Hunting, herding, and people in the rock art of Mongolia: New discoveries in the Gobi-Altai Mountains

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Abstract

Despite its harsh and arid conditions, the Gobi Desert has played an important role in shaping Holocene populations, including the transition from hunting to herding lifeways. Here we present three newly documented rock art sites in the Gobi-Altai Mountains of south-central Mongolia, a cave (Gazar Agui 1), a rock shelter (Gazar Agui 13) and an open-air landscape site overlooking a palaeolake (Unegt Uul). In addition, we re-examine the preservation of the rock art cave site of Saalit Agui some 20 years after its original recordation, using digital technology not available at that time. Comparisons of rock art at Gazar Agui 1 and Saalit Agui with previously documented rock art in Mongolia suggest links with Mesolithic and Neolithic anthropomorphic iconography. Unegt Uul and Gazar Agui 13 show Early Bronze Age to Iron Age symbols, suggesting two distinct periods of production, by hunter-gatherers during the Early Holocene and by later hunter-pastoralists during the Late Holocene. Our findings suggest that wet periods in mountainous basins of the Gobi-Altai were likely key to early human habitation, with pastoralism dominating during arid periods. Our observations further indicate that preservation of rock art sites in the region is currently under threat due to human activity and climate change.

Keywords: petroglyphs; ochre; paleoclimate; hunter-gatherer; hunter-pastoralist; preservation

1. Introduction

Archaeological research shows that despite the harsh conditions of the Gobi-Altai Mountains, a complex record of human activity is present. The earliest evidence of human presence in the Gobi-Altai Mountains is represented by the cave of Tsagaan Agui, which contained Middle Palaeolithic artefact assemblages (Derevianko et al., 2000b; 2000a). It has been suggested that human populations likely occupied the region intermittently during wet periods (Li et al., 2019). During the Last Glacial Maximum (LGM), Palaeolithic sites in the north are absent, suggesting regional abandonment or movements away from North Asia (Goebel, 2008). After glacial retreat, new lithic technologies such as microblades of the Late Upper Palaeolithic appear (Rybin et al., 2016a; 2016b; 2017), with much of the Palaeolithic evidence coming from stratified sites in the northern part of Mongolia (Jaubert et al., 2004; See: Gladyshev et al., 2012; Zwyns et al., 2014; Rybin et al., 2017). Severe

Holocene wind deflation of most of the landscape in the Gobi-Altai (Jugder et al., 2018) has made stratified archaeological sites rare. Late Palaeolithic archaeological sites in the Gobi-Altai Mountains are preserved in and around caves such as at the stratified rock shelter of Chikhen Agui (Derevianko et al., 2003), and its neighbouring open-air site, Chikhen 2 (Derevianko et al., 2015). Artefacts recovered from Chikhen Agui include miniaturised lithics and ornamental beads made from ostrich eggshell (Derevianko et al., 2008). Human occupation took place across the Gobi Desert during the Early Holocene wet period, possibly reflecting a broad diet, including large fauna as a main intake (Janz, 2012; 2016; Janz et al., 2017). Hunter-gatherers in this period occupied lake oases and dune fields throughout the desert (Janz, 2012). Later hunter-gatherer groups continued to use Chikhen Agui until the mid-Holocene, with the youngest levels yielding an estimated age of ca. 5630 ± 250 BP (SOAN-3732) (Derevianko et al., 2008).

Life in the Gobi region was transformed by the transition from hunting to mobile pastoralism, aided by the horse, which enabled early herders to make use of the region's expanding grassland. The first domesticated caprines and bovines occur in Central and Western Mongolia, indicating the appearance of pastoralism on the eastern steppe at ca. 5000 cal BP (Kovalev and Erdenebaatar, 2009; Wilkin et al., 2020b). Archaeological, skeletal and genetic evidence indicate a relatively late adoption of livestock among hunter-gatherers of the Gobi Desert, perhaps dating to ca. 3500 cal BP (Janz et al., 2017; Jeong et al., 2018; Wilkin et al., 2020a). Precise evidence for the transition from hunting and gathering to pastoralism, and the timing of the spread of domesticates across Southern Mongolia generally remain uncertain, although pottery with dairying lipids in the eastern Gobi has been found to date to ca. 3600 cal BP (Janz et al., 2020). The expansion of pastoralism appears to have coincided with climatic amelioration (Miehe et al., 2007; Klinge and Sauer, 2019; Rosen et al., 2019). Changing subsistence and land use patterns may have eventually led to overgrazing and deforestation (Janz et al., 2017). Given that stratified sites and well-preserved faunal assemblages are rare in the Gobi Desert, and across Mongolia more generally, understanding human subsistence choices and the dynamics of the hunting-herding transition in this region presents a difficult challenge.

1.1. Rock art

The rock art of Mongolia represents a significant cultural resource, which has been the focus of scholarly research for more than a century (Batbold et al., 2016; Gunchinsuren, 2017; Terguunbayar and Ankhsanaa, 2019). This long-term research has resulted in the identification of rock art in many geographic areas across Mongolia (Fig. 1), with at least ca. 1016 non-monumental sites recorded so far (Terguunbayar and Ankhsanaa, 2019). Of these, 945 are pecked or engraved images and designs on rock, usually on desert varnish of outcropping rock, though there are also 71 sites with pigments (Batbold et al., 2016; Terguunbayar and Ankhsanaa, 2019). Rock art preserves thousands of pictorial images related to early Mongolian lifeways from the Terminal Pleistocene (Okladnikov, 1972; Tseveendorj et al., 1997; Tseveendorj, 1999; Jacobson-Tepfer, 2013), through to the medieval period (ca.700 BP) (Okladnikov, 1962), and right up to the present day (O'Sullivan, 2020).

Dating rock art is, of course, notoriously difficult. The common source of material used for chronometric dating of rock art, carbonate or organic material, is generally absent in most sites. Attempts have been made in other regions to chronometrically date the surfaces that non-organic rock art appears on (Watchman, 2000; Liu, 2018), providing a maximal age, but these have met with little success. Recent research has aimed to improve dating by verifying qualitative temporal assessments through microanalytical and chemical analyses (Macholdt et al., 2018). Given the problems of chronometric dating, chronological assignments of rock art in Mongolia are typically made through the analysis of themes, styles, and techniques (Jacobson-Tepfer, 2013), with the appearance of domesticated animals, for example, serving as an important temporal marker. This approach has been routinely used across Central, Eastern and Northern Asia (Rozwadowski and Lymer, 2012; Miklashevich, 2016), where common motifs and methods are used to assess the relative age of rock art. However, the efficacy of this approach relies on securely linking changes in motifs with well-dated events in the archaeological record.

Petroglyphs are the most common forms of rock art in Mongolia, and are produced in a variety of ways, the most frequent of which is pecking. This involves removing spalls of rock from the surface with a (direct or indirect) percussive tool (Jacobson-Tepfer, 2015). Indirect pecking provides finer and more accurate petroglyph shapes.

Engraving is a less common method and involves carving the rock with a sharp implement. Paintings are another form of rock art, though these are less common in Mongolia than petroglyphs and engravings. The most frequent pigment used in the painted rock art of Mongolia is ochre (Batbold et al., 2016; Terguunbayar and Ankhsanaa, 2019). Most of the known rock art sites with paintings occur in caves or along vertical rock surfaces, particularly in the Khangai and Khentii Mountains. An exceptional painted rock art site is Khoid Tsenkher Agui, in the Khovd Aimag (province) of the Altai Mountains, which has ochre, as well as white and black pigments (Namnandorj, 1953; Dorj and Derevianko, 1970). Khoid Tsenkher Agui is considered one of the oldest rock art sites in Mongolia, ranging back into the Late Pleistocene, due to the presence of pre-LGM fauna (Okladnikov, 1972). Direct pecking has been suggested to be the oldest method of rock art production in the region (Fitzhugh and George, 2006), whereas indirect pecking and engraving may have been carried out using metal implements during the Bronze Age (Jacobson-Tepfer, 2015).

