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THE 2018 AND 2019 ROCK ART EXPEDITIONS TO LIANYUNGANG, EAST CHINA

Jin Anni and Chao Ge

Abstract. A series of surveys conducted in November 2018 and March 2019 in Lianyungang City, China, has systematically recorded and studied four site complexes including nine rock art panels with over 280 petroglyphs mainly consisting of cupules, 11 standing stones and one inscription. Researchers have secured 14 microerosion age estimates ranging from the 1st century BCE to the 14th century CE, by profitably utilising the universal calibration coefficient for quartz.

1. Introduction

The city of Lianyungang is located on the east margin of mainland China, facing the East China Sea. Its dominant landscape consisting of horst block mountains and alluvial plains was forged by crust movements during the geological time. Extensive metamorphic strata of Proterozoic exposed during the formation of fold and fracture structures, therefore, gneiss and schist are the most common types of rock in this area, and a tradition of rock art production has existed for thousands of years (Fig. 1).

An international research team visited the Jiangjunya site in 2014 and has secured eight age estimates (Tang et al. 2017). Four years later, during 2018 and 2019, the authors of this paper have conducted two expeditions to the petroglyph sites of Lianyungang, including the sites of Shipengshan, Xiaoxishan, Shizishan and Jiangjunya. Over 280 motifs (mainly cupules) on nine panels, 11 standing stones and one ancient inscription have been studied, and 14 age estimates by microerosion analysis have been secured.

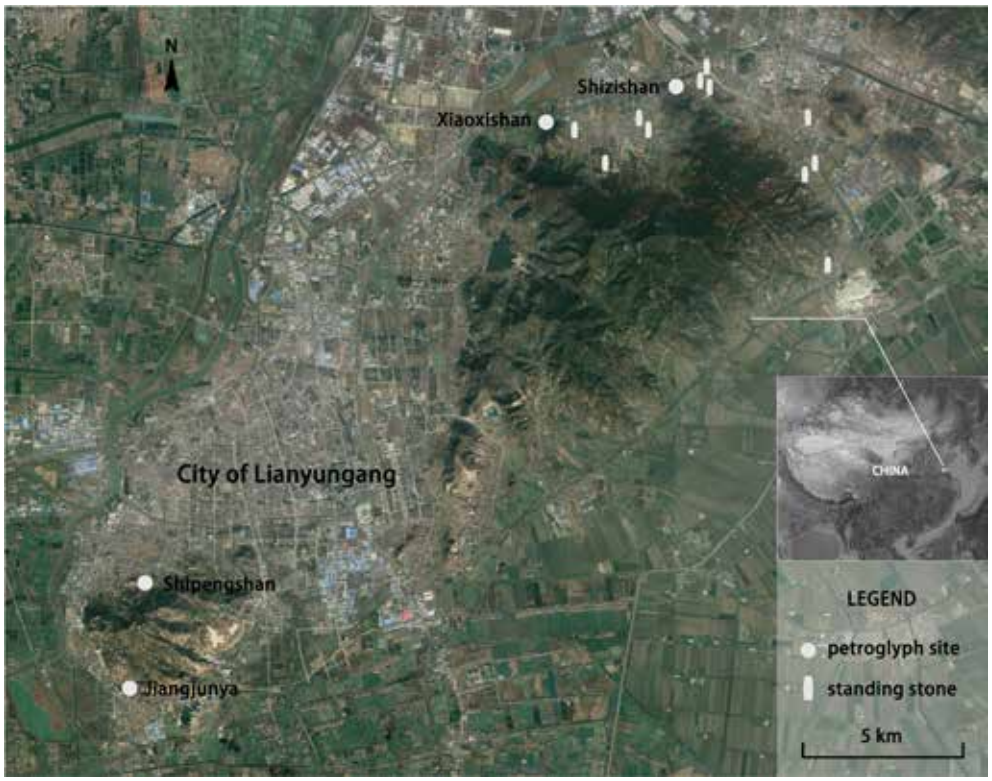

Figure 1. *The study area in Lianyungang City, east China.*

2. The sites

2.1 Shipengshan

The Shipengshan Hill, lying on the outskirts of Lianyungang city, was formed by crust collision during the 'Himalayan Phase' (a local term referring to the tectonic events of the late Alpide orogeny in China). The hill is 500 m long, 300 m wide and about 70 m above surrounding land (93

