



KEYWORDS: *Rock art – Microerosion – Precipitation estimation – Ili Valley – China*

## THE RECORDING OF FOUR NEWLY DISCOVERED ROCK ART SITES AND SCIENTIFIC RESEARCH IN THE ILI VALLEY, NORTHWEST CHINA

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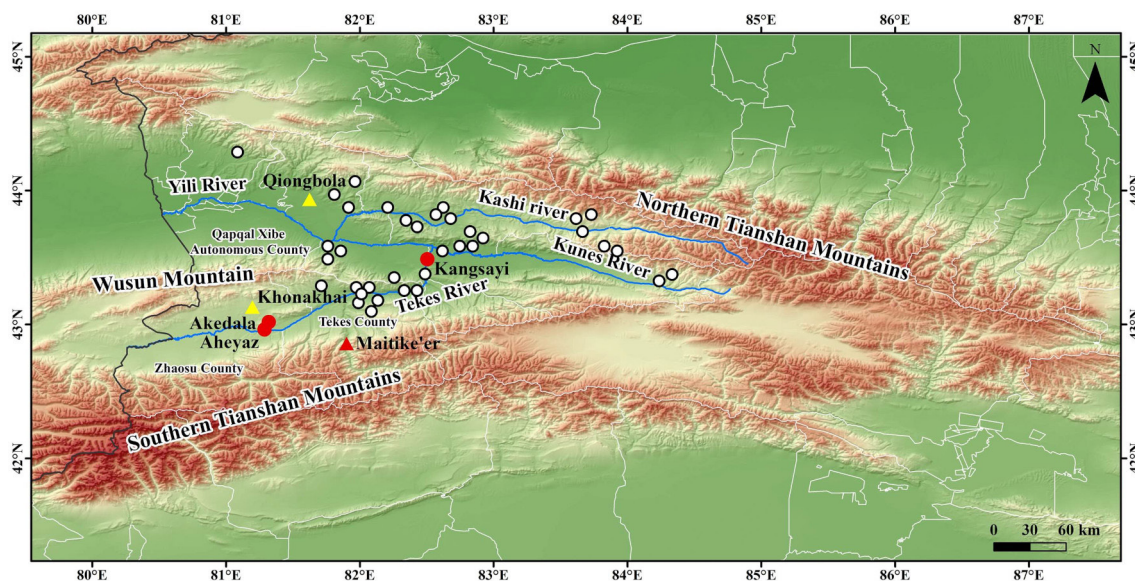
**Abstract.** The Ili Valley, a key area for trans-Eurasian cultural communications, occupies a significant geographical location in Central Asia. This paper documents four newly discovered rock art sites in this area. The sites, predominantly featuring 'ibex' motifs, reflect the region's nomadic cultural heritage and ecological environment. Furthermore, microerosion analysis, employing the Universal Calibration Curve, was conducted on petroglyphs and a stone menhir, accounting for orographic precipitation effects. The results underscore the cultural significance of these sites as markers of ancient nomadic life in the Ili Valley and highlight the challenges of dating in mountainous regions.

### 1. Introduction

Xinjiang Uyghur Autonomous Region (referred to hereafter as Xinjiang), known as Xiyu (the Western Area) in ancient times, is located in the hinterland of Eurasia, northwest China. Rock art was continuously created from the Neolithic Age to the Qing Dynasty in the late 19th century CE. Rock art is mainly distributed across the Altai Mountains, Tianshan Mountains, Kunlun Mountains, as well as the Junggar Basin and the Tarim Basin, surrounded by the three mountain

ranges (XWZW 2011). Rock art occurs near mountainous routes or areas ideal for animal husbandry that were closely linked to the travel routes of ancient nomads passing through the area (Wang 1956). Xinjiang rock art is numerous and extremely rich in styles, which reflect scenes of local nomadic people's life for thousands of years.

The Ili Valley is located in northwest Xinjiang, north of the Tianshan Mountains. This area, endowed with a humid climate, thriving water resources and



**Figure 1.** Distribution of the Ili Valley rock art. Triangles refer to the rock art sites that have been dated. Red marks refer to the newly discovered rock art sites. White dots refer to the other rock art sites of the Ili Valley. Map by WS.

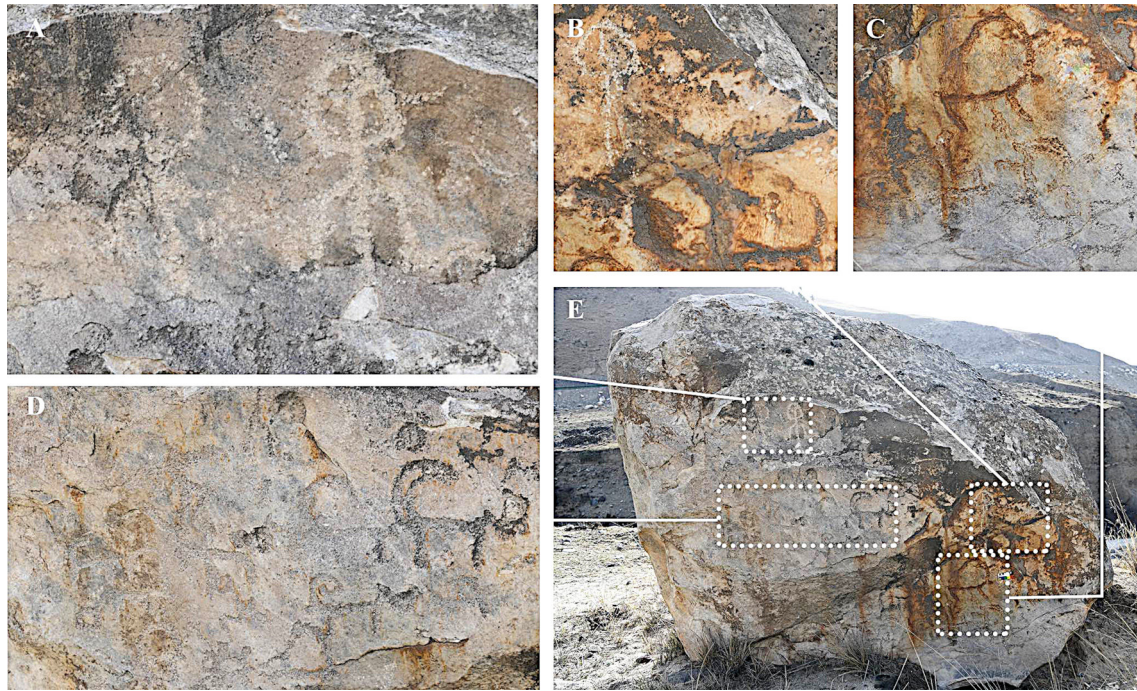


Figure 2. The Aheyaz petroglyph site and a close-up view of each pattern.

exceptional ecological conditions, has served as a historic multi-ethnic convergence area since antiquity. Simultaneously, it was a pivotal corridor for trans-Eurasian population migrations, cultural interactions, and knowledge transmission across inland Eurasia (XWZW 2011).

