Flag #134 in the wind on an undocumented Late Iron Age cemetery.
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1. Archaeology in the Altai Mountains

The Altai Mountains bordering Russia, Mongolia, Kazakhstan, and China have preserved an extremely rich cultural landscape (Bourgeois et al 2007, 464). The mountain range was already inhabited by people during the Paleolithic to the Neolithic period (ca. 120th millennium – 4th millennium BCE). From the Eneolithic period (3,200 – 2,400 BCE) onwards ancient steppe cultures began to construct funerary monuments from earth and stone which remain visible up until the present day (Plets 2013, 17-18). The plethora of archaeological monuments constructed during the Bronze Age (2,400 – 800 BCE) and the Iron Age (800 BCE – 400 CE) encompasses burial mounds, stelae, stone fences and circles, and other apparently ritual structures (Plets 2013, 19-20). The original intent for building many of these sites remains obscure and often we are left to speculate about their use (e.g. Demkin et al. 247).

The Altai mountain range as a geographical feature plays a very important role in forming a better understanding of Eurasian prehistory (Hank 2010: 469-470). With Mongolia to its East and to the West the pastures of Kazakhstan and Russia stretching all the way to the northern Black Sea region, the mountain range is situated between two major steppe zones (Gheyle 2009, 39). The landscape of the mountains themselves, with high plateaus and valleys, both separates and connects these two climatic areas, and thus early on formed a node of cultural interaction for nomadic pastoralists traveling from east to west and from west to east (Parzinger 2006, 526-536). For a very long time people travelled this region freely, unrestrained by the national borders, fences and military zones of the modern era (see figure 1).
Clearly this place should be studied as a whole and not split among four nation states who all follow their own narratives.

Figure 1: the area of interest and its surrounding orographical features.

Nonetheless, very few large-scale surveys have been conducted. Major reasons for this are the administrative fragmentation of the region which leads to a diverse set of rules and procedures, and an inscrutable network of responsibilities. Militarized border zones exclude huge areas from any kind of research and effectively prevent cross-border surveys. Differing national research cultures and linguistic barriers (scholars should ideally speak Russian, Chinese, and Mongolian), and the vastness and inaccessibility of the rugged landscape also contribute to a difficult research environment. Gaining a coherent picture of the archaeology of the Altai seems to be almost impossible.

However, the rapid development of technology in the area of remote sensing (Lasaponara and Masini 2012, 3-4) and the increasingly affordable and available
high-resolution optical satellite data from several missions like Quickbird, Ikonos-2, and Worldview-2 show potential for the circumvention of these limitations.

Figure 2: area of interest in Xinjiang.

2. Area of Interest

The Altai Mountains stretch over four countries and more than 150,000 square kilometers and are an important climatic border in Central Asia (Rudaya et al. 2009, 542): from forest steppe areas in the north, through the alpine climate on the high plateaus and in the valleys, to dry steppe and semi-arid zones in the south. Clearly, we are dealing with a very diverse geographical, topographical, and climatic complex, which makes finding a starting point for the analysis challenging.

So far the focus of international research campaigns has been on the Russian and Kazakh Altai Mountains (e.g. (Bourgeois et al. 2001) or (Gheyle 2009)) and the Mongolian region (e.g. Jacobson-Tepfer and Meacham 2009). This is understandable insofar as the largest part of the mountain range lies within the borders of the former
Soviet Union. The eastern part of the mountains lie on Mongolian territory, a country which to this day has a considerable amount of pastoral nomads and whose national identification builds heavily upon the former glory of early steppe empires. Therefore there has always been a strong interest in earlier nomadic pastoralist cultures in the area. As for China, Xinjiang has always been far west, peripheral, and intrinsically barbaric. Although the Xinjiang Institute of Archaeology has recently started to conduct surveys, most regions in far western China are blank spots on the archaeological world map and publication of the results of these efforts could take years.

There is a clear lack of archaeological research in the Chinese Altai Mountains. As a consequence, the process of mapping previously unknown monuments provides us with new knowledge and insights into a cultural landscape which form an addition to reports we have from the adjacent countries. Conducting a study in this part of the mountains potentially closes knowledge gaps and helps to form a more comprehensive image of the ancient nomadic cultures in Central Asia.