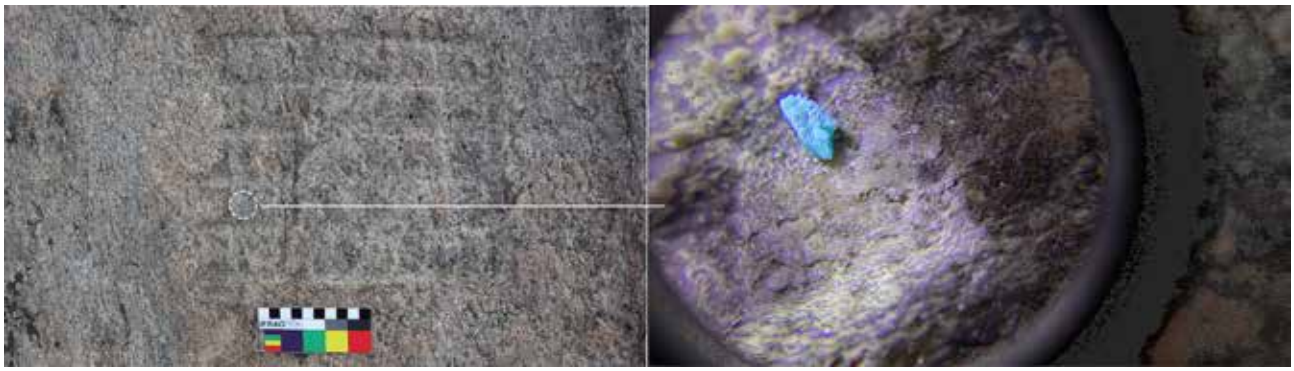

Figure 2. *Grid motif of Shipengshan 4, the measured micro-wane is marked by blue plasticine.*

m a.s.l.). Along its eastern slope, numerous gneiss outcrops of lower Proterozoic can be seen, the sites Shipengshan 1, 2, 3 and 4 are located in this area.

Shipengshan 1 is a rock bench at the foot of the hill. Twenty-nine cupules and two geometric motifs occur randomly or are arranged in circles on the top surface. The average size of the cupules is 45.8 (diameter) × 10.3 (depth) mm, in which the largest is 57.2 × 11.7 mm, while the smallest is 22.9 × 5.8 mm. The panel is granularly exfoliated and partially covered by a black deposit. Some inclusions of crystalline quartz can be observed, but the majority of them are of granular appearance and the fracture angles are outside the required range, thus the microerosion analysis is not applicable.

Shipengshan 2 is a rockshelter about 70 m south from Shipengshan 1. The severely weathered shelter is 5.5 × 5 × 3.5 (height) m, with the entrance of 1.5 × 1 m. One hundred and two cupules occur randomly or are arranged in rows or circles on the floor, and two larger and deeper cupules were made on the west wall. The average size of the cupules is 56 (diameter) × 14.9 (depth) mm, in which the largest is 147.1 × 35 mm, while the smallest is 32.3 × 8 mm. The panel is entirely covered by a black deposit; no suitable crystalline quartz can be observed.

About 310 m south-east from Shipengshan 2 lies the Shipengshan 3 which is an outcrop of 6 × 3 × 0.6 (height) m. Seventy-five cupules and two geometric motifs occur randomly or are arranged in circles or in rows on the top surface. The average size of the cupules is 61.5 (diameter) × 14.1 (depth) mm, in which the largest is of 132.6 × 20.9 mm, while the smallest is of 36.7 × 8 mm. The panel is covered by lichen and moss, so the researchers could not secure any age estimates.

The outcrop of Shipengshan 4 is situated on the south-east side of the hill, halfway up to its top, 170 m north-west from Shipengshan 3. A single grid or game board-like motif is engraved on the top surface which was formed by exfoliation (Fig. 2). The size of the motif is 275 × 235 mm, its grooves are 11.3 mm wide and 3.9 mm deep on average. A suitable fracture at 90° of 230 μm length was found on a crystalline quartz in one groove, yielding the following widths: 18, 18, 20, 20, 20, 20, 21, 22, 20, 19 = 198/10 = 19.8 μm.