Based on the Third National Survey of Cultural Heritage conducted by the Chinese government from 2007 to 2011, 40 rock art sites were documented in the Ili Valley (Fig. 1). Recent intensified field investigations have led to the discovery of four additional rock art sites at Zhaosu and Tekes county, which are not recorded in the Third National Survey of Cultural Heritage. This study aims to record these newly iden-

tified sites' iconographic characteristics and cultural attributes. It reports the microerosion analysis on some representative petroglyphs and one stone menhir distributed across the northern and southern slopes of the Wusun Mountain. Furthermore, when applying the Universal Calibration Curve (UCC) for microerosion analysis, we address critical factors in precipitation parameterisation specific to the Ili Valley's orographic precipitation system (Fig. 1).

2. Fieldwork in Zhaosu and Tekes Counties

2.1. Zhaosu County

The main range of the Tianshan Mountains covers the eastern side of Zhaosu County, while the Wusun

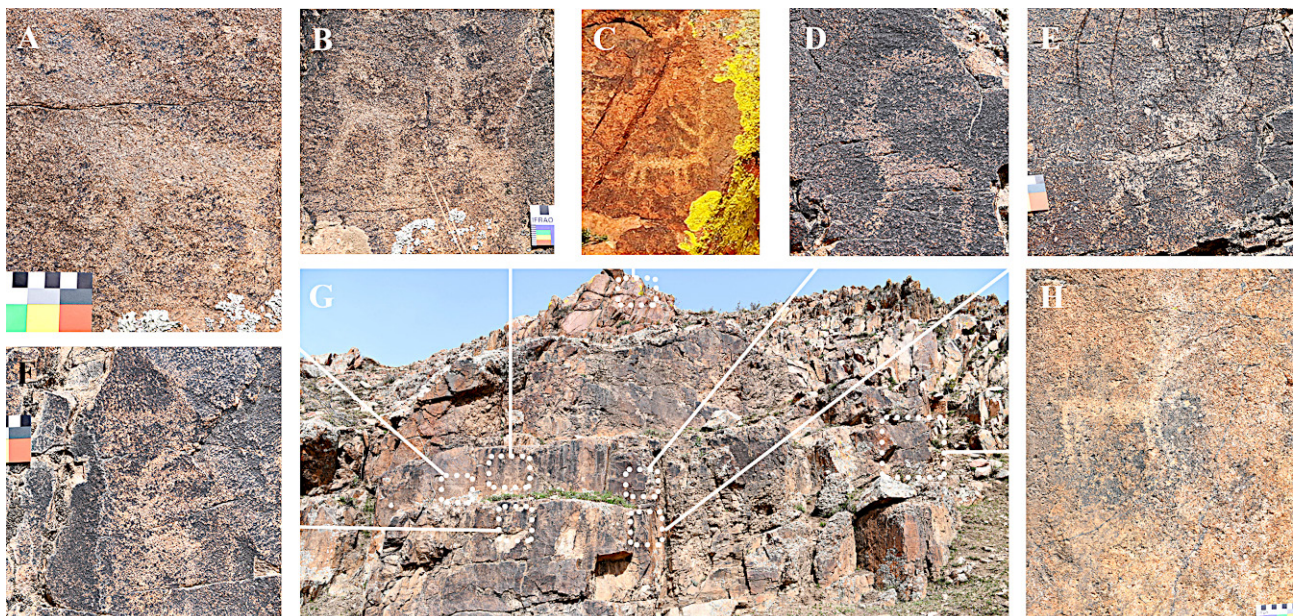


Figure 3. The Akedala petroglyph site and a close-up view of each pattern.

