Mapping and Surveying the Archaeological Monuments of the Altai Mountains (Altai Republic)

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Abstract

During three field campaigns (2003-2005), Ghent University and Gorno-Altaisk State University used Corona satellite imagery to produce reliable topographical maps for archaeological survey. They also tested different GPS devices for taking ground control points for archaeological survey. Large areas of six valleys in the Koch-Agatch region were surveyed and mapped, producing a database of more than 4,800 structures at 600 sites. All monuments from the Neolithic to the Turkic period have been recorded. The first goal was to obtain a general understanding of the patterns in the location of burial places, ritual monuments, and areas with petroglyphs. Local and regional patterns in the location of burial grounds and ritual monuments point to a narrow interaction between the succeeding cultures. The survey also revealed that varying types of valleys present different site distribution patterns. The second goal is to use this inventory as a tool for heritage management and protection.

1 Introduction

The Department of Archaeology and Ancient History of Ghent University, in cooperation with Gorno-Altaisk State University, has been active in archaeological research in the Altai Mountains for ten years (for an overview, see Gheyle et al. 2005). Though in the beginning excavations were the prime objective of this project, we realized that there was a great potential in mapping the archaeological monuments and in producing maps of the remote area where they are located (Gheyle et al. 2004). As the area was lacking good topographical maps, the use of satellite imagery was one of the only options to produce these documents. For financial and technical reasons, we decided to use historical CORONA images (Gheyle et al. 2005; Goossens et al. 2006). Finally, other satellite imagery (Aster, Landsat) was used to test a methodology for producing ground temperature maps of the Altai Mountains, in order to select areas of potential preservation in frozen context of burials, especially Scythian tombs (Goossens et al. 2006).

Indeed, global warming of our planet is threatening our climate, and the beautifully preserved frozen tombs of the Altai Mountains (see Molodin 1999; Molodin and Polosmak 2000) might thaw in the next decennia. Therefore, a global and ambitious project was set up and supported by the UNESCO, with a grant from the Flemish government (Flemish Trust Fund). A workshop was organized in Gorno-Altaisk and grouped specialists from the Altai region and the four neighboring countries (China, Kazakhstan, Mongolia, and Russia) (UNESCO International Workshop "The Frozen Tombs of the Altay Mountains: Strategies and Perspectives," Gorno-Altaisk, March 28-31, 2006).

This paper focuses on two aspects of the research in Altai: first, we will concentrate on the problems of producing accurate maps (topographic and archaeological); the second is devoted to a first analysis of the archaeological landscapes, from the Neolithic (4^{th}-3^{rd} millennium BC) up to the ethnographic period (17^{th}-18^{th} centuries AD).

2 Mapping in the Altai Mountains

This is not the place to discuss the CORONA images, but the basic idea is that these American intelligence images cover a major part of the Altai area and are cheap and useful images to realize topographical maps as a basis for landscape analysis of the archaeological monuments in the area (Gheyle et al. 2005).

During three campaigns from 2003 to 2005, a joint team from Ghent University and the Gorno-Altai State University surveyed several valleys in the Kosh-Agatch region (Figure 1). Different sets of devices were tested, which allowed us to improve and facilitate the inventory of the archaeological monuments. From a general point of view, three constraints were important:

1. For general orientation in the field, there is a need for accuracy better than 10 m;
2. In order to georeference the satellite images and to produce detailed topographic maps, the ground control points must be defined with great precision; in the case of the CORONA images, with a ground resolution of 9 or 6 ft (CORONA KH-4B and KH-4A, respectively), a precision in X, Y, and Z up to less than 1 m is necessary. For the sake of direct control, a device with real-time positioning results is preferable;
3. Finally, there is the actual archaeological survey. For

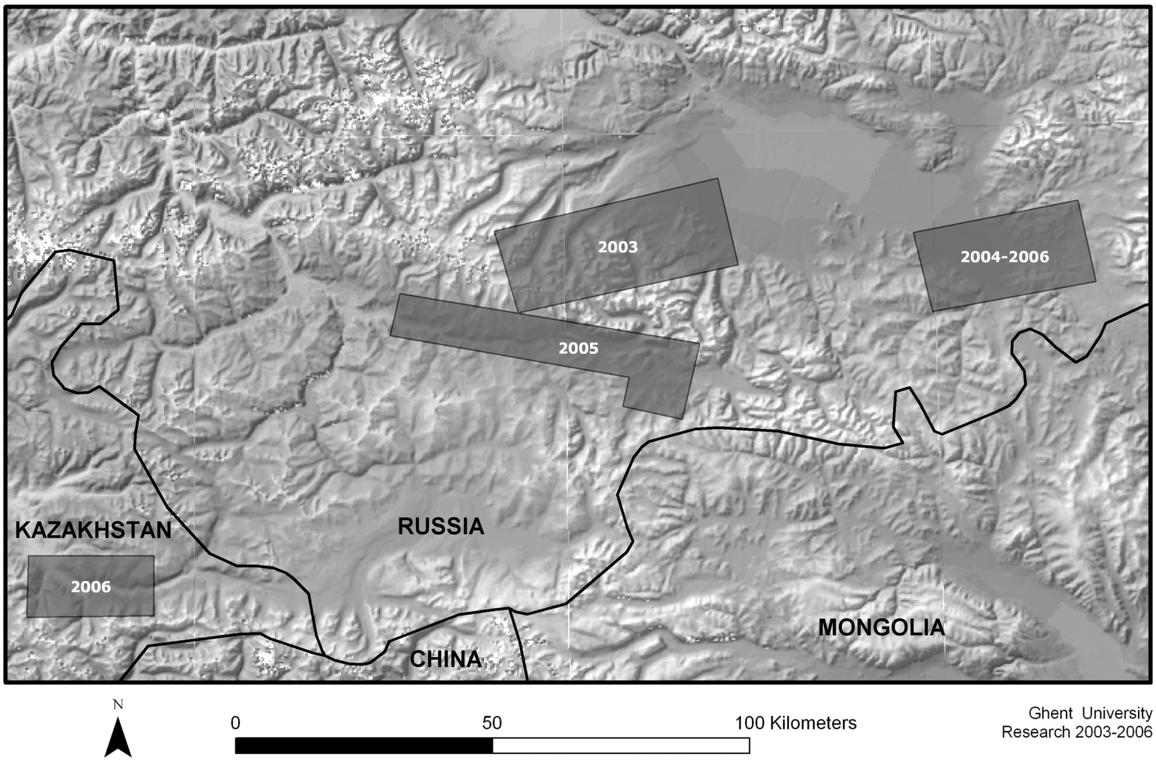


Figure 1. Map of the surveyed areas 2003-2005 and the planned area in 2006. The map is based on SRTM imagery, showing the relief of the Altai Mountains, with the country boundaries.

the localization of each site, a precision of 1 or 2 m in X, Y and Z is sufficient. But for the localization of the monuments within a single site, a higher precision is needed: in order to produce reliable plans, the individual monuments have to be measured with an accuracy of less than 0.5 m.

