

# Remote Sensing into the Study of Ancient Beiting City in North-Western China

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## Abstract

This paper presents an aerial-photographic study of ancient Beiting city, situated in the northern part of Tianshan Mountain in Xinjiang, north-western China. Ancient Beiting city was an important urban settlement on the ancient Silk Road (see figure 1). It is composed of exterior and interior walls, and bounded by moats. Several canals in the interior of the city are connected to outside moats. In this study three types of aerial photograph were examined. The analysis of these aerial photos revealed a palatial wall and some street remains, which were confirmed by subsequent field work.

## 1 Introduction

Chinese ancient cities are characterised by unique rammed earth walls. The rammed earth walls always have a foundation down to certain depth. The rammed earth walls could be easily destroyed and removed after the abandonment of the urban settlement. However, the foundations of the city walls are likely to be well preserved. In this study, aerial remote sensing techniques were employed to examine the layout of ancient Beiting city in the desert of north-western China and to detect the potential preserved foundations within the city.

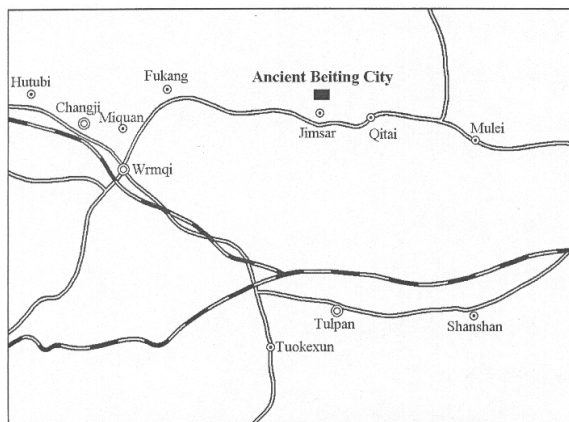


Figure 1. The location of ancient Beiting.

## 2 Background

Ancient Beiting city is about 12km to the north of Jimsar town (E89 12', N44 06' ), at an elevation of 640m. In this area, rainfall is high and the soil is fertile. To the south of ancient Beiting city is the Changshai River which runs from the Tianshan

Mountain ultimately dividing into the Dongba and the Xiba Rivers. Ancient Beiting city is situated on the west bank of the Dongba River, and it is about 800m away from the Xiba River. Local inhabitants have built houses along the exterior city wall. The south-west portion of the interior city wall is covered by farmland. Some other segments of the wall are poorly preserved and not easily recognised. (See Figure 2, & Figure 3, & Figure 4).



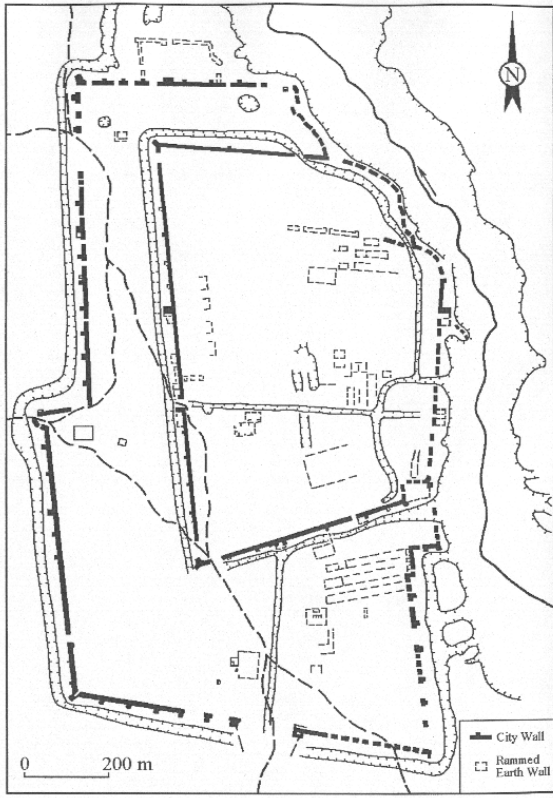
Figure 2. The Landscape of Ancient Beiting.



Figure 3 The Landscape of Ancient Beiting.



