian Mineral studies (henceforth CERCAMS) 'Mineral Deposits Database and Thematic Maps of Central Asia' (Seltmann et al. 2014) were employed. The latter aided in the retrieval of data on

the occurrences and distribution of individual types of raw materials in our study regions.

During the survey, both primary outcrops and secondary sources from waterways such as river cobbles and pebbles were considered. All the areas of interest such as river banks, outcrops, and valleys were surveyed on foot to locate possible sources of raw materials. The sample collection was based on the quality of the rocks (including cobbles and pebbles), i.e., fracturing properties and macroscopic similarities to the lithologies of the archaeological assemblages (some of the collected samples are illustrated on Fig. 4). We specifically targeted to locate sources of sedimentary rocks such as those of chert, jasper, chalcedony, silica rich shale and mudstone, as well as volcanic rocks such as porphyry. They are the main types of raw materials that were frequently utilised at various Upper Palaeolithic sites in the IAMC of Kazakhstan.

Data on the occurrences of individual types of raw materials were retrieved as KML files from the CERCAMS



**Fig. 2** Distribution of chert and jasper in the Qaratau range shown in relation with stratified Palaeolithic sites and raw material outcrops discovered during the survey. 1) Usiktas and 2) Yntaly raw material outcrops. Data sources: Global Administrative areas (GADM) (Hij-

mans 2012), vector and raster map data from Natural Earth ([www.naturalearthdata.com](http://www.naturalearthdata.com)) and Shuttle Radar Topography Mission (SRTM) Version 4 (Jarvis et al. 2008). Including Mineral deposits database (Seltmann et al. 2014)

database and loaded onto iPads to structure the survey. The data from each survey area were classed and described. The raw material occurrence points were recorded with high accuracy using a GNSS surveyor (Bad Elf GNSS surveyor BE-GPS-3300). Major raw material sources were photographed, and samples were taken for the further lab analyses.

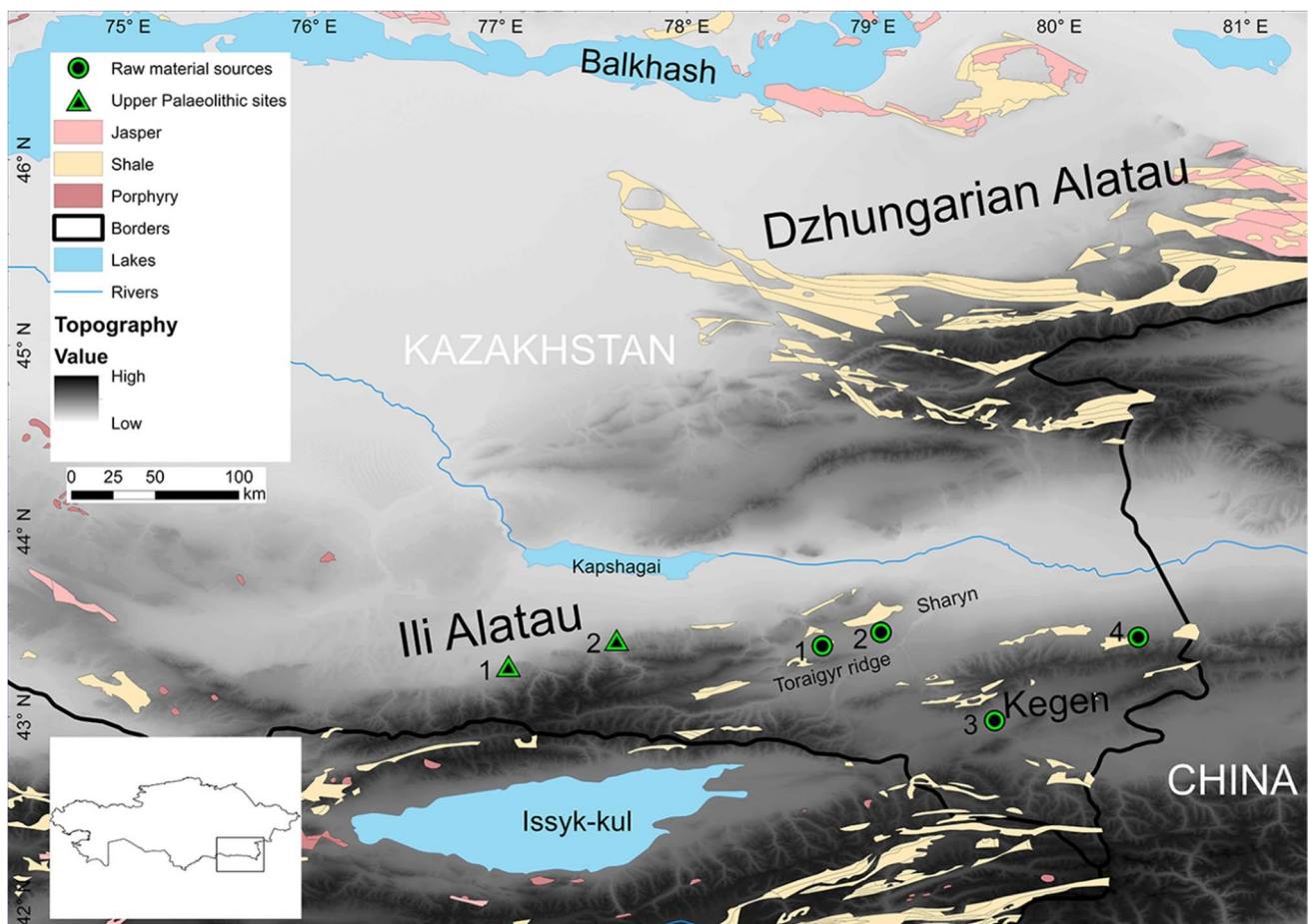
Our survey began in the foothills of the Qaratau range, then continued eastwards into the Ili Alatau and Tarbagatai ranges. The Qaratau range was surveyed as part of a cave prospection goal of the PSR project (Cuthbertson et al. 2021). In this region, we tried to locate sources of chert and jasper in primary and secondary geological contexts as it was suggested in the geological maps (Seltmann et al. 2014). The valleys of the northern and southern slopes of the range, and the adjacent territories, were extensively surveyed on foot.