During the 2003 campaign, our work focused on the valleys of Elangash, Irbistu, and Ozyok, though we also produced some measurements in the valley of Sebystei (Bourgeois et al. 1999; Bourgeois et al. 2000; Bourgeois et al. 1999) to allow the full integration of previous surveys there. In 2004, we concentrated our activity in the Yustyd valley, well known for the fieldwork and publication executed in the eighties by V. D. Kubarev (1991). The huge concentration of ritual monuments of the Bronze Age, as well as the interesting and large Scythian graveyards (see below), or the many Turkic monuments, were enough reasons to concentrate our attention on this place. Finally, in 2005, the survey focused on the Dzhazator Valley, because it lies between the valleys of the Chuya depression in the North—where our team worked in previous years—and the plateau of Ukok in the south. The last was researched for many years by the Institute of Archaeology of the Siberian Branch of the Russian Academy of Sciences in Novosibirsk and yielded the recent discoveries of frozen tombs of the Scythian period, well known as the Lady from Ukok (Princess) and the Man from Ak-Alakha (Polosmak and Seifert 1996; Molodin 1992, 1996).

2.1 General Localization

The general localization of the archaeological sites was realized with the use of Garmin Etrex Vista devices, which are cheap, quite trustworthy, and give information in real time. Unfortunately, it appears that the precision is at its best some 15 m in X and Y. This precision is obviously not sufficient for producing reliable localizations on topographical maps and plans of the archaeological sites. Even the general location of the sites, especially in Z (with precision generally up to 45 m) seems to be of no use.

2.2 Measuring Ground Control Points

Therefore, a C-Nav differential GPS (C & C Technologies) was used to measure the many ground control points in order to produce maps and georeferenced images. In 2003, we used the C-Nav 2000 GPS and in 2005 the C-Nav 2050 (Figure 2), which works faster. C-Nav appeared to be a reliable device. It provides a worldwide horizontal accuracy of 0.1m (after half an hour of logging), as the reference signal is available almost everywhere in the world from 72° N to 72° S latitude. There is no need for a reference station, and the C-Nav gives real time positioning.

The identification of the ground control points is not an easy task, as we were working with some 35-year-old satellite images and the research area did not have a lot of roads, houses, or other human-made identifiable objects. In most cases, we were obliged to look for elements in the landscape, such as outcrops, borders of terraces, or tracks. As these tracks often change, they were used only when other elements were absent. One reliable element, though, was the locations of farms: as their roofs were covered by a kind of concrete plate, they were clearly marked as white

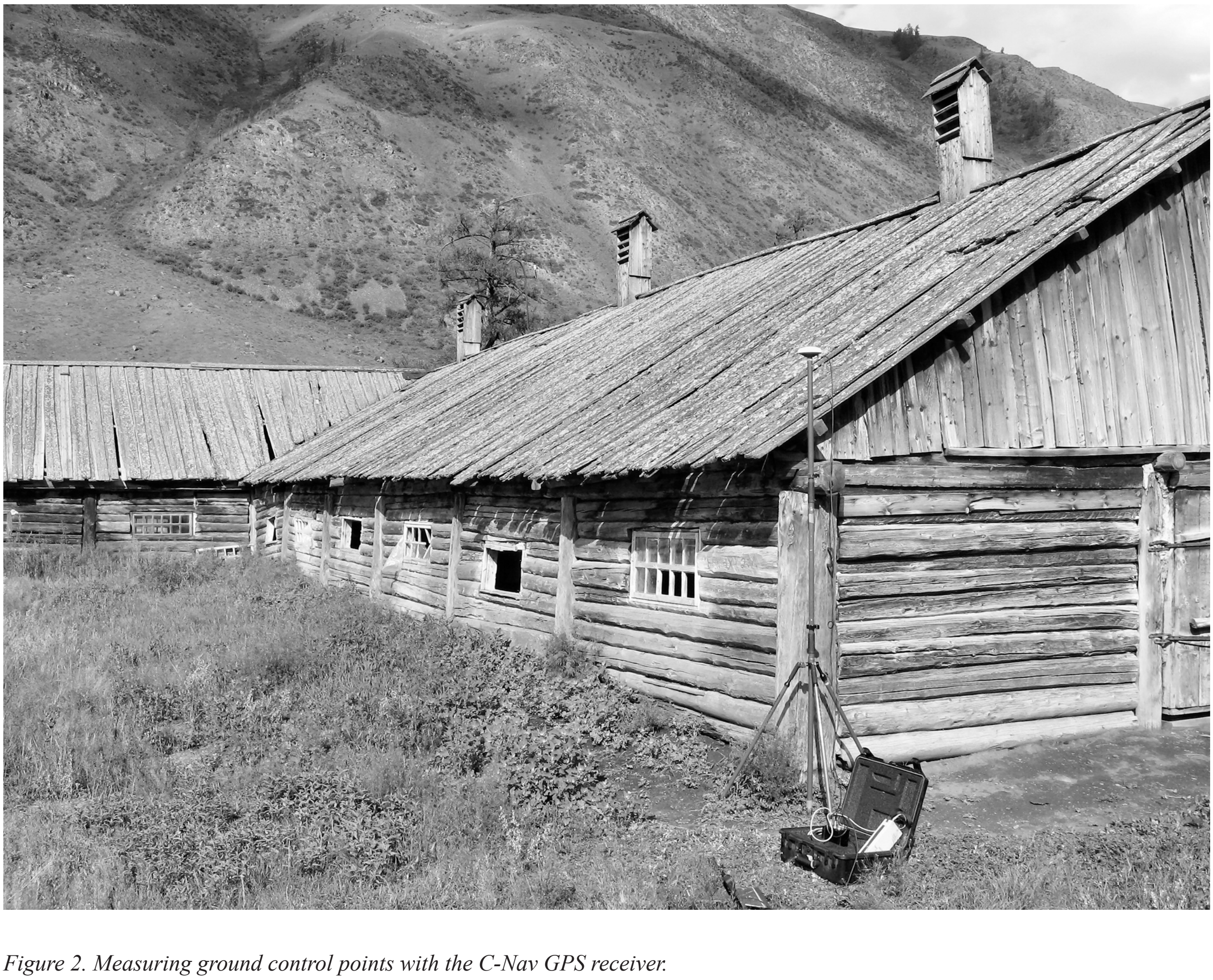


Figure 2. Measuring ground control points with the C-Nav GPS receiver.

Table 1. Mean (taken over all processed points) standard deviation of the position solution sets resulting from the three system setups.