In order to be a valid area for the study of the development of a cultural landscape a section of the mountains cannot be chosen at random. An area of interest has to be defined through natural topographical borders like mountains, rivers, or shore lines which limit access and at the same time make it more likely that the area in the past formed a culturally coherent entity.

The area of interest is a relatively isolated valley in the southernmost part of the Chinese Altai Mountains in Xinjiang Uyghur Autonomous Region, Habahe County. Reachable only through steep mountain passes, it stretches from the villages of Suwuke Basitao in the East through Hailiutan, Xinnongcun and Akebu Lakecun in the Northwest to Huiji’erte. To the North and the South the valley is defined by mountain
ranges. In the east, hills open up towards the Kanas Region and further into the heart of the Altai Mountains. By going across another pass in the Northwest which lies 1400 m above mean sea level, the second part of the plateau can be reached (figure 1).

The valley lies between 1150 and 1300 m above mean sea level and has at its core a plain area, nowadays only used for herding. It lies on the border of two climatic zones, the alpine climate of the higher mountains and the drier climate of the Dzungarian steppe. Several small creeks drain the plain and provide water. The upper parts of the valley are covered by lush pastures used for sheep, goat, and cattle herding. The hill flanks are partially covered by larch and birch forest.

Figure 3: early morning hour view from the southern mountain range bordering the valley (viewing direction: north).
3. Remote Sensing

Mapping archaeological features in high-resolution satellite imagery (Quickbird and Ikonos-2) soon showed that the valley is an extremely rich archaeological landscape. Even though much of the river plain has been regularly ploughed, and we would therefore expect most monuments to be severely affected if not completely destroyed by agricultural activity, a total number of 554 potential mound structures has been detected. Already a quick look at the number of data points in the area of interest gives a good impression of the enormous density of archaeological sites which – without the destructive influence of agriculture – must have been even more impressive earlier on (figure 4). Additionally, the landscape is covered with hundreds of ruins which range from herding facilities to residential buildings. A relatively small number of only sixteen Bronze Age ritual monuments or keregsurs was found in the middle of the valley in a very prominent and visible position, but as many as 103 Iron
Age burial mounds were identified. The keregurs are massive mound structures of up to almost 100 m in diameter, whereas the kurgans are generally smaller in size and only between 8 m and 20 m in diameter. Some big kurgans constitute exceptions with diameters of over 30 m. Size and shape alone, however, do not make it possible to date the largest portion of the discovered mound structures. In order to assign a majority of the 435 undated monuments to a time period, ground truthing is necessary.

4. Locating Mounds

The simple question “Where are mounds found?” is of importance for future field campaigns because it is a first step in the selection process of an area for survey or excavation. The appearance of mounds is highly correlated with slope. Logically, the relatively loose constructions made from pebbles and boulders would not resist gravity for a very long time and thus erode quickly when built on steep slopes.

As shown in figure 6 practically almost all mounds are found in areas with low slope of up to 8°. Even the ones which appear to reside on slightly steeper slopes are in fact built on relatively flat ground, but the resolution of the digital elevation model does not allow for a completely accurate assessment of the topographic situation. On the optical data we can often see that those mounds are actually built on small terraces which are neglected by the 90 m and even by the 30 m resolution of the DEM.
Vicinity to water on the other hand does not seem to be as important. I would argue that the appearance of mounds on alluvial terraces is connected to slope rather than to the existence of water nearby. The small creeks in this valley meander and can potentially damage burials, which was certainly not a desired effect by the builders. Burials and creeks merely coincide in the plain because of water naturally flowing towards the deepest point of the valley and mounds needing flat ground for construction. As a matter of fact, in the area of interest monuments seem to keep a certain distance from areas where there are a lot of small rivers. The optical data suggest swampy fields and this might not have been the most favorable ground for the construction of mounds.

Figure 5: slope as primary parameter for determining the presence of mounds.
5. Implications on Field Work

The findings of the analysis of this archaeologically rich landscape in the Chinese Altai Mountains show that there is a strong correlation between the slope of a given terrain and its richness in archaeological sites. There is an almost complete absence of finds in terrain with a slope of more than eight degrees (more than 90 percent of the mapped archaeological features are built in areas under 8° slope). Therefore, given that the landscape of this mountain range is very rugged and interspersed with high plateaus and valleys, we can already exclude large areas as potential regions for future surveys.

