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# Revealing a Wall with RTK – A Non-destructive Investigation of a Chinese Medieval Walled Site

Pauline Sebillaud<sup>1,2</sup> Liu Xiaoxi<sup>2,3</sup> Wang Xinsheng<sup>3</sup> Xing Chunguang<sup>4</sup>

**Abstract:** A non-invasive archaeological investigation was carried out using Real Time Kinematic (RTK) topographical survey on the AD 10th to 13th century Kujindui site in Northeast China. The examination of previous documentation and satellite photographs shows the lack of precision on the knowledge of this medieval site. The RTK measurement provided data to draw a topographical contour map and a 3D digital model that reveal the outline of the enclosure wall. It allows defensive architectural features to be reconstructed. The precisely geolocated plan provides the basis for future research and preservation.

**Key Words:** non-invasive method; survey; GPS; RTK; walled site; China; Jilin

In October and November 2013, a joint team from the Jilin Province Archaeology Institute and the Cultural Institute of the Nong'an 农安 District carried out a salvage excavation on a gas pipeline between Harbin 哈尔滨 and Shenyang 沈阳, in Northeast China, outside of the Kujindui 库金堆 site.

Located northeast of the town of Helong 合隆, west of the Yitong 伊通 River and north of its east-west running tributary, the Kujindui site is near the modern village of Chengzili 城子里 (Figure 1; Guojia Wenwuju 1993: 41). It is surrounded by a large number of contemporary medieval settlements, most of them attributed to the "Liao-Jin" period. The Liao 辽 Dynasty (AD 907–1125) ruled Mongolia (today both the Mongolia Republic and Inner Mongolia Province in the PRC), a part of eastern Russia, and Northeast China (often called Manchuria). The Jin 金 Dynasty (1115–1234) took control over this region during the 10th to 13th centuries. This whole period is often called "Liao-Jin" in Chinese history.

A walled settlement had been previously described at Kujindui as:

*An irregular square, oriented 30°, the east wall measuring 345 m, the west wall 330 m, the south wall 360 m, and the north wall 340 m, for a total perimeter of 1,345 m. The wall is built of rammed earth, the foundation of the south wall is preserved to a height of 5 m, only a height of 1 m exists for the west wall, and only fragments can be seen of the north and east walls. On each side there are three evenly spaced observation terraces: these are not very clear on the northern and eastern sides, but very distinct on the southern and western sides. The terraces have a top diameter of 2.5 m and a 10 m diameter at their base. There is a gate at the centres of the east and west walls, of 20 m width. Each of the four corners had a tower; the northeast and south-west ones are relatively well preserved, 3 m across at the top, 25 m across at the bottom, and 3.5 m in height. The northwest and southeast towers are only preserved 1 m above the ground level. Outside of the south wall, on the east and west sides, there is a terrace linking to each tower, the side of each measuring 10 m at the top, and 20 m at the foundation. Nowadays the eastern one is not visible any more, but the western one is well preserved (JSWB 1987: 136).*