Standard deviation	C&C C-Nav	Motorola Oncore VP	Garmin 12XL
Planimetric	0.02 m	0.88 m	1.98 m
Altimetric	0.03 m	1.75 m	2.82 m

Table 2. Mean position accuracy of the C&C C-Nav (receiver estimate) and mean mismatch between the C-Nav average position and the two other systems.

Mean position accuracy	C&C C-Nav, excluding initialization, in real time	Motorola Oncore VP mismatch, after post-processing	Garmin 12XL mismatch, after post-processing
Planimetric	0.52 m	2.68 m	2.14 m
Altimetric	0.91 m	4.25 m	2.44 m

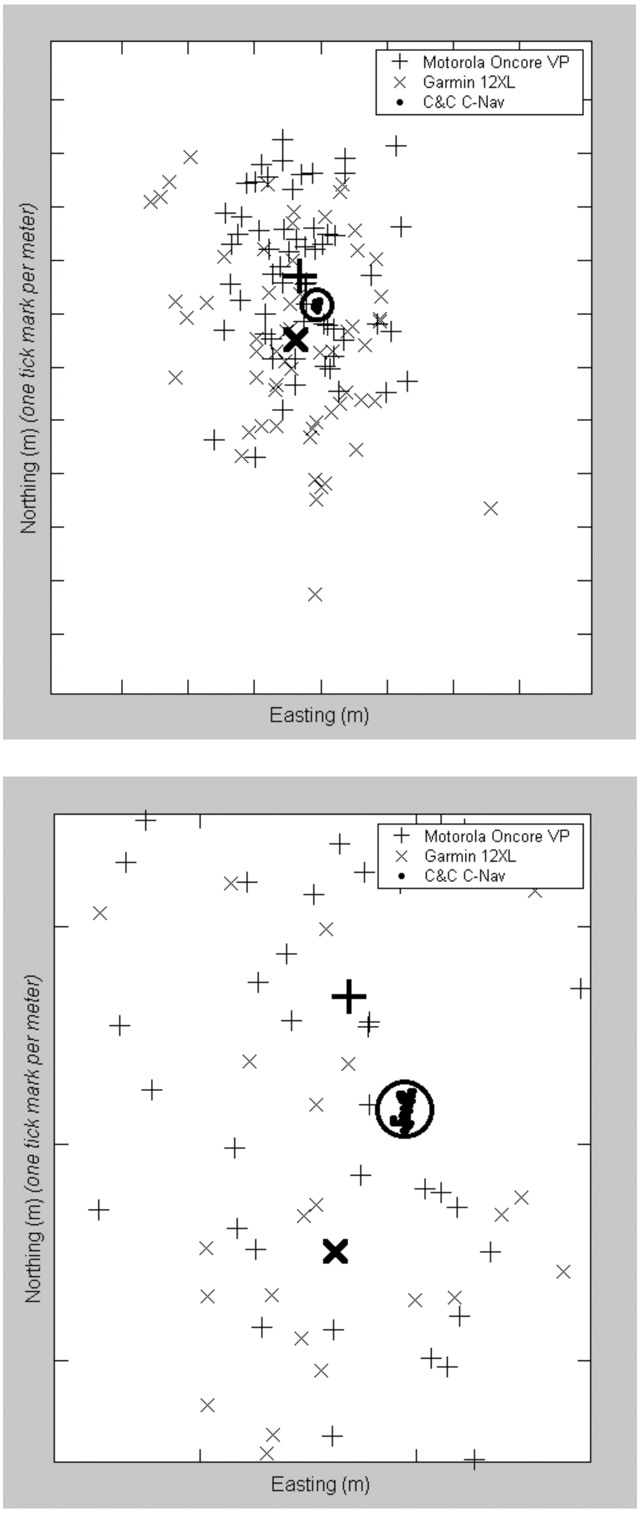


Figure 3. Comparison of the precision of the different GPS devices.

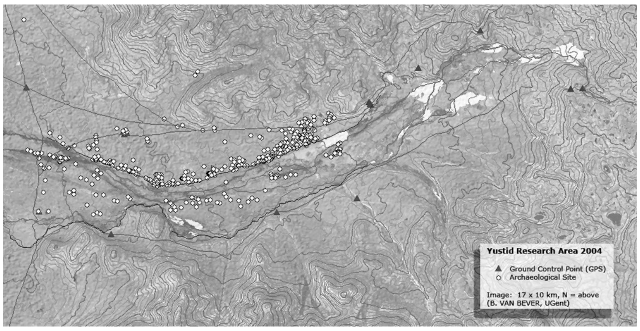


Figure 4. Topographic map of the Yustyd valley (with orthophoto based on the CORONA satellite images).

rectangular dots in the middle of a dark patch of animal dirt. Most of these farms, however, were abandoned or even completely destroyed, but the corners of the buildings were still identifiable.

For the 2004 campaign in Yustyd, as we could not have at our disposal a C-Nav device, we experimented with two other devices: a Garmin 12XL with external antenna and a Motorola Oncore VP with external antenna (prototype Tom Willems, Ghent University). In these cases, the measurements were post-processed to get a more precise, differential positioning, using the data from three far-away lying reference stations (at a distance of 800 to 1,000 km). In the first case, post-processing of the data was done with Gringo Software (University of Nottingham, UK) and we obtained a planimetric precision between one and two meters. For the Motorola, we used our own software (Tom Willems, Ghent University) and obtained a precision of one meter (Tables 1 and 2, Figure 3).

The obtained data of each campaign were then processed with VirtuoZo in order to produce topographic maps up to a scale of 1/25,000 (Figure 4) and three-dimensional (3D) models of the research area by using both the forward and afterward image of the stereoscopic cameras of the CORONA satellite (for more details about the methodology, see Goossens et al. 2006).

2.3 Evaluation

It is obvious that there is a need for special devices if one wants to study the archaeological monuments of a remote area, where modern commercial satellite images are quite rare and expensive and GPS reference stations are remote. It appears from our experience that it should be possible to use GPS with post-processing for localization of archaeological sites or even for the ground control points if the satellite images used have limited ground resolution (up to 2 m). In cases with better ground resolution, more precise differential GPS measurements are needed.

3 Surveying Archaeological Monuments in the Altai Mountains

As mentioned, we needed a planimetric precision of 1 m for the sites as a whole and less than 0.5 m for the localization of the individual archaeological monuments. During the campaigns of 2003 and 2004, we worked with the GPS with external antennae, as described above, and with decameters and goniometers to localize the individual sites (Figure 5). This quite primitive and time-consuming method produced, however, quite reliable plans of each individual site. In 2003, more than 750 and in 2004 some 2,300 different archaeological structures were recorded this way.