The information that regions with a low slope parameter encompass most sites has implications on the planning phase of field projects. Open-source digital elevation data, e.g. SRTM data, can already provide a good idea of the topographical nature of a valley. By means of calculating the slope from the elevation data in a GIS application, field researchers can focus on the areas that contain the most sites. Knowing the area a team has to cover during the limited time available during a field campaign helps to plan out a survey up front and increases the efficiency of the field work.

Surveys are conducted by foot, normally with satellite based global positioning systems. Eight to ten hours of walking per day can be very exhausting even if the terrain is flat, for example when examining a river plain. Mountainous terrains obviously require an even larger physical effort. Through the above analysis archaeologists know that they are not missing any major sites if they are leaving out steep parts of the landscape, this helps covering a larger area in the same amount of time with less physical effort.
Remote sensing applications for archaeology are still developing at a relatively high pace as availability of data in high-resolution is increasing and prices are decreasing. These tendencies together with much more user-friendly GIS applications change field archaeology and help to gain much more comprehensive overviews over past cultural landscapes. It would be desirable to see further development of predictive models that increase the accuracy of detecting, mapping, and dating archaeological sites based on remote sensing data and expand our range of non-invasive methods for the analysis of archaeological landscapes.

6. Barriers for Fieldwork in Xinjiang

The Chinese Altai Mountains are not only interesting because of the plethora of archaeological finds and the excellent preservation, but also because of their role as a route between major cultural entities. However, despite the long tradition of interdisciplinary research questions and cross-national cooperation of institutions in the adjacent countries, there are almost none of its kind in Xinjiang. The southern regions of the Altai Mountains are especially relevant for questions concerning cultural exchange and idea transfer due to their vicinity to the Silk Road and its relative direct connections to cultural centers in China. Since a long time, it seems to be clear that the Scythian animal style has been strongly influenced by stylistic tendencies from the south (Hancar 1952, 35-42), and it might as well have found its way through Xinjiang. It is thus surprising that large international exhibitions have so

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1 See for example the declassification of US military data (http://scholar.harvard.edu/jasonur/pages/corona-photography-1).
far been implemented without Chinese participation (see for example Menghin et al. 2007, 12-17).

The reasons for these particular circumstances are manifold. The Chinese language does provide a high entry barrier. The familiarization with the excavation reports which often are solely published in Chinese (now more and more providing English abstracts) does primarily need the skills of a sinologist, not those of an archaeologist. Despite the fact that there is immense progress in terms of English language skills in China throughout the past years, it is still difficult to lead fluent conversations on subject-specific topics. Additionally, the complex network of competences and power relations between Beijing, local research institutions and universities is extremely hard to grasp for an outsider. Many things depend on informal contacts and the choice of the right Chinese project partner within the system. What certainly helps are personal relations which again highly depend on language capability. A factor which is largely beyond control is the political instability concerning the ethnical struggle between Uyghur minority and Han majority in southern Xinjiang. The north largely consist of ethnic Kazakhs and Mongolians, but when security measures are tightening up, it also affects the north and anyone who is traveling into that direction. But in the end these challenges can be seen as a motivation on the way towards generating the data which helps clearing white spots from our archaeological maps.
7. Survey Methodology

The survey was planned as an intensive field walking project with the aim of mapping out all visible sites in the area of interest by means of GPS, describing them in terms of preservation, forming a dating hypothesis, and establishing a database of pictures and maps for future field research.

The approach was adapted as soon as we arrived on-site and saw that the circumstances allowed for more efficient mapping than originally planned. Sites in the basin have a very good visibility due to the thin vegetal cover. Even though it rains – in comparison to the Dzungarian Steppe down the passes – relatively often when clouds are blocked by the central massif, intense herding of sheep, goat, cattle, and horse helps keeping the grass short (usually not more than 5 cm). Some small areas have been fenced off in order to grow grass for the purpose of generating winter fodder for livestock. Figure 6 shows the two different covers next to each other. As a result if the intense grazing, most sites are visible from a long distance.

Figure 6: vegetal cover in the basin: left: with the effects of grazing; right: fenced off.

We had planned to walk the basin in lines with 20 m distance between the individual searchers, this distance would then be reduced to 5 m if we would come upon areas
with high grass, shrubberies, or rock outcrops. It, however, turned out to be much easier to spot sites and therefore we were able to cover a much larger area than intended at the beginning. In some circumstances it was even possible to cover parts of the basin center by slowly driving with a jeep in lines with 200 m distance without missing anything of importance. Stone structures generally appear as dark spots in the distance and cannot be overlooked. Small ridges, enclosures and earth covered sites are slightly more difficult to discover, especially in some cases where structures were almost completely destroyed by ploughing (some earthen mounds are barely visible anymore).

After the first few days when we worked during the hot early afternoon hours we discovered that the bright light makes it harder to detect structures. We thus adjusted the work schedule accordingly. We surveyed during early morning hours, sometimes getting up as early as 4 o'clock local time (6 o'clock Beijing time), took a long lunch break during the hottest hours of the day and then resumed work until sunset. Flat earthen mounds are easiest to spot when the light incidence is low and a shadow is cast by the structure.

The results of the remote sensing survey were used as the primary guide for site spotting. Figure 7 provides a rough overview over the planning. Decisions on which areas we could actually survey had to be adjusted several times during the field campaign because of changing opinions of the border police on how our permit should be interpreted. The county border of Bu’erjin and Habahe runs right through the basin. In the end – even though we would have liked to cover the complete basin including the pass in the west – we deemed it safest to stay outside the borders of Habahe County. This is unfortunate of course in terms of landscape analysis since especially the pass to the west is a dominant topographical feature of this area, but it
was certainly better not taking the risk of being removed from the field and not being able to finish at least part of the valley. The black line in figure 10 represents the border military told us not to cross during our tours. Everything east of it was covered.

![Figure 7: Survey Planning.](image)

After the rough morphological classification we proceeded to measure the north-south as well as the east-west extent of every monument. For large monuments which were too high to be accurately measured on site, we took several GPS points in order to derive the diameter in post processing. For monuments which are not round (ogradka and dwellings), we additionally measured their approximate orientation. For keregsurs both the diameter of the central mound and the outer ring or ditch were recorded.
Figure 8: example for a kurgan lining up with others of its kind in an approximate north-south direction (viewing direction: north).

Figure 9: example for a keregsur (on the left) with clearly visible circular ditch.
Figure 10: example for a Turkic ogradka, rectangular enclosure with stone slabs and a standing stone (balbal) on its eastern side (viewing direction: southeast).

Figure 11: example for a dwelling, rectangular shape with separate “rooms” and parts which could be considered an entrance.
Figure 12: example for an oval mound.

Figure 13: example for a stone circle.
Following this, we described each individual monument in terms of its visible characteristics and its state of preservation. Despite the overall good state of preservation, many monuments are affected by former agricultural activity i.e. ploughing. Some mounds have undergone considerable looting activities whereas
others only have small looting pits or depressions which might not have damaged the structure to an extent where it becomes largely useless for archaeologists.

Every monument was then mapped using a Garmin GPS MAP 64s with an accuracy of 4 m.² For most monuments one point was taken in the middle. For rectangular structures the point was taken in the north-western corner. It would have been ideal to measure all points with real time kinematic GPS in order to get very accurate measurements, however, for the purposes of generating overview maps the accuracy of the hand-held device is sufficient. All GPS measurements were done by our Chinese partners since foreigners are – despite the availability of high-resolution satellite imagery for any part of China – not allowed to pursue any independent mapping activities. The basis for these relatively strict regulations are provided the National Administration of Surveying, Mapping, and Geoinformation, especially by Article 15 and 16 of the law on participation of foreign organizations or individuals in mapping activities on Chinese ground, which ensure strict control of Chinese participation and even forbid the transmission of survey results generated within China to other countries.³ This is posing a problem for the timely completion of the analysis of the data by the author.

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² [http://www.gpsreview.net/gps-position-accuracy/](http://www.gpsreview.net/gps-position-accuracy/): A 4 m accuracy of the raw data “refers to the so-called 50 % CEP (Circular Error Probable). This means that 50 % of all measurements are within a radius of 4 m. [...] 95 % of all measured positions are within a circle of twice this radius and 98.9 % of all positions are within a circle of 2.55 the radius.”

Towards the end of the survey, selected structures were scanned as 3D-models with a structure from motion approach. We applied the software Agisoft which combines digital photographs into a dense point cloud and then connects the points into a mesh. Textures are generated from the original pictures and the model can be exported into PDF format, providing a very good impression of a specific monument. This method of documentation has major time benefits, is cost-effective and provides an enhanced scientific documentation value since data viewers do not receive an already interpreted two-dimensional version (e.g. a drawing) of an archaeological monument but a relatively unbiased multidimensional representation with much more detail than would be otherwise possible (De Reu et al. 2013, 1119-1120).
8. Results of the Survey

In just about three weeks of intensive fieldwork, often more than 12 hours per day, we covered an area of well over 140 km². The remote sensing data helped us immensely with planning and allocation of our efforts. In total, the team mapped over 980 ancient structures, ranging from the Early Bronze Age to the Turkic period and beyond. The steppe landscape seems to be one of the very few landscape types where such an extensive diachronic data collection over more than 4000 years of history of occupation is possible without the delve of a spade.

Figure 17: distribution of the sites mapped during the survey (the black line in the west is the approximate county border).

An extensive evaluation of the data gathered will be provided within a year of completing the survey, including the generation of exact maps, publication of articles and database.
Table 1: monument categories and their specific amounts detected during the survey.

Surprisingly many monuments we found were datable with relatively high likelihood. The dating always is preliminary until an excavation has been conducted, but the overall preservation of the remains is excellent. For the major categories (kurgans and keregsurs) the established dating hypotheses are highly likely to be accurate, since the morphology is in many cases very clear. However, the largest category (185) consist of morphologically undatable mounds either isolated or in context with other remains that do not provide enough evidence for a dating hypothesis. Iron Age kurgans are well represented with 147 specimens and possibly much more since many of the undatable mounds might in fact be dating back to the Iron Age. Keregsurs, despite their smaller number of 66, visibly dominate the archaeological landscape of the basin. They are by far the largest monuments with the highest mounds, easily visible from afar and clear landmarks. The second largest category “oval mounds” is heterogeneous. Some of the oval mounds do most probably date to the Hunno-Sarmatian period (Late Iron Age), according to the layout of the cemetery (Gheyle 2009, 187-189), others seem to be relatively recent burials maybe of Kazakh
origin. But also monuments of the Turkic period are found throughout the basin with 93 ogradka, partially outfitted with lines of standing stones.

![morphological categories chart]

**Figure 18:** morphological categories in percent.

The use of high-resolution satellite imagery for remote sensing surveys in this area provides a very good overview over the archaeological landscape. Smaller structures like stone circles and platforms as well as balbals do cluster around larger mounds. Those features, which are not visible in the satellite data, are very interesting for a diachronic analysis of the landscape and provide the context for larger sites. In many cases, the small peripheral structures associated with a mound make it possible to establish a dating hypothesis. In figure 19, the original remote sensing detections and the GPS data from the field can be seen for one of the large clusters in the middle of the basin.
Figure 19: comparison between on-ground survey (blue) and remote sensing survey (yellow) on a cluster consisting mainly of keregsurs.

Over large parts of the cluster, we have an almost perfect match of monument detections in the remote sensing survey and the ground truth. Some of the wrong detections (isolated yellow points) are due to natural or anthropogenic features that can look very similar to the nearby archaeological structures. Further down a number of explanations are given in order to understand these features better and potentially avoid future false detections. As a matter of fact, after visiting the area of interest, a lot of what was originally tagged as a potential archaeological structure could be either clearly identified as one or rejected due to the experience in the field. The accumulations of points in the southwest of the cluster do represent smaller structures which are not visible on the remote sensing image.
Figure 20: comparison between on-ground survey (blue) and remote sensing survey (yellow) on a cluster of smaller monuments.

In figure 20 we have an accumulation of smaller structures among which we find several lines of kurgans. Those smaller stone mounds are much harder to see and to differentiate from the surrounding natural features. This lead to quite a lot of wrong marks during the remote sensing survey, however, the cluster still has enough correctly marked structures that it led us to an area with a high density of archaeological features.

Overall, the preparation for a survey by means of high-resolution optical satellite data is very useful, saves time in the field, and is a good planning tool. There are however several pitfalls which influence the representativity of datasets generated from high-resolution data. These concern first and foremost circular structures or soil marks which look like mounds from space. They do generate a wrong impression of the
archaeological landscape and can be misleading. This is one of the reasons why fieldwork is so important. Looking at the landscape with a combination of technical methodology and traditional survey provides a lot more contextualized information. The mental image which can be built from a multi-method approach is much richer than one generated only by technical means.

Circular dark soil structures are created in two ways by anthropogenic activities in this landscape. Firstly, the Kazakh herders do fence of the sheep during night. Where no stone enclosures or stables are available, this happens through putting fencing posts in circular manner into the ground. Over time the sheep inside the fence cover the ground with manure and trample the thin vegetal cover with their hooves. When the fence posts are pulled out and the sheep are led to the next pasture, a dark circle remains on the ground which looks very much like an archaeological structure from space (see figure 21). Secondly, Kazakh yurts, which stand in one place for a longer period of time do leave a much smaller but also circular mark. Additionally the sides of the yurt are weighted with rocks which remain after the temporary housing is removed. Even on ground these traces can be tricky when the grass grows back and the stones start to sediment.
Figure 21: dark ring feature in Quickbird data.

Figure 22: phenomena which lead to the above feature in the remote sensing data
(left: mark of a yurt; right: mark of fencing).

Another problem of the remote sensing imagery was solved when we took a closer look at the ruins and enclosures which are scattered all over the landscape. Without excavations it seemed to be impossible to establish a date for these structures. Again, on-ground survey provided enough hints to make a reasonably likely statement on these structures: they are all relatively recent. Local houses are often built from mudbrick gained from the river plain. With a village abandoned and the roofs broken it does not take much time to completely sediment. When starting to document some of the structures we were informed by locals that it had actually been a winter village during the 60s and 70s of the last century. The walls were completely gone, only
small ridges remained which were clearly visible in the satellite data. This is the
general state of preservation we have to assume for mudbrick buildings in this area
after approximately fifty years. Therefore, none of the mapped earthen ruins are of
much interest for our analysis of the archaeological landscape of the Bronze and Iron
Age. Figure 30 shows a very recent building with one wall still standing. One side
already looks like what one can mistake in the satellite data for an ancient structure
covered by soil.

Figure 23: example for decaying local mudbrick architecture (left side already fully
destroyed). Approximate date: 1980s.
9. Conclusion

Figure 24: Gino R. Caspari during one of the long daily hikes.

Even though the Chinese Altai Mountains are a place where archaeological projects are not easily established, it is also a place which is incredibly rewarding to work in because of the great preservation conditions and the lack of research so far conducted. The remote sensing survey using high-resolution optical data and elevation data does provide a good starting base and a planning tool for the on-ground GPS-based survey. Additionally, in some cases contextualizing information can be derived from the satellite imagery which is almost impossible to gather on ground (e.g. very shallow and broad circular ditches around keregsurs). Working from remote sensing alone we can potentially cover large areas, but the impression we get from the archaeological landscape neglects all smaller monuments and therefore provides us with a rather fragmented picture. But as can be seen above, the large
Bronze and Iron Age monuments seem to act as an initial nucleus for the construction of later monuments. Therefore we still get a relatively good overview over places of archaeological interest by just looking at the large monuments. This enables us to map out important sites throughout the mountain range, forming an understanding of where sites are and then dealing with the question of why they were built there. For most other questions, fieldwork is absolutely mandatory and cannot be replaced by any technical means. However, the two methods mutually influence each other: the fieldwork informs the remote sensing and the satellite imagery analysis provides contextualizing information for the fieldwork. Without the meticulous preparation beforehand we believe that we might have missed important sites.

The almost one thousand mapped and documented monuments provide an extensive data base for future analysis of the archaeological landscape of the basin. In future field campaigns we hope to substantiate many of the preliminary dating hypotheses with small scale excavations.

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Bibliography