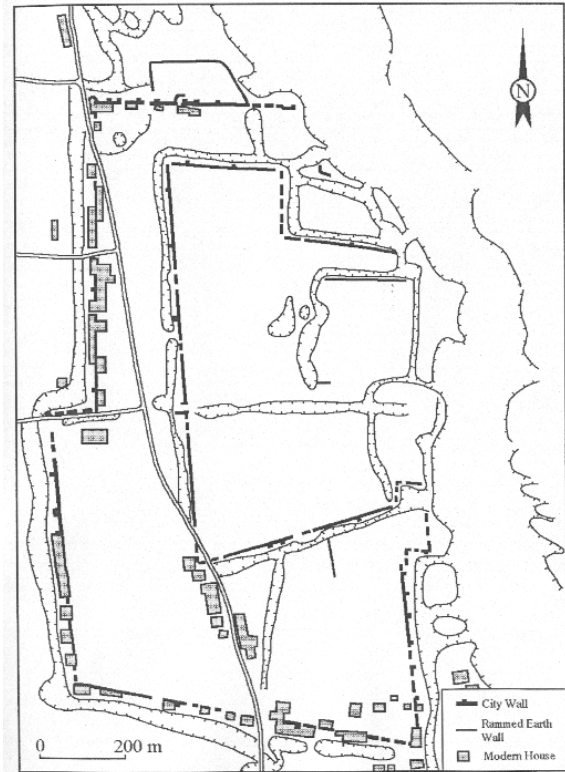
**Figure 4 The Landscape of ancient Beiting.**



**Figure 5. The city plan surveyed by Fuli Yuan in 1928.**

From the end of the last century, archaeologists from different countries have conducted several investigations in the ancient city. A good city plan was first provided by Yuan Fuli in 1928, as part of the Scientific Mission to north-western China (a Sino-Swedish scientific expedition to the north-western provinces of China organised by the Federation of the Scientific Institutions of China) (see figure 5). In 1980 an extensive surface survey was undertaken to map the more detailed layout of the ancient city by the Institute of Archaeology at the Chinese Academy of Social Sciences (see figure 6). These previous surface surveys show that the ancient city is enclosed by both exterior and interior walls. In addition, several ancient canals within the city were found to be connected with moats surrounding the

exterior city wall. Owing to the limitations of surface survey, potential subsurface features still remained elusive.



**Figure 6. The city plan surveyed in 1980.**

### 3 Method

Surface survey can be a time-consuming and expensive method in archaeological investigation. Remote sensing offers a rapid and non-destructive technique by which archaeological features can be detected if sub-surface disturbance results in the formation of crop and soil marks (Evans 1972). Sparse vegetation and dry soil conditions at ancient Beiting city allow us to study ancient remains by analysing soil marks and shadow marks. In this study three types of aerial photographs were obtained:

1. 1:60,000 black-and-white aerial photo taken in the summer of 1959 (see figure 7)
2. 1:32,000 black-and-white aerial photo acquired on the 14th of June, 1978 (see figure 8)
3. 1:60,000 color infrared aerial photo taken on the 6th of September, 1986 (see figure 9).

These three types of aerial photos were scanned into a computer. Then, the scanned aerial images were manipulated and analysed using image processing



software. Various procedures were employed in processing these images, including digital geometric correction, equalisation, edge enhancement, gray balance etc.



Figure 7.

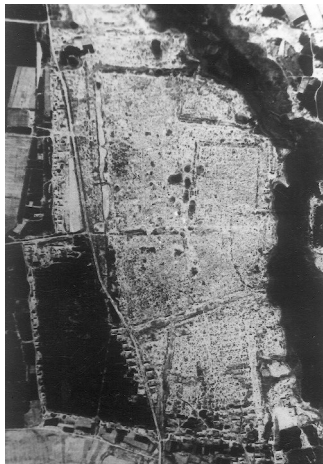


Figure 8.

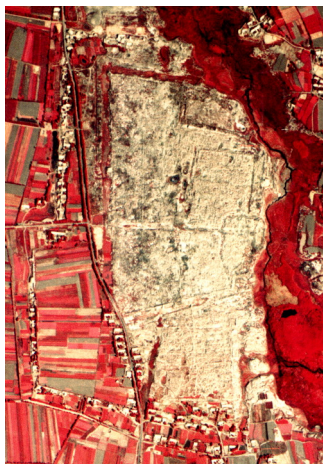


Figure 9.