In the Ili Alatau range, we mostly focused our survey on the piedmont and foothill zones. The survey began in the Kegen district which is located at approx. 2200

masl, followed by the foothills of the Toraigyr ridge, and around the Sharyn national reserve. As the foothills of the range are covered with thick deposits of loess, the primary goal here was to survey loess profiles and spring heads to find new Palaeolithic sites as well as to locate potential sources of raw materials, because these are the areas where erosion of the loess deposits would allow access to outcrops.

The survey in Tarbagatai began from the south-eastern valleys of the Saur range targeting outcrops of silica rich shales and mudstones, as well as jasper as the CERCAMS lithologies suggested the occurrence of these materials in the range. We then moved our survey westward along the northern foothills of the Tarbagatai range.

In addition, areas adjacent to stratified sites were surveyed to determine if the raw materials previously ascribed as ‘local’ were indeed locally sourced and helped decide which raw materials are more likely to have been transported from elsewhere.



**Fig. 3** Distribution of raw materials in the Ili Alatau study area shown in relation with the stratified Palaeolithic sites of 1) Maibulq, and 2) Rahat indicated as triangles, and raw material sources discovered during the survey 1) Tikenekti, 2) Sharyn, 3) Aqtasty and 4) Nazugum indicated as circles. Data sources: Global Administra-

tive areas (GADM) (Hijmans 2012), vector and raster map data from Natural Earth ([www.naturalearthdata.com](http://www.naturalearthdata.com)) and Shuttle Radar Topography Mission (SRTM) Version 4 (Jarvis et al. 2008). Including Mineral deposits database (Seltmann et al. 2014)

Where possible, all of the collected samples were then macroscopically compared with the archaeological materials from surface as well as known stratified sites. In cases where no access to the assemblages was possible the comparative data were extracted from the literature.