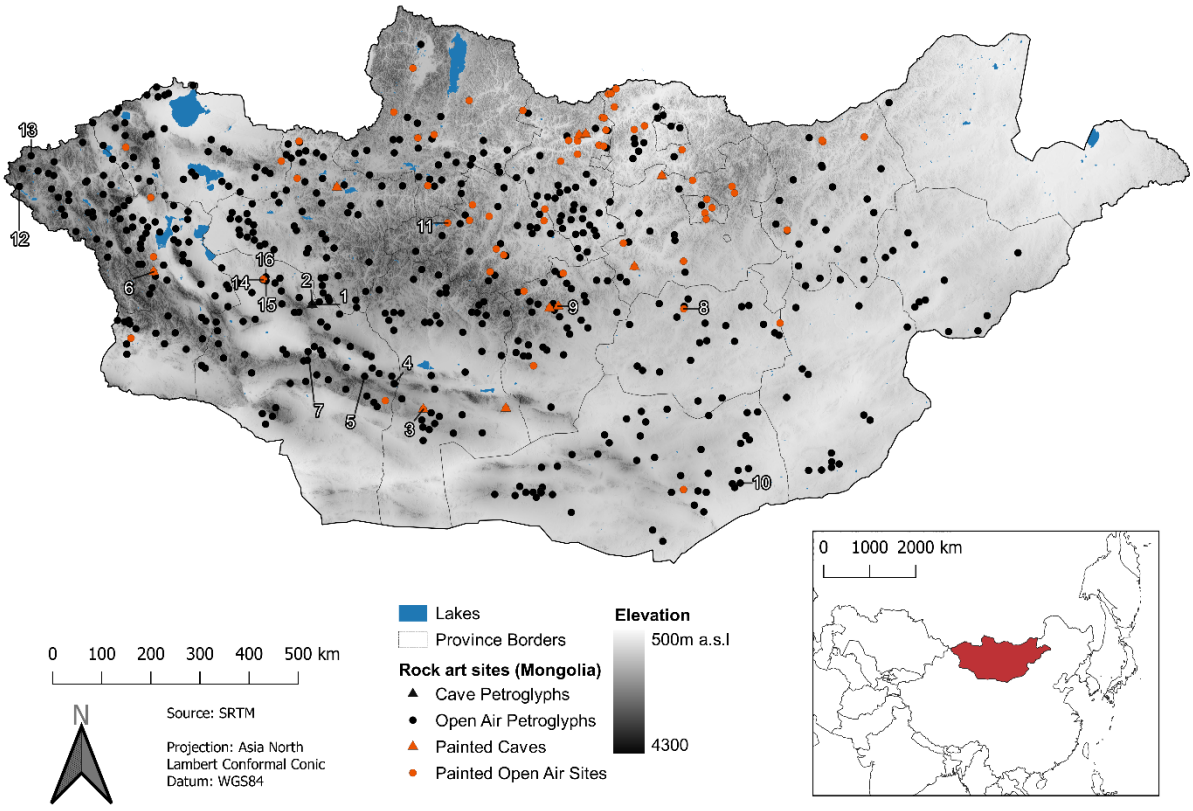

Fig. 1. Map of recorded rock art sites (petroglyphs, painted sites) in Mongolia. Sites mentioned in the text: (1) Gazar Agui 1, (2) Gazar Agui 13, (3) Saalit Agui, (4) Unegt Uul, (5) Shakhar Tolgoi, (6) Khoid Tsenkher, (7) Tsagaan Gol, (8) Baga Gazryn Chuluu, (9) Toonot Agui, (10) Javkhlant Khairkhan, (11) Bukhantyn Khad, (12) Aral Tolgoi, (13) Tsagaan Saala and Baga Oigor, (14) Byatsakan, (15) Salkhit, (16) Sazyn Khond. Labelled sites correspond to S.I. Table 1. Data from Terguunbayar and Ankhsanaa (2019, figs. 1 & 2) and Batbold et al. (2016, pp. 20–21 & 66–67).

The earliest instances of rock art in Mongolia, based on current chronologies, depict wildlife themes (Jacobson-Tepfer, 2013; Batbold et al., 2016) including the many large wild ungulates that inhabit the region, most commonly horses (*Equus przewalskii, E. hemionus*), wild goats (*Capra aegagrus, C. sibrica*), and the now threatened Argali sheep (*Ovis ammon)*. The early art of Khoid Tsenkher Agui (Okladnikov, 1972) and the Tsagaan Salaa-Baga Oigor petroglyph complex (Jacobson-Tepfer, 2013; 2019) depicts animals that are now extinct in Mongolia, such as woolly rhinoceros (*Coelodonta antiquitatis*), ostrich (*Struthio asiaticus*), mammoth (*Mammuthus primigenius*), wild camel (*Camelus ferus*) and aurochs (*Bos primigenius*), emphasising the early dates proposed for this art. The depictions of apparent ostrich, which became regionally extinct by ca. 8.9 ka cal BP (Janz et al., 2009), as well as woolly rhinoceros (*Rhinoceros tichorhinus*) and woolly mammoth, between ca. 13 ka cal BP and ca. 12 ka cal BP (Kuzmin and Orlova, 2004; Kuzmin, 2010) respectively, suggest that this rock art was produced, at the latest, in the Terminal Pleistocene and Early Holocene (Dorj and Derevianko, 1970; Okladnikov, 1972; Jacobson-Tepfer, 2013). The extinction of Pleistocene megafauna thus provides a useful, well-dated reference point for stylistic dating of Gobi rock art.

A wide array of rough linear animal silhouettes characterises the rock art of Mongolia in the Early Holocene (Jacobson-Tepfer, 2015). The introduction of Holocene art can be detected in the depiction of specific animal taxa, including what have been identified as horses, camels (*C. ferus*), caprines, moose (*Alces alces*) and aurochs, frequently featured without anthropogenic figures. Jacobson-Tepfer and Meacham (2010) suggested that Mesolithic and Neolithic rock art could be distinguished on the basis of the introduction of anthropomorphic figures. Some of the earliest rock art

depicting humans or humanoid figures may occur at Aral Tolgoi, where stick figures with raised arms, usually labelled as “birthing women” or sometimes as “dancing figures” (Jacobson-Tepfer, 2015, fig. 4.1) are depicted. Later, more detailed, Bronze Age anthropomorphic petroglyphs in similar positions at Biluut, in Bayan-Ulgii (Kortum et al., 2005), demonstrate women giving birth (Kortum, 2014, fig. 18). Other early anthropomorphs include “spirit” figures, with animal features (Jacobson-Tepfer, 2015, pp. 100–113). Detailed anthropomorphic figures are thought to begin to have been produced in the Bronze Age, depicting bow and spear hunting (Jacobson-Tepfer, 2015, p. 153) and occasionally showing human conflicts (Jacobson-Tepfer, 2015, fig. 5.2). Details and weaponry in these depictions appears to differentiate this rock art from earlier Mesolithic anthropomorphic figures.

Table 1 Timeline of environment of the Gobi-Altai and rock art of Mongolia, based on current systems of rock art chronologies

Later rock art has been assigned to periods by linking motifs to specific dated introductions of technologies and domesticates. The transition between the Neolithic and Bronze Age in rock art is frequently determined by the depiction of domesticated bovines and wheeled carts, both of which appear in western Mongolia around ca. 5 ka cal BP (Kovalev and Erdenebaatar, 2009). The Late Bronze Age transition is marked by the introduction of domesticated horses by ca. 3.2 ka cal BP (Taylor et al., 2017) which were used for transport from this time, through chariots or, later, mounted riding (Taylor et al., 2015). Other domestic animals frequently depicted in what is thought to be Early-Late Bronze Age rock art from Western Mongolia are camels, bovines (Jacobson-Tepfer, 2019, pp. 102–103) and dogs in hunts (Jacobson-Tepfer, 2015, fig. 5.13). Smaller livestock, such as goat and sheep, are difficult to distinguish from wild ones in rock art. Wheeled transport frequently appears, including depictions of chariots pulled by horses or camels (Novgorodova, 1984) and carts pulled by bovines (Jacobson-Tepfer, 2012). The Bronze Age shows a shift from the scenes of the wild that appear to dominate earlier art towards a greater focus on anthropogenic themes, highlighting the increased relationship between people and livestock. Despite challenges with accurate dating,

representations of certain types of technology and animal species allow for the approximate reconstruction of the age of at least some of Mongolia's extensive rock art record. This is also useful for examining human-environment interactions across periods, compensating for the dearth of stratified archaeological sites in the important, but still understudied region of the Gobi-Altai.

Here we describe archaeological research that we have undertaken in the Gobi-Altai Mountain region that resulted in the identification of several key rock art sites. Our general project aim was to examine human landscape use and the associated environments of the Gobi-Altai Mountain region. We present here two new cave petroglyph rock art sites (Gazar Agui 1 and Gazar Agui 13) and findings from the re-examination of a third cave, Saalit Agui. In addition, we present newly identified petroglyphs at Unegt Uul (mountain) in proximity of a paleolake. These rock art sites are examined relative to surrounding landscapes and the fauna of the Gobi-Altai Mountains. We situate the rock art sites chronologically in order to explore their relationship with cultural changes and past environments.

2. Geographical setting and identification of rock art sites

The four rock art sites examined here are located in the Gobi-Altai and Bayankhongor provinces of Mongolia (Fig. 1). The Gobi-Altai Mountain range runs through the centre of these provinces, and the south-eastern extension of the Altai Mountain System reaches deep into the Gobi Desert (Owen et al., 1999). The geology of the region is complex and characterized by active faults (Cunningham, 2013) leading to the presence of rock outcrops and exposed rock sections (Kröner et al., 2007). Caves are known throughout the region, but remain poorly documented (Avirmed, 1999). The mixed semi-arid to arid climate on the northern slope of the mountain range produces a typical steppe environment. By contrast, the areas on the southern escarpment are characterized by the arid steppe and desert landscapes of the Gobi Desert (annual average temperatures are around 0 ºC; however, the annual temperature amplitude is around 40 ºC). The Gobi-Altai Mountains receive little summer precipitation (100-200 mm/year), and the main water sources are springs (Endo et al., 2006).

Paleoenvironmental studies conducted on the north side of the Gobi-Altai Mountains, in an area known as the 'Valley of the Gobi Lakes', indicate that increased moisture supplies led to larger lake extents during the Late Pleistocene and the early phases of the Holocene (Lehmkuhl et al., 2018). There are no current glaciers in the Gobi-Altai, but recent research shows that glaciers expanded unsynchronised with other glaciers in the Holocene (Batbaatar et al., 2018). Wind erosion (average wind speed is 15-30 km/h, but winds over 80 km/h are common) is a major force in the formation of the steppe landscape (Jugder et al., 2018), and also plays a critical role in creating desert varnish on the rock outcrops.

Wild game currently extant in the region includes large ungulates such as argali sheep, ibex, and gazelle (*Gazella subgutturosa*), felids including the snow leopard (*Uncia uncia*), Pallas's cat (*Otocolobus manul*) and lynx, as well as small carnivores including foxes, corsacs and mustelids (Clark et al., 2006).

