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A preliminary study of chronology for a newly-discovered ancient city and five archaeological sites in Lop Nor, China

LÜ HouYuan[1*], XIA XunCheng[2], LIU JiaQi[1], QIN XiaoGuang[1], WANG FuBao[3], YIDILISI Abuduresule[4], ZHOU LiPing[5], MU GuiJin[2], JIAO YingXin[6] & LI JingZhi[7]

[1]*Key Laboratory of Cenozoic Geology and Environment, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China;*
[2]*Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China;*
[3]*School of Geographic and Oceanographic Sciences of Nanjing University, Nanjing 210093, China;*
[4]*Xinjiang Archaeological Research Institute, Urumqi 830000, China;*
[5]*Laboratory for Earth Surface Processes, Department of Geography, Peking University, Beijing 100871, China;*
[6]*Museum of Luolan Relic, Ruoqiang 841800, China;*
[7]*The Center of Popularization and Propaganda for Science Exploration, Beijing 100029, China*

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In the past century, it has long been debated in the archeological, historical, geographical, and many other related communities where the capital of the Luolan and Shanshan states was in the Lop Nor region. This paper presents three AMS radiocarbon ages from a newly-discovered ancient city at about 6.3 km to the northwest of the Xiaohe Graveyard, and fifteen new radiocarbon ages from the Loulan (LA), LE, Qieerqiduke, Milan, and Tuyin sites in Lop Nor. The new investigation shows that the age of newly-discovered ancient city is at ca. 440–500 AD, belonging to the Northern Wei Dynasty (386–534 AD). This is about 100–300 years younger than Loulan (ca. 100–230 AD), LE (ca. 230–300 AD), Qieerqiduke (ca. 200 AD), and Tuyin (ca. 100 AD). A wooden beam from Milan fortress is dated to ca. 370 AD, while the age on north wall at west gate of the fortress is younger, around 770 AD, suggesting that its construction time might be at the Tang Dynasty. According to ^{14}C ages, cultural relic style, and the geographical location, the newly-discovered ancient city is probably attributed to "Zhubin City", as documented in the historical literature. Temporally, we name the city "ancient Zhubin River City". However, the characteristics and functions of this ancient city are largely unknown and need more detailed archaeological excavation and investigation in the future. Given its location near the ancient postal relay of Alagan on the crossroad, there is no doubt that the newly-discovered city was at an important geographical position on the Silk Road, no matter whether it was called "Zhubin City", or "Lielo City", or the capital of Loulan state–"Yuni City". Our findings provide new evidence for the temporal and spatial distribution of ancient relic sites and the development of civilization in western China, thus contributing to our understanding of the relationship between human activities and environmental change in the Lop Nor region.

Lop Nor, newly-discovered ancient city, Loulan, chronology

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Loulan and Shanshan are important ancient local states in the western region of China, ranging from the Lop Nor to the Niya River basin in the eastern Tarim Basin. From the Han Dynasty, a close relationship between Loulan State and central government of China had been established [1–7]. It is generally accepted that the Loulan site (LA site) in the Lop Nor [8], found by Sven Hedin in 1901 AD, was a western governor's house of the Wei-Jin Dynasties. It was a political and military center and the East–West cultural exchange point in western China[9–11]. However, over the past one hundred years, the issues as to where the capital of the Loulan-Shanshan State is and what the LA

*Corresponding author (email: xzh@ecust.edu.cn)

site is, have long been debated among scholars of archeology, history, geography, and many other disciplines [12−15]. The focus of contention is whether the capital was relocated after the Loulan State had been renamed the Shanshan State. For this, there are many assumptions, including: (1) The LA site was not only the old city of Loulan, but also the capital of Loulan State. After the 4th year under the reign of Yuanfeng (77 BC), the Loulan State was renamed Shanshan State, and the capital was said to have moved to "Yuni City". Some scholars thought that the "Yuni City" was the Qieerqiduke old city, which is presently adjacent to the Ruoqiang County [6,10,13−15]. However, no wooden writs of the Han Dynasty have yet been found at the LA site, leading to widespread doubt if the LA site was indeed the capital of Loulan State. (2) The LA site was the "Yuni city", the capital of Loulan State. After Loulan changed its name into Shanshan, its capital remained unmoved[16]. (3) The LA site was the old city of Loulan, not its capital. The Loulan State's capital city was "Yuni City" in the vicinity of Ruoqiang County, which was also the capital of the Shanshan State, the capital city was never moved[12]. (4) The capital of Loulan State was at LE City, not at the LA City; after Loulan changed its name into Shanshan, the Shanshan State capital was moved to "Yuni City"[17].

Over the last one hundred years, many scholars from different fields made a wide range of investigations on Loulan archaeology and ancient Silk Road. However, as many important ancient sites have been buried and undiscovered in the desert and there has been limited chronological evidence for the already discovered sites in the Lop Nor, the nature of LA and the history of Loulan-Shanshan State remain largely unknown. Little is known about the East and West cultural exchange along the Silk Road. It is therefore urgent to develop an integrated approach to study these issues which should involve field investigation, literature analysis and scientific research.