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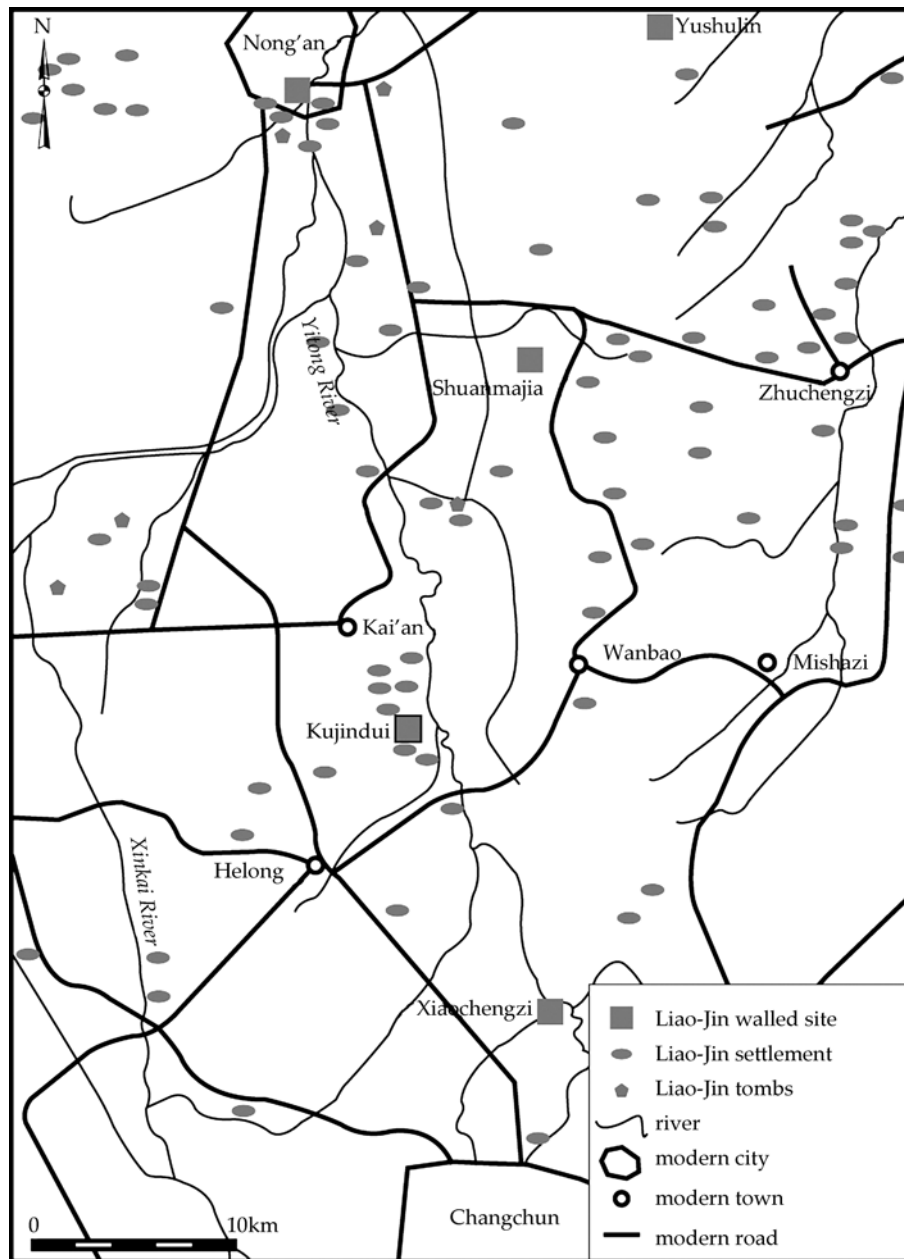


Figure 1 Location map of the Kujindui site and its environs in Jilin Province, northeast China.

The outline of the wall is not very clear on satellite photographs (Figure 2). Using the concepts of isoaxiality and isotopy we can make some hypotheses concerning the outline of the wall. Isoaxiality designates the fact that two elements, one ancient and vanished, and the other still visible in the planimetric patterns, should line up (Chouquer 2007: 259). Isotopy describes the fact that a lot of the landscape's natural or man-made boundaries remain at or around the same location (Chouquer 2000: 147).

Pedestrian survey showed that the remains of

the wall are also not very visible on the ground surface, except for the south wall (Figure 3). The site might have been built on the edge of a natural terrace above a pre-existing marsh south of the site. One of the reasons for the choice of this location might have been due to its location on the edge of a terrace on the side of the largest ancient river bed belonging to the east-west tributary stream of the Yitong River. The longest previous description of the site fits into just one short page, and it is difficult to precisely locate the wall, as it has never been mapped or drawn before.