Our archaeological team conducted two seasons of interdisciplinary archaeological fieldwork in the Gobi-Altai and Bayankhongor provinces of Mongolia with the aim of understanding the human occupation history of the region. Both survey and excavation were carried out, and findings beyond the rock art are discussed in other, forthcoming publications.

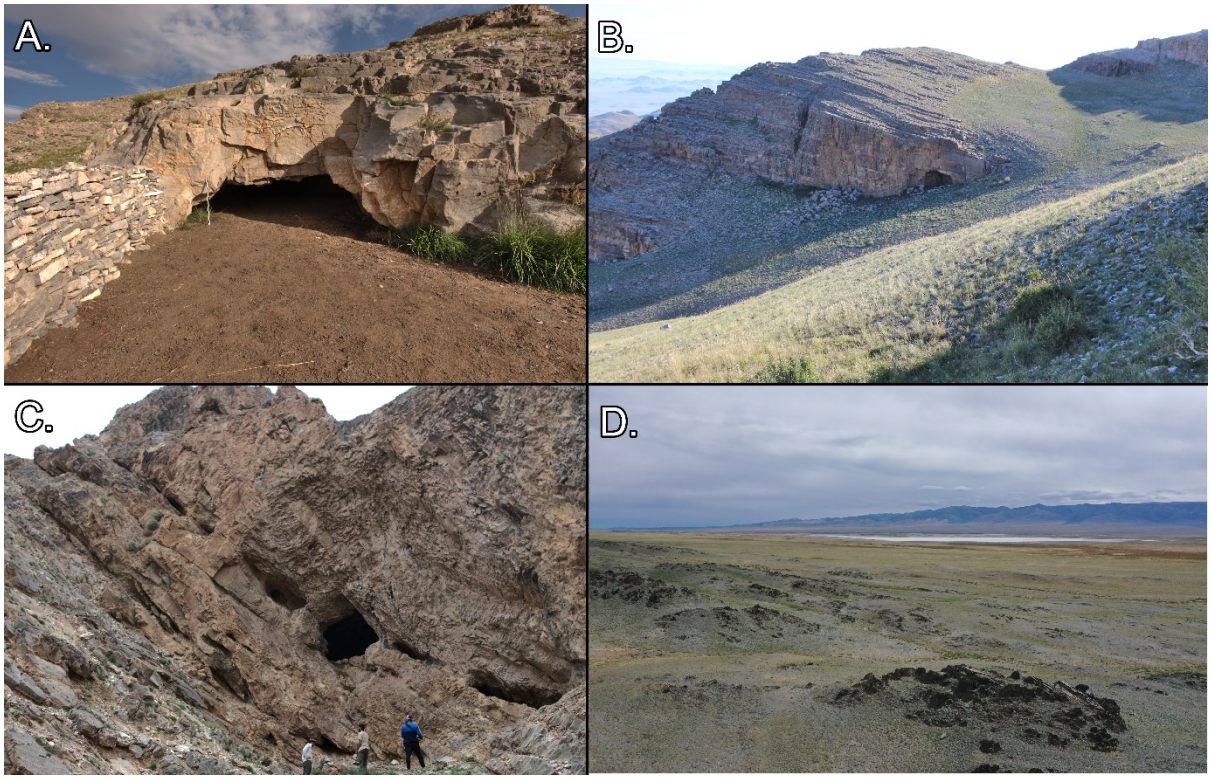

Fig. 2. Rock art site contexts in the Gobi-Altai region. (A) Gazar Agui 1 showing its entrance. (B) Gazar Agui 13 and its surrounding landscape. (C) Saalit Agui showing its geological context. (D) Unegt Uul schist outcrops and the position of Khutag Nuur (lake).

2.1. Gazar Agui 1

The Gazar region is characterised by foothills between the Khasagt Khairkhan Mountain and the dammed Zavkhan Gol (river). Cutting through the foothills is the seasonal river of Bayan Gol, fed by the meltwater of the Khasagt Khairkhan. Situated on the carbonate-bearing Tsagaanolom Formation of the Zavkhan terrane (Levashova et al., 2010; Serezhnikova et al., 2014), this region contains numerous caves and rock shelters (Avirmed, 1999).

The cave known locally as Gazar Agui is a tourist attraction, but it is also used today as a seasonal herding pen. Gazar Agui 1 is a 13 m long karst cave with a wide but low entrance and consists of two cupulas (Fig. 3B). Our archaeological investigations involved placing an excavation trench at the cave entrance near the drip line. This trench produced several small lithic bladelets and an unidentifiable piece of bronze. Inside the first, and largest cupula, several panels of petroglyph rock art were identified.

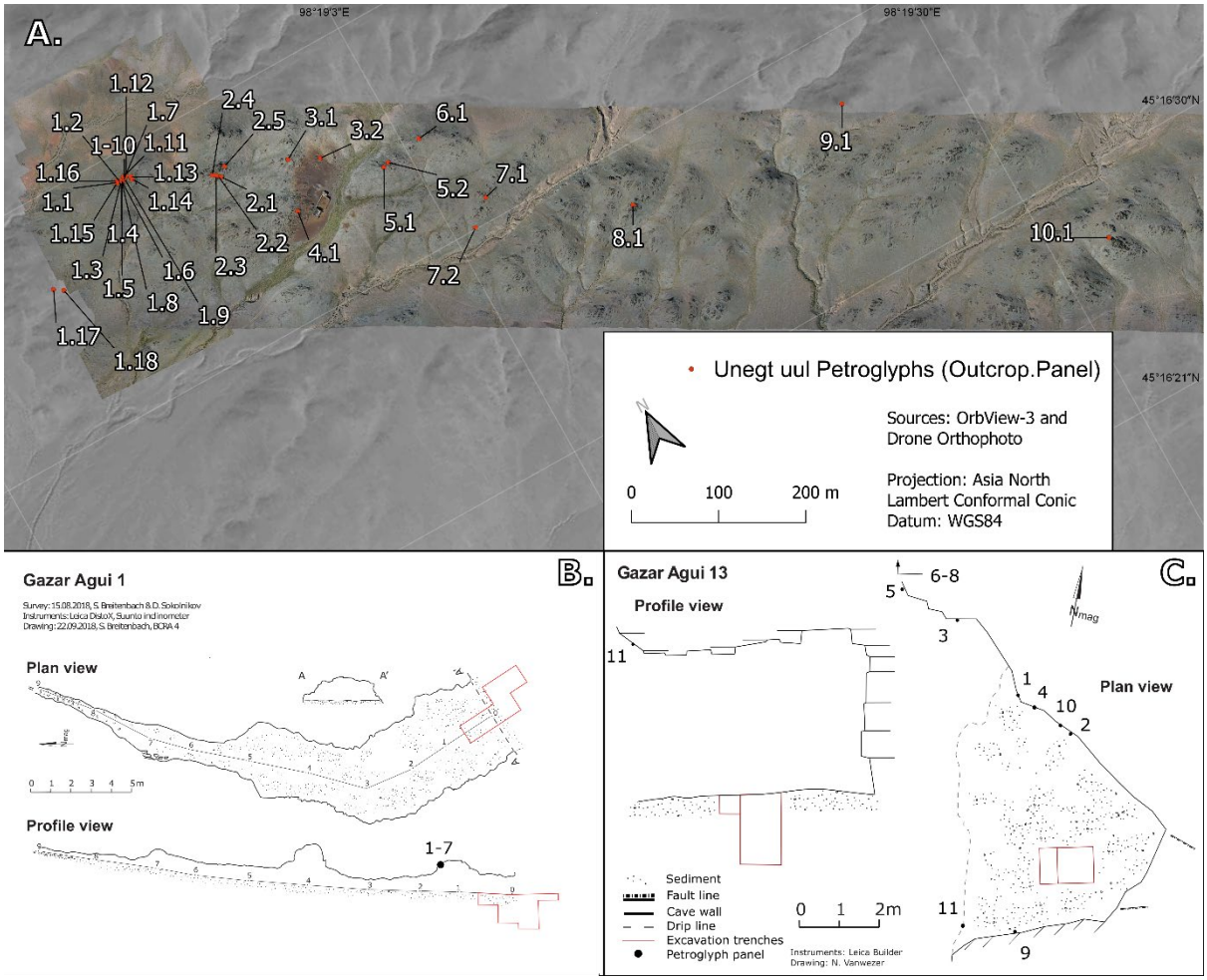

Fig. 3. (A) Satellite and drone map of Unegt Uul with labels indicating outcrop number and panel number of petroglyph locations. (B) Plan and section of Gazar Agui 1, with location of petroglyphs. (C) Plan and section of Gazar Agui 13, with location of petroglyph panels.

2.2. Gazar Agui 13

Survey of the area surrounding Gazar Agui 1 located an additional 12 caves including Gazar Agui 13, which is a rock shelter made of thickly layered limestone created by the division of two fault lines in the eroded section of uplifted rock strata. Similar to Gazar Agui 1, this rock shelter is also used today as a herding pen. Given identification of the rock art at Gazar Agui 13, we considered that it may have archaeological potential. A test trench was therefore placed, but no archaeological evidence of occupation was found, although a small microfaunal assemblage was

recovered, including bird and lagomorph bones. Both internal and external walls of this rock shelter exhibited various types of pecked petroglyphs (Fig. 3C).