However, from 2005 on, we started to use a Leica SR-20 receiver, using a reference station in the field to get a differential positioning (either the C-Nav or another Leica SR-20). Several Leica SR-20 receivers could then be used to measure the structures in the field (Figures 6 and 7). With this device, it was possible to work faster and in more reliably. You get stand-alone positioning results in real time, but simple processing with the Leica GeoOffice software gives you a more precise, differential positioning result. Some 1,700 structures were recorded in 2005.

It should be emphasized that all structures are recorded, from huge *kereksurs* (ritual mounds with stone circle,

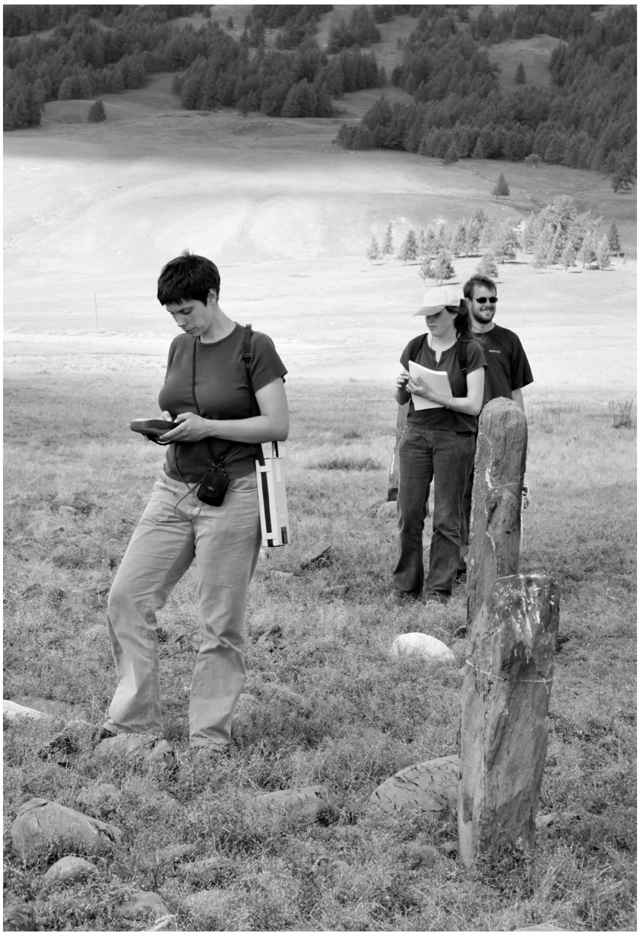


Figure 6. Field work with SR-20 receiver.

Figure 5. Measuring in the field with decameter and goniometer.

mostly Bronze Age) and *kurgans* (burial mounds, different periods, mostly Scythian) to small stone circles or even structures with unidentified functions. All periods are covered. Petroglyphs, however, are not specially researched; they are often located in special places where the presence of archaeological structures is less evident, so we did not specifically search for them. Nevertheless, when encountered, they were quickly described and located.

The chronological attribution of the monuments, as well as their probable function, is mainly based on their formal characteristics and on literature. At this moment, no specific excavation has been realized in order to produce internal chronology.

4 A GIS-related Archaeological Database

All descriptions, photographs, and measurements are recorded in a database. The database is written in Access and covers three levels of information (the site level, the graveyard (or settlement or petroglyph site) level, and the level of the individual structure. Images and plans are available in a direct live link (Figure 8-10).

Finally, the database is linked in an ArcView GIS or ArcMap project to the produced maps, DTMs, and other products from the satellite images.

5 Preliminary Results of the Archaeological Survey

A large range of archaeological structures were recorded during these field campaigns. They go from the Neolithic period (Afanassiev) (3^{rd} mill. BC) to the Ethnographic period (17^{th}-18^{th} centuries AD). In almost all cases, these monuments can be defined as funeral (kurgans) or ritual (kereksurs, steles, ogradki). Settlements are very rare, which is not unexpected, as most of these populations were nomads. However, one should not exclude the possibility of discovering settlements, as some of them have already been excavated (Chicha, near Novosibirsk, is the most impressive, see Molodin et al. (2002), but also excavations in Maima, Altai Republic, see Kireev (1992) and Kireev et al. (2002)).