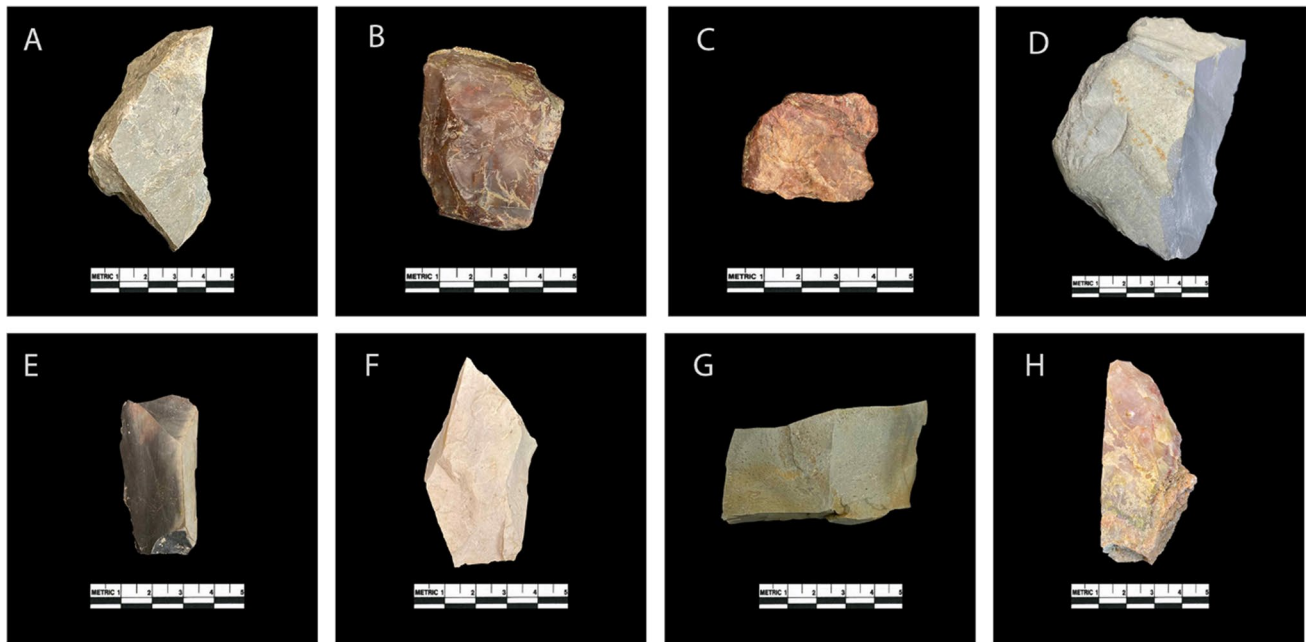
## 4 Results

Each study region presents a unique geological evolution providing a variety of types of good quality potential raw materials for use by prehistoric human groups. Below we discuss the preliminary results of raw material occurrences and describe their geographic distribution patterns in each region separately. The size of the landmass and general geological features of study areas presents a series of unusual challenges. As one of such challenges can be considered large distances between study areas as well as thick sediment

deposits, specifically in the southern and south-eastern Kazakhstan, creating difficulties to access outcrops Table 1.

### 4.1 The Qaratau range

In this study area outcrops of chert were discovered approximately 15 km south-east of Saudakent near the village of Yntaly in the north-eastern part of the Lesser Qaratau. The landscape of the valley is characterized by cuesta topography, i.e., a sequence of beds with different degrees of erodibility that dip uniformly in the same direction. The lithology of the beds consists of fossiliferous limestone, marble limestone and conglomerates at the base of the exposed sequence. Between the limestone layers interbedded quartz and chert nodules are common. The Yntaly chert outcrop is found on a small, elongated hill which is oriented north-south. The outcropping chert materials can be described as variously white, grey, pink, and dark colours (for example



**Fig. 4** Illustration of selected raw material samples. **A)** Shale, Tikenekti **B)** Chert, Tikenekti **C)** Chert, Sharyn **D)** Shale, Ushbulaq **E)** Shale, Nazugum **F)** Shale, Aqtasty **G)** Shale, Aqtasty **H)** Chert, Yntaly

**Table 1** Description of major raw material sources discovered during the survey

Study areas	Sites	Context	Rock type
Qaratau	Yntaly	Primary	Chert
	Usiktas	Primary	Vein quartz
Ile Alatau	Aqtasty	Primary	Shale
	Tikenekti	Secondary	Shale
	Sharyn	Secondary	Chert
	Nazugum	Secondary	Shale
Tarbagatai	Ushbulaq	Secondary	Shale
	Chilibastau	Secondary	Shale
	Kokbastau	Secondary	Shale

see Fig. 4H). In a few of the collected samples, intrusive veins of quartz can be observed. Moreover, a number of lithics made of the same material were scattered on the south-western slope of the hill, whereas no lithics were found on the north-eastern slope. The abundance of archaeological lithic materials on the south-western slope of the Yntaly chert outcrop typologically reminiscent to Upper Palaeolithic indicates that the outcrop was likely used by prehistoric human groups for raw material procurement. The presence of Yntaly cave with Neolithic material culture located about 2–3 km to the north-west provides further evidence of prehistoric human occupation in this area.