2.3. Saalit Agui

Saalit Agui is a previously reported cave (known as Saaltyn Cave) with painted rock art (Derevianko et al., 1998; Avirmed, 1999). The cave is in a canyon made of tilted lenticular limestone. It is the remnant of a joint-controlled collapse cave formed along bedding planes prior to the uplift of the host rock above the water table. Currently, the cave is filled with unconsolidated debris from local herders and their livestock. The site is located 6 km away from the well-studied rock shelter Chikhen Agui, which hosts important Late Pleistocene and Holocene archaeological material (Derevianko et al., 2008). The previous survey of the area around Saalit recovered several blade fragments and a core (Derevianko et al., 1998). Four distinct panels at Saalit Agui were traced by members of the 'Joint Mongolian-Russian-American Expedition in Mongolia'. These were on the northern walls of the cave, including a total of 37 ochre figures. Three of these figures were anthropomorphic and seven were "X" symbols, while the remainder consisted of assortment of lines, speckles and possibly a quadrupedal animal. Our investigation of Saalit Agui verified the existence of these depictions, but some could not be located, and many were degraded. We photographed and documented the current condition of the paintings in order to assess their preservation since their original recording in 1998.

2.4. Unegt Uul

Unegt Uul is located in an Ordovician-Silurian greenschist of the Unegt Uul Crystalline Complex (Hrdličková et al., 2008). The rock art occurs in a basin along the main East-West corridor of the Gobi-Altai Mountains of Chandmani Soum (county), in close proximity to the endorheic saline lake of Khutag Nuur. The current water body consists of two lakes, divided by a large sandbar running north-south. Mountainous semi-arid steppe terrain characterizes the landscape, with large alluvial fans descending from canyons in the mountains down to the boundary of the basins. Palaeolake landforms indicate several periods of higher-than-modern lake levels.

Environmental signatures for palaeolakes in Mongolia have been shown to be asynchronous in their lake level rises, which from the Late Glacial onward rose from East to West (Lehmkuhl et al., 2018; Klinge and Sauer, 2019). Higher lake levels at Khutag Nuur probably corresponded with periods of higher water supply in the Early Holocene (Klinge and Sauer, 2019), meltwater of remnant nearby glaciers (Batbaatar et al., 2018), and permafrost in the Gobi-Altai (Owen et al., 1998; Vaks et al., 2013). Our archaeological and paleoenvironmental surveys have identified relict paleolake landforms and lithic scatters near the lake that can be attributed to Late Bronze Age that will be reported in full elsewhere. The lithic scatters contain stone tools consisting of arrowheads, bladelets, bifacial blade fragments and fragmented flakes. Situated amongst the outcrops there is a seasonal herder's pen (Fig. 3A). On the easternmost end of the schist a large outcrop with many rock art panels was found, and further survey found smaller clusters of panels nearby.

Table 2 Identifying features used to classify rock art figures

3. Rock art survey results

3.1. Gazar Agui 1

Gazar Agui cave contains 7 rock art panels with a total of 13 figures (Fig. 4). All figures except for those on Panel 5 were created by pecking the limestone surface of the wall. The figures in Panel 1 (Fig. 4D) and in Panel 5 (Fig. 4 A, B) are anthropomorphic. All of the depictions, except for some of those on Panel 1, are incomplete and/or damaged. The images are distinguished by an "X" shape to represent arms and legs and a teardrop for the head; often a horizontal bar appears below the arms and head. Panel 4 may represent another anthropomorphic figure, but it is pecked with little detail. The figures in Panels 2, 3, 4, and 6 are difficult to distinguish as specific symbols. The symbols in Panel 5 were carved into the limestone wall, which explains their simplicity with the use of straight lines. The lack of patina to provide contrast may explain the use of carving as opposed to pecking. The other panels are all pecked but have little detail or contrast, as the limestone

surface on panel 5 is covered in modern or historic damage, making it difficult to distinguish possible additional individual figures. The burning by modern herders seems to have resulted in little damage or build-up of soot on the cave's first cupula. The aridity of the region means water is only available during high precipitation and meltwater events, so no carbonate crusts have built up on the petroglyphs since their creation. The clearly defined anthropomorphic symbols are crude in comparison to those that have been attributed to the Late Bronze Age, and suggest a potential Neolithic or Early Bronze Age date on the basis of current chronologies (Jacobson-Tepfer and Meacham, 2010). The remaining symbols are difficult to define but are likely from the same period.

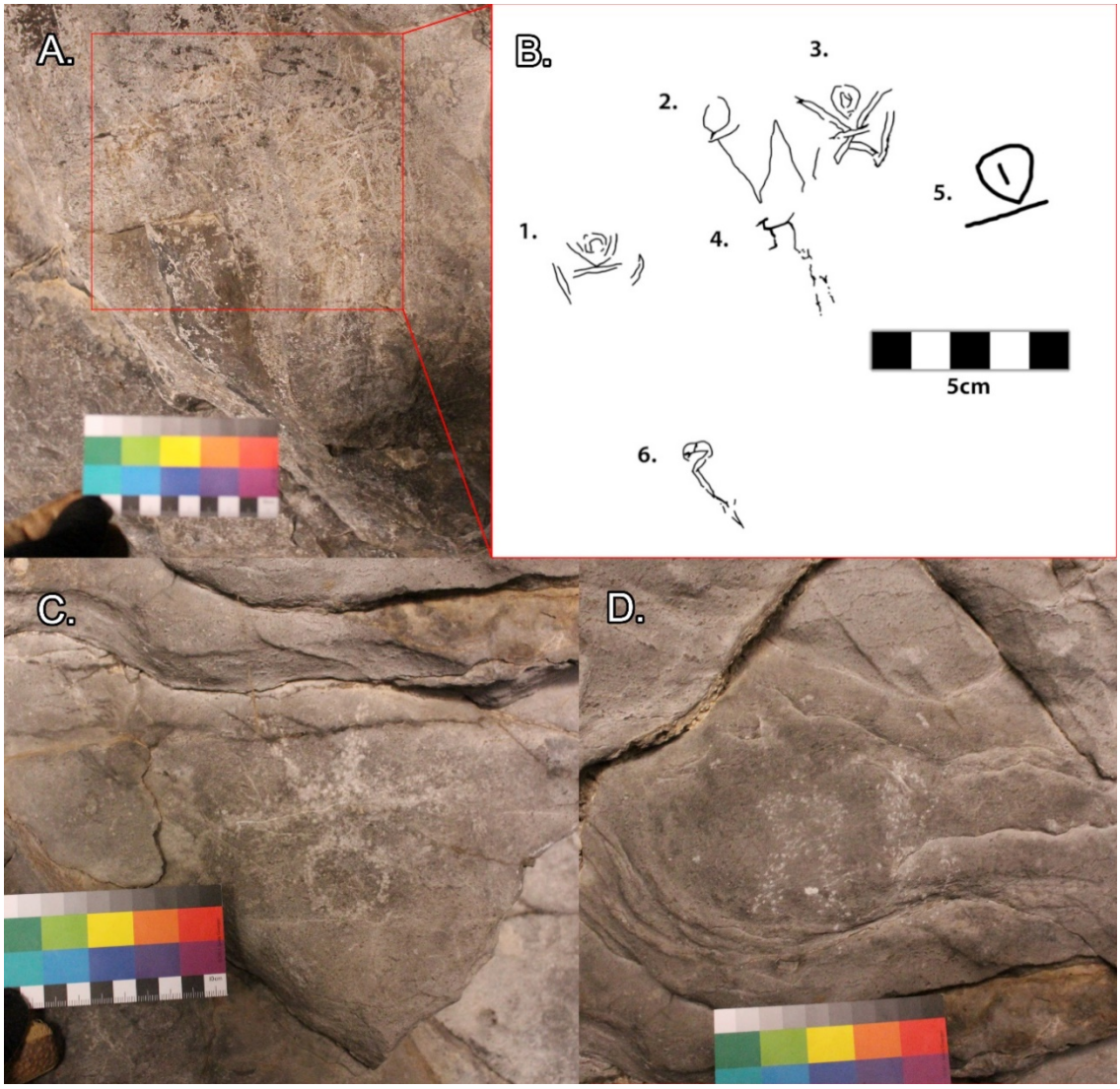

Fig. 4. Petroglyphs from Gazar Agui 1. (A, B) Outlines of engravings in Panel 5 showing anthropomorphs (1-3, 5 & 6) and a caprine (4). (C) Panel 1 showing an

upside down anthropomorph. (D) Panel 4 showing an anthropomorph (left) and an unidentifiable figure (right). Other panels are S.I. Figs 1-4

3.2. Gazar Agui 13

In the nearby rock shelter of Gazar Agui 13, 11 separate panels with a total of 17 pecked figures were recorded (Fig. 5). Eight of these are recognizably zoomorphic, especially on the largest, Panel 7 (Fig. 5 G, H). Three potential horses are depicted in Panel 7, one lacks a tail to properly distinguish it from a doe. In Panel 3 (Fig. 5 C, D), there is an apparent horse and another horse with an anthropomorphic figure riding it. Two probable caprines are visible in Panel 5 (Fig. 5E); the caprine labelled 5 in Panel 7 has a box-shaped body. Petroglyph 6 in Panel 7 displays a bird in outline (Fig. 6), where two overlying Vs create the impression of wings, similar to the figure in Panel 8 (Fig. 5F). The two bird figures at Gazar Agui 13 are more linear and complex compared to other bird petroglyphs, which are commonly depicted as silhouettes (Kubarev and Zabelin, 2006). Four of the images are likely *tamgas*, symbols frequently used in Mongolia and Central Asia to indicate clans (Fijn, 2011) and to brand livestock (Vainshtein, 1980). Panel 1 and 11 depict the same tamga, though petroglyph 4 in Panel 7 (Fig 4 G,H) and Panel 6 (S.I. Fig 9) is different; however, references to these symbols are present in the same booklet on Mongolian tamga (from anonymous source in Fijn, 2011, fig. 4.4). The remaining figures in other Panels, 2, 4, 9, 11 (S.I. Figs 5-8), are faint, unrecognizable shapes. The rock shelter and the external wall have preserved most visible damage to most of the rock art, however, Panel 8 has large crisscross scratches across a large part of the surface. The walls of the rock shelter have some patina as well as frost cracking, but these have not had much impact on the existing rock art. Like in Gazar Agui 1, there were no signs of carbonate growth. The presence of a horse rider would appear to place the petroglyph to sometime after ca. 3 ka cal BP (Taylor et al., 2017; 2019).

