IPAEB

Volume I

Preliminary Report of the First Season work of the International Pluridisciplinary Archaeological Expedition to Bactria

2006

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Introduction

The International Pluridisciplinary Archaeological Expedition in Bactria (IPAEB) was created in 2006. The name underlines the international character of the team (which includes Uzbeks, Spanish, French, British and Greek members), the presence of specialists from various fields apart from archaeology and the fame of Bactria[1].

The first field season of the IPAEB took place from the 12th of September till the 12th of October 2006 with the participation of the following members from the Catalan side:

- Enrique Ariño (Professor at the University of Salamanca)
- Josep Maria Gurt (Professor at the University of Barcelona)
- Maria Lafuente (Geophysical firm SOT)
- Yannick Miras (Research Fellow at the University of Barcelona)
- Mateu Reus (Student at the University of Barcelona)
- Roger Sala (Director of the Geophysical firm SOT)
- Sebastian Stride (Research Fellow at the University of Barcelona)

And from the Uzbek side

- Larisa Baratov (Senior Research Fellow at the Institute of Archaeology)
- Durdona Muradova (Junior Research Fellow at the Institute of Archaeology)
- Samariddin Mustafakulov (Senior Research Fellow at the Institute of Archaeology)
- Shakir Pidaev (Director of the Institute of Archaeology)

The archaeological expedition was co-directed by Josep Maria Gurt and Shakir Pidaev with the collaboration of Sebastian Stride and financed by an **EXCAVA** grant of the Generalitat de Catalunya.

The mission would not have been possible without the collaboration of the Franco-Uzbek Archaeological Expedition in Bactria, with whom we are working on the site and whose generosity in sharing the results of their work during the last 13 years was exemplary.

We would also like to extent all our gratitude to the following institutions:

- The IFEAC for their logistic help in Uzbekistan.
- The Fundació Arqueològica Clos (Museu Egypci) for their help in obtaining tickets and their interest in our work.
- Turkish Airways who enabled us to transport the material for the geophysical survey free of charge and were extremely helpful at all times.
- The commander of the military camp of Ancient Termez
- The local authorities in Termez and the Surkhan Darya province

1 The name is also a reference to the TAKÈ (Pluridisciplinary Archaeological Expedition to Termez) ledby M. E. Masson in the late 1930's.

Preliminary considerations

J.-M. Gurt, Sh. Pidaev, S. Stride

Creating a new archaeological mission in Central Asia is not an easy task especially when, to our knowledge, no large scale Spanish team has previously worked further east than Iraq[1]. For this reason it is necessary to lay out in a few paragraphs the reasons for which we have chosen to work in this part of the world, the aims of our expedition and the manner in which we hope to fulfil those aims.

Fig. 1: General map showing the localisation of Termez (from Google Earth)

Why Central Asia?

Most Western Europeans, including specialists, have long considered that the Mediterranean World is a coherent area whose history and culture form a clearly distinguishable unit which does not extent beyond the Near East. This perspective derives from the historiography of our discipline (which developed at a time when the European Nation States where being created) and from a generalised ignorance of the world that stretches East beyond the Euphrates.

It will therefore come as a surprise to many that the Antique and Early Medieval history of southern Central Asia runs parallel to that of much of the Iberian peninsular. This is true from a purely historical point of view with events such as the Greek colonisation, the integration into a vast empire during the Roman / Kushan period, the invasions of the 4th and 5th centuries and finally the Arab conquest at the beginning of the 8th century.

But it is also true from many other perspectives including urbanism (with the emergence of major cities, their collapse after the end of the Roman / Kushan empire, the appearance of early Medieval castles and finally the reappearance of major cities after the Arab conquest) and pottery (with the same evolution of techniques and shapes in Bactria as in Catalonia)!

Our first aim is therefore a general one: by studying the history and archaeology of Central Asia we want to demonstrate not only that this helps understand the history of Western Europe but that we share a single history and are part of the same cultural sphere.