We also surveyed the area around the locality of Usiktas, located in the southern foothills of the Lesser Qaratau,

10 km north-east of Algabas village. Previously, at this locality Alpysbaev (1979) discovered a cluster of lithics scattered on the surface and exhibiting various techno-typological features. The bedrock geology of the area consists of vein stockwork and limestone. During this survey, we checked the outcrops of carbonates for the presence of replacement chert. However, this survey did not yield any such outcrops. It is important to note that loess accumulation and erosion at different periods may have facilitated or hampered access to raw materials throughout the Pleistocene. It is also possible that the potential raw material outcrops are covered with the thick layers of loess that we observed during our survey.

The majority of the lithic finds in the Qaratau range and adjacent territories, as reported by earlier archaeological surveys (Alpysbaev 1972b, 1979; Taimagambetov 1990), are predominantly made on silica rocks such as chert and jasper. The prevalence of these rock types can be explained by the geological formations of the range being mainly composed of limestone. It creates a precondition for the formation of replacement chert in the carbonate host rocks that may be present as nodules or layers. According to Bushinsky (1966), certain layers of the mountain range are comprised of beds of silica rocks such as quartzite, replacement chert and even silicified shales, which may explain the large number of silica rocks in the lithic collections (see Alpysbaev 1961a; Taimagambetov 1990; Derevianko 2006). This data can also be attested by the data retrieved from the CERCAMS database which illustrates the distribution of individual types of minerals and rocks. In the CERCAMS data, we can observe

an abundant distribution of chert and jasper in the Qaratau range and the adjoining areas (see Fig. 2). Our survey results also corroborate this observation.

## 4.2 Ili Alatau

A vast area stretching approx. 500 km from east to west has been surveyed in this study area. Several localities with surface lithic scatters have been discovered. Such sites were found beside a spring in the locality of Aqtasty in the Kegen district of Kazakhstan. A concentration of lithics, mainly represented by microblades, were identified in the back dirt of a pit dug to accommodate a waterpipe. According to macroscopic analysis of the lithics, various types of raw materials were used, including a few bladelets knapped on chert, but shale being the predominant raw material type. The valley was then extensively surveyed on foot and an outcrop of fine-grained shale was found approx. 1 km north of the surface scatters. The sources of chert were not found during this survey, and so the provenance of these raw materials in the area remains unknown. The distribution of raw materials is illustrated in relation to the known stratified Palaeolithic sites and localities discovered during our survey on Fig. 3.

Additional scatter of lithics was discovered at the locality of Tikenekti located in the north-eastern foothills of the Toraygir ridge previously described in Iovita et al. (2020). Here, we found a cluster of lithics in the slopes of the foothills, which were scattered in a radius of more than 1 km. The raw materials are represented by various types of sedimentary rocks, primarily fine-grained mudstones, and shales. The samples of locally occurring shale and a single find of chert were collected (Fig. 4A and B) and sent for further lab analyses to the University of Tübingen. Other types of potential raw material sources were found around the area of Sharyn. A number of dark-red coloured fine-grained silica rocks that were macroscopically reminiscent of microcrystalline sedimentary rocks were discovered (see Fig. 4C) in a secondary context at the Sharyn district. We were not able to locate the source of this material in the wider landscape. Similar types of rocks were found at the locality of Tikenekti, 20 km south-east of Sharyn. However, we have not found lithics made of the aforementioned material. Considering the vicinity of the petrified wood located in the national park of Sharyn, it could be suggested that these could represent fragments of this material, scattered around the area, which were not suitable for knapping purposes due to its proneness to fragmentation. However, petrographic analysis is necessary to confirm this.

Raw materials of lithic collections from this region differ from those at the Qaratau sites. The Palaeolithic of the south-eastern region is represented by two stratified open-air loess sites at Maibulaq and Rahat (Taimagambetov 2009; Fitzsimmons et al. 2017; Dzhasybaev et al. 2018;