In September 2004, and June and November 2008, the senior authors of this article took part in three expeditions to the Lop Nor region and collected samples from the LA, LE, Qieerqiduke, Milan, and Tuyin sites for radiocarbon dating. The integrated scientific investigation conducted in November 2008 led to the discovery of an ancient city, located about 6.3 km to the northwest of the Xiaohe Graveyard. The newly-discovered city is about 220 m × 220 m from north to south and from east to west. This is the second largest city site that has been found in the Lop Nor region so far, which raised many speculations on what the city was in the past. This paper attempts to address the temporal and spatial distribution of the archaeological sites and the ancient cultural changes along the Silk Road based on the ^{14}C ages from these archaeological sites in the Lop Nor region.

1 Material and methods

Eighteen samples were taken from the LA, LE, Qieerqiduke, Milan, Tuyin sites, and the newly-discovered city site in the Lop Nor region for AMS dating (Figure 1), the dating materials were plants or charcoals, or clothes remains collected from buildings or tombs at these sites.

Qieerqiduke City (38°57′10.73″N, 88°10′4.61″E, altitude 957 m): Located in the Gobi Desert, about 6 km southeast from Ruoqiang County, Bayan Gol Mongolia Autonomous Prefecture in Xinjiang. Presently, the residual mound of city wall is about 1 m high. The surface of mound made of plants mixed mud has a thickness of 2−4 cm. One sample of plant stems and leaves was taken for dating (RQ-1) (Figure 2 (b)).

Milan City: Located about 80 km east from Ruoqiang County. The conservation area of Milan historical sites attains ~44.49 km^2, consisting of 8 stupas, 3 buddhist temples, 2 beacons, the water protection facilities, and the ancient

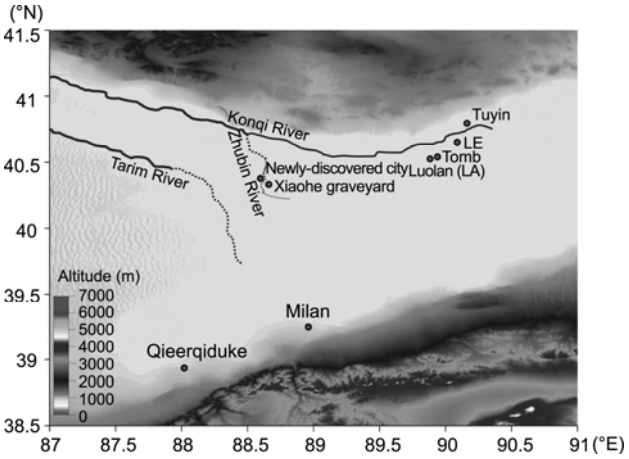

Figure 1 Sketch map of main cultural relic sites and ancient cities in Lop Nor.

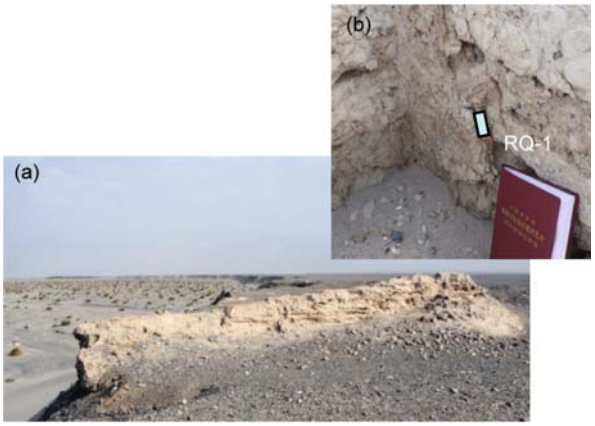

Figure 2 (a) Remnant mound of Qieerqiduke site; (b) sampling location and outer surface of mound made of plants mixed mud.

fortress. Milan site has been considered the ancient Yixun City of Shanshan State. The ancient fortress (39°13′ 36.23″N, 88°58′ 14.83″E, altitude 926 m) presents an irregular square, having two gaps at the west and south walls, which were suspected to be entrances. The 1-m-thick wall base of north side at west entrance in is composed of the plant debris, charcoal, and soils (Figure 3(a), (b)). One sample was taken from ca. 20 cm above the wall base (ML-1) (Figure 3(c)). Another sample was taken from a wooden beam in the fortress (N15) (the N serial number samples were gathered by Wang Fubao in September, 2004, similarly hereinafter).

LE City (40°38′41.16″N, 90°7′3.31″E, altitude 783 m): This city shows a square outline, about 130 m×130 m, located ca.185 km northeast from Milan. The remaining city wall is more than 3 m high, consisting of mud and twigs of Chinese tamarisk (*Tamarix chinensis*). One sample was taken from the south-east wall of LE City (LL8-3) (Figure 4), another one from a wooden beam in the city (LL8-2).