Although the detailed study of the archaeological

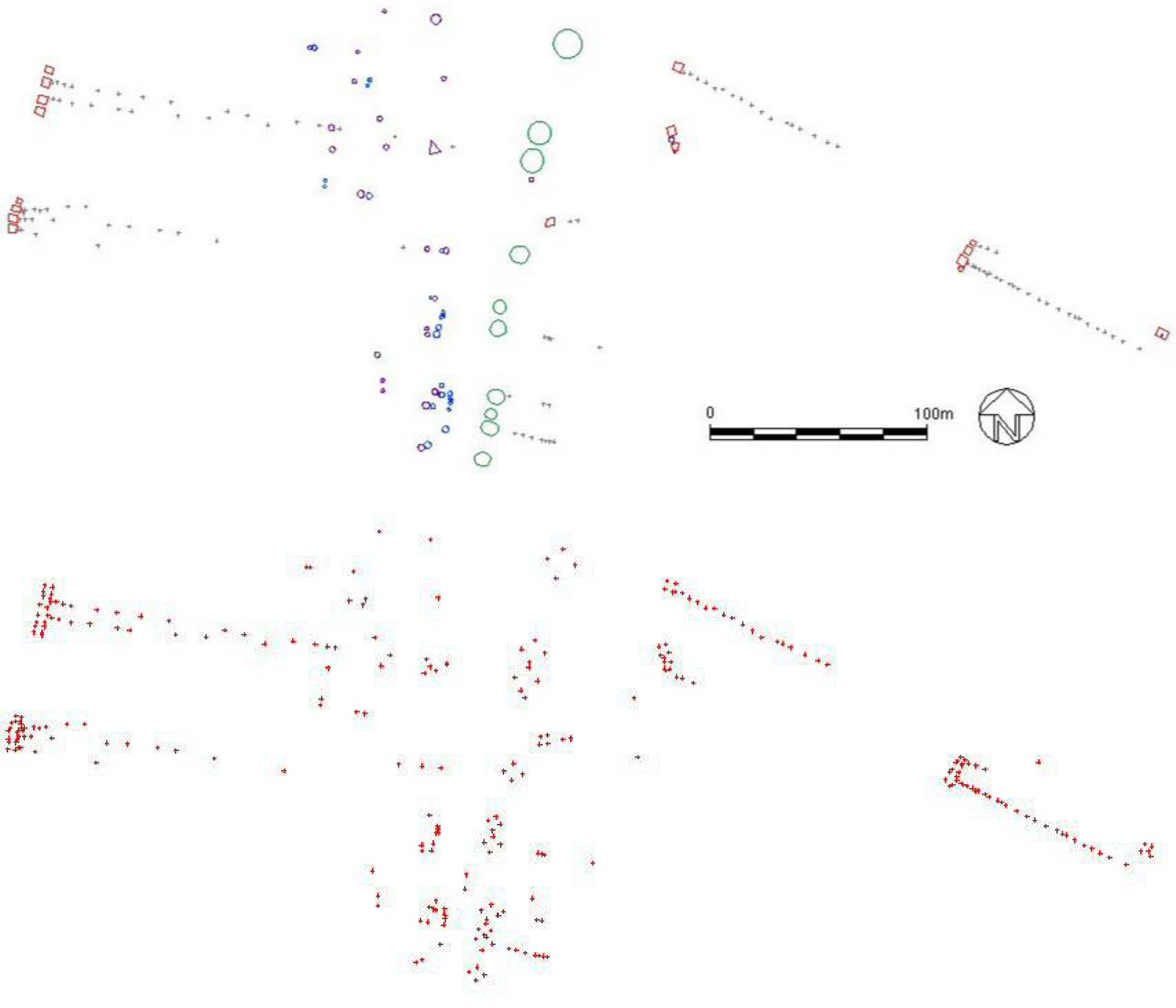
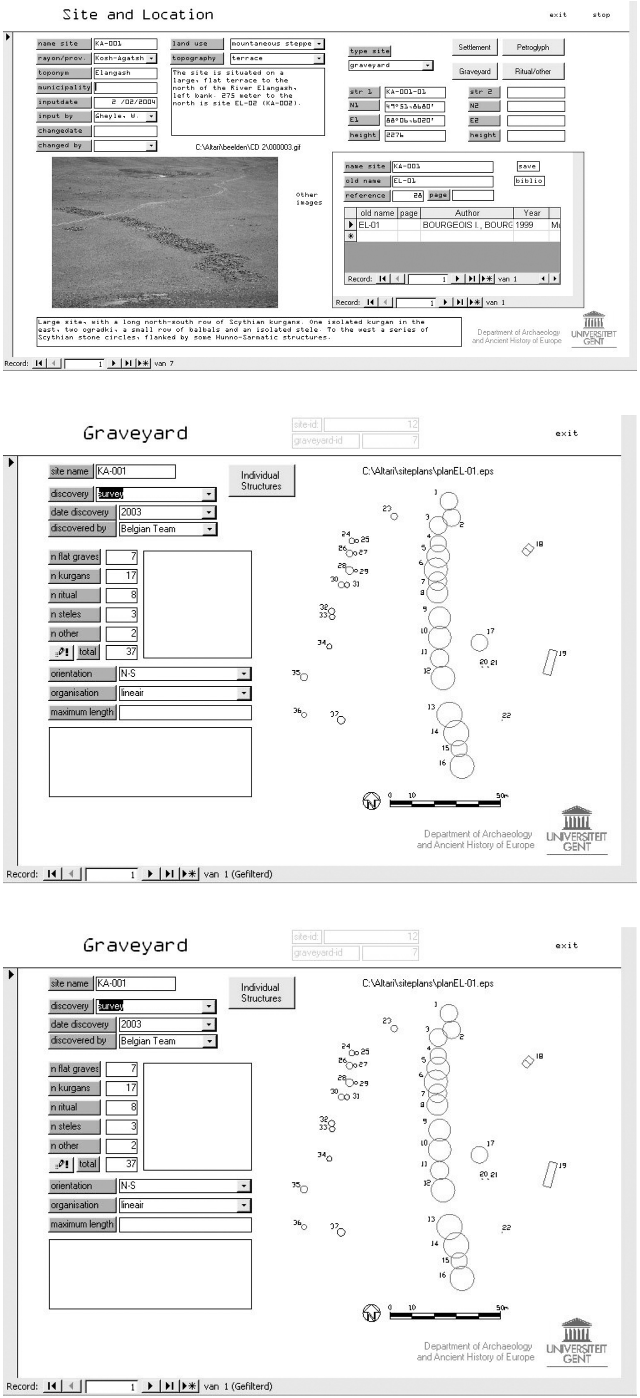


Figure 7. An example of SR-20 measurements (left) as a basis for a detailed plan of the site (right).



Figures 8, 9, and 10. The detailed description of the archaeological remains in the database, at the level of the site (8), the graveyard (9), and the individual structure (10).

landscapes will be finished in the next years, several elements clearly appear. Scattered in the different valleys we surveyed are remnants of the Afanassiev (4th-2nd mill. BC) and Karakol (3rd mill. BC) cultures. They are not numerous, and their topographical setting, as well as their relation to later monuments, is still unclear.

Kereksurs are undoubtedly the oldest common structures in the area. They can be defined as a large central heap of stones surrounded by a large stone circle or square fence, with mostly four (or more) lines, as spokes, joining the stone fence to the stone mound (Figure 11). In many cases, small stone circles are located in the neighborhood. These monuments are quite large: they range from 20 m up to 100 m in diameter in exceptional cases. The stone heap can be some decimeters high, but here also in some special cases the height can reach 2 m. Though very few of them have been excavated, they are considered to date to the Bronze Age and to have played a ritual role, as no burials have been found. A recent study of the Mongolian kereksurs (Allard and Erdenebaatar 2005) showed that comparable monuments are known in other areas. They seem to be dated in the last half of the second millennium BC and in the early first millennium BC. Their structure is in some ways comparable to the ones in the Chuya, but differences can be noted.

Their location in the landscape is certainly not haphazard. The most striking example is the Yustyd valley; here, more than 60 kereksurs are located in one specific part of the valley. Many of them border the first terrace, and when the right bank of the valley narrows, they concentrate and even have to make place for one another (Figure 12 and 13). Obviously, when one also considers the other structures in the same area, this part of the valley is completely atypical (see below). In other areas of the Kosh-Agatch region, the kereksurs appear to be concentrated again at specific places, as in the western part of the Chuya steppe, where we found two of these concentrations at places where one can leave the steppe to enter the higher parts of the area, linking them with the valleys of the Tchagan and the Tchagan-Uzun (near the village of Bel'tir). Finally, it also appears that kereksurs mark the transition between the Chuya steppe and the main valleys in the south (Elangash, Irbistu, Ozyok, and Sebystei). Clearly, kereksurs function as territorial markers in the landscape.

Quite often one can also find large steles, supposed to date into the Bronze Age. Their age is difficult to assess, but they are generally impressive (Figure 14).