2.2 Xiaoxishan

Xiaoxishan is the name of a ridge on the north side of Mt Nanyuntaishan, about 3 km east from the city . A gentle slope lies in front of the hillside, where a single blackish gneiss outcrop bearing multiple petroglyphs can be seen in the centre of a cultivated area (Fig. 3). The outcrop was bent upwards by crust movement, and twenty-eight cupules occur randomly or are ar-

Figure 3. *The Xiaoxishan site, the measured micro-wane in '*yan shi hou san shi li*' inscription is marked by blue plasticine and indicated by the white arrow.*

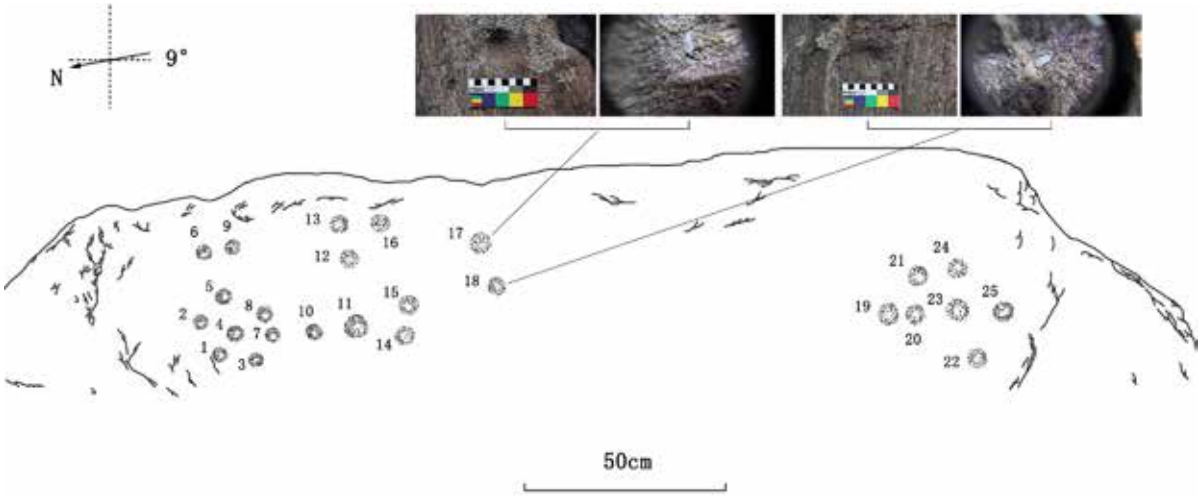

Figure 4. *The drawing of the panel 1 of Xiaoxishan site; the measured micro-wanes in cupules 17 and 18 are marked by blue plasticines.*

ranged in circles on two broken surfaces. Panel 1 is in the north half of the top surface, while panel 2 is on the opposite side, suffering severe granular exfoliation. The average size of the cupules is 52.2 × 17.3 mm, in which the largest is 79.8 × 23 mm, while the smallest is 40.9 × 10 mm. The rock surface is rich of quartz, but the majority of the crystals are either metamorphosed or with edges out of measurable range, thus the two scientists have secured only six groups of micro-wane widths from three cupules and one inscription.

A quartz vein cuts through the cupule 17 of panel 1 on which two broken edges at 90° were observed (Fig. 4). Wane 1 is 90 μm long, yielding the following widths: 8, 9, 10, 10, 11, 12, 14, 14, 14, 13 = 115/10 = 11.5 μm. Wane 2 is 70 μm long and its widths are: 10, 15, 15, 12, 12, 12, 11, 10, 10 = 107/9 = 11.89 μm.

The researchers have successfully located two micro-wanes at 90° on a quartz nodule in the cupule 18 on the same panel. Wane 1 of 100 μm long yielded the following widths: 8, 8, 7, 9, 10, 10, 10, 10, 9 = 81/9 = 9 μm. Wane 2 is 120 μm long yielding these widths: 10, 11, 12, 10, 10, 9, 10, 11, 10, 12 = 105/10 = 10.5 μm.

The cupule 3 of panel 2 also provided a group of data (Fig. 5). A crystalline quartz body was found below the cupule's rim, and one of its fractures at 90° which is 80 μm long offered the following widths: 10, 13, 15, 15, 14, 15, 15 = 97/7 = 13.86 μm.

On the east inclined surface of the rock, an inscription '*yan shi hou san shi li*' (meaning 'this stone is thirty miles far from the town' in Chinese) was carved, which indicates that the rock used to be a milestone in the old time. A quartz grain bearing a 100 micron-long micro-wane was found in the groove of the third character from above, of which the average width is 15, 15, 14, 12, 10, 12, 10, 9, 9, 9 = 115/10 = 11.5 μm.

2.3 Jiangjunya

Jiangjunya is probably the most well-known petroglyph site in east China which has been studied by numerous researchers. An international team has visited this site and secured seven age estimates by using microerosion analysis in 2014 (Tang et al. 2017). The authors of this paper have re-checked this famous site in 2019 and obtained three new groups of data.