Loulan City (LA): Located at the northwestern bank of the Lop Nor, about 340 km southeast from Korla City. The LA site is situated on a wind-eroded terrace of lacustrine deposits. This city takes a shape of an irregular square, the eastern wall is ~333 m long, southern wall is ~329 m, both western and northern walls are ~327 m, respectively. The LA site is divided into two parts of the northeastern and southwestern districts, in between them an ancient water canal passed through from northwest to southeast. The main buildings in the northeastern district are the stupa tower (40°30′59.29″N, 89°54′53.83″E) and some other buildings. Stupa tower with a height of about 10.4 m was constructed by the adobe, wicker, Hu poplar (*Populus euphratica*), and soils. The tower base is nearly a square with an altitude about 792 m a.s.l. where four samples were taken, one from

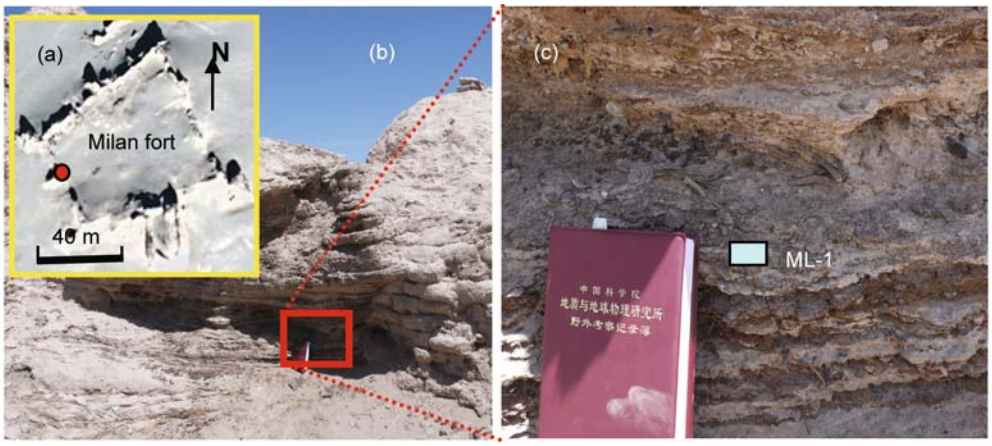

Figure 3 (a) Remote sensing map of ancient fortress site, the red dot indicates the entrance position of the west wall; (b) the wall base of north side at west entrance; (c) sampling location.

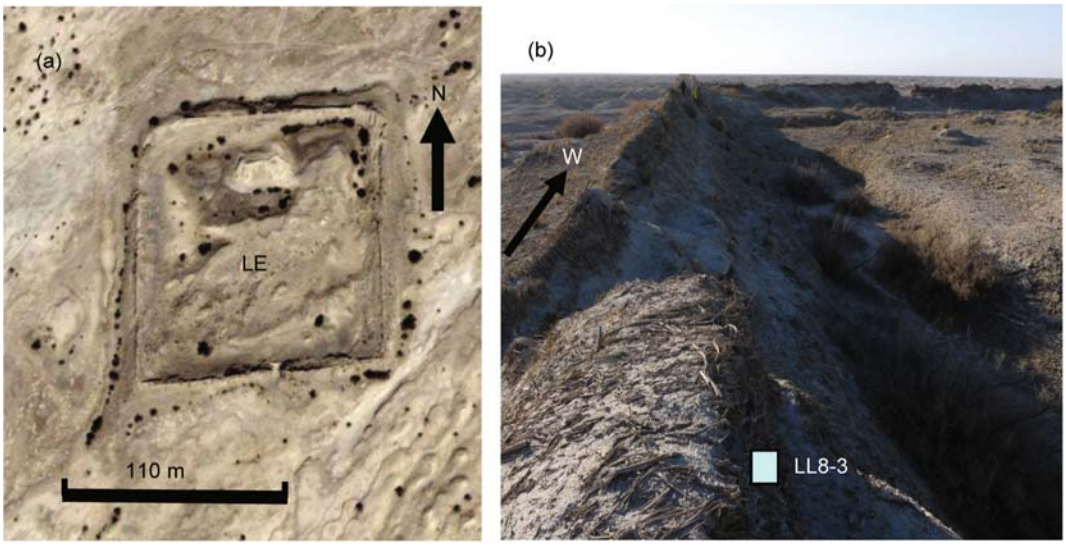

Figure 4 (a) Remote sensing map of the LE City; (b) photo of the LE City and the sampling location.

Chinese tamarisk (LL-3), one charcoal sample (LL-5) (Figure 5), and two Chinese tamarisk (N5, N6). In the southwestern district, there is a famous "Three Rooms" site. A sample was taken from a roof timber laid on the southeastern floor at the "Three Rooms" (LL-5-1) (Figure 6(a)). Three samples were collected from the branches of *Populus euphratica* by Wang Fubao in 2004 from the west side of the "Three Rooms" (N1, N3, and N4). Sample LL-12 was obtained from residual clothes and silks in a tomb at 3.4 km northeast from LA City (Figure 6(b), (c)).

Tuyin site: Located in the northeast of the LE city, on a high terrace to the north of Lop Nor (Figure 1), which was found and named by Professor Huang Wenbi[5] in 1930. A wood sample from *Populus euphratica* was collected by Wang Fubao in 2004 (N10).

A newly-discovered ancient city: Located about 6.3 km northwest from the Xiaohe Graveyard. This City site (40°22′23.04″N, 88°36′58.25″E, altitude 810 m) was found in November 2008 by the first author using the remote sensing map from the Google Earth, and it eventually was confirmed during the field investigation. This is a big city ruin, only second to the LA City relic site in Lop Nor area.