The Scythian period (8th to 2nd AD) is, next to the Bronze Age, one of the most interesting periods of the area. Their graveyards are well known and characteristic. Many of them have been excavated over the centuries. The kurgans are generally built in stone (round boulders from the nearby river valley or broken stones from the nearby slopes). Mostly, their diameter varies from 10 to 15 m, although much larger kurgans are known (as the princely kurgans of Pazyryk, Tuekta, or Berel'). The amount of kurgans per burial-place ranges generally from 2 or 3 up to 10 or 15 (Figure 15); in some cases, as in Yustyd, their were 29 kurgans in a row (see Kubarev 1991, site Yustyd XII). The most striking aspect of their localization and setting is that they are almost always organized in north-south oriented rows, on a flat terrace and perpendicular to the river. To the east there are often erected standing stones (balbals), sometimes decorated. To the west, small stone circles and heaps of stones are probably the remnants of ritual activities (Figure 16). In Yustyd, it sometimes appeared that the row of Scythian kurgans was placed close to an (older) kereksur, but this has not been assessed in other areas.

The fact that Scythians seem to bury their dead within a clear temporal continuum (next to older graves and graves to come) and with clear spatial rules reveals a probably well-structured and very constrained ideational world.

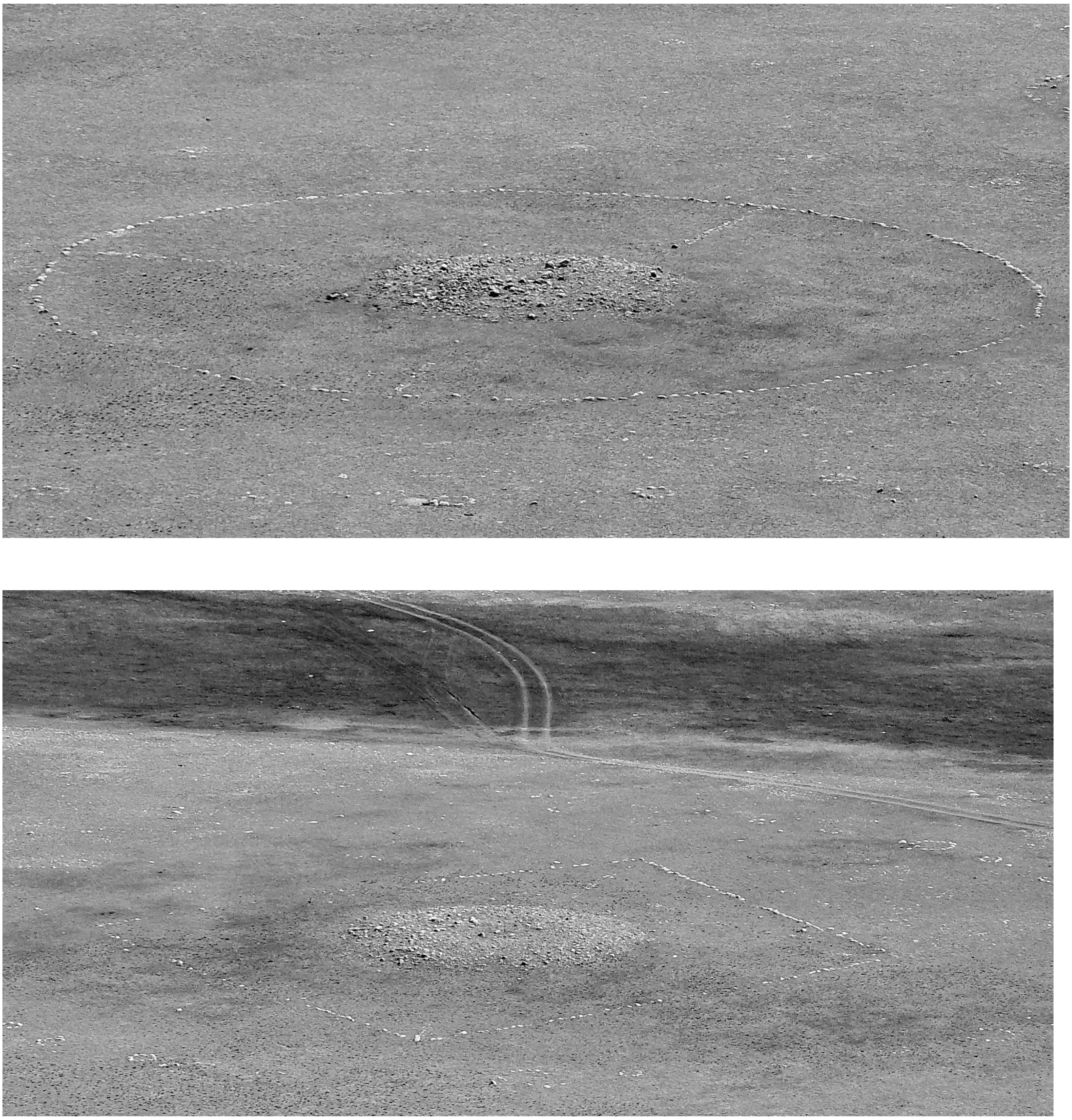


Figure 11. Examples of a circular and quadrangular kereksur in Yustyd, seen from the hills in the north.

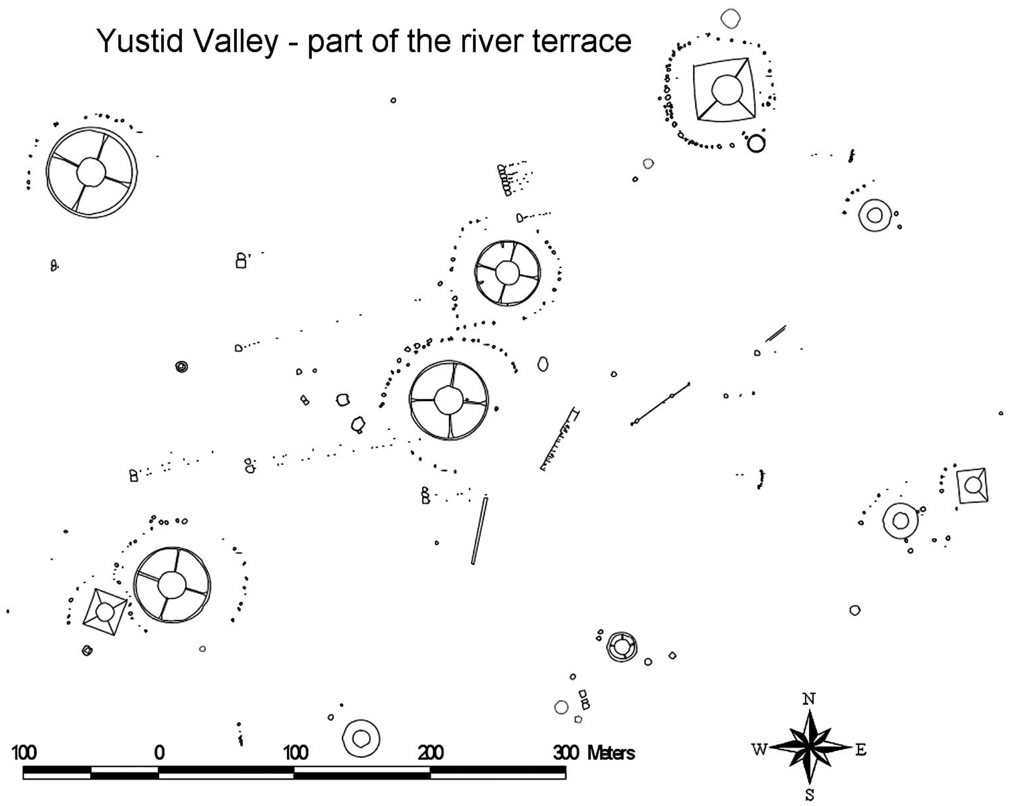


Figure 12. Part of the archaeological map of the Yustyd valley with kereksurs.