Ozherelyev et al. 2019), both located in the foothills of the Ili Alatau range. The raw materials of the lithic assemblages are mainly composed of volcanic rocks, such as porphyry, rhyolites, diorites etc., however, tools made of chert and shales are present in limited quantities. The surrounding area of these sites are characterized by uplifted volcanic beds of middle Devonian and late Ordovician granodiorites, granites, granosyenites and their porphyritic varieties. Respectively, a high number of volcanic rocks can be found locally in the form of pebbles in the river and stream beds. Their well-rounded shapes correspond to the medium to long distance transport by water action. However, primary, or secondary sources of chert or other microcrystalline silica rocks were not located in this study region. The absence of chert in the local and sub-local environments around these stratified sites raise questions about the origin of these materials found in archaeological contexts. According to the CERCAMS database and the Soviet geological maps (1:500 k), the nearest outcrops of these rocks are located in the Dzhungarian Alatau and the Qaratau range. If this is true, then we can assume that the chert lithics recovered from the stratified and surface sites, the single find of chert (Fig. 4B) discovered in the Tikenekti locality and, few bladelets from Aqtasty, were possibly transported over a long distance suggesting that hominin groups were highly mobile during the Pleistocene. However, it should also be considered that some smaller outcrops, although not located either in the CERCAMS datasets or during foot survey, might only be visible at a local level and periodically covered or uncovered by loess and colluvium at different periods.

## 4.3 Tarbagatai and adjacent territories

Our survey began in the south-eastern valleys of the Saur range to locate primary and secondary sources of raw materials. Previous discoveries of Palaeolithic sites in the area include Ushublaq (Anoikin et al. 2017; Derevianko et al. 2017; Shunkov et al. 2017), which is an Upper Palaeolithic site located in the southern slopes of the Saur range (Figs. 5, 6). The lithic assemblages are composed of fine-grained shale and mudstone with high silica content (Anoikin et al. 2017). The source of the raw materials is located about 7 km to the south-east of the site. Such raw materials were found in a stream as blocks and pebbles sized around 10–15 cm (Fig. 5). These raw materials are high quality fine-grained, structurally homogeneous and silica rich shales that readily show markers of conchoidal fracture when knapped. The pebbles have fractured and cracked exteriors that resulted from crashing together with other pebbles in the water course over a long period of time. These pebbles are not well rounded, and are coarse in size, which indicates that they were not transported over long distances. Samples were photographed (Fig. 4D) and collected for further lab analysis.

**Fig. 5** The secondary source of raw materials located 7 km east of the Upper Palaeolithic site of Ushbulaq, East Kazakhstan. A) Panoramic view of the spring and the surrounding landscape. B) View of the spring and the pebbles of raw materials brought by the stream (people as scale). C) Fractured pebble from the spring: high quality, fine-grained knappable shale



These observations correspond with the data retrieved from the CERCAMS database, which show that the surrounding area of the site is rich in silica rich shale and mudstone deposits.

Previously, the foothills of the Tarbagatai range were surveyed by Taimagambetov (2016), who found several scatters of lithics around the spring heads. Overall, our Tarbagatai survey also yielded a few localities with surface lithic scatters beside the spring heads of Kokbastau and Chilibastau (see Iovita et al. 2020), as well as secondary sources of raw materials mainly represented by pebbles in river and stream beds. The area is rich in water sources, such as river and perennial springs, and the abundance of knappable pebbles that were found in the riverbeds likely attracted human groups to the area. During this survey we were able to find only secondary sources of raw materials.