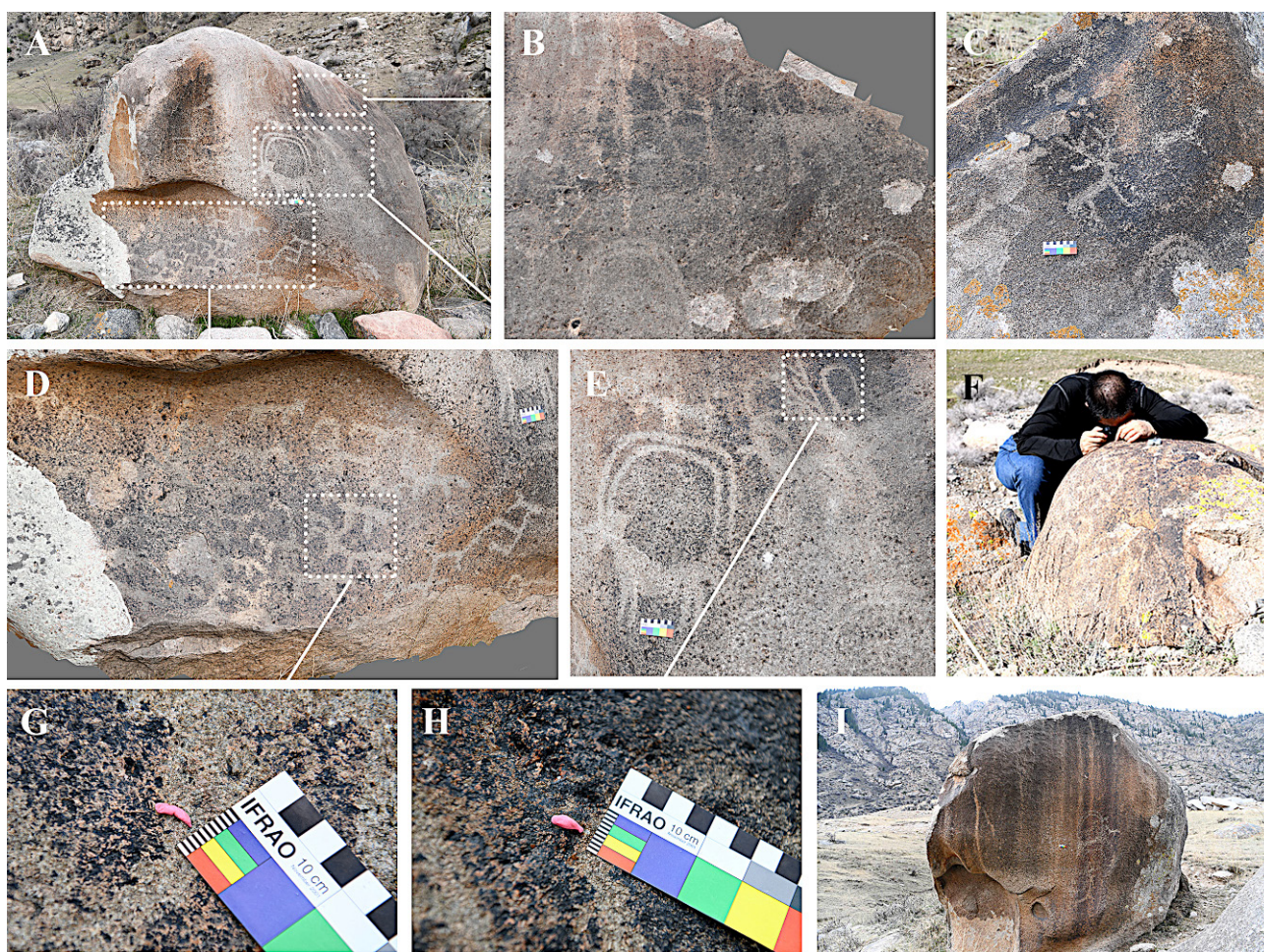


Figure 4. A–D: the Maitike'er petroglyph site 1 and close-up view of each pattern; E–F: the Maitike'er petroglyph site 2 and close-up view.

Mountains are to the north. To the west, Zhaosu shares a border with Kazakhstan. The county's terrain forms a basin that is relatively high on the southern, western and northern sides while lower in the east.

#### 2.1.1. The Aheyaz Site

The Aheyaz petroglyph site (elevation 1375 m above sea-level; Fig. 2) is located inside the middle part of the Aheyaz Valley, where the river surface is flat and open, with an elevation of 1900–2100 m above sea-level. Several 'ibexes' and 'argalis' are engraved on a 2.9-m-long, 2-m-high boulder.

#### 2.1.2. The Akedala Site

The Akedala petroglyph (elevation 1694.2 m a.s.l.; Fig. 3) is located at the riverside of the Akedala gully and in hilly areas. This survey has located a petroglyph site with 'ibex' and 'deer' images engraved on the cliff. Some patterns have become unclear due to the weathering of the stone.

### 2.2. Tekes County

Tekes County lies on the northern foothills of the western part of the Tianshan Mountain range. It borders Zhaosu County to the west and Qapqal Xibe

Autonomous County to the northwest. The county's terrain is mainly mountainous, and it also contains the basin of the Tekes Valley. The county's elevation is high on the south and north and low on the east and west. The southern range of the Tianshan Mountains cuts through the south of the county, while the northern range passes through the north, encircling the flatland of the Tekes Valley in the middle. The county's name comes from the Tekes River, the largest tributary of the Ili River, flowing through the county from west to east.

#### 2.2.1. The Maitike'er Sites

The Maitike'er site (elevation 1500 m a.s.l.; Fig. 4) lies at the upper stream of the Kuokesu Valley (the name of which means 'blue' in the Kazakh language). Three boulders with petroglyphs are identified near Maitike'er thermal spring gully (Fig. 4A, C, F). Boulder one is 2.5 × 3 m, with a well-preserved 'ibex' engraved in the middle, and other blurred 'deers' and 'ibexes' (only the horns of some are legible). Images of 'shepherds', 'dogs' and 'horse-riding humans' appear at the bottom, implying a grazing scene. Engraved 'deer' and 'ibexes' are found on another rock around 200 m from this petroglyph site.