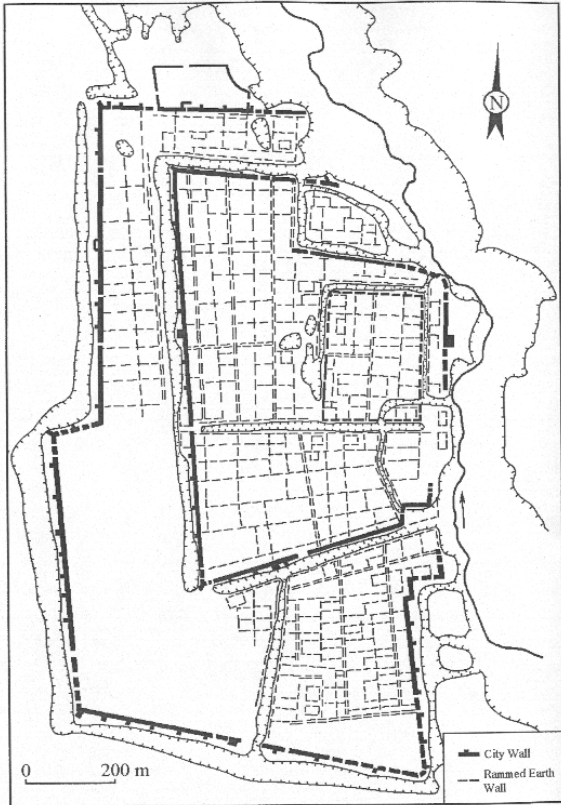
#### 4 Results and discussion

All the aerial photos of ancient Beiting city are of high quality and clearly show various features of the city. The 1959 black-and-white aerial photo shows only a few modern settlements within the ancient city. The exterior city wall, interior city wall, moats, and buttresses are clearly shown. Only the south-west portion of the exterior wall is not preserved - it is covered by modern farmland. This aerial photo series gives the same picture as the city plan surveyed in 1928 (see figure 5), indicating that not much disturbance and destruction occurred between 1928 and 1959.

However, both the 1978 black-and-white, and the 1986 infrared aerial photos show that both the exterior and interior city walls have been largely destroyed as a result of the rapid growth of modern habitation in the area. A highway was built across the ancient city in 1960. The city wall west of the new highway has been substantially destroyed by farming and building construction.

Both figures 7 and 9 show many light gray vertical and horizontal lines. (see figure 7) After ground-survey, it was found that these lines were caused by the presence of layered city wall foundations made of rammed earth. After determining the position of the city wall foundations on aerial photos, it became easy to interpret the location of moats and canals, which have dark gray hues. In the 1986 infrared colour photo (see figure 9) vegetation has a red colour, water a black colour, and wall foundations of rammed earth a light gray colour.

In the aerial photos there are some specific features appearing as two light gray parallel lines. During field work, I found that these lines were rammed earth wall foundations. Between the two walls were linear shapes, 3 meters wide and composed of road-soil, that were actually the streets of the ancient city. According to the interpretation of these results, I drew a plan of the remains (see figure 10). This showed that ancient Beiting city had rammed earth walls on either side of all the ditches and streets.



**Figure 10. The city plan drawn from the interpretation of aerial photos.**

From the centre of the interior of the city a canal extends to both the east and west gates of the interior city. It is as wide as 15m to 30m and about 1m deep. In the southern portion of the exterior of the city there is another canal extending to the south gate of the exterior city through the moat of the interior city. The canal is 12m to 25m wide, and 1m deep. These two canals are dated to the period of ancient Beiting city because;

1. they are much wider than the ancient streets in the city
2. they have the same depth as other ancient moats
3. they are connected to known moats forming a cohesive water system.

## Bibliography

Evans, R, 1972 Air photographs for soil survey in lowland England: Soil patterns, *Photogrammetric Record*, 7, 302-322

By analysing these aerial photos, a smaller rectangular wall enclosure was found in the north-east part of the interior of the city. It is most likely a palatial wall. Wall foundations made of rammed earth have been revealed to be about 1m thick. Surrounding the wall are trenches on the east, south and north sides, and a pond on the west side. They constitute a water system similar to the moats around the exterior and interior city walls. In addition, this area is in an elevated position, which is in accordance with the common practice of the ancient Chinese of building palatial sites on higher ground.

The interpretation of aerial photos reveals meridian and latitudinal canals within the city and a series of moats and the Dongba river itself surrounding both exterior, interior, and palatial city walls. These canals and moats are all connected as a developed water transport system. According to historical documents boats were a frequent site in the city pond during the North Song Dynasty (AD 960-1279). Most transportation may have been by boat when the city was in use, and this may explain why no wide streets exist in the ancient city.

## 5 Conclusions

Remote sensing is a new development in the study of ancient Beiting city. The analysis of aerial photos revealed new features that had not been found in previous surface-based archaeological surveys. Figure 5 shows a straight line representing a rammed earth wall in the north-east portion of the interior of the city, but the line in Figure 10 is the north wall of the palace enclosure. The channels shown in Figure 6 were the moats of the palatial city shown in figure 10. These demonstrate the value of aerial photography for the discovery of hidden archaeological features. The comparison of figures 5 and 10 suggests that the Dongba River shifted its channel toward the west bank between 1928 and 1959. The current river channel is now closer to ancient Beiting city (figure 9) and is eroding away the east city wall. Engineering work is needed to prevent the further migration of the river, otherwise the ancient city remains will be destroyed.

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