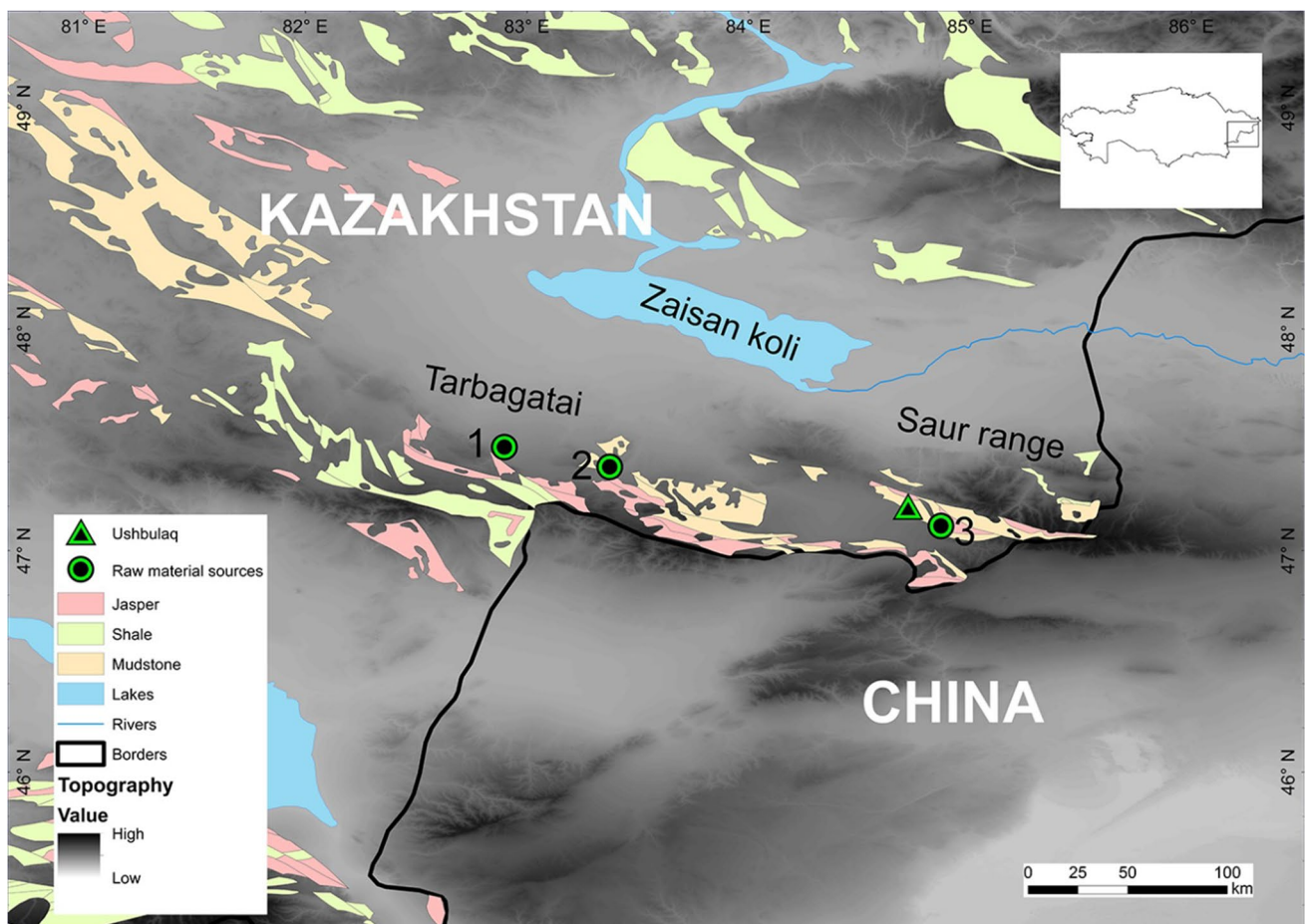
In contrast to other study areas, the stone tool assemblages from the stratified sites in eastern Kazakhstan, such as Ushbulaq, are predominantly knapped using shales and mudstones, which are fine-grained silica rich sedimentary rocks. Our survey results yielded various sources of raw materials in the region, predominantly represented by secondary sources of siliceous shales and mudstones found as pebbles throughout the foothills of the Tarbagatai range. Outcrops of flint, chert, or jasper were not located, although the CERCAMS database indicates the availability of jasper around the site of Ushbulaq, the north-eastern and the south-eastern slopes of the Tarbagatai range. The site of Shul'binka, also

located in the same administrative region around 500 km north-west of our study area, is an Upper Palaeolithic site excavated in the 1980s. The assemblages of stone tools consist of more than 5000 lithics, primarily knapped on flint, jasper, chalcedony and siliceous shale as reported in Aki-shev et al. (1978) and Taimagambetov (1983). These data suggest the availability of high-quality raw materials by the site. However, Taimagambetov (1983) reports that sources of jasper and chalcedony are located 80 km south-west of the site, which is corroborated by the CERCAMS data.

Based on the macroscopic observations of the stone tool assemblages found in both stratified and surface sites, and reviewing the available literature, it is possible to observe that the reported raw materials comprise a variety of types that differ regionally depending on the local specificity of the geological features of each region. However, detailed description of raw materials from specific layers of stratified sites were beyond the scope of the current work.