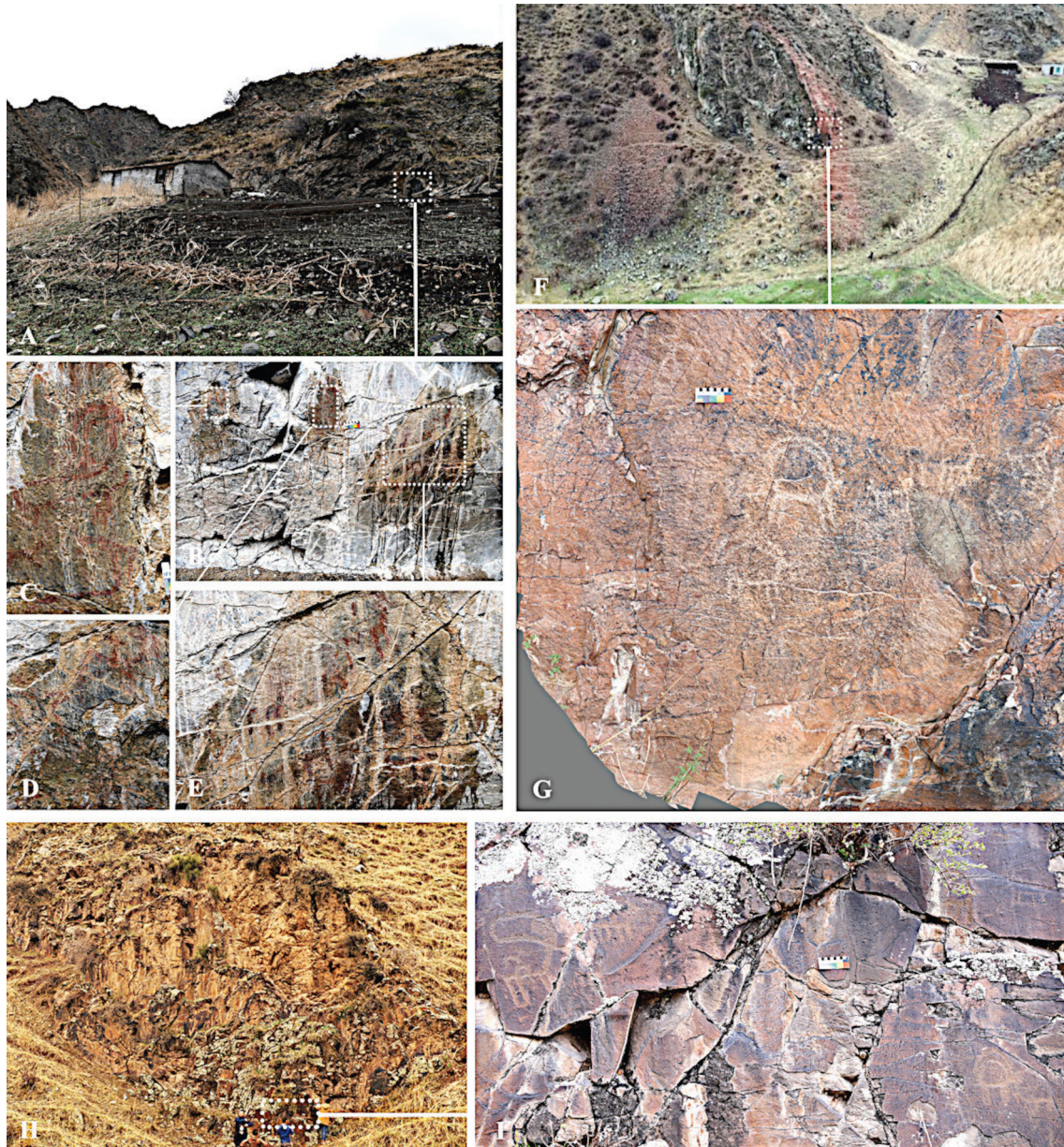


Figure 5. A–E: the Kangsayi rock painting site and close-up view of each pattern; F–G: the Kangsayi petroglyph site 1; H–I: the Kangsayi petroglyph site 2.

### 2.2.2. The Kangsayi Sites

The Kangsayi rock art (elevation 1800 m a.s.l.; Fig. 5) is located inside the gully to the south of Kangsayi, at the northern side of the Tekes River. One pictogram and two petroglyphs are found within a range of 60 m width (east-west) and 260 m length (south-north). Paintings are applied on a limestone rockshelter with ochre pigments. The villagers use the place as a sheep-fold. Most of the images are severely blurred. Close examination suggests that they might represent ibex and other motifs. Some areas of the rockshelter are covered with carbonate, but it does not form a coating above the painted areas. Two other petroglyphs are located 85 m to the northwest and 261 m to the north of the rock painting site, with one showing a 'hunting scene' of 'hunter' and 'ibex', while the other mainly exhibits ibex patterns (Fig. 5F–I).

### 2.3. Iconography analysis

The four newly discovered rock art sites exhibit spatial distribution and imagery characteristics consistent with other rock art in the Ili River Valley. These sites are predominantly located in mountain passes and lush pastoral areas, a distribution pattern reflecting the ancient nomadic peoples' emphasis on strategic transportation routes and resource-rich zones, the valley's geomorphological features and seasonal migration paths. Through analysis of eight rock art panels across the four sites (Table 1), the following key traits are identified: percussion is the dominant method (87.5%), while painting is only used in Panel 1 of the Kangsayi Sites, representing a rare example of pictograms in the region. Silhouetted style prevails (62.5%), characterised by simplified outlines to emphasise dynamic animal forms. Animal motifs

Site	Panel	Motifs	Technique	Style
The Aheyaz Site	1	23 'ibexes', 1 'argali', 2 unknown	percussion	linear
The Akedala Site	1	4 'deer', 2 'ibexes', 2 unidentified	percussion	silhouetted
The Maitike'er Sites	1	1 'deer', 1 'person' on a 'horse', 3 'wolves', 3 'dogs', 12 'ibexes', 1 unknown, several unidentified	percussion	silhouetted, linear
	2	3 'deer', 1 'ibex'	percussion	silhouetted
	3	3 'ibexes', 1 wolf-like, several unidentified	percussion	silhouetted
The Kangsai Sites	1	16 'ibexes', several unidentified	painting	silhouetted, outlined
	2	4 'huntsmen', 3 'dogs', 5 'ibexes'	percussion	silhouetted, linear
	3	8 'ibexes'	percussion	linear

Table 1. Four newly discovered rock art sites in Zhaosu and Tekes County.

dominate the rock art, with 'ibexes' accounting for 72.97% (54 individuals), their prevalence closely tied to the widespread distribution of wild goats in the Ili Valley's mountainous ecosystem. 'Deer' rank second (10.81%, 8 individuals), while 'wolves', 'dogs' and 'argali sheep' appear sporadically, collectively depicting the steppe's ecological community. 'Human' motifs include a 'hunter on horseback', reflecting nomadic hunting practices. These imagery characteristics significantly correlate with the Ili River Valley's geographical environment and its historical nomadic cultural patterns (Gai and Gai 2010).

### 3. Microerosion analysis in the Ili River Valley

#### 3.1. Precipitation estimation

Due to the absence of reliably dated stone artefacts in the surrounding region, there is currently no available local calibration curve for microerosion analysis. To address this limitation, we adopted the Universal Calibration Curve (Bednarik 2019) to estimate appropriate microerosion coefficients.

Situated in the upper reaches of the Ili River, China's Ili Valley features a distinctive trumpet-shaped terrain that narrows eastward and widens westward, with higher elevations in the east and lower in the west. Enclosed by mountains on its northern, eastern and southern sides, the valley opens westward through a gentle outlet oriented toward the Atlantic Ocean, the Mediterranean Sea and Lake Balkhash. This unique topography facilitates the intrusion of moisture-laden air masses from the Atlantic and Caspian Sea regions, creating a humid continental temperate climate. Further enhanced by the Ili River and its three tributaries—the Tekes, Kunes and Kashi Rivers—which traverse Xinjiang from east to west, atmospheric precipitation and glacial meltwater converge into a dense network of waterways. These combined factors make the Ili Valley one of the most precipitation-abundant regions in Xinjiang and across northwestern China.

However, three critical challenges emerge when determining precipitation parameters for the Ili Valley during microerosion analysis employing the Universal Calibration Curve (UCC):

- Inter-study data discrepancy: precipitation records for the same region exhibit significant discrepancies across literature sources (e.g. Zhang 2011; Cheng et al. 2020; Chen 2021), introducing substantial uncertainties in interdisciplinary data selection.
- Orographic bias: research on mountain heritage sites, exemplified by the Ili Valley petroglyphs, predominantly relies on meteorological data from lowland stations. However, such datasets demonstrate systematic bias in characterising montane precipitation due to unaccounted orographic enhancement effects.
- Spatiotemporal data limitations: even mountain meteorological stations exhibit inadequate spatial coverage (average density <0.3 stations/1000 km<sup>2</sup>) and temporally limited records (typical duration <30 years), insufficient for robust regional climate pattern analysis.

Due to a vertical precipitation gradient, the actual annual precipitation at the three rock art sites cannot be directly represented by the precipitation observations from nearby meteorological stations, as they have significant elevation differences. Therefore, we estimated the annual precipitation at the three sites based on the study area's empirical patterns of precipitation gradient. Generally, precipitation increases with elevation until reaching the maximum precipitation height, which is c. 2000 m a.s.l. for the northern slope of the Tianshan Mountain (Su et al. 2007). Below this height, the rate of increase in precipitation with elevation gradually slows.