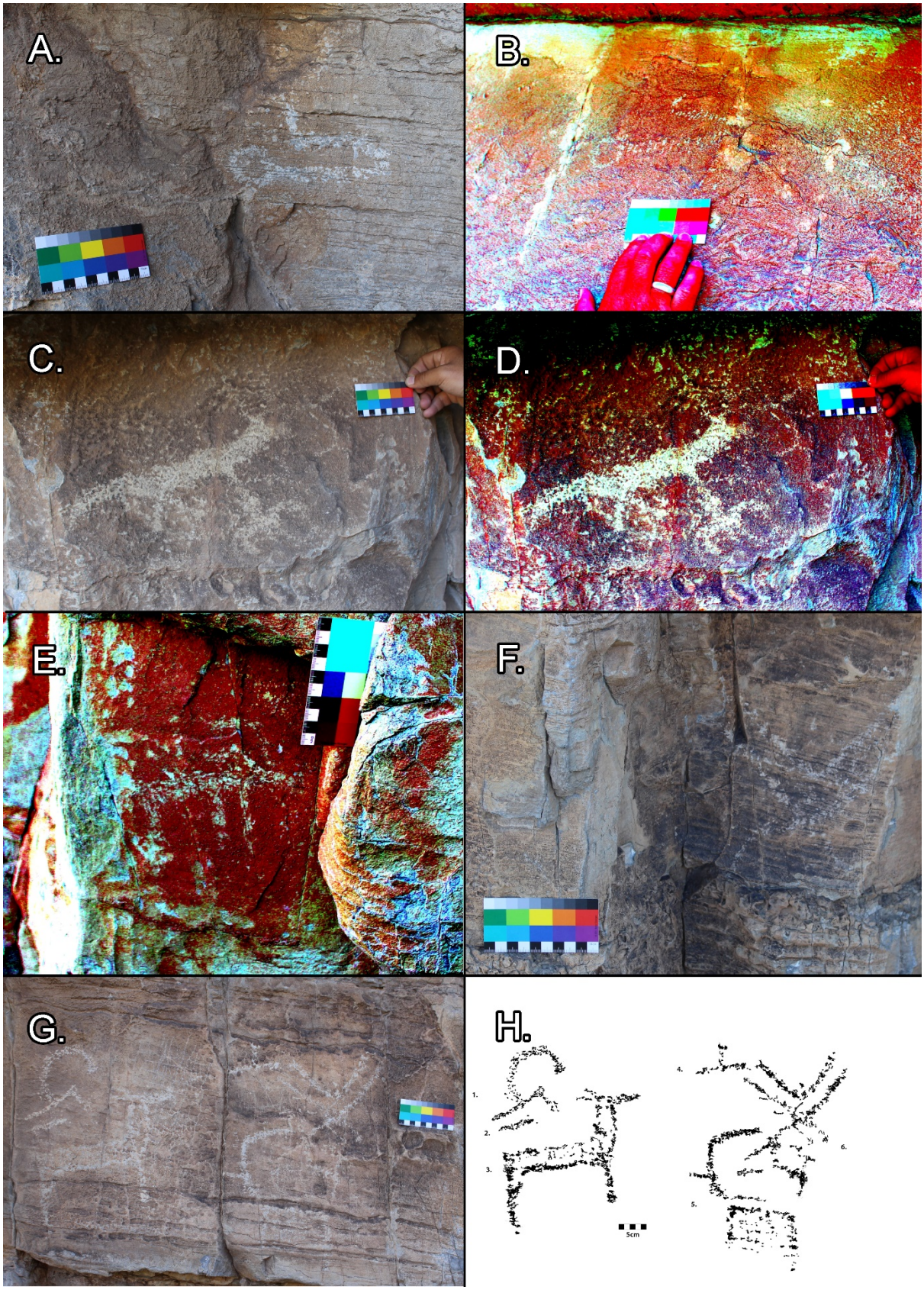

Fig. 5. Petroglyphs from Gazar Agui 13. (A) Panel 1 showing a tamga. (B) DStretch YWE (15%) colour image of Panel 11 showing a tamga (same shape as Panel 1).

(C, D) DStretch YRD (15%) colour image of Panel 3 showing a male horse (top) and a horse and with anthropomorphic rider (bottom). (E) DStretch YRD (15%) colour of Panel 5 showing a caprine. (F) Panel 8, linear depiction of bird. (G, H) Outlines of Panel 7 petroglyphs showing a caprine (1), a line (2), a horse or doe (3), a tamga (4), a box-shaped caprine (5) and a bird (6).

3.3. Saalit Agui

Upon re-visiting Saalit Agui, we relocated the majority of the original described paintings, though several degraded rock paintings were noted. Ochre is heavily worn away on many of the existing paintings, and their full extents could only be discerned using the photographic editing plugin DStretch (Harman, 2005) for the software ImageJ (Schneider et al., 2012) (See methods in S.I. Section 1). This technique highlighted the full occurrence of the ochre as well as the extent of visual loss. In Panel 1c (Fig. 6C), the upper left “X” no longer carries its notable shape and has been distorted, likely due to the flaking of the patina it was painted on. We were unable to re-locate Panels 3 and 4 (Derevianko et al., 1998, figs. 147 & 148). Several black and white outlines can be found tracing around some of the figures. It was not possible to discern whether they were modern, as their presence is not noted in the original tracings, though white outlining of ochre is common on other regional rock art (Batbold et al., 2016, figs. 16–19). DStretch allowed us to identify several additional areas of ochre markings not recorded in the original investigations. This was the case for Panel 1b, which has an unrecorded smudge of ochre below one of the anthropomorphic figures (Fig. 6B). In Panel 2 (Fig. 6E), though heavily faded, additional lines to the right of the largest X can now be seen, extended painting of the lower figure, making it look like the head of a caprine, though the heavy abrasion on the rest of the ochre and the black outlines make this difficult to identify. An additional ochre line (Fig. 6F) above Panel 2 is also visible. We identified two additional Panels, 5 (Fig. 6H) and 6 (Fig. 6G), which respectively represent a line and several Vs with a large spread of ochre in the corner. The presence of the anthropomorphic figures, which resemble early “birthing women” or “dancing” figures in Mongolian rock art, together with the “X”, suggests the ochre paintings from Saalit Agui might date from the Mesolithic to the Bronze Age (Jacobson-Tepfer and Meacham, 2010; Batbold et al., 2016).