## 5 Discussions and conclusion

There has been new interest in the Palaeolithic of Central Asia providing original studies on the archaeology of Pleistocene, human occupation, and dispersals through the region (Glantz 2011; Beeton et al. 2014; Fitzsimmons et al. 2017; Khatsenovich et al. 2019; Zwyns et al. 2019; Iovita et al. 2020; Varis et al. 2022; Namen et al. 2022). However, a



**Fig. 6** Raw material distribution in the piedmont and foothill zones of the Tarbagatai range. 1) Chilibastau, 2) Kokbastau, 3) Ushbulaq. Data sources: Global Administrative areas (GADM) (Hijmans 2012), vector and raster map data from Natural Earth ([www.naturalearthdata.com](http://www.naturalearthdata.com)) and Shuttle Radar Topography Mission (SRTM) Version 4 (Jarvis et al. 2008). Including Mineral deposits database (Seltmann et al. 2014)

lot of the basic data are missing. The current research is the first study of raw material identification in the IAMC of Kazakhstan to be used for examining Palaeolithic raw material economies, transport behaviours, and social network size. Even though preliminary, our results provide new data concerning the types of raw material, their distribution throughout the study areas and observes regional patterns of land-use.

The various raw materials in the different regions within the study area show clearly that the utilisation of raw materials varied between regions, and the hominin groups accessed a variety of landscapes with changing opportunities and limitations. We can clearly see the systematic use of accessible raw materials in both stratified and surface sites. This means that the prehistoric hominin groups predominantly utilised locally available raw materials which were suitable for knapping purposes. However, as discussed above, a few occurrences of higher quality, possibly exogenous raw materials are found at the localities of Aqtasty, Rahat and Tikenekti,

suggesting possible raw material transport over long distances (see subchapter 4.2). If so, this can be considered as an indicator of hominin mobility, and perhaps also an indicator of the value of these raw materials to hominins, in an otherwise expedient and local technology.

Further field survey will provide more details understanding of the distribution of raw material sources. Ongoing experimental analysis into the mechanical properties of various types of raw materials will complement the study of raw material selection behaviour and their effect on knapping technology. Secondly, statistical analyses of lithic assemblages from stratified sites to differentiate the raw material types are required to provide an in-depth study of landscape use, transportation of exogenous materials and hominin mobility.

A number of Palaeolithic sites in the piedmont and foothill zones of Kazakhstan are a major source of evidence for intensive hominin occupation in the region. Understanding the different aspects of raw material utilisation

in these sites still remains to be comprehensively evaluated through more substantial fieldwork and laboratory studies, but this study has provided a necessary first step towards more systematic investigation. In this article, we have described the raw material use patterns observable in a selection of assemblages in the region, and the implications of these patterns for the understanding of hominin behaviour. The results indicate that raw materials are heterogeneously distributed throughout the study regions, revealing regional raw material utilisation patterns. In conclusion, further research into the raw material landscapes of the study areas is desirable to comprehensively examine the factors influencing raw material selection and use, and also to link these factors with technological aspects of hominin behaviour in the region.

**Acknowledgements** We would like to thank Dean Mendigul Nogai-baeva, Prof. Gani Omarov, Dr. Rinat Zhumatayev (Faculty of History, Ethnology, and Archaeology, Department of Archaeology, Ethnology and Museology of Al Farabi Kazakhstan National University, Almaty, Kazakhstan) for their support of our project. The current study was performed within the PALAEOSILKROAD project and all field research was conducted under license No. 15008746 (12.05.2015) of the National Museum of the Republic of Kazakhstan based on the collaboration protocol between the Eberhard-Karls University of Tübingen and the National Museum. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement n° 714842; PALAEOSILKROAD project). We would also like to thank two anonymous reviewers for their insightful comments that helped to improve our work. We acknowledge support by the Open Publishing Fund of the University of Tübingen.

**Authors' contribution** AN – conceptualization, methodology, writing – original draft, visualization, PC - conceptualization, methodology, writing – review and editing, AV – conceptualization, writing – review and editing, validation, PS – conceptualization, writing – review and editing, validation, supervision, ZT – writing – review and editing, validation, supervision, RI - conceptualization, writing – review and editing, validation, supervision, funding acquisition.

**Funding** Open Access funding enabled and organized by Projekt DEAL. This paper is part of the ERC PALAEOSILKROAD project (grant agreement n° 714842) obtained by Prof. Dr. Radu Iovita.

**Data availability** The data that support the findings of this study are openly available in OSF repository via <https://doi.org/10.31235/osf.io/uztq6>

**Code availability** Not applicable.

## Declarations

**Conflict of interest** The authors declare that they have no conflicts of interest.

**Ethics approval** Not applicable.

**Consent to participate** Not applicable.

**Consent for publication** Not applicable.

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