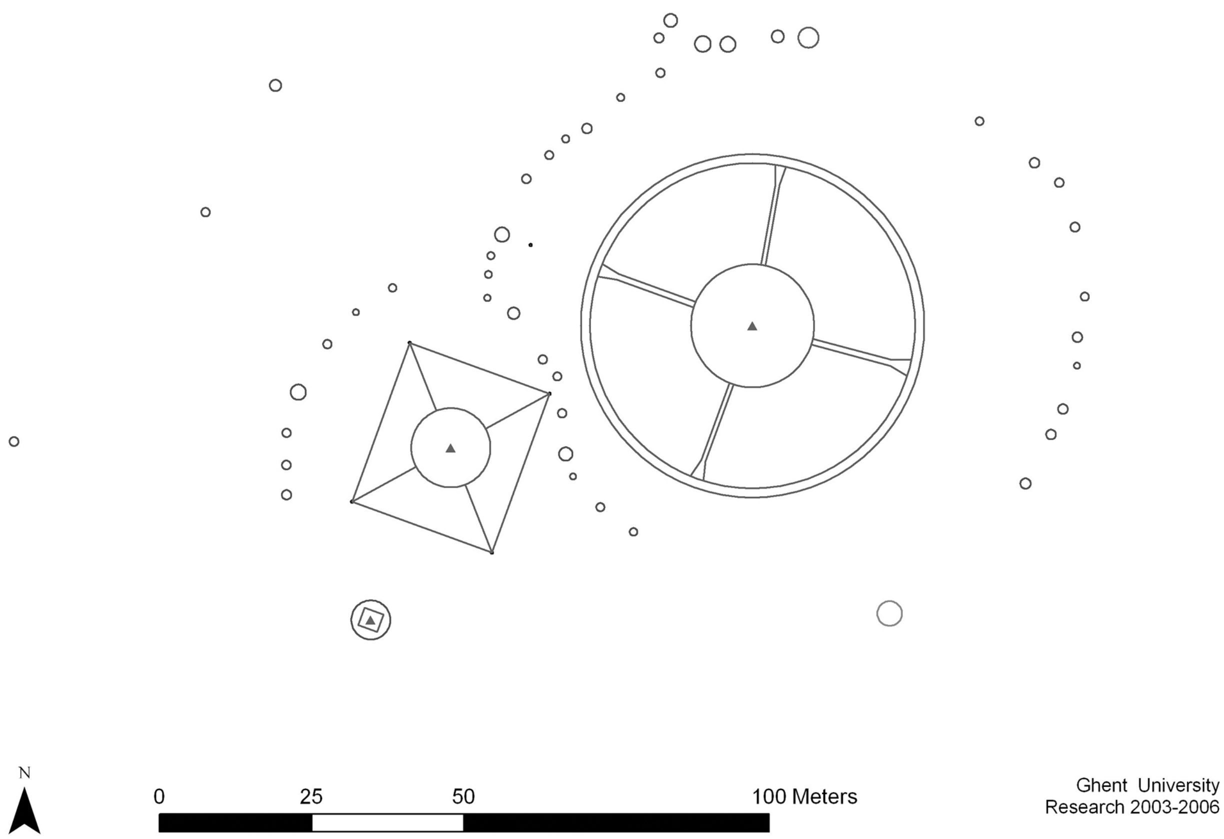


Figure 13. An example of the close relation between kereksurs in the Yustyd valley.

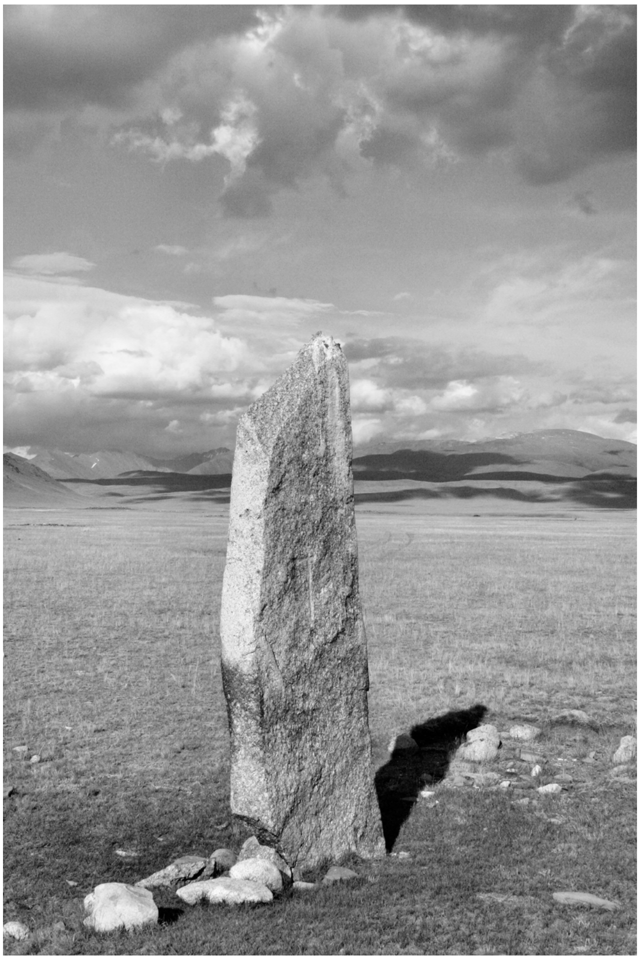


Figure 14. *Some of the Bronze Age steles are impressive and decorated.*

When we consider the relation between monuments of different periods, it is also obvious that Turkic populations did integrate their monuments, especially their ritual ogradki memorial monuments, in a landscape where Bronze Age kereksurs and Scythian graveyards were common. It often happens that next to one of these Scythian rows of kurgans, one finds to the east one or more Turkic monuments (Figure 17). This is not only the case in Yustyd, a valley with, as mentioned already, special characteristics, but we faced this relation in other valleys, also. This relationship needs, however, a more detailed analysis to be confirmed and described more precisely.

Finally, it is interesting to also consider the valleys as a whole. The difference between narrow valleys with steep slopes and more open valleys is clear. The setting of the monuments in both types of valleys is very different. The much larger variety of periods and monuments is especially obvious in the open valleys. The difference between Elangash and Irbistu (narrow valleys, with very interesting monuments and petroglyphs, but with less variety—Scythian and some Turkic), and Ozyok and Sebystei (large open valleys, with a variety of monuments, from at least the Scythian period on to more recent periods, but with less petroglyphs) is clear. In the Dzhazator Valley, one can only find Scythian and Turkic monuments in the higher parts, while in the lower parts the variety is much larger (from Afanassiev and Karakol, to Scythian, Hunno-Sarmatian, Turkic, Mongolian, and even a lot of ethnographic burials). Even the petroglyphs are confined to the lower part of this valley.

6 Conclusion

The first goal of the project in the Altai Mountains was to set up a methodology for mapping remote areas where

Figure 15. A row of 6 Scythian kurgans in Yustyd, seen from the hills in the North. Note the presence of steles to the East (in the image, above the kurgans), and stone circles and platforms to the West (directly under the kurgans and bottom of image).

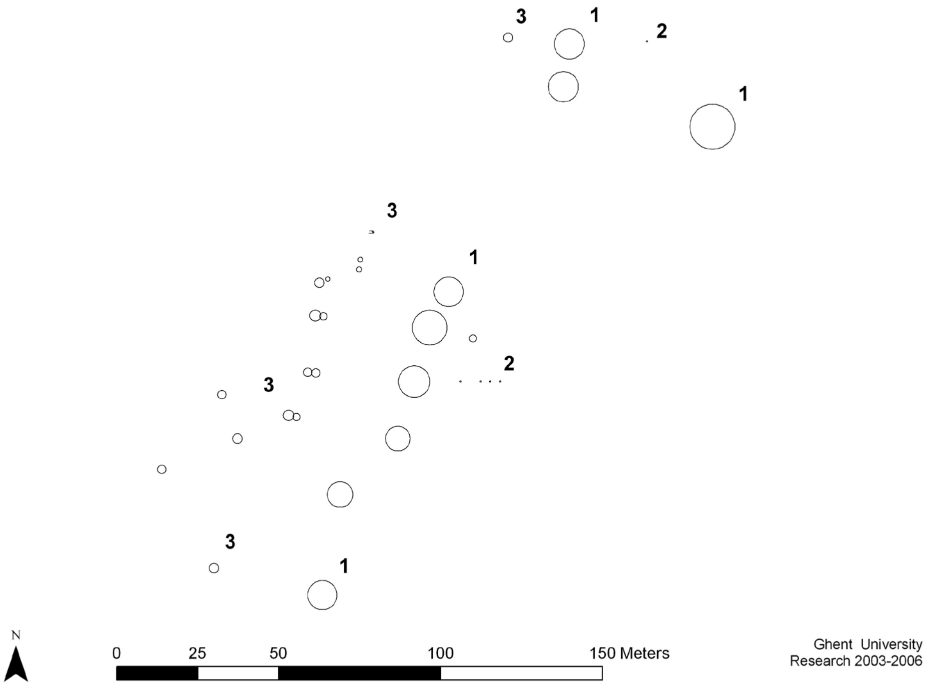


Figure 16. Steles (to the East, 2) and stone circles (to the West, 3) structure the space around a row of Scythian kurgans (1).

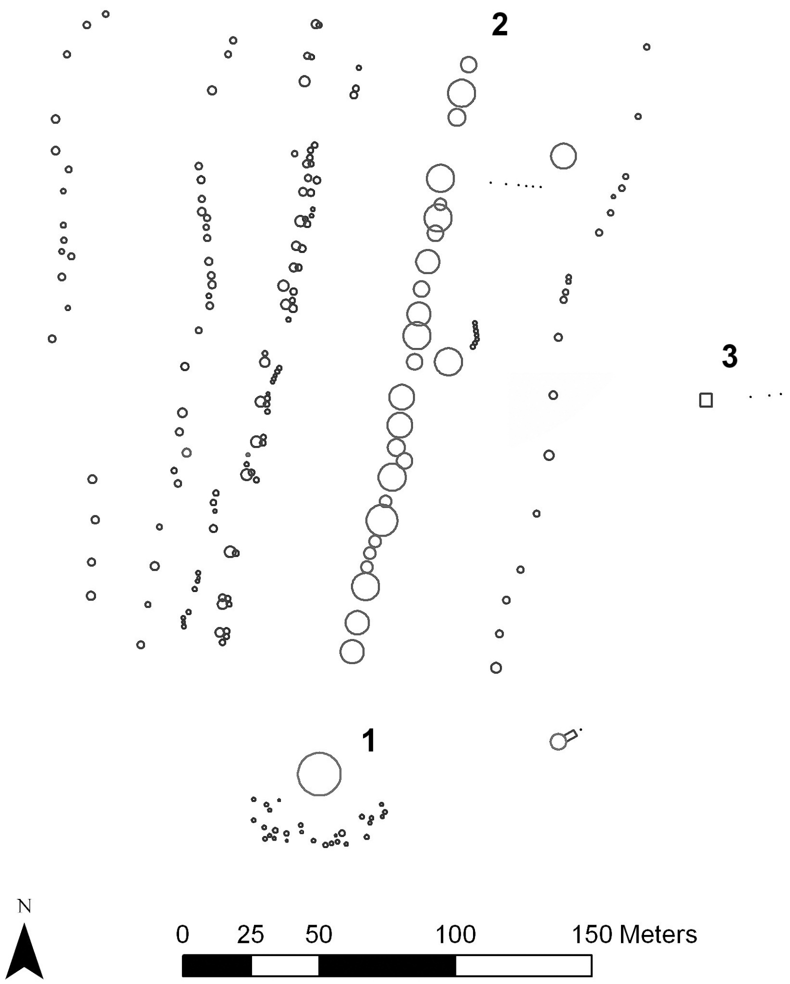


Figure 17. Plan of an archaeological site, with Bronze Age kereksur and accompanying stone circles to the south (1), Scythian kurgans with several rows of side structures (2) and a Turkic ogradka with steles in the east (3).

topographical maps and reference stations for GPS were missing. Tests with different devices showed that differential GPS in real time or even GPS with external antennae and post-processing yielded reliable information to produce topographical maps based on satellite imagery, DEMs, morphographic maps, and archaeological maps. The combination of these maps is the basis for an analysis of the way different cultures used and perceived the landscapes. Some elements are obvious, but others need further analysis.

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