1.- A team from the Universidad Autonoma de Madrid, directed by J. Cordoba, are currently setting up an expedition to Turkmenistan. See:
http://www.uam.es/otroscentros/asiriologiayegipto/proyectos/proyectos.html

A second concern is more directly methodological: if the Iberian peninsula and Central Asia share many elements, then by studying Central Asia we should be able to test our theories, methods and interpretations. The potential benefits of such an approach are immense and would warrant an article in themselves, three examples are given here:

- Can we analyse the sherds of Termez and dig the site with the same methodology as we use in Barcelona or do we need to adapt our methods to another context and to what extent?
- Are the theories that explain the decline of urbanism in the Mediterranean World valid in a Central Asian context and if not what are the implications of this?
- How do the commercial networks compare and to what extent are they interlinked?

Finally a third reason is linked to the contemporary situation of this part of the world. The archaeology of Central Asia was studied exclusively by Soviet archaeologists during over 70 years. The results of their work are remarkable but remain very little known in the West because they were not translated or diffused. Since the independence of the countries of Central Asia in 1991, the economic situation has been difficult and the former soviet school of archaeology has been through a major crisis with limited funds available and very few new vocations.

By collaborating closely with the Institute of Archaeology of the Academy of Sciences of the Republic of Uzbekistan, the IPAEB, like other International Teams, can help both preserve and diffuse the results of the Soviet school of archaeology and that of our Central Asian colleagues to a wider audience.

Why Termez?

The site of Ancient Termez is situated in southern Uzbekistan, on the Afghan border. It is a major urban site occupied at least since the Hellenistic period and up until the Mongol conquest of 1220. It therefore provides an excellent parallel where we can study the evolution of the site over the Antique, Early Medieval and Early Islamic periods and compare it to that of cities in the Iberian peninsula.

Fig. 2: General view of the site of Termez from space (image taken from Google Earth)

Fig. 3: The Archaeological Base of the Institute of Archaeology in Termez

The site also has another major advantage for a new team: it has been excavated by Sh. Pidaev, the Uzbek co-director of the IPAEB since 1979, by a Franco-Uzbek archaeological team since 1993 and by a Japano-Uzbek team since 1998. The IPAEB has thus been able to profit not only from the excellent infrastructure (including an archaeological base where we are accommodated) but also from the knowledge of our colleagues.

We in turn can propose new techniques and methodologies, which have so far not been applied at Termez and, in many cases, in the whole of Central Asia. These include geophysical surveys, archaeometrical analysis of the ceramics and palynology.

Finally it must be stressed that the work of the team is not limited to Termez alone but to the whole of the Surkhan Darya province in which Termez is situated. In this respect the fact that a member of the team has written his PhD thesis on the area is a major advantage [Stride 2005].

Methodology

Because the European side of our team comes from a country that has never previously excavated or even studied Central Asia, many of the members of the IPAEB know almost nothing of Central Asia even though they are excellent scholars in their domains.

Simultaneously, because of the contemporary situation, many of the Uzbek members of the IPAEB lack access to modern techniques and methodologies. Our respective skills and aims are therefore different and our main challenge is to succeed in building a true pluridisciplinary project within which these differences become advantages.

The focus of our project has been to apply a series of new techniques in order to approach historical and archaeological questions that were relevant both from Central Asian and Mediterranean perspectives.

The main lines of investigation chosen are as follows:

- Geophysical survey of Tchingiz Tepe

Despite the fact that the Kushan empire stretched over a vast area, from Central India toCentral Asia and was considered as one of the four great empires of Antiquity alongside the Roman, the Han Chinese and the Parthian, we do not yet have an urban plan of a single major Kushan city. This fact alone justifies the decision to attempt to understand the plan of at least part of Ancient Termez.

In order to do this we have chosen to undertake a geophysical survey of Tchingiz Tepe, an area of the city, which was relatively little disturbed by later occupations and where the Franco-Uzbek team have been working on the fortification walls and a number of major cultic buildings [see the articles in La Bactriane au carrefour, 2001.].

- Archaeometry and the excavation of a ceramic kiln

So far no attempt has been made to trace the origins and distribution of the production of a given site or workshop and we have almost no data about the local and regional commercial systems which existed during the Kushan period. Because the ERAUB team is specialised in the analysis of ceramics and in particular that of the Late Imperial period, the analysis of Kushan period ceramics is a logical priority (they date from the same period, are derived from the same Hellenistic types and closely resemble those of the Western Mediterranean both in form and in technology). In addition we were lucky enough to be authorised to dig an area of production in which we localised a number of Kushan period kilns.

- Palynology

No palynological study has yet been attempted in this area and we have extremely limited paleoclimatological data and no data on the anthropic impact on the environment. One of the major emphasis of the team has therefore been to undertake a palynological survey, not only at the site of Termez but also upstream, in the Bajsuntau mountains where the conditions for preservation of pollen are better.

- Information Systems

Finally, in order to integrate the data from the various sources as well as that from the work of our Uzbek, French and Japanese colleagues we have decided to create a GIS and a series of databases of the material from Ancient Termez. This work will be fully integrated into a larger project for the development of an Archaeological Information System of Central Asia, which is described in the attached document.

Publish or die

The IPAEB has chosen to follow a code of conduct as regards diffusion of the results of our work. This can be resumed as follows:

- All material is made available to any scholar wishing to access it. This includes not only the final reports but also all the archives and the excavation material.
- All results of fieldwork or laboratory analysis must be published within a period of one year at maximum.
- The results should be linked to the work of other teams so as to ensure maximum diffusion and ease of use.
- Digital publication should have priority over paper publication – even if reports should be made available in both formats if possible.
- Copyright should remain in the hands of the team that undertook the work and not be pas-

This report has been written and published within a period of six months from the end of the First Season field work. It may be imperfect but at least it exists. Furthermore, by making it available online and by publishing it within SIRODE, a common project of which all institutions and teams currently working in Central Asia are part, we can ensure that it is widely diffused to interested parties and linked to other similar projects currently underway in Central Asia.

Most of the raw material of our work will also been placed online, including the ceramic drawings, the excavation plans and the original data of the geophysical survey.

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The Ceramic Kilns of Kara Tepe

E. Ariño, R. Sala, M. Lafuente, J.-M. Gurt, Sh. Pidaev, S. Stride[1]

One of the main focuses of the 2006 Catalano-Uzbek Mission was a small, flat, topographical elevation situated in the northern part of Ancient Termez, 200 meters to the north-east-east of to the main stupa of the Buddhist complex of Kara Tepe. The area in question is approximately 120 meters long with a maximal width of 40 meters and overlooks the plain to the north by about 3 meters. It is limited to the South by a long East-West elevation, which marks, according to most investigators, the outer wall of the urban area of Termez[2] .

Fig. 1: The topographical elevation (shaded) as seen on Google Earth, from the West.

The area was selected because it had already been identified as a ceramic producing zone by K. Kawasaki and Sh. Pidaev, who partially excavated a ceramic kiln here in 2002[3]. In addition, there were numerous sherds and vitrified material on the surface, leading us to suppose that there were probably other kilns in the same area. Although we cannot yet be certain of this, it would appear that the elevation is not of anthropic nature but corresponds to a natural sandstone outcrop or terrace. During the excavation, the bedrock appeared immediately under the lower levels of occupation. The area is exposed to strong aeolian action, which generates both phenomena of deposition (loess) as of erosion.

1.- The main text is by E. Ariño who directed the excavation of this area assisted by M. Reus and two workers. R. Sala and M. Lafuente undertook the geophysical survey and wrote this part of the report. J.- M. Gurt, Sh. Pidaev and S. Stride added comments, references and comparisons.

2.- See the interpretation of this elevation in the article “Ancient Termez on the QuickBird Images” in this report.

3.- The excavation of the kiln in 2002 took place as part of the Japano-Uzbek Archeaological Expedition in Kara Tepe.

The area seems not to have been cultivated, neither recently nor in the past. The activities of the local garrison (including the digging of trenches and other militar structures) have had a serious, but localised, effect on the archaeological deposits an the remains of various types of ammunition lie scattered over the surface. The top layers are disturbed by animal burrows that bring archaeological material to the surface.

Fig. 2: General view of the surveyed area.

We carried out an intensive surface survey, a detailed geophysical survey, cleaned and recorded the partially excavated kiln and finally excavated a new kiln. We also selected sherds, charcoal, ashes and other material that will be analysed during the coming winter 2006-2007.

The survey

Intensive surface survey (Ariño, E. and Gurt, J.-M.)

Our first task was to define a rectangle of 30 x 80 meters, with the same East-West orientation as the flat topographical elevation where we where working. This rectangle was divided into a 5x5 meter grid in which we carried out an intensive surface survey during which the totality of the surface material was gathered and registered in function of the square where it had been found.

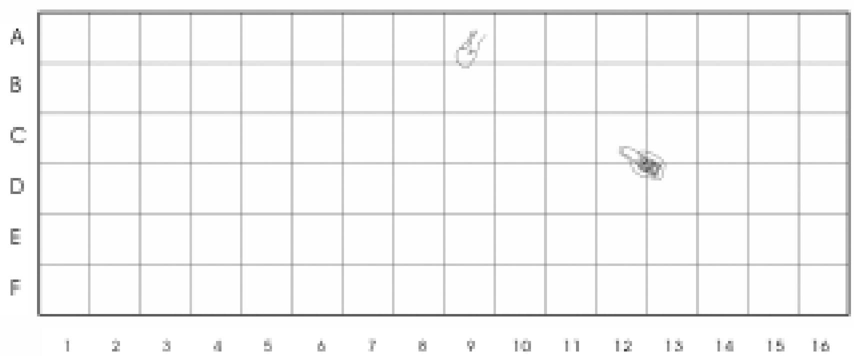

Fig. 3: The survey grid, with the location of the ceramic kilns.

The material was divided into three basic categories: sherds covered with a red, brown or almost black slip (CER), common sherds (CC) and glazed sherds (CV). All identifiable sherds of the first two categories were characteristic of the Kushan or Kushano-Sassanid periods. Together these two categories totalled respectively 553 and 1390 sherds. Only 5 sherds of glazed material, typical of the Islamic period, were found. The greatest density of fragments is situated in the central part of the elevation, whilst the peripheral areas are significantly less rich in material. Apart from the sherds, there were also an important number of vitrified mud-bricks of grey-green colour, which can be interpreted as evidence of the use of this area for ceramic production and in particular of the presence of kilns.

Fig. 4: Slipped Ware from the survey

Geomagnetic survey (Sala, R. and Lafuente, M.)

The area surveyed was flat and devoid of major obstacles apart from the previously excavated kiln and the spoil heaps situated around it. Despite our efforts to clear all metallic fragments before starting the survey, it is possible that the ammunition scattered throughout the area had a punctual effect on some of the readings.

We chose to carry out the geophysical survey with a magnetic gradiometer, which measures the extension of the small local variations in intensity and orientation of the magnetic field [Clark 1990 ; Kvamme 2000]. The magnetic response of large kilns on maps of magnetic variation obtained thanks to this type of survey is well known [Bevan 1998; Canti 2000; Clark 1990; Crew 2002; Gaffney 2003; Linford 2001; Marmet 1999; Proceedings, 2005]. It consists of magnetic anomalies with a positive and a negative pole of high magnetic contrast (> +/- 20nT), which form a U shape, the upper part of which corresponds to the mouth of the structure where the fuel is placed.

Fig. 5: Surveying with the magnetic gradiometer

The detection of this type of structure with a magnetic gradiometer is relatively easy thanks to the phenomena of thermoremanent magnetism associated with the combustion. Because the constructive materials and infill have passed through a process of combustion that has reached a temperature superior to Curie's point (about 650º), the magnetizable particles that they contain have reoriented themselves according to the most powerful magnetic field to which they were submitted at this point, which usually corresponds to the earth's magnetic field. Therefore a diagram of the magnetic variations will show a coherent area of alteration above a kiln, which will contrast with other built structures, whose intensity may be 50 times or more lower (Clark 1990).

In the area of ceramic production to the North East of Kara Tepe, we surveyed a surface of 30x90 m around the kiln that had previously been excavated, using a magnetic gradiometer FM-256 of Geoscan Research. The spatial resolution of the recording was fixed at 50x25 cm and the sensitivity at 0,1 nt. The most promising area was then surveyed a second time, using the same spatial resolution but in the opposite direction and with a lower recording speed (1,5 sg/m) in order to obtain more precise data.