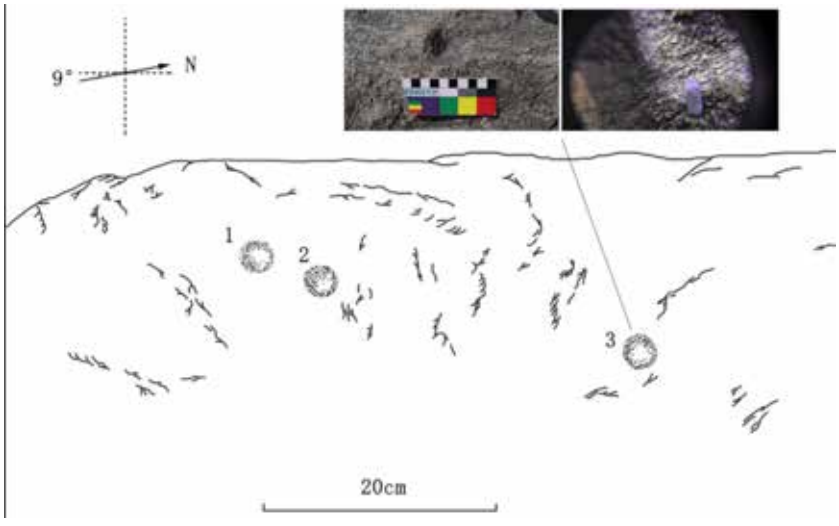

Figure 5. *The drawing of the panel 2 of Xiaoxishan site, the measured micro-wane in cupule 3 is marked by blue plasticine.*

Two fracture edges of 90° were observed on a quartz grain in the central groove of a sun-like motif at the lower part of the rock surface facing south (Fig. 6). Wane 1 is 50 μm long, yielding the following widths: 12, 14, 16, 16, 13, 11, 11 = 93/7 = 13.29 μm. Wane 2 is 70 μm long, providing these widths: 12, 12, 11, 11, 12, 10 = 68/6 = 11.33 μm. A quartz nodule bearing a perfect micro-wane was found in the groove of the 'nose' of a mask-like motif at the upper part of the exposure, and the wane is 15, 15, 17, 18, 18, 15, 15, 13, 13, 13 =

152/10 = 15.2 μm wide (Fig. 7).

2.4 Shizishan

A ridge lies 4 km east from Xiaoxishan, where the Shizishan Site is located. Thirty-six cupules and six geometric motifs occur randomly or are arranged in rows or circles on a rock exposure of 10 × 10 m. The average size of the cupules is 49.2 × 13.2 mm, in which the largest is 69.6 × 22.2 mm, while the smallest is 26.7 × 6.6 mm. The panel is severely weathered, suffering granular and laminar exfoliation, thus most of the quartz crystals are well-metamorphosed, no measurable micro-wane has been observed.

2.5 Standing stones

Standing stones, or menhirs, are usually large man-made upright stones with or without petroglyphs on their surfaces. They are widely distributed across Europe, Africa and Asia, but most numerous in western Europe and central Asia. In China, this type of ancient remains can be often witnessed in northern regions like Xinjiang or Inner Mongolia, with names of '*bal-bal*' or 'deer stone'; however, reports from the south are extremely rare. Therefore, the existence of a large number of standing stones within a traditionally agricultural area like Lianyungang far away from nomadic regions in the north is an unusual phenomenon.

In Lianyungang, these stones which are called '*shiganma*' (meaning 'stone mother') by local people, are usually gneissic slabs of rectangular section with engraved anthropomorphous motifs on their surfaces and have been erected in or around villages, being exposed directly in precipitation. The authors have studied eleven samples of them during the surveys in 2018 and 2019, and secured four age estimates.

The first group of data was provided by Shiganma 1. A fracture edge at 90° was observed on a quartz nodule in the groove of the 'beard', the wane is 150 μm long, yielding the following widths: 10, 10, 11, 12, 13, 15, 15, 12, 10, 10, 12 = 130/11 = 11.82 μm (Fig. 8). In the groove of 'right eyelid' of Shiganma 3, a micro-wane of 100 μm long was found, offering these widths: 8, 8, 9, 10, 12, 10, 10, 11, 12 = 90/9 = 10 μm (Fig. 9). The researchers have located two measurable fractures in the grooves of the 'right collar' and 'left chin' of Shiganma 5 (Fig. 10). Wane 1 is 170 μm long, yielding the following widths: 7, 8, 10, 10, 9, 9, 8 = 61/7 = 8.71 μm,