From the remote sensing map of the Google Earth, a reversal "L" shape mark can be seen in the northwest of the Xiaohe Graveyard, situated at the center of meander of an old river channel (Xiaohe), and two white stripes compose a right angle prolonging from south to north and from east to west (Figure 7(a)). This "L" angle points towards the southeast, completely different from the direction of extending sand dune and Yadan landform distribution that are apparently controlled by wind. The stripe on the south part of the "L" shape shows a shadow image looking like a convex. Thus, it was suspected to be an artificial construction.

On November 27, 2008, the exploring team arrived at a site about 2.3 km west from the suspected spot ("L" shape mark), and turned to east through the desert. When the exploration crew reached a flat place between sand dunes, about 1.5 km from the suspected "L" spot, many spinning wheels, pottery fragments, and animal bones were found (Figure 8), and moreover, two coins of "Five Baht". On arrival of the suspected spot, first encountered were reddish burnt soils of a few square meters and many stone artifacts sized 10–20 cm in diameter. The southern wall of the city was composed of mud and Chinese tamarisk extended to the east end (Figure 9). A sample of the Chinese tamarisk was taken from the center part of southern wall (XH-1). The eastern wall, which is south-north extending, only has part of its base exposed, with a width of about 6–8 m, relatively flatted, and comprising artificially accumulated mud. A discontinuous red burnt soil is distributed along the inner wall (Figure 10). Charcoal samples were collected from the southern and central part of the eastern wall (XH-2 and XH-3). Pottery fragments are scattered on the wall and its surroundings. The east-west extending wall on the northern side of the city was measured with about 6 m width on the top. No wall in the west was found due to the coverage of the dunes. Thus, we confirmed that this suspected "L" spot is a big city ruin with remains of three walls about 220 m long, respectively. For lack of wall in the west, it remains uncertain if the city was square or rectangular shape. Professor Yidilisi proposed a name for this site as "Relic 4 of Han and Jin Dynasties" based on a number of ancient remains observed at this spot and its surrounding area.

Eighteen samples collected from the above six relic sites were dated at the AMS Laboratory of Peking University and Conventional ^{14}C Laboratory at Institute of Earth Environment, Chinese Academy of Sciences. All ^{14}C dates have been calibrated into calendar ages (Cal. a BP) using software of CalPal2007_HULU (http://www. calpal-online.de/).

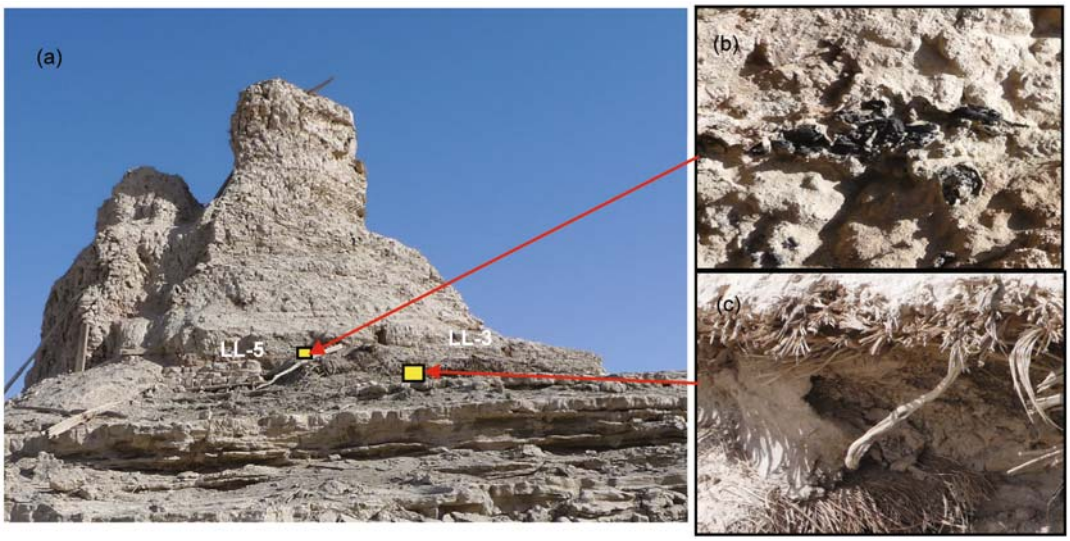

Figure 5 (a) The west side of the stupa with sampling locations; (b) and (c) details of the charcoal and plant sampling locations.

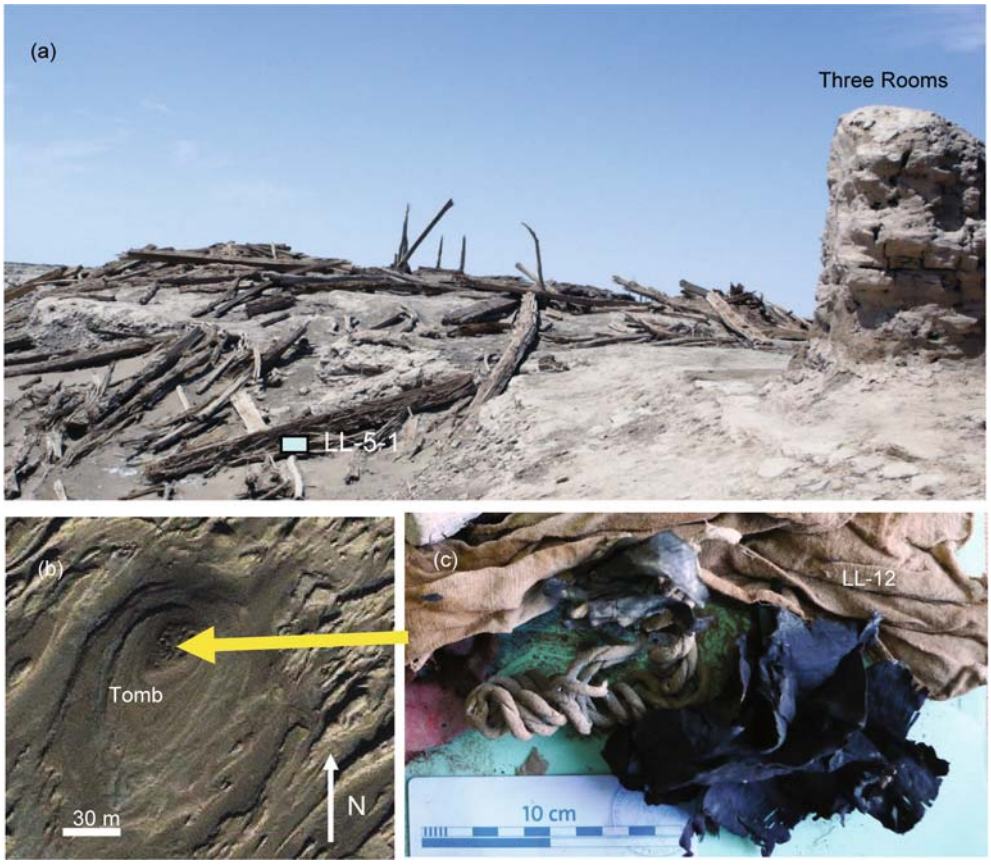

Figure 6 (a) The "Three Rooms" site with the sampling location; (b) remote sensing map of an ancient tomb located 3.4 km northeast from LA site; (c) residual clothes and silks in the tomb.

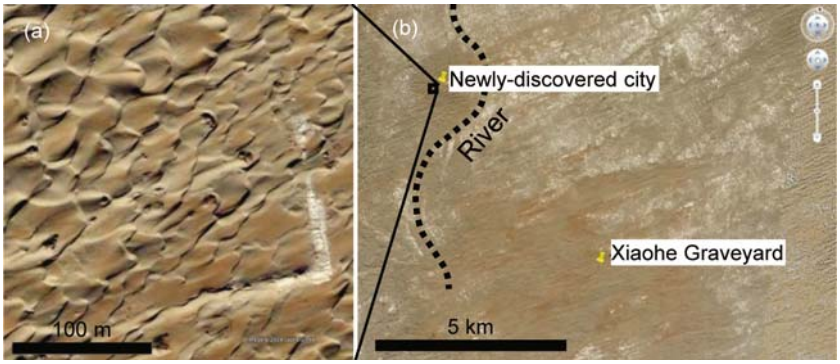

Figure 7 (a) Remote sensing map of the newly-discovered archaeological site; (b) this site is located 6.3 km northwest from the Xiaohe Graveyard, situated at the center of meander in the west bank of an old river channel.

2 Results

The ^{14}C ages for the 18 samples are shown in Table 1. Except that one sample from Milan site yields a younger age of 1173±65 Cal. a BP, all other dates fall within the range of 1450–1900 Cal. a BP (about 50–500 AD), i.e. spanning ~500 years from the Eastern Han, Wei, Jin, to the Northern and Southern Dynasties.

The newly-discovered city site was dated to 440–500 AD (Figure 11), corresponding to the Northern Wei Dynasty (386–534 AD) of the Northern and Southern Dynasties. As the three dated samples were collected from the city walls, we speculate that this city was still inhabited by people at least during the Northern Wei Dynasty. The age of this city is younger than the Han–Jin Dynasties that was estimated during the field investigation.

Among the nine samples from Luolan (LA) City site, four were collected from architectural materials and charcoal layers at the base of the stupa. Their dates should represent the construction time of the stupa, which turns out

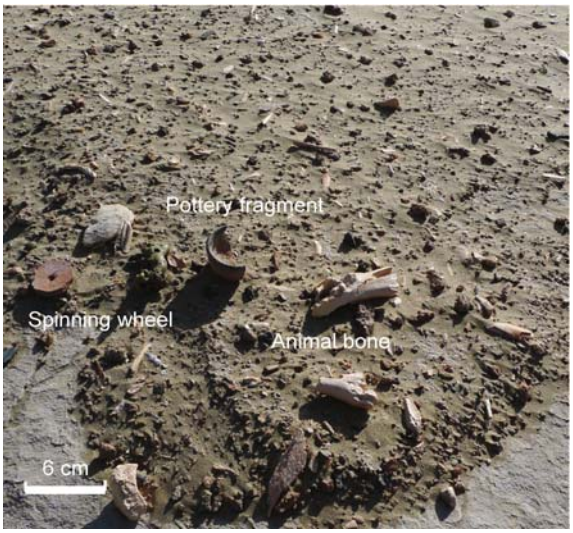

Figure 8 Spinning wheel, pottery fragments, and animal bones presented on the ground surface of the newly-discovered city relic site.

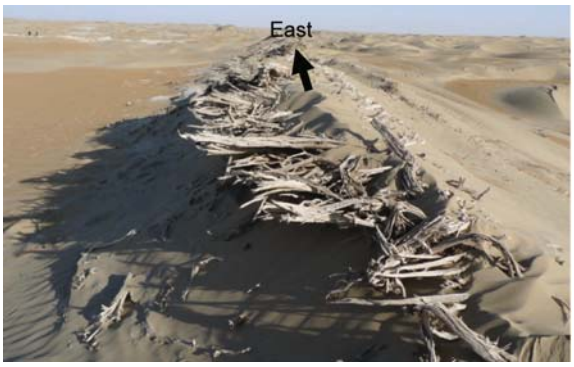

Figure 9 The southern wall of the newly-discovered city was constructed by mud mixed with Chinese tamarisk.

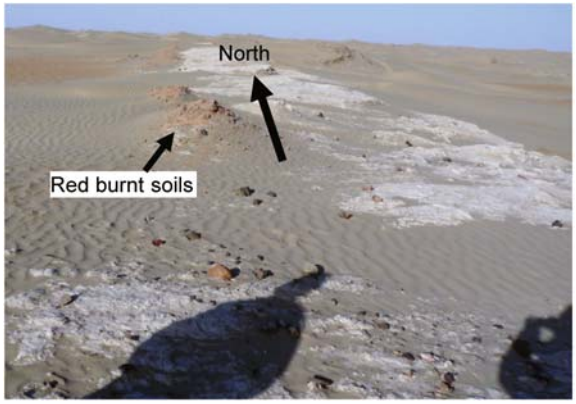

Figure 10 The exposed eastern wall base of the newly-discovered city relic site.

to be at 1720–1880 Cal. a BP (~70–230 AD). This age range is consistent with that of the "Three Rooms" (1770–1880 Cal. a BP), which belongs to the Eastern Han Dynasty. The silk sample obtained from the ancient tomb located 3.4 km east from Luolan City site yields a slightly older age of 1900±37 Cal. a BP (~50 AD), roughly corresponding to the early period of the Eastern Han Dynasty.

Two samples from LE City site were collected from an architectural wood laid on the ground surface and the Chinese tamarisk contained in the southern wall of the city. Their ages are 1720±66 Cal. a BP and 1650±51 Cal. a BP (~230–300 AD) respectively. This is approximately equal to the Three Kingdoms–Eastern Jin Dynasties, but slightly younger than the time of Loulan (LA) City.

One sample was taken from wall base in the Qieerqiduke site. Its age is 1747±60 Cal. a BP (~203±60 AD), roughly contemporaneous with Luolan (LA).

The plant sample from the northern wall base of the western entrance in the Milan fortress site yields a young age of 1173±65 Cal. a BP (~777±65 AD), corresponding to the Tang Dynasty. However, the age dated on the wooden beam of Milan fortress is relatively older, about 370 AD.

The Tuying site yields an age of 1864±103 Cal. a BP (~80 AD) that is contemporary with the Luolan site (Figure 11).

3 Discussion and conclusions

(1) The newly-discovered city site situated 6.3 km northwest from the Xiaohe Graveyard has undergone ~1500-year wind erosion, and its eastern wall which was south-north extending, but vertical to the northeastern wind was eroded completely. Only wall base ruins remain on the old ground surface, and many portions are buried by dunes. The east-west extending southern wall is found to be made of mud and Chinese tamarisk, showing the same architectural material and style as in the LE City. Three ^{14}C dates obtained from charcoal and Chinese tamarisk represent approximately the construction time of the city, around 440–500 AD, corresponding to the middle period of Northern Wei Dynasty (386–534 AD). The construction age of the wall should be 100–300 years younger than those of Luolan (LA), LE, and Tuying sites.

The size of the newly-discovered city relic site is just secondary to Luolan (LA) City, thus it should have its historical record in the ancient literatures. After an intensive search in numerous historical literatures, we found two ancient cities whose exact locations in the Lop Nor area are presently unknown and we speculate that they might be related to the newly-discovered city ruins according to their geographic locality and chronological data.

1) Zhubin City. It was recorded in a book "*Shuijing Zhu*" in Chinese, written by Li Daoyuan in the Northern Wei Dynasty. The author of this book described the Zhubin River as follows: "Water flows eastwards through the south of Moshan State, and the south of Zhubin City, and again orientates through the south of Luolan City to farther east".