To develop an equation for precipitation as a function of elevation, we obtained annual precipitation during 2000–2016 from Qapqal, Gongliu, Tekes and Zhaosu meteorological stations from the Statistical

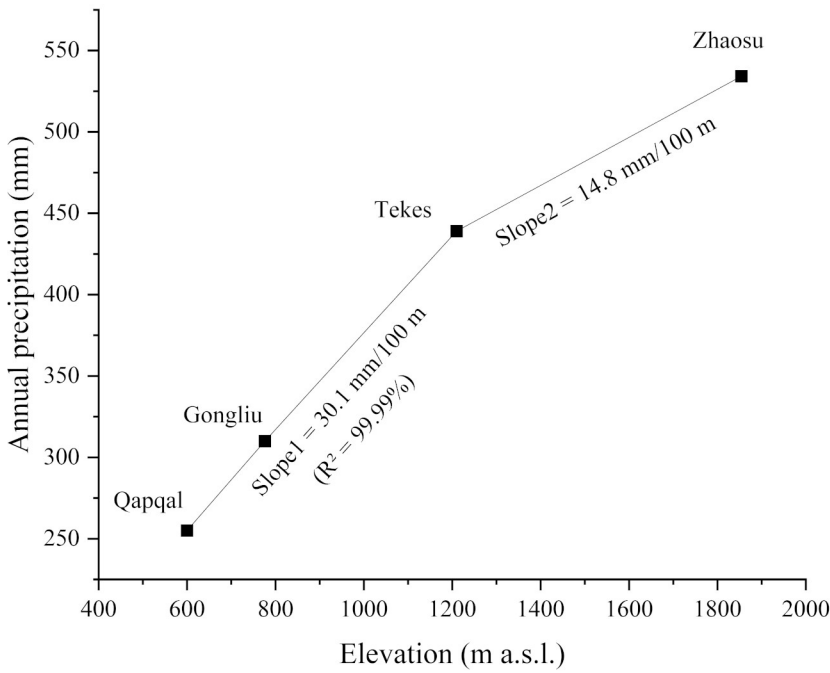


Figure 6. The precipitation-elevation relationships for the Qapqal, Gongliu, Tekes and Zhaosu meteorological stations over 2000–2016.

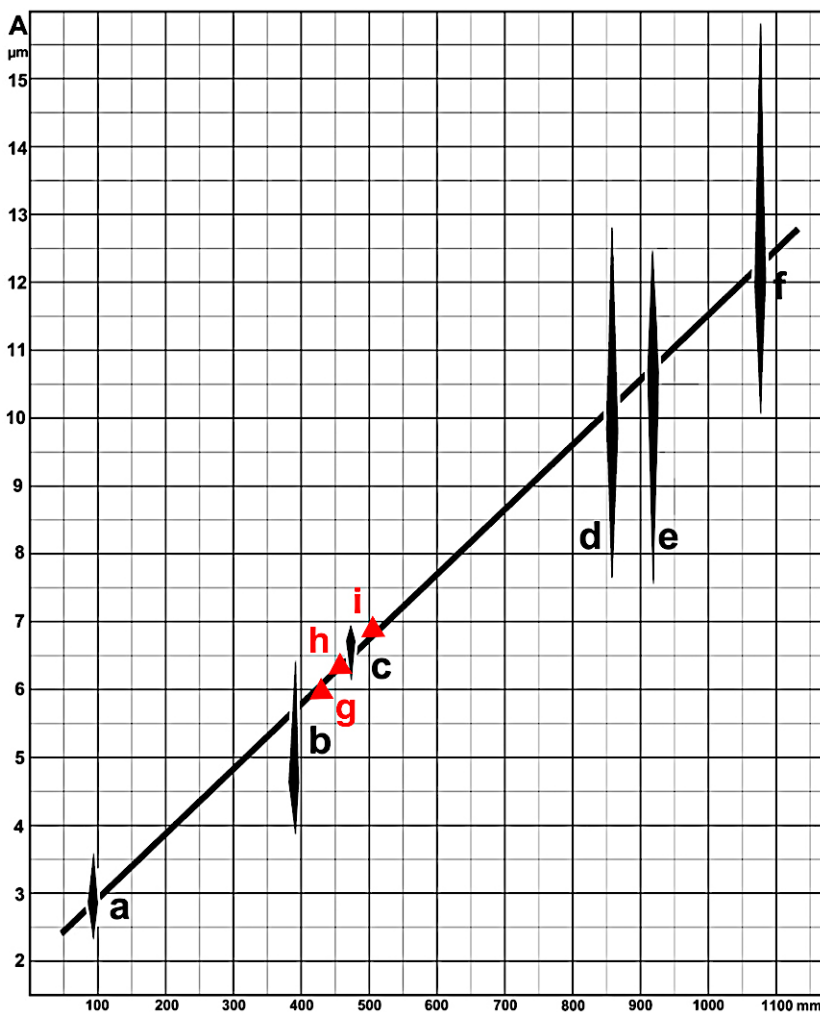


Figure 7. The Universal Calibration Curve for microerosion analysis (after Bednarik 2019). a- Jubbah, Saudi Arabia; b- Spear Hill, Australia; c- Deyunshan, China; d- Lianyungang, China; e- Grosio, Italy; f- Vila Real, Portugal; g- Qiongbola, China; h- Maitike'er, China; i- Khonakhai, China.