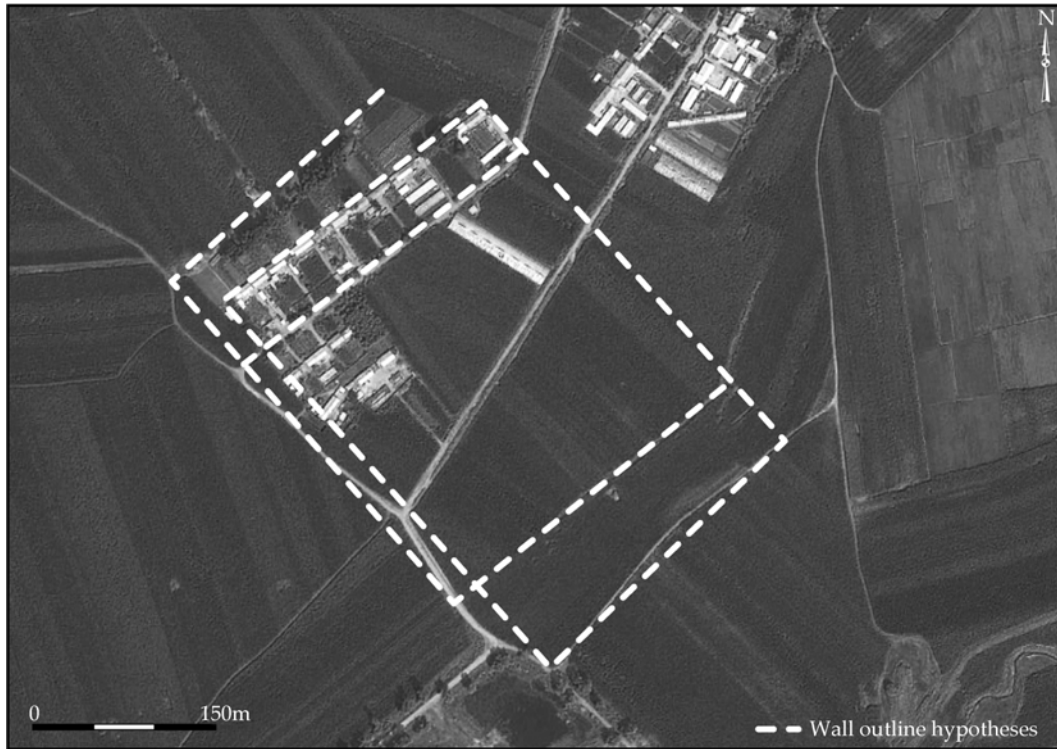


Figure 2 Satellite photograph of the Kujindui site and hypothesized wall outlines. Adapted from Google Earth.



Figure 3 Ground surface survey photographs of the Kujindui wall: (top) east wall south section and (bottom) south wall middle section.

Buried archaeological structures are often reflected in the overlying surface topography;

the micro-reliefs are frequently a good sign of subsurface material. Could non-invasive topog-

raphical survey give us more information about the remaining anomalies in the topography, thus revealing the outline of the medieval wall? Even if the landscape of corn fields is fairly open, the modern village of about 30 houses still makes it difficult to use a total station. In addition, one can only take a few hundred points a day with a total station, and would have to change measurement stations many times. Even if the error could have been minimal (a few centimetres), this method was not ideal for the conditions.

A location and altitude survey was carried out with the help of a RTK (Real Time Kinematic), which is a ge positioning technique that requires two specialized GPS receivers; one is set as a base station, so it can send the correction message to the moving receiver. Both receivers collect extra data from the GPS satellites. RTK permits maintaining centimetre-level accuracy. This technique has been quite frequently used on non-invasive archaeological survey (Bogacki et al. 2010), and its use is developing in China (Wang 2009; Duan 2010).

RTK (GeoSun Inc., eFix R1) field survey benefited from the Geopac application used to mark out and to register the points with WGS84 projection of the UTM grid coordinates. After a day of pedestrian survey and preparation, 1221 points were taken in one day of fieldwork, in order to keep the highest level of accuracy. The DXF files were then processed with the CASS program and AutoCAD. Geophysical maps were produced with the Surfer 8.0 application.

Processing of the survey's results generated a contour plan for the entire site (Figure 4). The topography of the survey area is of very low relief with a maximum vertical relief of approximately 12 m (167 to 179 m) in the 19.62 ha of the survey boundary. The surface area surrounded by the wall is 7.95 ha. The wall is oriented 44° west, the east side is roughly 352 m long, the south side 228 m, the west side 305 m and the north side 253 m, for a total perimeter of 1140 m.