Table 1 ^{14}C datings from archaeological sites in Lop Nor

Lab code	Field number	Material	Locality	^{14}C date (a BP)	Cal. a BP	68% range (Cal. a BP)	Cal. AD
BA081854*	XH-1	Chinese tamarisk	City wall of the newly-discovered relic	1635±35	1513±59	1454–1572	437±59
BA081855	XH-2	Charcoal	Wall base of the newly-discovered city relic	1555±40	1457±49	1407–1506	493±49
BA081856	XH-3	Charcoal	Wall base of the newly-discovered city relic	1545±40	1449±53	1396–1502	501±53
BA081861	LL-3	Grass	Luolan stupa base	1820±35	1765±43	1722–1808	185±43
BA081862	LL-5	Charcoal	Luolan stupa base	1790±35	1720±66	1653–1786	230±66
XLLQ1669**	N5	Chinese tamarisk	Luolan stupa base	1857±39	1798±52	1745–1850	152±52
XLLQ1728	N6	Chinese tamarisk	Luolan stupa base	1930±55	1883±59	1823–1942	67±59
BA081863	LL5-1	*Populus euphratica*	In southeast of "Three Rooms", Luolan	1825±40	1768±46	1721–1814	182±46
XLLQ1672	N1	*Populus euphratica*	West side of "Three Rooms", Luolan	1930±120	1884±146	1738–2030	66±146
XLLQ1670	N4	*Populus euphratica*	West room of "Three Rooms", Luolan	1930±115	1883±139	1743–2022	67±139
XLLQ167?	N3	Camel excrement	Livestock stall in west side of "Three Rooms"	1915±100	1861±118	1742–1979	89±118
BA081864	LL-12	Silks	Tomb in Luolan	1945±35	1900±37	1862–1937	50±37
BA081865	LL8-2	*Populus euphratica*	LE City	1790±35	1720±66	1653–1786	230±66
BA081866	LL8-3	Chinese tamarisk	LE City wall	1740±40	1650±51	1598–1701	300±51
BA081867	ML-1	Charcoal	West entrance wall of Milan City	1235±40	1173±65	1107–1238	777±65
XLLQ1673	N15	*Populus euphratica*	House pole of Milan City	1660±115	1574±132	1441–1706	376±132
BA081868	RQ-1	Plant stems	Qieerqiduke relic	1810±45	1747±60	1686–1807	203±60
XLLQ1666	N10	*Populus euphratica*	Tuying site	1920±85	1864±103	1761–1967	86±103

*BA: Laboratory code of AMS Lab, Peking University, ** XLLQ: Laboratory code of ^{14}C Lab, Institute of Earth Environment, Chinese Academy of Sciences.

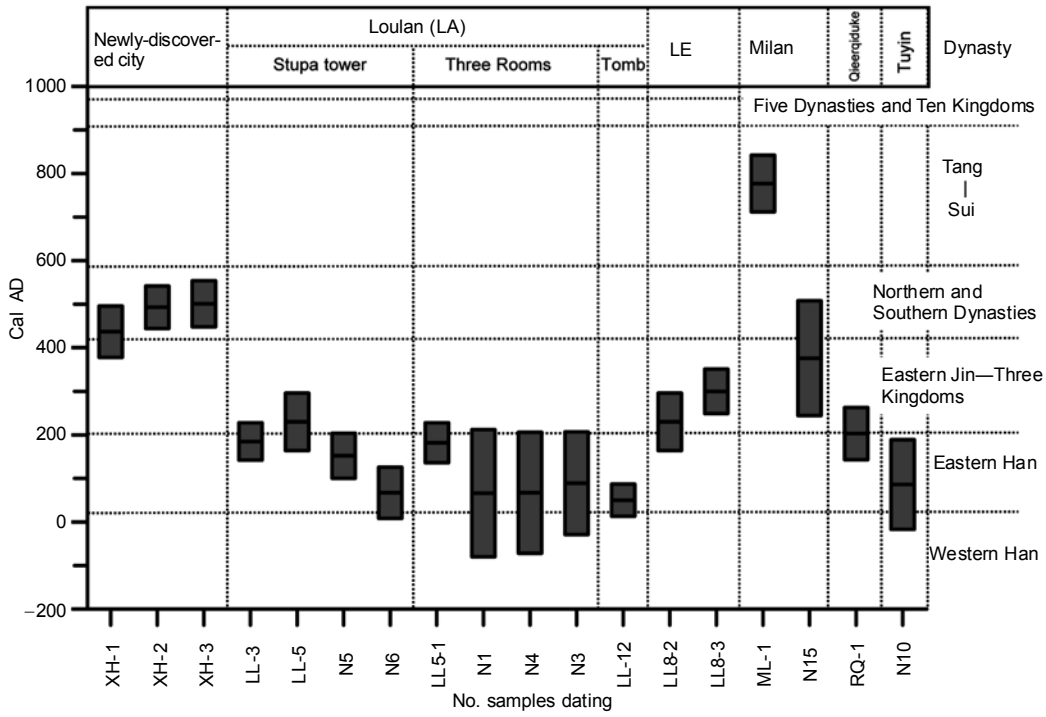

Figure 11 ^{14}C ages and historical chronology of main archaeological sites in Lop Nor (gray showing the dating error, 1σ).

These words indicate that the location of Zhubin City was at the southeast of the Moshan State and the west of Luolan City. The newly-discovered city is situated about 80 km southeast from Yinpan City (the capital of Moshan State?) and about 110 km west from the LA site. Where was the Zhubin River located then? It may be represented by the small channel (a tributary of the Konqi River) to the west of Xiaohe Graveyard according to the study by Huang Shenzhang[15] as it was a common practice to name a city by an adjacent river in ancient China. Therefore, based on the geographic location and chronology of this city, as well as information from ancient literatures, we can infer that the newly-discovered city was Zhubin City, as recorded by Wei Daoyuan. Temporarily, we call it "ancient Zhubin River City". Undoubtedly, an accurate definition needs more investigation and excavation through archaeological and historical studies in the future.

2) Lielo City. According to the historical literature, this city located at a meander of the Konqi River delta was built by the Administration of the Western Regions during the Western Han Dynasty and military army resided there at that time. However, its exact location in Lop Nor area is still unknown[4]. Some scholars thought that the name of "Lielo City" was an alternative translation of "Luolan City"[4]. For this, more studies, including archaeological excavation and literature interpretation are necessary in the future.

The newly-discovered city was settled at a conjunction area between the west Takelamagan Desert and the east Lop Nor region where affluent rivers and lakes were distributed. Furthermore, this city, situated at the intersection of south-north and east-west traffic routes and close to the ancient postal relay of Alagan, was an unavoidable pass on the Silk Road. No matter whether this city was Zhubin City, or Lielo City, or even the capital city of Luolan State, it undoubtedly occupied a very important position on the Silk Road during the ancient time.

(2) According to the explanations of the words on wooden writs and paper documents retrieved from LA City in the past century, this area maintained about 78-year close relationship with the central governments during 252–330 AD. This was documented in "Libai Letter" written by Libai, a governor (324 AD) of the Western Regions at the Western Liang Dynasty. This Letter, stolen by Japanese Zuicho Tachibana from a wall hole in the "Three Rooms" of LA City after a Swedish S. Hedin and a British Marc A. Stein visited there, recorded its exact time of composition at about 328—330 AD. As no wooden writs of the Western and Eastern Han Dynasties have been found until now in LA City, many scholars questioned whether LA City was really Luolan City during the Western and Eastern Han Dynasties.

In 1980, an exploration crew of LA City collected a rotten wood from the eastern entrance fence in the western yard of LA City, and had it dated to 1865±80 a BP (uncalibrated ^{14}C age)[6]. This is consistent with our age range obtained on the samples from the stupa base and the "Three Rooms", but slightly younger than the age of 1900±37 Cal. a BP, dated on silks from the ancient tomb. All ages are approximately corresponding to the Eastern Han Dynasty, indicating that the main buildings in LA City were constructed during that time.

(3) LE City was found and named by the British Marc A. Stein. It was a city of the Han Dynasty, located in the northwest of the Lop Nor and at the end of the Tieban River, which is not far from the Tuyin site and about 22 km northeast from LA City, called a "Square city" by the Xinjiang Institute of Archaeology. Professor Lin Meichun of Peking University suggested that LE City should be older than LA City, and LE City might be the early capital of Luolan States[17]. Unfortunately, apart from three documents (265–274 AD) of the Western Jin Dynasty, very few ancient remains were found in the LE. Moreover, ^{14}C dating has not been done at this site until now. In this study, the age obtained on the architectural materials from the LE City wall is about 230–300 AD, that is basically coincident with the date recorded by the three documents, but slightly younger than the age of the samples from LA City.

(4) A book called "*Han Book and Western Region Biography*" recorded that "The Shanshan State originally called Luolan State had its capital at Yuni City, about ~800 km from the Yang Pass, and ~3000 km from the Chang'an, the capital of central government in China. The "*Wei Book*" also has a description that "Shanshan State also was the ancient Luolan State, its capital at Yuni City". Presently, there are three assumptions as to where the locality of Yuni City was: (1) it was Luolan (LA) City in Lop Nor; (2) Milan City (ancient Yixun City) in Ruoqiang County; (3) Qieerqiduke City near Ruoqiang County City. Very little information about Qieerqiduke City had been obtained from archaeological excavations. Until now, only a relic of the Sanskrit Pattra Sutra belonging to the India's Gupta Dynasty shows the age of about 320–540 AD. In this study, the age obtained from a plant sample of the city wall base suggests a time around 200 AD, attributed to at least the late period of the Eastern Han Dynasty.

(5) The age from the city wall base of the ancient Milan fortress presented in this paper is much younger than those from LA City and Qieerqiduke site at ~770 AD, indicating the construction time of this fortress at the middle Tang Dynasty. It was recorded in the book "*New and Old Tan Book and Tubo Biography*" [9] that at the early period of the Tang Dynasty this area was a territory occupied by Tuyuhun tribe. At 638 AD, the Tubo tribe attacked the Tuyuhun tribe who escaped to the north of Qinghai area, and then this area became dominated by the Tubo tribe. Based on the style of architectural structure and arrangement, and excavated antiquities from the fortress and castle, these relics were identified as the remains of Tubo prevailing period. The age for the city wall base of the fortress' western en-

trance is consistent with that of literature, but the age from wooden beam is much older at about 370 AD. Therefore, whether the age from the wall base of western entrance really represents the construction time of all buildings at this fortress is still uncertain and further dating work is needed.

Although the archaeological study of LA City has a history of one hundred years, it is still a hot topic of world-wide interest up to date in international academic circles[18]. In this study, ^{14}C ages were obtained and analyzed for several large city relics in the Lop Nor region, especially for the newly-discovered city situated at the northwest of Xiaohe Graveyard. Although the accuracy of the ^{14}C ages is lower than that of the historical literature, they can provide some important information and references for exploring the processes of historical development in ancient Luolan States, particularly when the historical literature is scarce.

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