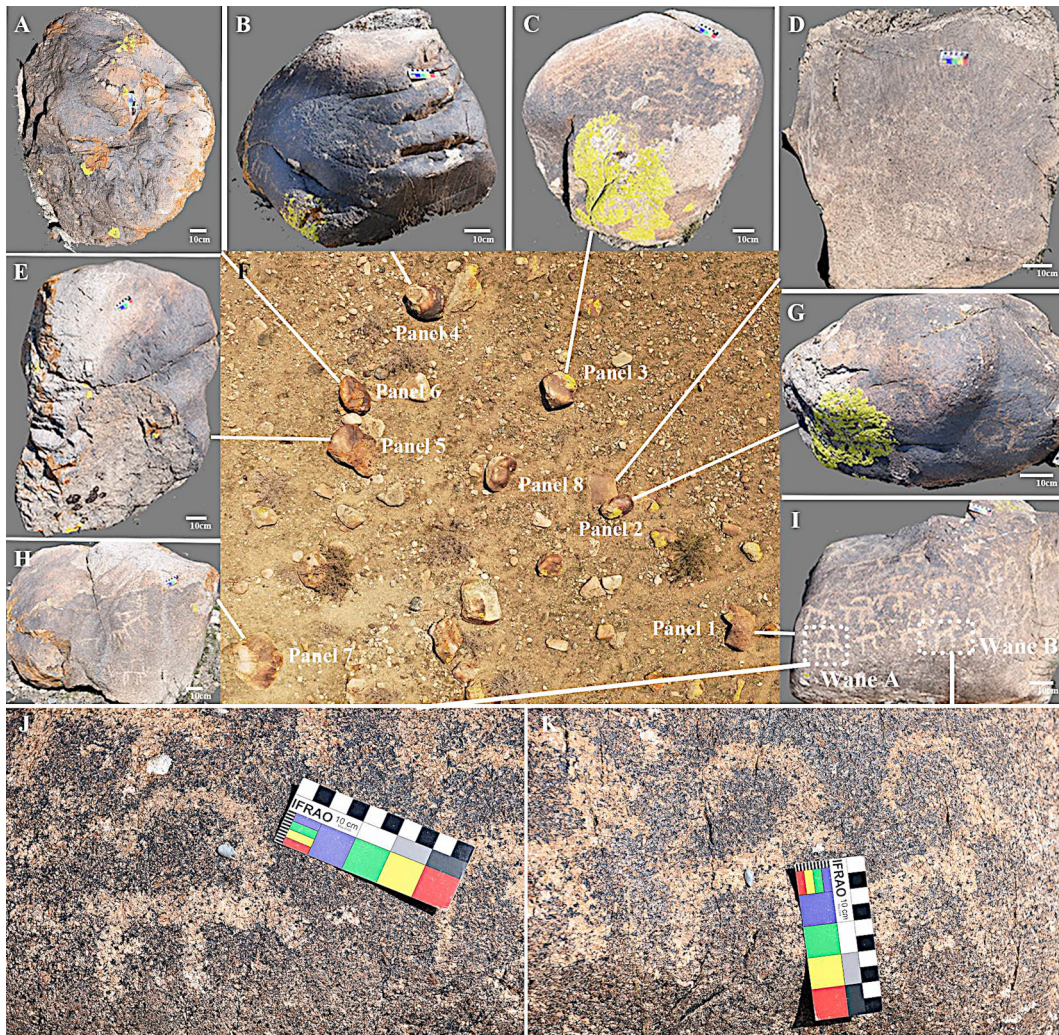
Yearbook of Ili Kazakh Autonomous Prefecture. These four stations range in elevation from 600 to 1854 m a.s.l. and are located on the northern (Qapqal, Gongliu) and southern (Tekes, Zhaosu) slopes of the Wusun Mountain. Their elevations and mean annual precipitation are shown in Figure 6. The Qapqal, Gongliu and Tekes stations show an excellent linear precipitation-elevation relationship (Slope1 = 30.1 mm per 100 m, R<sup>2</sup> = 99.99%), indicating a consistent vertical precipitation gradient for both slopes of the Wusun Mountain. This phenomenon can be attributed to the parallel orientation of the mountain and the westerly, which is this region's primary carrier of moisture (Su et al. 2007). The precipitation-elevation relationship observed from the Tekes and Zhaosu stations (Slope2 = 14.8 mm per 100 m) reflects the slowing rate of increase in precipitation at higher elevations. Considering that the three rock art sites are located between the elevations of Tekes and Zhaosu stations, we used Slope2 to estimate their annual precipitation using the following formula:

$$P_{\text{site}} = P_{\text{Zhaosu}} - \text{Slope2} \times \Delta H \quad (1),$$

where  $P_{\text{Zhaosu}} = 510.3$  mm, which is the mean annual precipitation at the Zhaosu meteorological station from 1956 to 2016, and  $\Delta H$  is the elevation difference between the petroglyph site and the stone menhir at Zhaosu. The Zhaosu station has the longest precipitation records available in this area and is, therefore, a suitable benchmark for inferring long-term local precipitation. The resultant annual precipitation estimation is 500.8 mm for the Khonakhai stone menhir at Zhaosu, 463.0 mm for the Tekes Maitike'er petroglyph and 440.2 mm for the Qapqal Qiongbola petroglyph (Fig. 6).

### 3.2. Results of microerosion analyses

In selecting sites for microerosion dating, this field expedition took into account a combination of practical and geological factors, including the



**Figure 8.** A–I: the Qiongbola petroglyph site and close-up view of petroglyphs on panels 1–8; J–K: the measured micro-wane is marked by grey plasticine.

accessibility of the rock art localities, the degree of surface weathering and—crucially—the petrographic characteristics of the rock surfaces, especially whether the stone contained exposed microcrystalline feldspar or quartz grains suitable for wane formation and observation.

Based on these criteria, three sites were chosen as candidates for analysis: the Khonakhai stone menhir in Zhaosu County, the Qiongbola petroglyph site in Qapqal Xibe Autonomous County and the Maitike'er rock art site in Tekes County.

As mentioned above, the mean annual precipitation at Zhaosu, Qapqal and Tekes is 500.8 mm, 440.2 mm and 463.0 mm, respectively. According to the UCC, these precipitation levels correspond to micro-erosion coefficients of approximately  $7.17 \mu\text{m}/\text{ka}$ ,  $6.30 \mu\text{m}/\text{ka}$  and  $6.63 \mu\text{m}/\text{ka}$  (Fig. 7).

### 3.2.1. The Qiongbola petroglyphs

Qapqal Xibe Autonomous County is situated south of the Ili River, at the southern foothills of the Wusun Mountains, a spur of the Tianshan Mountains. The county's terrain is narrow in the east and open in the west, while the altitude is high in the south and low

in the north.

Within Qapqal, only one rock art site has been identified to date: the Qiongbola petroglyph site (elevation 1380 m a.s.l.; Fig. 8), which is located at the eastern slope of the Qiongbola gully. There is a forest on the southern side of the gully, while a road passes through on the eastern side. The petroglyphs are scattered on eight granite boulders facing towards the east. The content of the petroglyph is mainly of animal motifs, especially ibex, such as panel 1, which is 1.6 m long and 0.9 m high. On the panel are 15 'ibexes', one 'horse' and three 'people riding on horseback'. All figures, horses and the herd are moving towards the same direction, bringing forth a pastoral scenery. There are further images of 'argalis, horses and deer'.

The most favourable location for microerosion analysis was identified on Panel 1, in an area where a petroglyph groove intersects a quartzitic bulge, resulting in a natural fracture. Examination was conducted for over one hour at this location to find suitable fractures that undoubtedly came from the petroglyph (Fig. 8).