From the results of this survey, it is clear that the shape of the site today is different to that at the date of the national antiquity survey in the 1980's when the site was first described. The erosion is due to the agricultural ploughing of the fields for at least the past 60 years,

particularly intense on the west side. But a contour map (Figure 5) and a raster 3D surface digital model with custom light positions and shading (Figure 6; Plate V, 2) allow for further observations and hypotheses on the architectural features. They can be reported on a map compiling the 25 cm contour plan and satellite photographs of the site (Figure 7). The micro-relief variations indicate the possible location for the corner towers, as well as two breaches on the west and east sides of the wall that could have been entrances and that were linked by a path that roughly follows a present day concrete road. The observation terraces are harder to locate, and might not have been evenly spaced. Three of them can be placed on the north and south walls, where the view is actually the widest.

From the distribution of the artifacts observed on the ground surface during the survey, pottery sherds are only distributed inside the city wall. Very few architectural materials are visible outside the outline of the wall, only next to the tombs on the west (bricks and sherds dug out for the construction of 20th century mound burials). Architectural materials were also visible outside the wall on the north side corner tower that could have collapsed both inward and outward. Thus, most of the inhabitants' activities might have taken place inside the enclosure, which had quite strong defensive features. In addition, inside Kujindui's wall there are only Liao-Jin and end of Qing (1644–1911) to Republican period (early 20th century) diagnostic sherds. Was this settlement totally abandoned during the Ming 明 Dynasty (1368–1644)? It is possible that there was a continuation of the Liao-Jin material culture with very little exchange with Central China. Therefore, there was no import of characteristic Ming porcelain. The geolocated vector version of the Kujindui site map will be used as the basis for the site's analysis and for future research and preservation. By only investing two days of fieldwork, this method proved to be very efficient for this type of site. Thus, a settlement analysis of the hundreds of buried walled sites in the Manchuria Plain could greatly benefit from the development of the use of RTK topographical measurement.