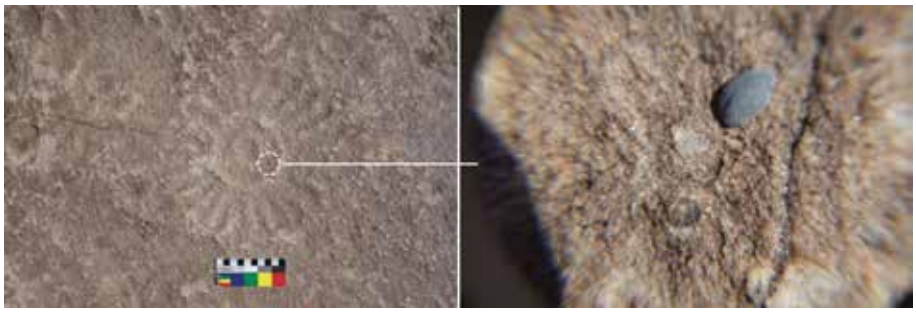

Figure 6. *A sun-like motif of Jiangjunya, the measured micro-wanes are marked by blue plasticine.*

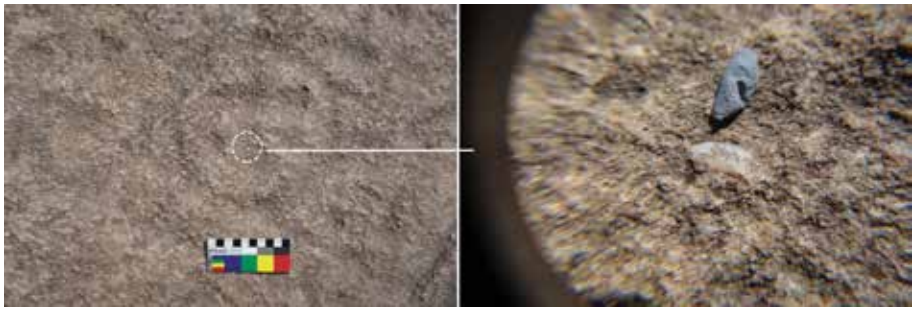

Figure 7. *A mask-like motif of Jiangjunya, the measured micro wane is marked by blue plasticine.*

Figure 8. *'Beard' of Shiganma 1, the measured micro-wane is marked by blue plasticine.*

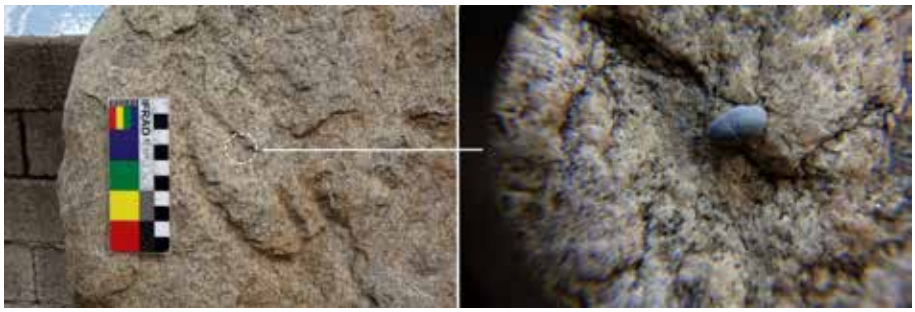

Figure 9. *'Right eyelid' of Shiganma 3, the measured micro-wane is marked by blue plasticine.*

Standing Stone	**Size** $_{\text{length}}$ × width × $_{\text{thickness}}$ **(cm)**	**Photo**
Shiganma 1	94 × 36 × 16	
Shiganma 2	107 × 58 × 19	
Shiganma 3	167 × 43$_{\text{head}}$ /48$_{\text{body}}$ × 21	
Shiganma 4	123 × 39 × 18	
Shiganma 5	131 × 45/55 × 15	
Shiganma 6	68 × 55 × 14	
Shiganma 7	86 × 30/50 × 25	
Shiganma 8	90 × 60 × 17	
Shiganma 9	118 × 49 × 11	
Shiganma 10	77 × 51 × 13	
Shiganma 11	128 × 42$_{\text{hip}}$ /38$_{\text{shoulder}}$ /31$_{\text{head}}$ × 16	

Table 1. *The studied standing stones in Lianyungang.*

while wane 2 of 100 μm long yielded these widths: 5, 6, 6, 7, 7, 8, 9, 8, 7 = 63/9 = 7 μm.

3. Interpretation of the data and discussion

3.1 Calibration curve

The researchers of the 2014 expedition used the Deyunshan coefficient of 6.6 μm/ka for calibrating age estimates of petroglyphs in Lianyungang (Tang et al. 2017), due to the lack of a local calibration curve, and the results range from E5380 to E360 (see Table 2). However, some unexpected results occurred when the authors applied the above-mentioned coefficient in processing the data of 2018 and 2019: the inscription '*yan shi hou san shi li*' is carved in *Kai Shu* style which is a Chinese calligraphic style meaning 'regular script' established during the Tang Dynasty (618–907 CE). Its age estimate is E1740 + 530 / - 380, calibrated by the Deyunshan curve. This result indicates that the inscription was made in the late years of the Three Kingdom period (220–280 CE), but it contradicts the fact of the establishing period of *Kai Shu* style. However, the annual average rainfall of Lianyungang is over 900 mm, which is much higher than the value of Deyunshan area (600 mm). According to the *Universal Calibration Curve* proposed by Beaumont and Bednarik (2015), 900 mm equals 9.8 μm/ka, so the age estimate of the inscription will be E1170 + 360 / - 250 with this calibration coefficient (Bednarik 2019). This new age estimate indicates that the inscription was probably made during the 9th century when the Tang Dynasty was falling into decline and *Kai Shu* style had already been designated the official script for almost two hundred years. This new result can perfectly match the fact and successfully solve the problem caused by the old coefficient, thus should be regarded as the most possibly true calibration coefficient so far for microerosion dating of quartz in Lianyungang, and the results of 2014 need to be re-calibrated based on the new coefficient (see the last column of Table 2).

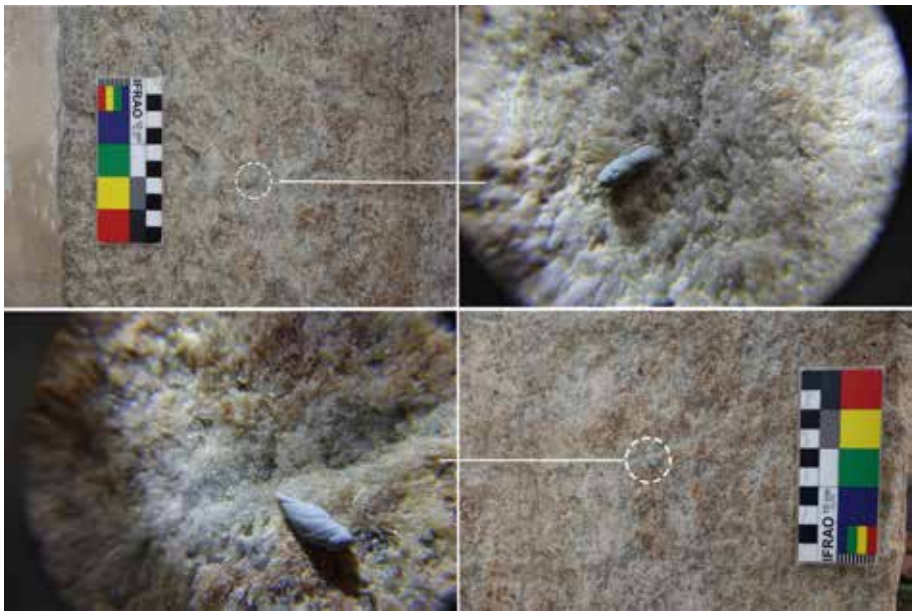

Figure 10. *'Right collar' (a) and 'left chin' (b) of Shiganma 5, the measured micro-wanes are marked by blue plasticines.*

3.2 Age estimates

By applying the new calibration curve mentioned above, fourteen age estimates have been secured in the present research, and are listed in Table 3.

3.3 Discussion on the standing stones 'shiganma'

The standing stones '*shiganma*' are very common but typical remains prevailing across northern Jiangsu and southern Shandong (two geographically neighbouring provinces) in the old time, they are also called '*shipopo*' (stone grandmother), '*shiganda*' (stone father) or '*shijiangjun*' (stone general). However, nowadays, nobody knows their real age, for instance, the local government of Lianyungang announces that these stones

Site	Motif	Micro-wane	Age estimate in 2014	Re-calibrated age estimate
Jiangjunya	Rectangle	China-Jiangjunya1-EQ-13/7/2014	E1630 + 190 / - 110	E1100 +120 / - 80
Jiangjunya	Cupule in 'sun'	China-Jiangjunya2-EQ-13/7/2014	E3200 + 440 / - 170	E2150 + 300 / - 110
Jiangjunya	Petroglyph 1	China-Jiangjunya3a-EQ-13/7/2014	E2210 + 210 / - 90	E1490 + 140 / - 60
Jiangjunya	Petroglyph 1	China-Jiangjunya3b-EQ-13/7/2014	E360 + 90 / - 60	E240 + 60 / - 40
Jiangjunya	'Meridian'	China-Jiangjunya4-EQ-13/7/2014	E920 + 140 / - 160	E620 + 90 / - 110
Jiangjunya	Diagonal groove	China-Jiangjunya5-EQ-13/7/2014	E2650 + 80 / - 230	E1790 + 50 / - 160
Jiangjunya	Large cupule	China-Jiangjunya6-EQ-13/7/2014	E5380 + 380 / - 530	E3620 + 260 / - 350
Duijiu Nunnery	Large cupule	China-Duijiu1-EQ-14/7/2014	E850 + 210 / - 90	E570 + 140 / - 60

Table 2. *The results of re-calibration on the age estimates of 2014.*

Site	Motif	Micro-wane	Age estimate
Shipengshan 4	'Grid' 1	China-Shipengshan4-1-EQ-1/11/2018	E2020 + 220/ - 180
Xiaoxishan 1	Cupule 17	China-Xiaoxishan1-17a-EQ-2/11/2018	E1170 + 260/ - 350
	Cupule 17	China-Xiaoxishan1-17b-EQ-2/11/2018	E1210 + 320/ - 190
	Cupule 18	China-Xiaoxishan1-18a-EQ-2/11/2018	E920 + 100/ - 210
	Cupule 18	China-Xiaoxishan1-18b-EQ-2/11/2018	E1070 + 150 /- 150
	Yan shi hou san shi li	China-Xiaoxishan1-26-EQ-2/11/2018	E1170 + 360/ - 250
Xiaoxishan 2	Cupule 3	China-Xiaoxishan2-3-EQ-2/11/2018	E1410 + 120/ - 390
Shiganma 1	'Beard'	China-Shiganma1-EQ-2/11/2018	E1210 + 320/ - 190
Shiganma 3	'Right eyelid'	China-Shiganma3-EQ-21/3/2019	E1020 + 200/ - 200
Shiganma 5	'Right collar'	China-Shiganma5-1-EQ-21/3/2019	E890 + 130/ - 180
	'Left chin'	China-Shiganma5-2-EQ-21/3/2019	E710 + 210/ - 200
Jiangjunya 2	'Sun' 2	China-Jiangjunya2-S2a-EQ-22/3/2019	E1360 + 270/ - 240
	'Sun' 2	China-Jiangjunya2-S2b-EQ-22/3/2019	E1160 + 60/ - 140
Jiangjunya 3	'Mask' 2	China-Jiangjunya3-M2-EQ-22/3/2019	E1550 + 290/ - 220

Table 3. *The microerosion dating results from Lianyungang of the surveys in 2018 and 2019.*