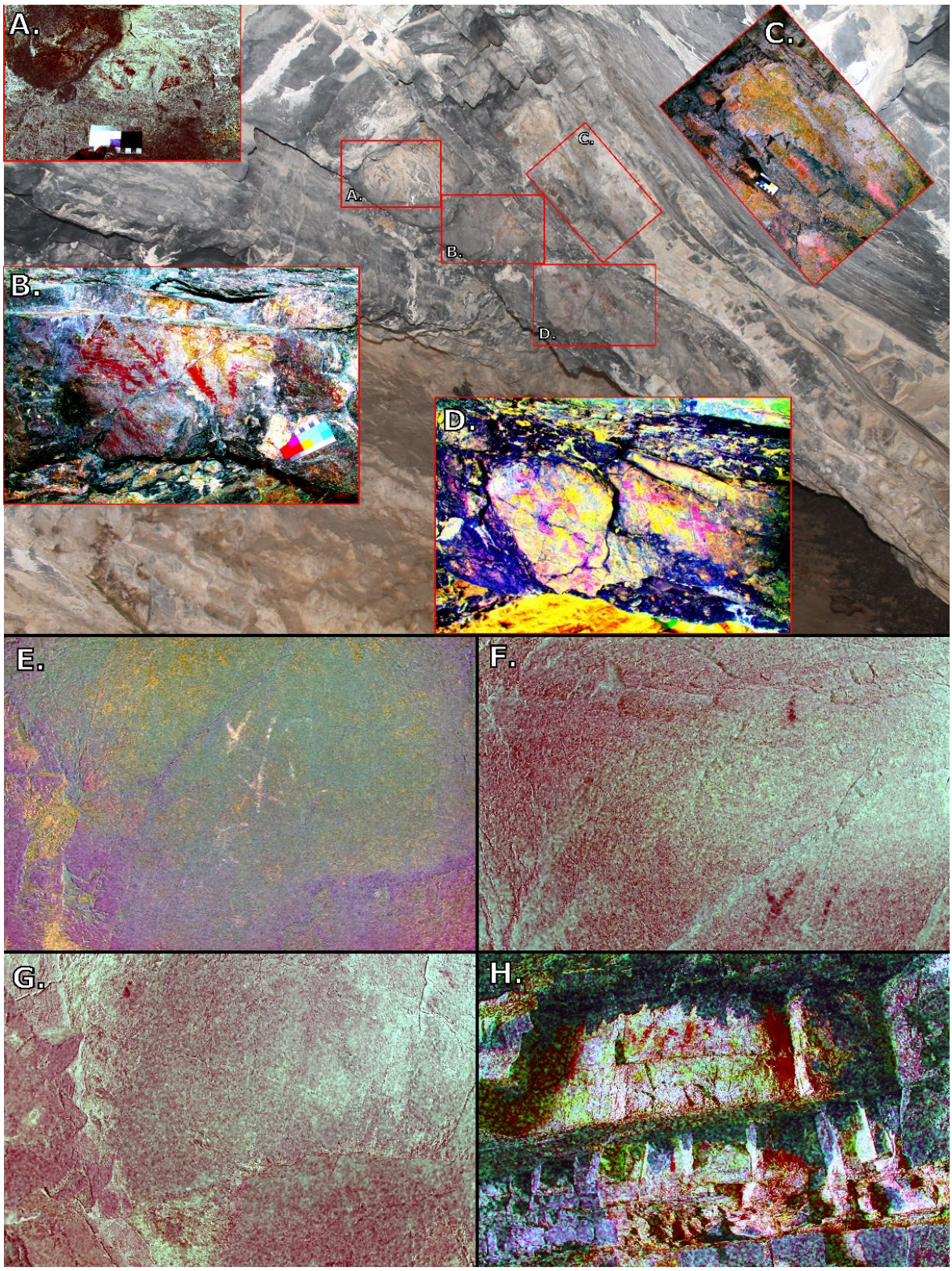

Fig. 6. Rock art from Saalit Agui. (A) Panel 1a with DStretch YRE (15%) showing four painted lines. (B) Panel 1b with DStretch YRD (15%), showing an

406 anthropomorph, two “X”s and four lines. (C) Panel 1c with DStretch LBL (15%)
407 showing two “X”s. (D) Panel 1d with DStretch YBK (15%), showing two
408 anthropomorphs and two “X”s. (E) Panel 2 with LABI (15%), showing two “X”s, two
409 lines, and possibly the head of caprine. (F) Panel 2 (upper) with small ochre line,
410 previously not recorded DStretch YRE (15%). (G) Panel 6 with DStretch YRE (15%),
411 with newly records painted line. (H) Panel 5 with DStretch YRD (25%), with two
412 broken “X”s, a line and painted corner (top right).

413 **3.4. Unegt Uul**

414 At Unegt Uul, 10 schist outcrops were documented, including 34 panels with a total
415 of 95 petroglyphs, distributed over 1250 m in an WNW-ESE direction (Fig. 3A).
416 Caprines (n=35) are the most common animals depicted on the outcrops. The
417 caprines are standardised in their characteristics (Table 2), with a distinctive
418 backwards curving horn, two visible legs and a raised short tail. Horses (n=25) are
419 the second most common animal depicted and they appear both in wild and
420 domestic scenes. Bovines (n=7) also show standardisation, with large torsos and
421 snouts, and two-pronged horns that meet in the middle (Fig. 7 D-F). Deer (n=9)
422 generally have distinctive antlers, drawn like ladders, with one possible exception in
423 Panel 2.2 (S.I. Fig. 23) where they are depicted with more stylised horns. A potential
424 moose can also be identified in Panel 2.1 (Fig. 7H), distinct for its dewlap and long
425 rounded snout. The westernmost outcrop 1 is the largest with 18 separate panels on
426 it.

427 The panels are characterized by different levels of detail and ways of depicting
428 similar animals. Panel 1.7 (Fig. 7 A, B) is the largest, containing 22 individual
429 animals. Rough linear peckings of horses, finely pecked goats, and deer, are all
430 clearly identifiable on this panel. There is also clear evidence of one canid,
431 petroglyph 16 in Fig. 7B, due to the presence of claws. Petroglyph 17 is missing
432 claws but could also represent a canid, considering the similarities in size and body
433 features. One of the smaller images (no. 19) is distinct and has two pronged horns, it
434 could be a gazelle or saiga antelope. Domesticated animals are also present in
435 several panels, for example, in Panel 1.10 (Fig. 7 C, D), which depicts a petroglyph
436 of a bovine pulling a cart. Other examples of domesticates include Panel 2.1 (Fig.
437 7H) which has an anthropomorphic figure with a bow and arrow riding a horse.

Panel 1.10 with the chariot could be from the Early/Middle Bronze Age or younger (Taylor et al., 2017; 2020a). The presence of a potential moose in the same panel may provide a narrower time frame, as the species does not seem to present in other Mongolian rock art after the Middle Bronze Age (Jacobson-Tepfer and Meacham, 2010). The horse-riding scene in Panels 2.1, 1.18, 1.11 and 10.1 dates these panels to after ca. 3200 cal BP (Taylor et al., 2017).

Many of the panels are in good condition, but some depictions have suffered from cracking of the underlying schist. One of the main forms of damage is the loss of sections of the patina on the schist. Panel 1.11's host rock also shows damage to the schist, which resulted in the removal of the head of a possible horse. Similar damage occurs in Panel 4.1, where the patina on the schist that contained the body of a pecked argali has spalled off and only the distinctive horns remain. The same type of damage has occurred on Panel 2.2, at the lower end of a deer. Another way that damage manifests itself is through cracking of the desert varnish surface or the host rock. Panel 1.10 (Fig. C,D) has a large crack dividing the engraving, particularly the cart and the legs of the bovid. Panel 1.17 (Fig. 7H) is severely affected by fracturing of the desert varnish making both argali petroglyphs difficult to identify.

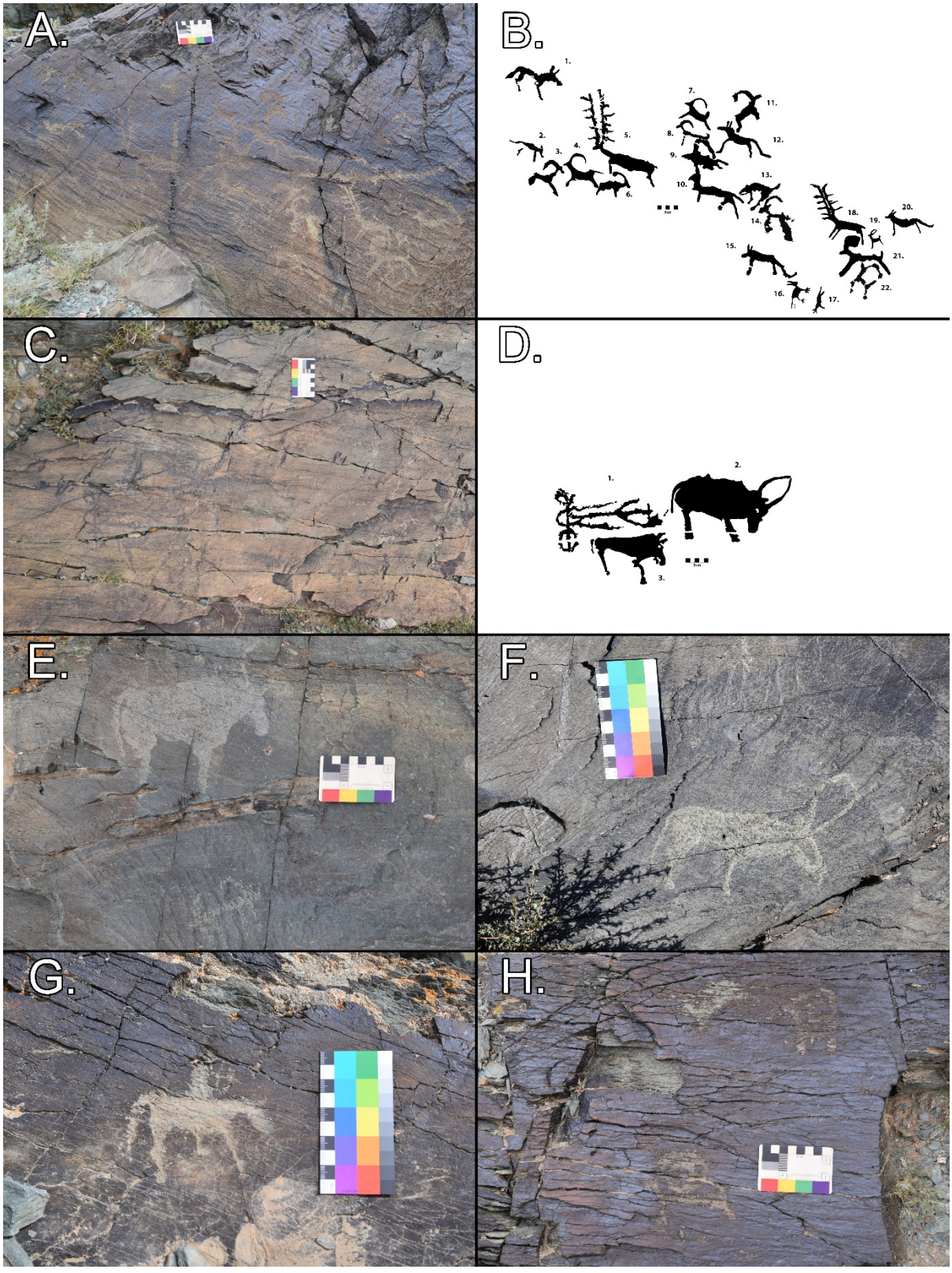

Fig. 7. Rock art at Unegt Uul. (A, B) Panel 1.7 contains the largest variety of fauna, including caprines, horses, a canid, a gazelle; and the outlines of the petroglyphs from Panel 1.7. (C, D) Drawn outlines of Panel 1.10 containing bovine pulling a cart and horse beside it. (E) Panel 1.12 with detailed bovine (top) and coarse caprine

(bottom). (F) Panel 1.15 petroglyph of bovine. (G) Panel 2.1 depicts a single horse rider with bow and arrow. (H) Panel 1.17 shows two argali sheep petroglyphs on a heavily weathered surface.