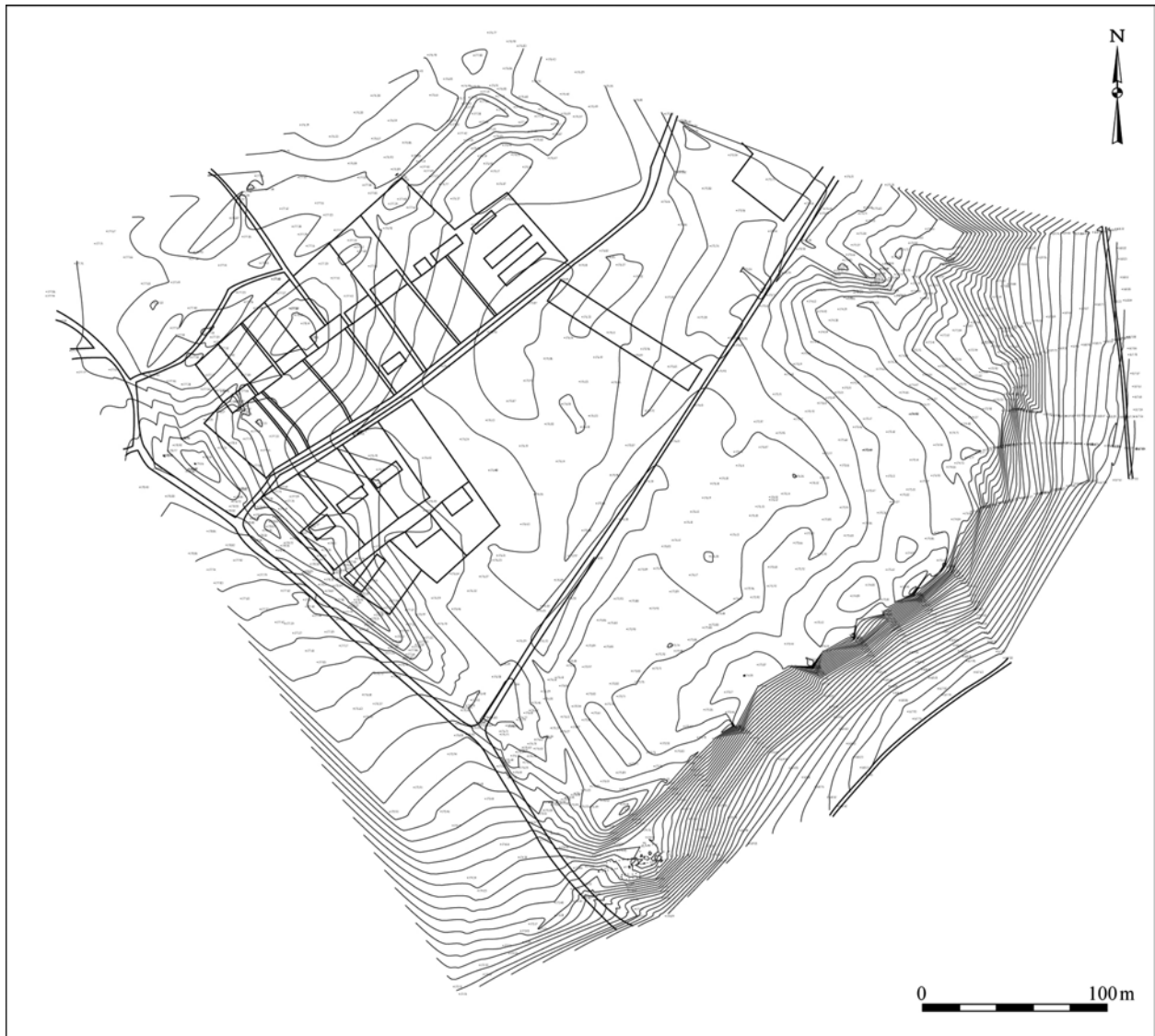


Figure 4 Topographical map of the Kujindui site.