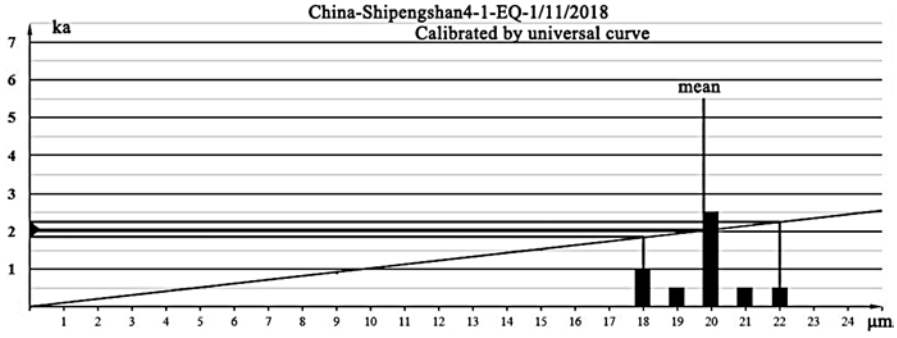

Figure 11. *Microerosion age estimate of the 'grid' 1 at Shipengshan 4.*

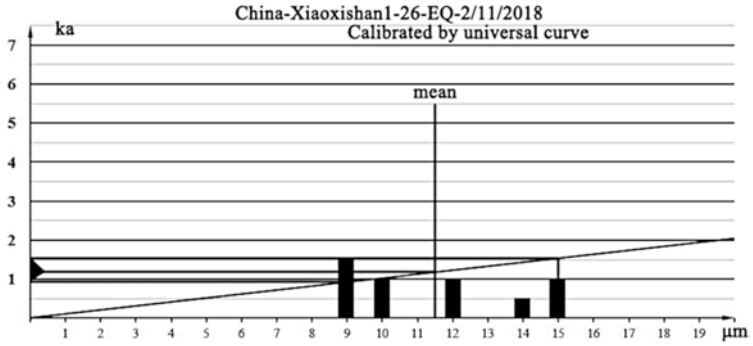

Figure 12. *Microerosion age estimate from the inscription of* 'yan shi hou san shi li'.

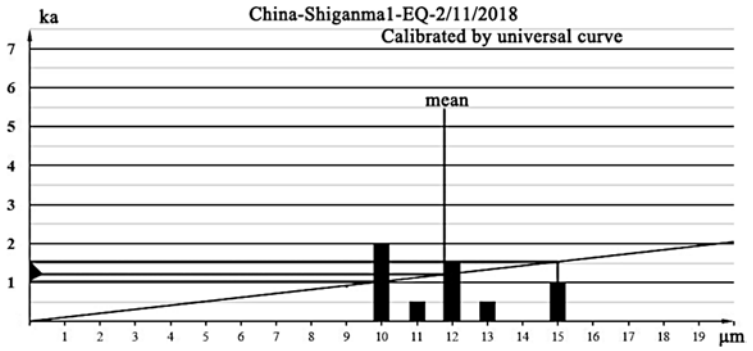

Figure 13. *Microerosion age estimate of Shiganma 1.*

were probably made during the 19th and 20th century, but some local researchers insist that they are remains of the period from the 10th to the 12th century (the Northern Song Dynasty), after comparing with some generals' profiles recorded in ancient literature (see Fig. 14: 1–4) (ICHCL 2015). The age estimates of the *shiganma* 1, 3 and 5 provided by the present research range from the 9th to the 14th century (from the late Tang Dynasty to the Yuan Dynasty) can strongly support those local scholars' judgement.

Furthermore, after searching numerous historic sources, the authors have found that the existence of these standing stones *shiganma* was first mentioned in some literature of the period from the 8th to the 9th century (the Tang Dynasty) with the name *shigandang* (meaning 'protected by the stone'), and the people at that time regarded them as symbols of household gods who can protect houses and families from devils. A variant of *shiganma* has long existed but been ignored by researchers: the tradition of *menshen* (gate god) painting which originated in the Tang Period and was believed to play the same role of guarding houses (see Fig.14: 5).

Generally speaking, the authors believe that the main breakthrough of the works in 2018 and 2019 was the use of the universal

Figure 14. *'*Fengchikui*' (phoenix wing helmet) in ancient graphic records: 1 - partial view of Shiganma 10; 2 - partial view of the painting* Mian Zhou Tu*, by Li Gonglin in the 11th century CE; 3 - partial view of an illustration in* Wu Jing Zong Yao*, a military guidebook written by Zeng Gongliang in the 10th century CE; 4 - partial view of the painting* Wo Kou Tu Juan*, by Qiu Ying in the 16th century CE. The* fengchikui *was a typical style of helmet for superior warriors or generals prevailing in Chinese armies from the 8th to the 15th century CE, local researchers' judgement is mainly based on this. 5 -* menshen *painting.*

curve for microerosion. The dating result of 2014 of Jiangjunya petroglyphs has been properly adjusted, and the age of the standing stones *shiganma* has been successfully clarified by applying this coefficient, and more importantly, these age estimates can be verified by some ancient literature and inscriptions. Therefore, although it still needs more extensive tests, the effectiveness of the universal curve for microerosion has been tentatively confirmed in the research of Lianyungang petroglyph sites during 2018 and 2019.

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Dr Jin Anni
School of Humanities
Minjiang University
C-519, Fu Wan Lou, No. 200, Xiyuangong Road
Minhou District
Fuzhou, Fujian Province, China
sagapo330@163.com

Dr Chao Ge (corresponding author)
Associate Professor
School of Humanities
Minjiang University
C-519, Fu Wan Lou, No. 200, Xiyuangong Road
Minhou District
Fuzhou, Fujian Province, China
chaogemanu@163.com

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