The first wane was observed on a quartz nodule at the groove of an ibex. The wane measured 112

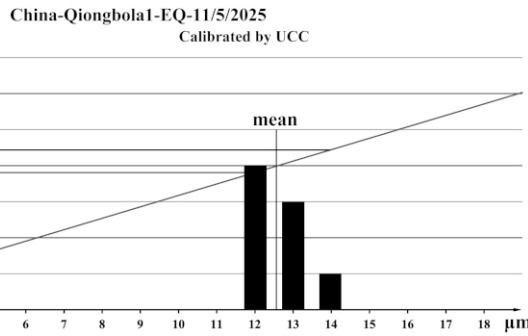


Figure 9. Microerosion age estimation from Qiongbola wane A.

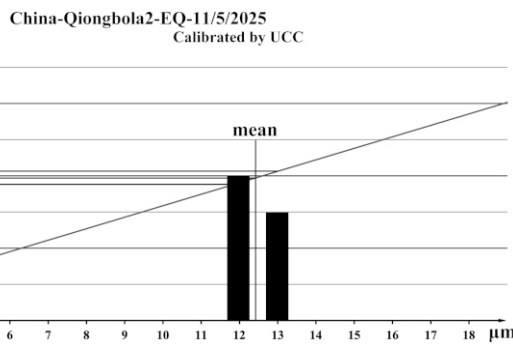


Figure 10. Microerosion age estimation from Qiongbola wane B.

μm in length, and the widths of eight micro-wanes were recorded as: 12, 12, 12, 13, 13, 13, 14, 12 =  $101/8 = 12.625 \mu\text{m}$ . Applying a microerosion coefficient of  $6.30 \mu\text{m/ka}$  yields an estimated age of  $E2000 + 220/ - 100$  years BP (Fig. 9). The second wane measured  $90 \mu\text{m}$  in length, with seven micro-wane widths recorded as: 13, 13, 13, 12, 12, 12, 12 =  $87/7 = 12.43 \mu\text{m}$ , which corresponds to an age of  $E1900 + 90/ - 70$  years BP (Fig. 10).

3.2.2. The Khonakhai stone menhir

Stone menhirs have been found in many counties across the Ili Valley, with those at Khonakhai being the most significant examples (Fig. 11). The tomb associated with the Khonakhai stone menhir is located at the southern slope of the Wusun Mountains, on the eastern side of the Khonakhai Valley. The terrain around the tomb is relatively flat, being a part of the Zhaosu basin plain at the northern bank of the Tekes River. The stone figure stands in front of the tomb, at the southeastern corner of an earthen platform, the side of which is six metres in length. The figure is made of brown granite. The height above the soil is now around 180 cm. The stone menhir is facing towards the east. The head and the shoulder have a clear border. The menhir wears a 'crown', which has a small ring in the centre. The face of the figure is broad, eyebrows projecting prominently, with a high, protruding nose and curled up moustache. The mouth of the figure is already broken. His ears wear ring-like earrings. At the back, ten braids are dangling at the waist. The menhir wears a lapel-waisted tunic with a belt around the waist. He holds a cup with his right hand while his left hand holds a curved short sword in front of his abdomen. Inside the pleats below the waist are 20 lines of Sogdian inscriptions.

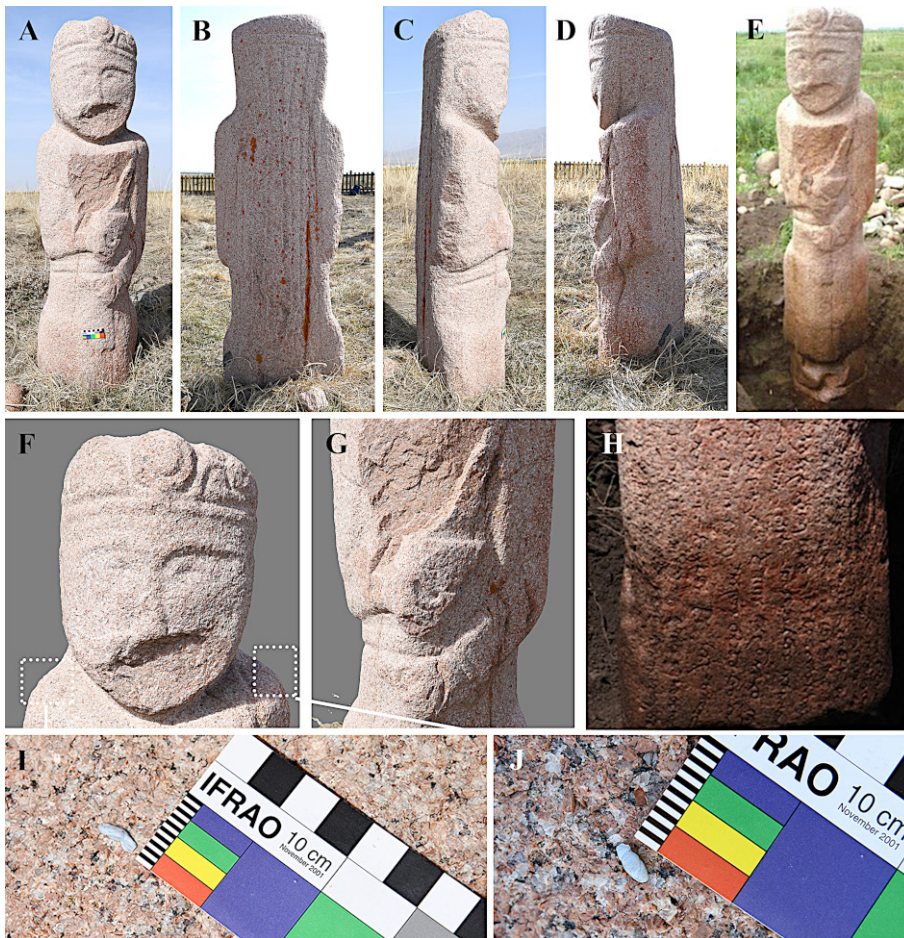


Figure 11. The Khonakhai stone menhir and close-up view of Sogdian inscriptions and measured micro-wanes.

Previous studies have applied the Universal Calibration Curve (UCC) to estimate the age of the Khonakhai stone menhirs using microerosion dating, providing a useful preliminary chronological

framework (Chao et al. 2023). However, these earlier efforts generally relied on regional average climate parameters. They did not systematically account for the site-specific environmental factors that may significantly affect the rate of surface microerosion. Building upon this foundational work, the present study refines the analysis by incorporating the abovementioned meteorological variables. It employs updated precipitation data to reassess the chronology of the Khonakhai stone menhir.