4. Discussion

4.1. Relative rock art chronology and comparisons

The motifs and symbols we documented at the four Gobi-Altai sites share morphological characteristics that are similar to documented petroglyphs from other sites in the Gobi-Altai and to those at Arkhangai, Bayan-Ulgii and Umnugobi provinces, implying cultural connections among the Khangai, Altai, and Gobi Desert regions as early as the Mesolithic. The paintings of Saalit Agui contain two of the three common images in ochre paintings found throughout Mongolia, namely anthropomorphic figures and “X” symbols (Batbold et al., 2016). “X” symbols are found in different regions and sites, such as the open-air sites of Baga Gazryn Chuluu and Toonot Agui (Batbold et al., 2016, pp. 48–49). The anthropomorphic figures found in Saalit Agui have the same stance as the petroglyphs in Dalain Duulga (Batbold et al., 2016, p. 191,199), Javkhlant Khairkhan in the Umnugobi province (Tseveendorj et al., 2004) and Aral Tolgoi in Bayan-Ulgii (Kubarev, 2007, fig. 6 (37); Jacobson-Tepfer, 2015, fig. 4.1). The raised arms, crouched legs, and linear protrusion between the legs of these figures (Fig. 8 B, C) have been referred to as Mesolithic representations of “birthing mothers” (Jacobson-Tepfer, 2015). Their widespread presence across Mongolia may indicate shared origins in pictorial traditions. These depictions, using different mediums, indicate that specific imagery is not restricted to any rock art method or technique.

The engraved petroglyphs at the Gazar Agui 1 are poorly preserved, but it is possible to suggest an attribution to the Neolithic or Bronze Age. The anthropogenic figures from Panel 5 are near identical in shape (Fig. 8A) to the ochre paintings at Bunkhantyn Khad in the Arkhangai province (Batbold et al., 2016, fig. 14). At the Gazar Agui 13 rock shelter, the squared goat in Panel 7 is similar to other animals found in the Tsagaan Salaa and Baga Oigor complex (Jacobson-Tepfer, 2019, p.

228). The remainder of the animal depictions match classic silhouetted petroglyphs that have been attributed by previous researchers to the Late Bronze Age.

The tamga petroglyphs (Fig. 8 D, E) differ from others recorded nearby in the Gobi-Altai Mountains, such as Shakhar Tolgoi, Byatskhan and Salkhit in Bayan Uul Soum (county) (Batbold et al., 2016, figs. 331–333), as well as Tsagaan Gol in Khaliun county (Kwang-jin et al., 2010; Turbat et al., 2012). The first use of tamgas is not well documented, but their occurrence in dated archaeological contexts links them to the Iron Age, and perhaps as far back as the Late Bronze Age (see Taylor et al., 2020b, fig. 9). Despite the physical proximity of Gazar Agui 1 and 13, there is very little resemblance in their motifs and style. It is possible that there is no historical connection between the sites. The caves have a clear symbolic importance, but the lack of archaeological material during excavations make it difficult to fully understand the extent of their significance.

The petroglyphs at Unegt Uul suggest use of this locality across the Bronze and Iron Ages. However, the rider with a bow, which dates to ca. 3000 cal BP or after, is pictured alone and is separated from panels depicting wildlife. The panels of wildlife (such as in Panel 1.7) are more likely depicting the biodiversity encountered by pre-Late Bronze Age hunters. Middle Bronze Age technologies and domesticates, including the cart pulled by a bovine in Panel 1.10, mirror similar figures found in Sazyn Khond, in the Bayan-Uul county of Gobi-Altai (Batbold et al., 2016, fig. 212). The continuous use of desert varnish outcrops across different periods is quite common in other parts of Mongolia. For example, the petroglyph site of Shakhar Tolgoi, located in the same mountain valley, contains apparent Bronze Age petroglyphs together with Turkic Khaganate period rock art (Tseveendorj et al., 2007).

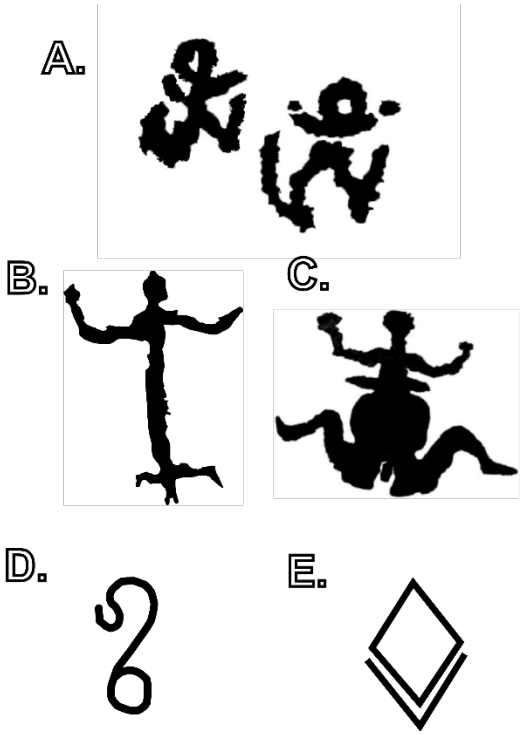

Fig. 8. Rock art and tamga symbols similar to those found in this article. (A) Outline of ochre painted anthropomorphic figures from Bunkhantyn Khad (adapted from Batbold et al., 2016, fig. 14). (B) Outline of petroglyphs of Pre-Bronze Age “birthing women” from Aral Tolgoi (adapted from Jacobson-Tepfer, 2015, fig. 4.1). (C) Outline of Bronze Age, more detailed, “birthing woman” in the Biluut Petroglyph Complex from Kortum (2014, fig. 19). (D, E) Two tamga symbols similar to those found in Panel 1, 11 and 6 at Gazar Agui 13 (adapted from anonymous source in Fijn, 2011, fig. 4.4).

4.2. Environment and biogeography

The presence of wetland and forest fauna in potential Early Bronze Age rock art panels suggests the use of this landscape by hunters and hunter/pastoralists in the wet phases of the Early Holocene. Wild animals indicate the presence of forest taxa during high-activity periods. The wet periods of the Early Holocene in the Gobi-Altai (Batbaatar et al., 2018; Klinge and Sauer, 2019) may have increased lake water levels in Khutag Nuur, improving grazing conditions and freshwater sources. Today, only a few mountains in the Gobi-Altai have conifer forest islands between 2500-

3000 m a.s.l. (Miehe et al., 2007; Battulga et al., 2018). Prior to ca. 5 ka cal BP, it is likely that taiga forests extended across the region (Cermak et al., 2005; Miehe et al., 2007).

The faunal rock art depicts a variety of wild animals that might reflect a forested/marsh landscape, linked to Early Bronze Age climates. At Unegt Uul, the main panel (1.7) has a large number of caprines present in the panels, which may attest to their continued ubiquity in the landscape throughout the Holocene. However, other taxa such as deer, boar and moose – adapted to forest conditions - are uncommon in the region today. Their presence is attributable to the early Bronze Age, and is suggestive of a wetter and forested period, which likely dates to before the mid-Holocene dry period of ca. 4.5 ka cal BP. The absence of avian petroglyphs at Khutag Nuur is unusual, seeing that Mongolian wetlands are hotspots for bird diversity (Gombobaatar et al., 2012; Ganbold et al., 2018), and they are present at Gazar Agui 13 and other Bronze Age sites (Kubarev and Zabelin, 2006). Bird petroglyphs at Gazar 13 likely reflect the important role that this area played in avian migrations. Rock shelters such as Gazar 13 are attractive for birds, particularly raptors. This is reflected by both the microfaunal assemblage of bird and lagomorph bones at Gazar Agui 13, as well as the area being a hotspot of biodiversity in the greater region (Gombobaatar et al., 2012). Therefore, the selective representation of terrestrial forest taxa in the panels at Unegt Uul likely held a higher priority for hunters in these landscapes. This mountain oasis was a prime area for hunter-gatherers and early hunting pastoralists, similar to the lakes found in the Gobi Desert (Janz et al., 2017). Pre-existing Late Holocene lithic technology would have been optimised for hunting medium-large mammals, reflected by the larger mammals present in most of the rock art panels.

In contrast to earlier periods, the predominance of Iron Age economies and technologies, specifically mounted horseback riding in some panels suggests that this innovation was necessary for expanded use of the Gobi-Altai region (Taylor et al., 2020a). During the Early-Mid Holocene, the rivers of the area and streams were likely perennial sources for water (Stolz et al., 2012), making nearby fresh water readily available. The drier Late Holocene period probably affected the suitability of the area for year-round grazing. The environmental data for the Late Bronze Age and Early Iron Age in the Gobi-Altai indicate the drying of lakes (Lehmkuhl et al.,

2018), but wet signatures are noted in mountain glaciers and fossil wood records (Batbaatar et al., 2018; Klinge and Sauer, 2019). In Gazar Agui 13, the presence of the horse rider figure, and the absence of hunting iconography, suggest that most of the animal depictions in the rock art may be domesticates. The increased mobility provided by horse riding likely made the more arid Mongolian landscapes of drier periods viable locales of human activity. Later periods of nomadic empires (Turkic and Uighur) suggest that the overreliance on herds made survival more difficult during climatic amelioration (Di Cosmo et al., 2017; 2018), whereas extensive wet periods aided in the creation of large hegemonies such as the Mongol Empire (Pederson et al., 2014; Putnam et al., 2016). Thus, perhaps the hunting and herding strategies of early horse riders provided greater environmental plasticity.