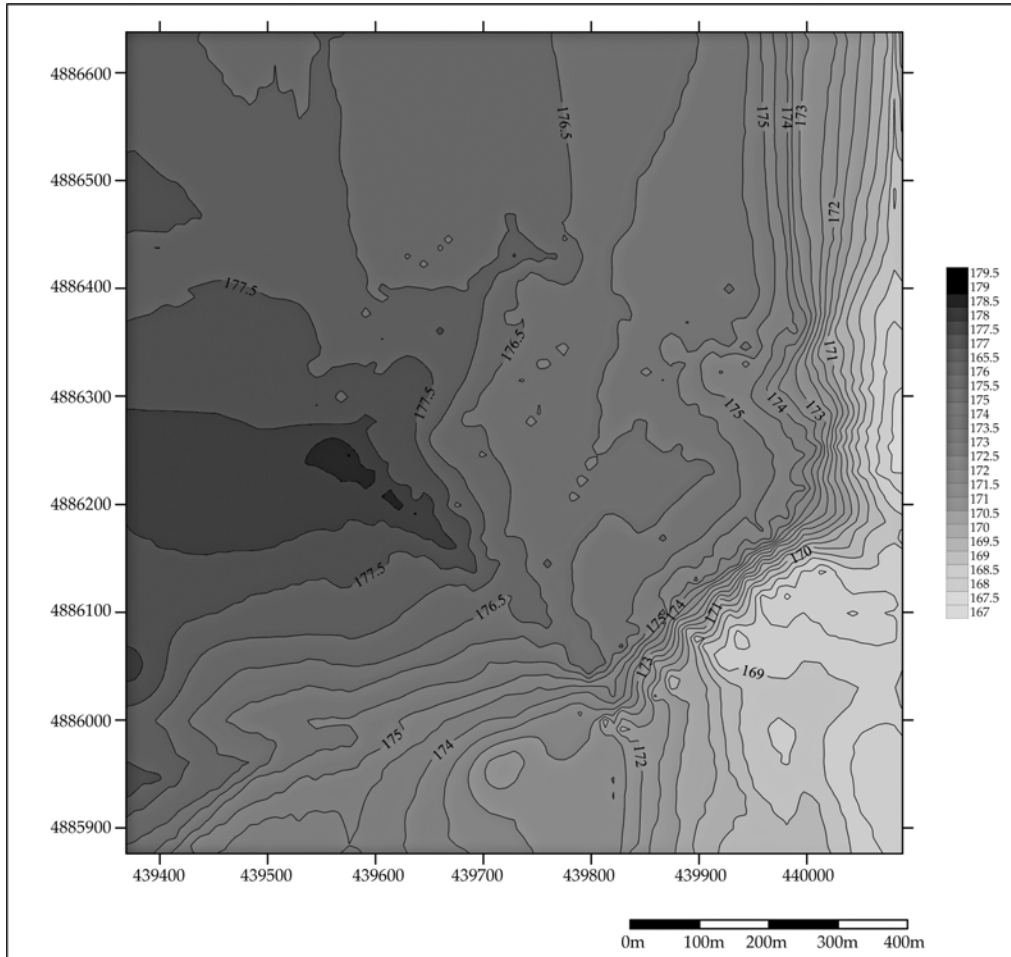


Figure 5 Contour map of the Kujindui site.

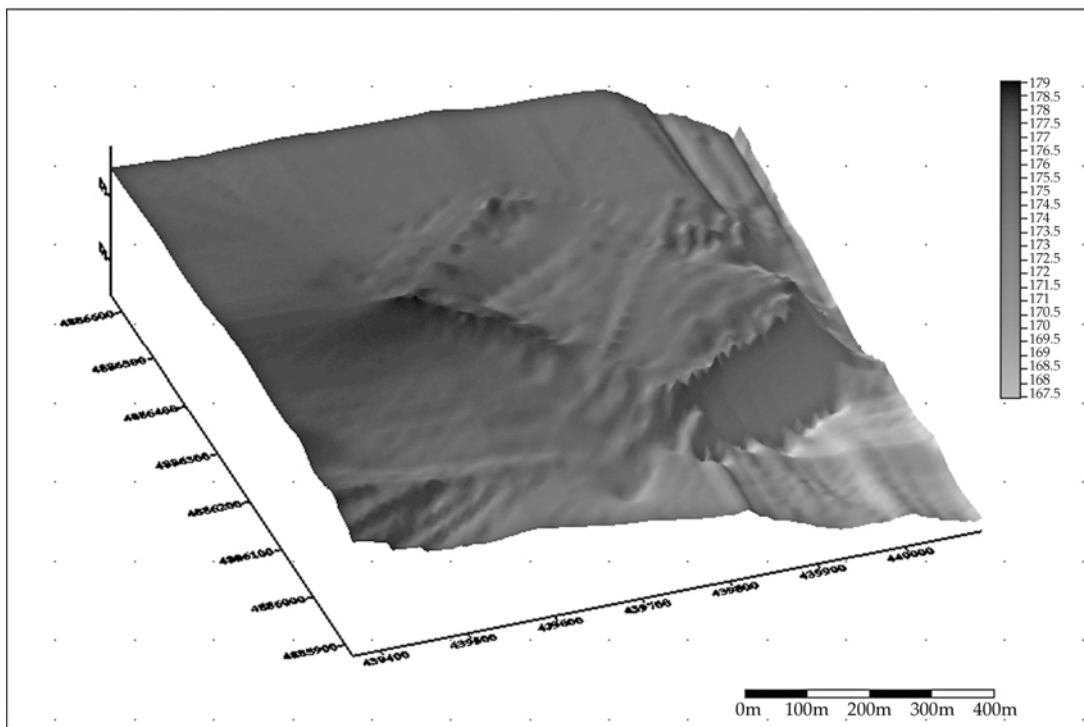


Figure 6 Raster 3D surface digital model.





Figure 7 Map showing the reconstructed outline of the Kujindui site wall based on the RTK survey results.

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