Micro-wanes were observed on both shoulders of the Khonakhai stone menhir. The first wane measured 120  $\mu\text{m}$  in length, and the widths of ten micro-wanes were recorded as follows: 11, 11, 11, 10, 10, 12, 12, 12, 12 =  $113/10 \approx 11.3 \mu\text{m}$ , which provides an age of  $E1580 + 100/-180$  years BP (Fig. 12). It is noteworthy that the micro-wane data obtained in this study deviate from those reported in previous research. For instance, Chao et al. (2023) documented significantly narrower wane widths of 7.5  $\mu\text{m}$  and 9.0  $\mu\text{m}$  on the nearly vertical neck region of the same Khonakhai stone menhir. This discrepancy is likely attributable to differences in sampling location and surface morphology. While the earlier study targeted steep, relatively sheltered surfaces, the present analysis focused on a flatter area on the shoulder, which is more exposed and thus more susceptible to prolonged weathering processes such as wind and rainfall erosion. The accelerated erosion on this more exposed surface likely accounts for our measurements' higher micro-wane width values. This divergence underscores the need for further investigation that integrates taphonomic analysis and micromorphological context in the future.

### 3.2.3. The Maitike'er petroglyphs

The Maitike'er petroglyphs are located beside a road in Kuokesu Gully, Tekes County. The rock art is all facing east. In the lower left corner of the image is a herd of 'goats'. The upper part of the image has circular patterns, the middle and the right sides of the image are scattered representations of 'ibex'. At the Maitike'er rock art site, two micro-wanes have provided age estimation (Fig. 4). Micro-wane A measured 112  $\mu\text{m}$  in length, and the widths of eight micro-wanes were: 13, 13, 13, 13, 14, 14, 14, 13 =  $107/8 = 13.375 \mu\text{m}$ . Using the UCC-derived coefficient of 6.30  $\mu\text{m}/\text{ka}$ , this measurement corresponds to a date of  $E2010 + 90/-60$  years BP (Fig. 13). The 114- $\mu\text{m}$ -long micro-wane B, with widths as followed: 14, 14, 14, 14, 15, 15, 14, 14, 13 =  $127/9 = 14.11 \mu\text{m}$ , resulting in an age estimation of  $E2130 + 130/-170$  years BP (Fig. 14). In the context of

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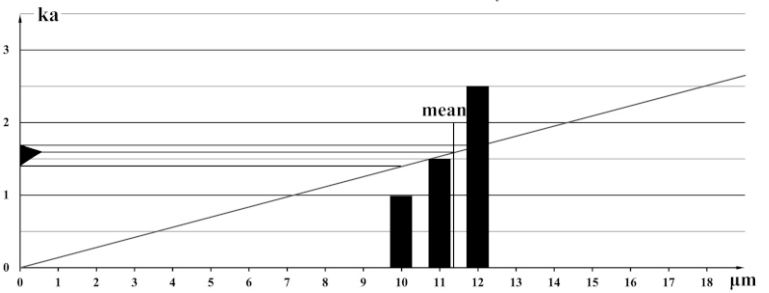


Figure 12. Microerosion age estimation from Khonakhai stone menhir.

China-Maitike'er1-EQ-11/5/2025  
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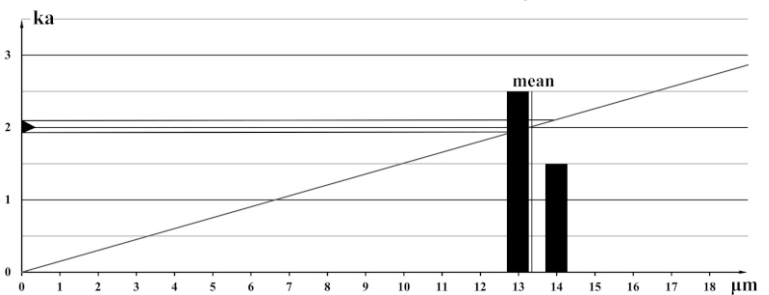


Figure 13. Microerosion age estimation from Maitike'er wane A.

China-Maitike'er2-EQ-11/5/2025  
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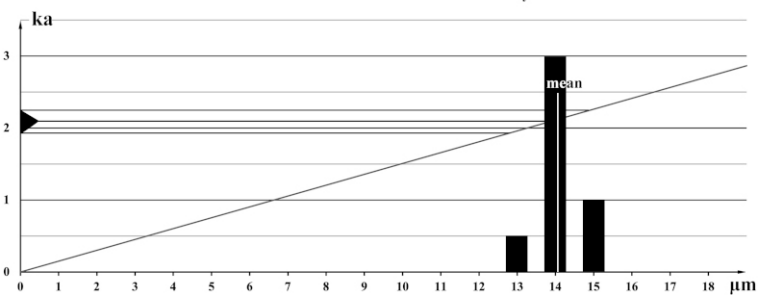


Figure 14. Microerosion age estimation from Maitike'er wane B.

this microerosion analysis, 'BP' refers to 2023 CE rather than radiocarbon reference point being 'the present'.

## 4. Discussion

This study presents the discovery and analysis of four new rock art sites in the Ili Valley, expanding the known distribution of rock art in this historically significant nomadic region. The sites primarily depict 'ibex', alongside 'deer', 'wolves' and 'human' figures, reflecting ancient nomadic communities' pastoral and hunting practices.

A key contribution of this research is the application of microerosion dating, calibrated using the Universal Calibration Curve (UCC), to estimate the age of petroglyphs and a stone menhir. Precipitation estimates (440–510 mm/year) were adjusted for elevation effects, yielding microerosion coefficients (6.30–7.17  $\mu\text{m}/\text{ka}$ ) and dates ranging from 1580 to 2130 BP. The

results align with broader regional chronologies but highlight discrepancies in wane measurements due to micro-environmental factors, emphasising the need for localised calibration in future studies. Methodologically, the study demonstrates the challenges of dating rock art in mountainous regions, where orographic precipitation and micro-environmental conditions significantly influence erosion rates.

Future research should expand the application of microerosion analysis to encompass a more comprehensive selection of sites throughout the Ili Valley, which would establish a robust regional chronology and advance our understanding of the region's rock art. Upon this foundation, systematic comparative studies should then be conducted between the Ili Valley and other parts of Xinjiang. Ultimately, this research framework should be extended through cross-regional comparisons with key neighbouring areas (particularly the Altai, Mongolia and Central Asia), enabling us to trace cultural connections across the broader Eurasian steppe region.

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