Across both the Bronze and Iron Age, the strategic position of schist outcrops at Unegt Uul, as well as the presence of desert varnish, made it an ideal location for rock art (Fig 2D). Rock art sites with a wide viewshed may carry additional significance (Jacobson-Tepfer, 2019, pp. 98–99), as the location of rock art in mountain passes is often associated with commonly traversed routes (O'Sullivan, 2019). Because of its highly visible location, we suggest that the panels at Unegt Uul reflect a high-traffic area, and the panels at this location might have carried important semantic meaning (i.e. that the surrounding Khutag Nuur basin was ideal hunting ground). In contrast, Gazar Agui 1 & 13 do not provide an advantageous position in the landscape but may have provided temporary shelter and served a symbolic purpose.

Thus, consideration of rock art content alongside paleoenvironmental data suggest that while drying of the Gobi may have reduced the suitability of the area for hunting during the Late Holocene, the additional mobility provided by horse riding and the emergence of mobile pastoralism, supplemented by hunting, enabled continued use of the region from the Late Bronze and Early Iron Ages.

4.3. Preservation

Currently, all known painted sites in Mongolia are in caves or on vertically sheltered locations (Terguunbayar and Ankhsanaa, 2019). If painting was conducted in open-air contexts in the past, intensive aeolian erosion mechanisms would lead to the

obliteration of the depictions. Southern Mongolia is subject to a high degree of wind deflation and abrasion (Jugder et al., 2018), which could account for the higher frequency of ochre paintings in the north (Fig. 1). Paintings are also particularly sensitive to atmospheric damage, hence the increasing aridity in Mongolia poses a sustained threat to this type of art.

Petroglyph sites are durable in comparison to painted sites, of course, though they too suffer from weathering and environmental damage.

Open-air rock art sites, such as at Unegt Uul, are prone to alterations by environmental actions. Damage to the cortex of desert varnish has significantly altered petroglyphs at Unegt Uul, likely caused by either thermal stress or wind erosion. Metamorphic rocks generally exhibit crystallization, compact textures, high strength, small porosity and low water permeability. In this case, high levels of foliation lower the resistance against weathering. In today's climate, weathering is driven mainly by temperature changes, humidity variations, and strong winds. Therefore, fluctuations in temperature give rise to insolation weathering and freeze-thaw phenomena, affecting rock art preservation, which is a common problem across Mongolia (Jacobson-Tepfer, 2019, p. 71). In addition, humidity changes encourage wetting and drying processes as well as haloclasty. Furthermore, due to the absence of vegetation, aeolian mobilization of sand, dust and salt erode surfaces with petroglyphs. Soft metamorphic rocks, such as the schists at Unegt Uul, exfoliate naturally at a rate of 1-10 mm per millennium (Bednarik, 2017). It is therefore anticipated that freeze-thaw cycles will contribute to an increasing amount of damage to rock art in the future.

Modern activity may also be considered an on-going threat to the long-term preservation of rock art in Mongolia. Modern pecking and scratching of Mongolian petroglyphs is a common occurrence, though some researchers see it as part of the rock art's on-going life cycle (O'Sullivan, 2020). Despite this view, vandalism is a significant problem for the long-term preservation of ancient forms of rock art. Our newly documented assemblage at Gazar Agui 1, for example, shows well preserved sections in the panels, except for alterations on Panel 5. In many other cases, modern actions have obscured and obliterated petroglyphs, making it sometimes impossible to examine prehistoric images and methods of production.

5. Conclusion

We have examined a set of rock art sites in the Gobi-Altai region, and provided a relative outline of the potential chronology of the depictions, allowing us to assess environmental and subsistence changes across the Holocene. Comparative study tentatively places Saalit Agui to the Mesolithic, Gazar Agui 1 to the Neolithic, and Gazar Agui 13 and Unegt Uul to the Late-Bronze or Iron Age. Gazar Agui 13 and Unegt Uul appear to be closely connected to the complexes at Shakhar Tolgoi and Tsagaan Gol, in the Gobi-Altai Mountains, in their depictions of animals and tamgas.

From a palaeoenvironmental perspective, the wet periods of the Early Holocene likely meant that the regions around the sites were forested, with expanded lakes and surrounding wetlands. During this humid period, animals such as deer, canids and wild horses are reflected in the rock art. During the Late Holocene, drier climatic conditions are present, and archaeological evidence indicates that this corresponds with the pastoralism in the Early Iron Age in the Gobi. Mounted horseback riding, as depicted in the rock art, illustrates the sustained use of the Gobi outside of wet phases.

The aim of our study was to record rock art sites in the Gobi-Altai region in order to complement previous research carried out in Mongolia. Improvement of recording methods and the creation of extensive and detailed databases will aid in the documentation and the protection of the rock art sites. Further surveys of caves and open-air sites in search for rock art will help us to expand our knowledge about past environments and the changes in the population history of Mongolia.

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989 **Table 1**

Dates, ca. cal BP	Archaeological Period	Janz's periods[2]	Geological subdivision[2]	Temp.[3]*	Moisture[3]*	Vegetation	Rock art[4]		
							Anthropomorphic	Domesticated fauna	Wild fauna
>13,500	Late Upper Palaeolithic		Late Pleistocene (Glacial)	Cold	Dry	Desert Steppe	-	-	Mammoth, aurochs, bactrian camel, woolly rhinoceros, ostrich
13,500 - 8000	Mesolithic	Oasis 1	LP -> Early Holocene	Warm	Wet	Forested/ Wetland marshes	"birthing" women	-	Aurochs, argali, ibex, horses, moose, bear, ostrich
8,000 - 5,000	Neolithic	Oasis 2	Middle Holocene	-	Wet	Forested/ Wetland marshes	Hunters, "birthing" women, "spirit" figures	-	Aurochs, argali, ibex, horses, bear, moose, deer, canids
5000 - 3500	Early/Middle Bronze Age	Oasis 3	Middle - Late Holocene	Cold	Wet	Wetland marshes	Hunters, "birthing" women, "spirit" figures, carts, chariots, herding, combat	Goats, bovine	Aurochs, argali, ibex, horses, elk, bear, moose, deer, canids
3500 - 2900	Late Bronze Age	Oasis 3	Late Holocene	-	Dry	Steppe	Hunters, "birthing" women, carts, chariots, herding, combat	Horses, goats, bovine, bactrian camel, dogs	Argali, ibex, elk, deer, stylised deer, canids
2900 - 1450	Iron Age		Late Holocene	-	Dry	Desert Steppe	Hunters, "birthing" women, carts, chariots, herding, combat, horse and camel riders,	Horses, goats, bovine, bactrian camel, dogs	Argali, ibex, elk, deer, leopards, canids

1. (Janz, 2012), 2. (Walker et al., 2012), 3. (Klinge and Sauer, 2019), 4. (Jacobson-Tepfer and Meacham, 2010)

*based on Gobi-Altai palaeoenvironmental records

Table 2

Petroglyph features	Anthropomorph	Caprine (goat/ibex)	Caprine (argali)	Gazelle/Saiga	Horse	Bos
Limbs	Downward pointing legs, upwards pointing arms, sometimes feet	2-4 downward legs	2-4 downward legs	2-4 downward legs	2-4 downward legs (sometimes with stifle and hock joints present in the hind legs)	2-4 downward legs
Body	Vertical line or centre of joining limbs	Horizontal (line or cylindrical) body	Horizontal (line or cylindrical) body	Horizontal (line or cylindrical) body	Horizontal (line or cylindrical) body	Large realistic body
Head	Teardrop or circle	Nondescript snout	Nondescript snout	Nondescript snout	Curved snout	Nondescript snout
Tail	-	Short upward pointed tail	Short upward pointed tail	Short upward pointed tail	Long downward curved tail	Short downward pointed tail
Ears	-	Possible ear	None	None	Two short ears	Single ear
Horns	-	Semi-circular curve horn	Spiral shaped horn	Two curved horns that meet at end	None	Two curved horns that meet at end
Other notes	Can be found riding animal, and/or with weapons like bows, can also display phallus	Sometimes has phallus	-	-	Domesticated have anthropomorphic rider	All are likely domesticates
Example:						

	Deer	Canid	Bird	Moose	Boar	Chariot/cart
Limbs	2-4 downward legs	2-4 downward legs (possibly with claws)	1-2 linear legs and 2 wings forming V shape	2-4 downward legs	2 downwards legs, thicker and longer hind legs	2 opposing wheels Centre axle
Body	Horizontal (line or cylindrical) body	Small horizontal (line or cylindrical) body	Created by joined lines from wings	Horizontal (line or cylindrical) body	Curved cylindrical body	Central circular platform Pole
Head	Nondescript snout	Nondescript snout	Dot or not visible	Long rounded snout, including dewlap	Large head with pointed snout	Beam Yoke Reins
Tail	Short upward pointed tail	Short horizontal or upward curved tail	Downward pointing line	Short downward pointed tail	Upward pointed tail	
Ears	Two ears	Two long ears		Two short ears (female)	One small ear	
Horns	Two vertical antlers with "ladder rungs" (Females have none), later versions have more elaborate horns	-	-	Crown like antlers (male)	-	
Other notes	-	Can look like horse (lack the long tail)	-	-	-	
Example: