The unique Frozen Tombs of the Scythians threatened by climate change: Archaeological survey and permafrost research in the Altay Mountains

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Summary (10 lines):
The frozen tombs of the Scythian civilization, preserved for over 2000 years in the permafrost of the Russian, Mongolian, Chinese and Kazakh Altay Mountains, are a major archaeological find dating back to the 1920s. Inside the tombs lie bodies which have often been so well preserved that even the tattoos on their skin remain intact. With the permafrost that preserves the tombs now gradually thawing due to climate change, the remaining frozen tombs and the insights they provide into the ancient nomad culture could be lost for ever. Ghent University and the UNESCO World Heritage Centre started a project in 2005 to preserve the remaining frozen tombs. Besides making an inventory of the archaeological heritage, they are looking for ways to detect the tombs that are frozen, and are searching for technical solutions to preserve the tombs in situ.

Samenvatting (10 regels) - De unieke bevroren graven van de Scythen bedreigd door klimaatsverandering: archeologisch onderzoek in het Altaj-gebergte
De bevroren graven van de Scythen, die meer dan 2000 jaar lang bewaard gebleven zijn in de permafrost van het Russische, Mongoolse, Chinese en Kazachse Altaj-gebergte, zijn een unieke bron van archeologische informatie. De permafrost zorgde voor de bewaring van organisch materiaal, in die mate dat ook tatoeages op de lichamen van de doden intact zijn gebleven. Recentelijk zorgt klimaatsverandering er voor dat de permafrost in Altaj langzaam aan het smelten is; samen met de rijke grafinhoud gaan zo ook de unieke inzichten in de vroegnomadische Scythische cultuur verloren. De Universiteit Gent en UNESCO's Werelferfgoedcentrum lanceerden daarom in 2005 een project om de overgebleven bevroren graven te beschermen, onder meer door het maken van een inventaris, het bestuderen van de permafrost en het zoeken naar oplossingen om de graven tegen de opwarming te beschermen.

Résumé (10 lignes) - Les tombes gelées des Scythes et la menace du changement climatique: la recherche archéologique dans les monts de l'Altaï
Les tombes gelées des Scythes, qui ont été conservées pendant plus de 2000 ans dans les Monts de l'Altaï en Russie, Chine, Mongolie et Kazakhstan forment une source d'information archéologique de tout premier ordre. Le permafrost a permis la conservation des matières organiques, à un point tel que même les tatouages sur les corps sons restés presque intacts. Depuis quelque temps, les changements climatiques font que le permafrost fond lentement. Avec tous ce matériel organique et le contenu des tombes, c'est également une source importante sur la

vie de ces populations nomades de la culture des Scythes qui disparaît. L'université de Gand et le Centre pour le Patrimoine Mondial de l'UNESCO se sont alors lancés en 2005 dans un projet ayant pour but de protéger les tombes gelées encore conservées, notamment en lancant un inventaire du patrimoine de l'Altaï, en étudiant le permafrost et en cherchant des solutions techniques pour préserver les tombes du réchauffement.

Introduction

The goal of this paper is to give a status quaestionis of the UNESCO/Flanders Funds-In-Trust Project "Frozen Tombs of the Altay Mountains: Preservation and Conservation (Phase 1, 2005-2006)" and the related research that has been done at Ghent University in the last decade. The project and its outcome have been published in several articles and conference proceedings over the past years, so this paper will summarise the content of these articles and provide an update. For more details, see e.g. Bourgeois et al. (2007).

The Altay Mountains are situated where China, Kazakhstan, Mongolia and the Altay Republic (Russian Federation) meet (Figure 1). Scattered across the mountains are thousands of surface structures dating from the 3rd millennium BCE up to the 19th century CE, funerary monuments as well as ritual structures and petroglyph sites. The most famous of these structures probably are the burial mounds or kurgans of the Early Iron Age Scythians (9th to 2nd cent. BCE) (Figure 2). In the first millennium BC, the Scythian culture covers the Eurasian steppe from the borders of the Black Sea to the Yellow River (Parzinger, 2006a). There are two sources of information about this mainly nomadic civilization. Amongst the written sources, especially the Greek historian Herodotus (5th century BC) is important, as he devoted the fourth book of his Histories to the Scythians and their society. The second source is the archaeology. The interest in Scytho-Siberian art started during the reign of Peter the Great (1689-1725). Since his collections focused on the Black Sea region, the Scythian archaeology of the Altay mountains remained largely unknown until the beginning of the twentieth century.

In 1929-1949, the discovery of the frozen mummies of Pazyryk (Figure 3) attracted world-wide interest, thanks to research by M. Gryaznov and S. Rudenko in Pazyryk, Tuekta and Bashadar (Gryaznov, 1969; Rudenko, 1970). Research in the 1990s brought the fascinating world of the Scythian graves of the Altay Mountains back into the light, through the excavation of some frozen tombs on the plateau of Ukok in the South of the Altay Republic by the Institute of Archaeology and Ethnography of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk (e.g. Molodin et al., 2004). Some ten years ago, excavations in north-eastern Kazakhstan, in Berel, by the Margulan Institute of the Kazakh Academy of Sciences and CNRS France revealed at least two frozen tombs (e.g. Samashev, Bazarbaeva, Zhumabekova & Francfort, 2000). And recently, a new frozen tomb was excavated in Mongolia by a team of German, Russian and Mongolian archaeologists (H. Parzinger, German Archaeological Institute, Berlin; V. I. Molodin, Institute of Archaeology and Ethnography of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk; D. Tseveendorj, Institute of Archaeology of the Mongolian Academy of Sciences, Ulaanbaatar) (Parzinger, 2006b).

A New Threat: Climate Change

Grave robbers and fortune hunters have been the tombs' traditional enemies but, today, climate change causes part of the frozen ground to thaw, and the remaining frozen tombs could be lost forever. Warming is now occurring over most of the globe and is consistent with the global retreat of mountain glaciers, reduction in snow-cover extent, the earlier spring melting of ice on rivers and lakes, and increases in sea-surface temperatures and ocean heat content. The Earth's surface is currently warming at a rate of about 0.17 ºC per decade or 1.8 ºC per century and the top ten warmest years have all occurred since 1990. Air temperature in the Altay Mountains has increased at a higher rate than the global mean during the 20th century. Significant reduction or

disappearance of the permafrost is predicted for the middle of this century in the Altay Mountains. The most significant impacts will be observed near the lower boundary of alpine permafrost, where the frozen grounds are very sensitive to climate change. Many frozen tombs in Altay are situated within this area of sporadic and discontinuous permafrost, and are therefore extremely vulnerable. In these areas, the formation of permafrost under a burial mound is partially due to the structure of the mound itself: although the surroundings have no traces of permafrost, the tombs are frozen due to the cooling influence of the stone mound on top of the burial (Figure 4). Studies show that the temperatures inside the stone mound are typically 3-5°C colder than the air temperature outside (Marchenko, 1999, 2008).

Other Threats to the Archaeological Heritage in Altay

A more general and less visible threat is undoubtedly the expansion of tourism in the area. More and more tourists from all over the world are visiting this part of Asia, as it is still natural and undisturbed. Mountain hiking, skiing, rafting, camping and even hunting are very popular. Thousands of tourists 'invade' the area every year, and it is obvious that, next to interesting economic potentialities, their presence constitutes a danger for the preservation of the archaeological heritage (Plets, Gheyle & Bourgeois, 2011). Moreover, in some cases, the area is also confronted with the threat of industrial expansion. The project to build a pipeline from Siberia to China through the plateau of Ukok, as announced by President V. Putin of Russia in March 2006, is probably the most obvious threat of this kind (Plets, Gheyle, Plets, Dvornikov & Bourgeois, in press). A PhD research is now studying the impact of agriculture, tourism and construction works on the heritage of the Russian Altay (drs. Gertjan Plets, IWT 2010-2013). One of the objectives is to propose a plan for sustainable management of the archaeological heritage in several research areas (e.g. the Karakol valley).

The UNESCO preservation initiative

The exceptional conservation combined with the rich heritage of the Scythians make these tombs extremely valuable for scientific research. The scientific community has, together with the international organisations, the responsibility to preserve these treasures of our past for future generations. UNESCO is interested in including the frozen Scythian tombs in the World Heritage list, and a part of the Russian Altay Mountains is already listed in UNESCO's Natural World Heritage, briefly mentioning the archaeological monuments in the area (The Golden Mountains of Altay, see http://whc.unesco.org/en/list/768).

Considering the importance of this archaeological heritage for our world and the threat caused by climatic change, a global and ambitious project "The Frozen Tombs of the Altay Mountains" was set up and supported by the UNESCO, with a grant from the UNESCO/Flanders Funds-in-Trust for a first, preliminary programme (Phase 1, 2005-2006). Such a project necessitates international cooperation. At different levels, co-operation with American, Belgian, Chinese, French, German, Kazakh, Mongolian and Russian colleagues was set up. The objectives of the project were: an inventory of the frozen tombs and the archaeological heritage; an examination of the evolution of permafrost conditions to indicate which tombs are likely to defrost within the next decades and a search for solutions for the preservation of permafrost in situ. As a last step, tombs that are thawing and can not be saved should be excavated. We will develop these objectives in the next paragraphs.

Archaeological fieldwork in the Altay Mountains: survey and inventory

For the purpose of inventory, accurate maps are needed to precisely locate all archaeological structures. These maps do not exist for all of the research area. Taking into account the surface of

the research area, the high costs of topographic measurements and the non-existence of a total coverage with aerial photographs, the mapping is being executed with the help of existing satellite images (mainly CORONA, ASTER, QuickBird). The basic advantage of the CORONA images is that these American intelligence images cover a major part of the Altay area and are cheap and useful images to produce topographical maps, as a basis for landscape analysis of the archaeological monuments in the area. This is not the place to discuss the technical details, for which we refer to Goossens et al. (2006). With the resulting maps as a background, survey campaigns were set up to map the archaeological heritage and the possible frozen tombs.

From 2003 on, a series of valleys in the Altay Mountains have been surveyed systematically. Most of them were located in the Russian part of the Altay (Dzhazator, Elangash, Karakol, Irbistu, Ozek, Sebystey and Yustyd), some also in Kazakhstan (Bukhtarma and Karakaba) (Figure 1). This research was realised in collaboration with the Gorno-Altaysk State University and the Margulan Institute of Archaeology.

It should be emphasized that all structures are recorded, from huge stone mounds to small stone circles or even structures with unidentified function or date. All periods are concerned. We are convinced that the necessary selection of the burial mounds to be preserved from thawing has to be made within a global analysis of the landscape, with full consideration of the complete archaeological heritage of the area. Only a holistic approach of these landscapes will give reliable results. All descriptions, photographs, and measurements are recorded in a database. The ALTARI database is written in Access and covers three levels of information (the site location level, the site organisation level and information on the individual structure). Images and plans are available in a direct link. Finally, the database is linked in an ArcView GIS or ArcMap project to the produced maps, DTM's, and other products from the satellite images.

This way, more than 15,000 different monuments have been recorded in the ALTARI database.

All this information was gathered not only to start up conservation processes or heritage management; it is also the subject of scientific research. The database and maps make it possible to study the archaeological landscape as a whole. Where did the population of a certain culture prefer to construct their burial sites or individual graves? And why? In what part of the landscape are the ritual monuments located? Can we reconstruct the archaeological landscapes from the different chronological and cultural subdivisions, and analyse to what extend the successive populations or cultures did reuse the setting of older burial or ritual sites, or, on the contrary, did avoid these locations? This forms a completely new way of looking at the archaeology in the area, as the research here was mainly limited to excavations of single sites or even single monuments within one site. In the last decennia, the concept of studying the archaeological landscape has developed quickly, and it is rightly considered to be an important part of the archaeological research (Anschuetz, Wilshusen & Scheick, 2001; Bradley, 1998, 2000; Thomas, 2001).

Study of permafrost and detection of the frozen tombs

A next objective of the global project is to map the permafrost of the Altay Mountains, its past and future evolution, in order to contextualize the frozen tombs. First preliminary research in this field was realised by Ghent University, based on field measurements, augerings and ASTER-imagery (Goossens, De Wulf, Gheyle & Bourgeois, 2006), by the University of Alaska Fairbanks (round-year ground temperature monitoring with temperature data loggers in the Ulandryk Valley) and by the Russian Academy of Sciences in Almaty (augerings and temperature measurements in the Karakaba Valley, Kazakh Altay).

Extensive permafrost research regarding the thermal state of the frozen tombs and the spatial distribution of the mountain permafrost is necessary to forecast which of the tombs are

endangered by thawing. To assess this threat and to calibrate future climate models on the local scale of the frozen tombs, a PhD research project was set up at the Geography Department, funded by the IWT (drs. Ruben Van de Kerchove, 2009-2012). The source data are temperature measurements performed in the Russian Altay between 2008 and 2010. The thermal regime is studied at three levels. At first, surface temperatures inside a tomb are compared to undisturbed natural temperature profiles located in its vicinity. Next, temperatures at depth inside a burial mound are compared to undisturbed borehole-temperatures. Therefore an archaeological/periglacial experiment was carried out in the Ulandryk Valley, where a burial mound, excavated in 1972, was reconstructed in 2008 and loggers were installed inside the reconstructed burial chamber and covering stone mound. Finally, temperature loggers were installed in a burial mound at the Ukok-Plateau, an area known for its frozen burial mounds, intended to study 2D and 3D temperature-fluxes inside the coarse debris layer. Some preliminary papers were already published, and the final outcome of this PhD project will be published in the next months (e.g. Van De Kerchove & Goossens, 2010a, 2010b; Van De Kerchove, Goossens, De Wulf, Bourgeois & Gheyle, 2009; Van De Kerchove, Lhermitte, Veraverbeke & Goossens, submitted April 1, 2011).

It was not possible within the first phase of the UNESCO project to undertake any serious attempt into the detection of individual frozen kurgans, but there is already great experience in geophysical prospecting methods for small scale survey in archaeological zones. Obviously, this part of the global project has to be developed in the next future. The experience of the German Institute of Archaeology (as shown in Mongolia) is of prime importance in this field.

Preservation of the selected frozen tombs

If the consequences of global change are detectable on individual tombs, methods have to be considered to preserve the graves in their frozen condition. The search for technical solutions to preserve the ice lens in situ has already been started and different methods of frozen ground preservation and prevention of permafrost degradation are being studied (Marchenko, 2006). The height and thickness of the coarse debris (the stone burial mound) is a determining factor for the formation and preservation of an ice lens. So, the easiest way to protect the frozen core of a tomb could be enlarging the stone cover. From a heritage point of view, this is of course not an applicable solution. A second possibility is to protect the kurgan from rainfall, sunlight and snowfall, by shading the burial mound. This method decreases the ground temperature with 3 to 7 °C (Zhang & Liu, 1998). Here also, the visual impact on the natural landscape is great and therefore we should maybe focus on a third solution which could be installing self-regulating seasonally acting cooling devices or thermosyphons (Figure 5). They act like refrigerators, but without needing an external power source. By extracting heat from the ground and dissipating it into the air, they lower the ground temperature and prevent the degradation of permafrost (Haynes & Zarling, 1988). Obviously, still more research is to be realised here. There is no doubt that other techniques and methods will be designed in the future. All these techniques should of course consider the problems of sustainability and of respect for the landscape.

Excavating Endagered Tombs?

It is evident that we will not be able to apply these methods and technologies to all the frozen tombs in the region. A well balanced selection will most likely have to be made. What to do with the tombs that can not be saved from thawing? If excavation is the only solution, it will be necessary to work with different groups of experts, using the latest techniques and equipment. Much attention should also be paid to the conservation and restoration of the finds, and to their

final destination. In the case of excavations, we also have to take into account the attitude of the local population towards the graves of their ancestors.

Conclusions

The similarities between the different Scythian type cultures make the frozen tombs of the Altay Mountains a very important source of information for all the cultures dominating the Eurasian steppe zone in the first millennium BC. They form one of the main sources of information for the archaeology of this huge region, covering parts of Europe and Asia, from the Danube and the Black Sea to Manchuria. It is clear that these frozen tombs are of major importance for the international scientific community and for mankind. The countries concerned by this heritage (China, Mongolia, Kazakhstan and Russia) are also the most interested. The geographical context of the graves, the Altay Mountains themselves, is part of our world heritage. But the archaeological heritage remains unprotected. Nominating and inscribing the monuments to the World Heritage List will change this, and make legal protection possible.

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Notes

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FIGURE 1: The central part of the Altay Mountains with indication of the research areas within the survey project, from 2003 to 2010. Image: UGent.

FIGURE 2: Aerial view on a burial site in the Karakol valley. The Scythian kurgans (foreground) are generally placed in a N-S oriented line, and typically have smaller circular stone setting in the west and some standing stones in the east. Image: UGent, deltaflight by J. Bourgeois.

FIGURE 3: A three-dimensional reconstruction of a part of the tatoos that were found on the body of the man from the second kurgan of Pazyryk (Altay Republic, 5th to 4th cent. BCE). Image: UGent, reconstruction by Ivo Verhaeghe.

FIGURE 4: A view on a Scythian kurgan with the ice lens situated underneath the stone mound (kurgan 11 at the Berel' site in the Kazakh Altay). Two dimensional steady-state temperature field by Sergei Marchenko, the funerary pit geometry according to Samashev et al. 2000.

FIGURE 5: Suggested position of thermosyphons to protect the frozen core of a Scythian kurgan from thawing. Image by Sergei Marchenko (Marchenko 2006).

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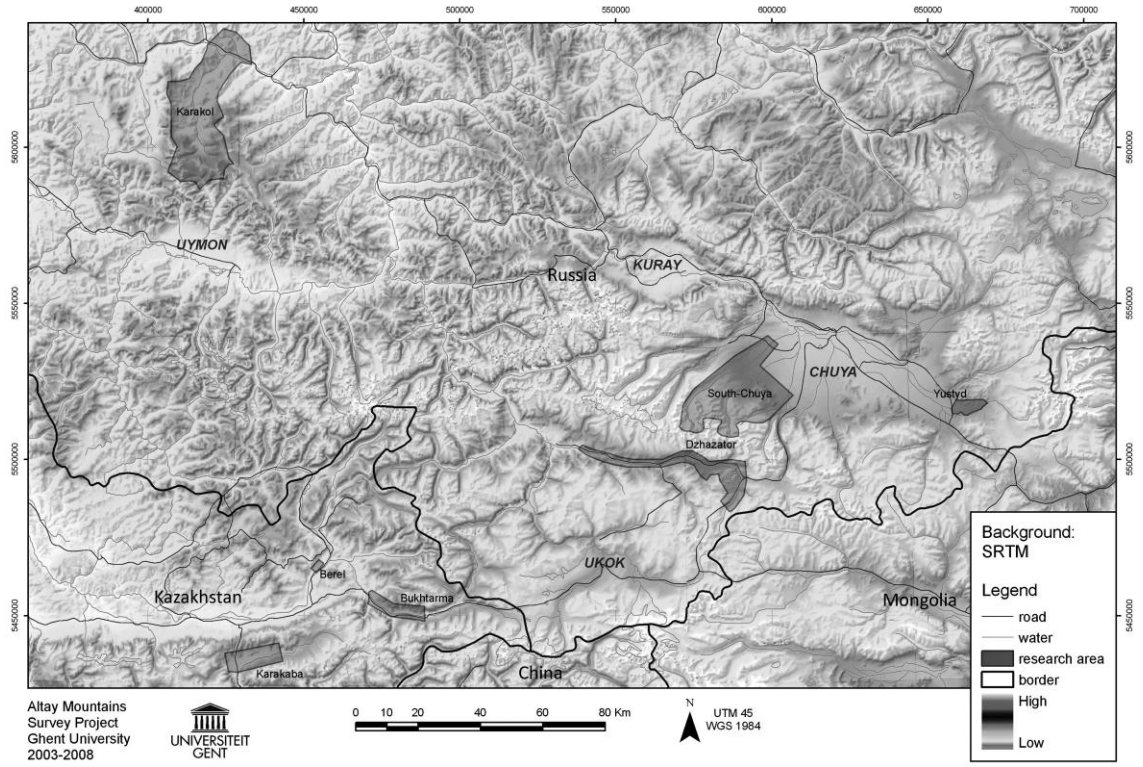

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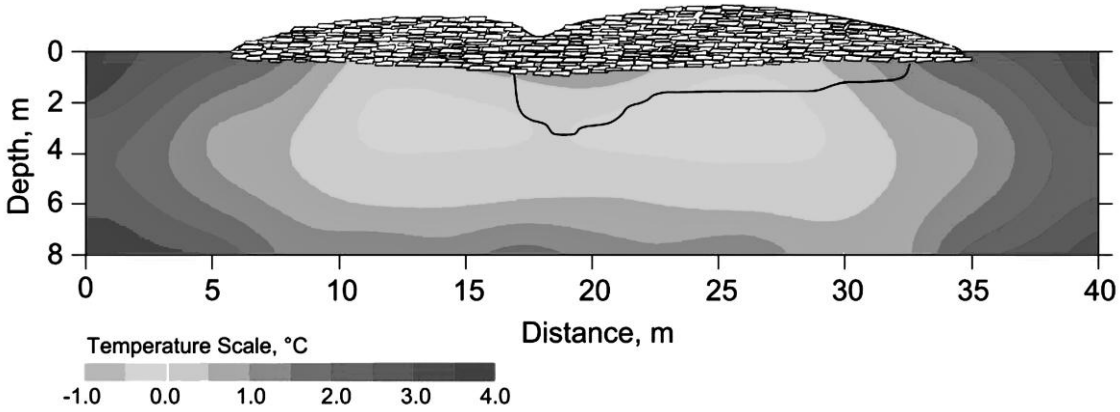

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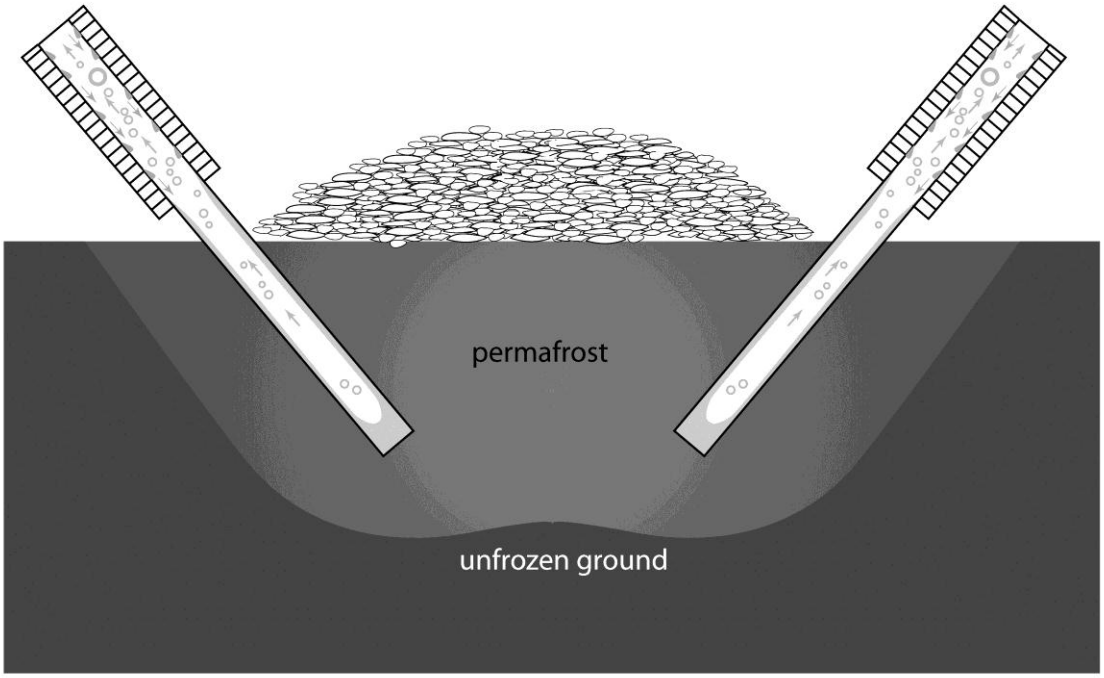

Figure 5