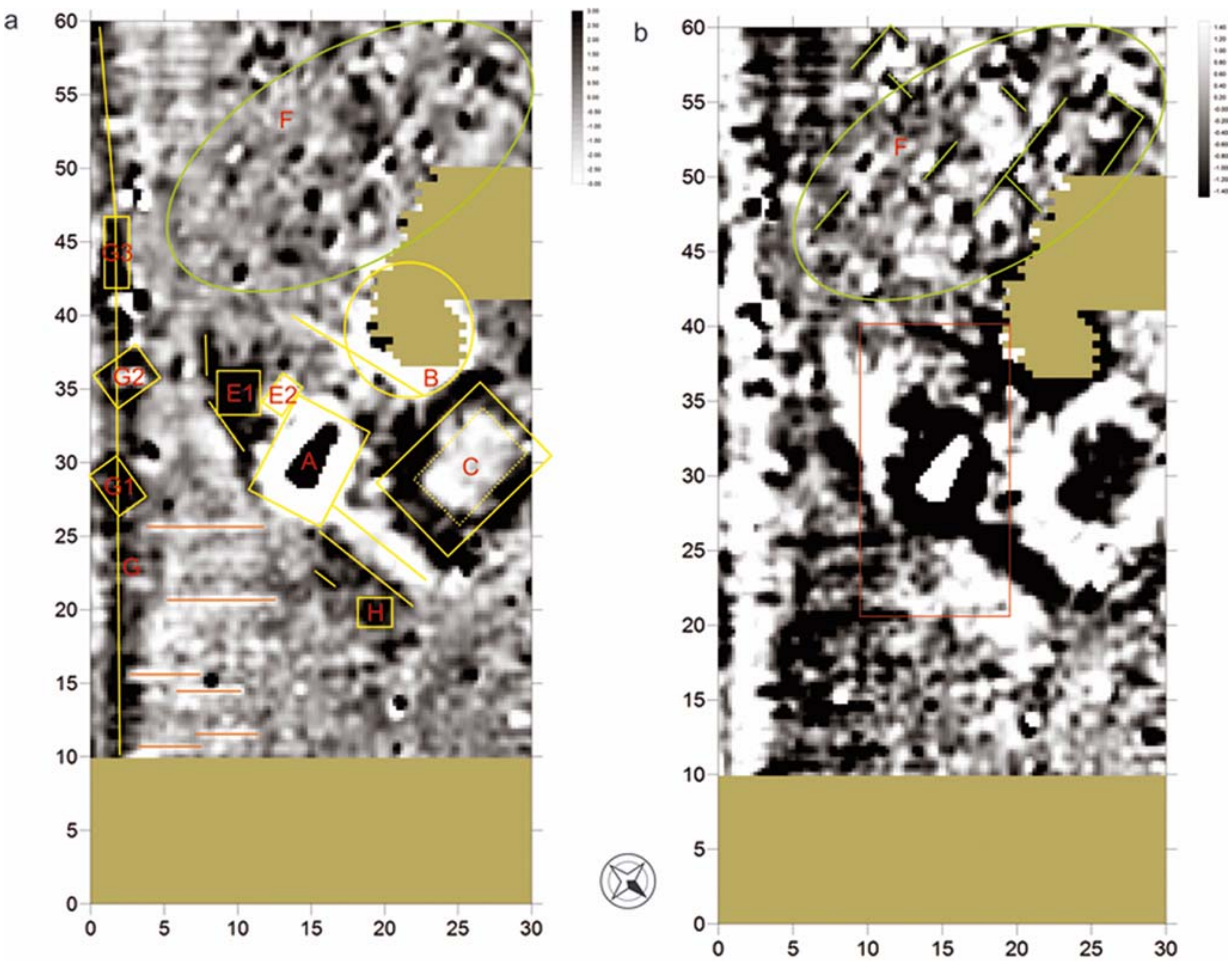

Fig. 6: The results of the geophysical survey.

Results

The results of the first survey enabled us to localise a structure associated to a combustion in form of U that had been submitted to high temperatures according to the intensity and contrast of its magnetic signature[4]. This was interpreted as a kiln, something that was clearly demonstrated by the excavation.

To the north of this anomaly, we recorded a negative lineal anomaly[5] and a quadrangular positive one[6], whereas to the south there were two quadrangular anomalies, one positive and one negative[7] that could correspond to structures associated with the kiln.

To the north-north-east of the kiln, there was a quadrangular structure with a high magnetic contrast that, because of its proximity to the kilns, could mark the remains of a building linked to ceramic production.

Between the two kilns, we localised another possible combustion structure[8], however its proximity to a spoil heap left over by the initial excavation of the first kiln and thereforecontaining sediments from kiln 1, make it possible that the anomaly was in fact generated by this material.

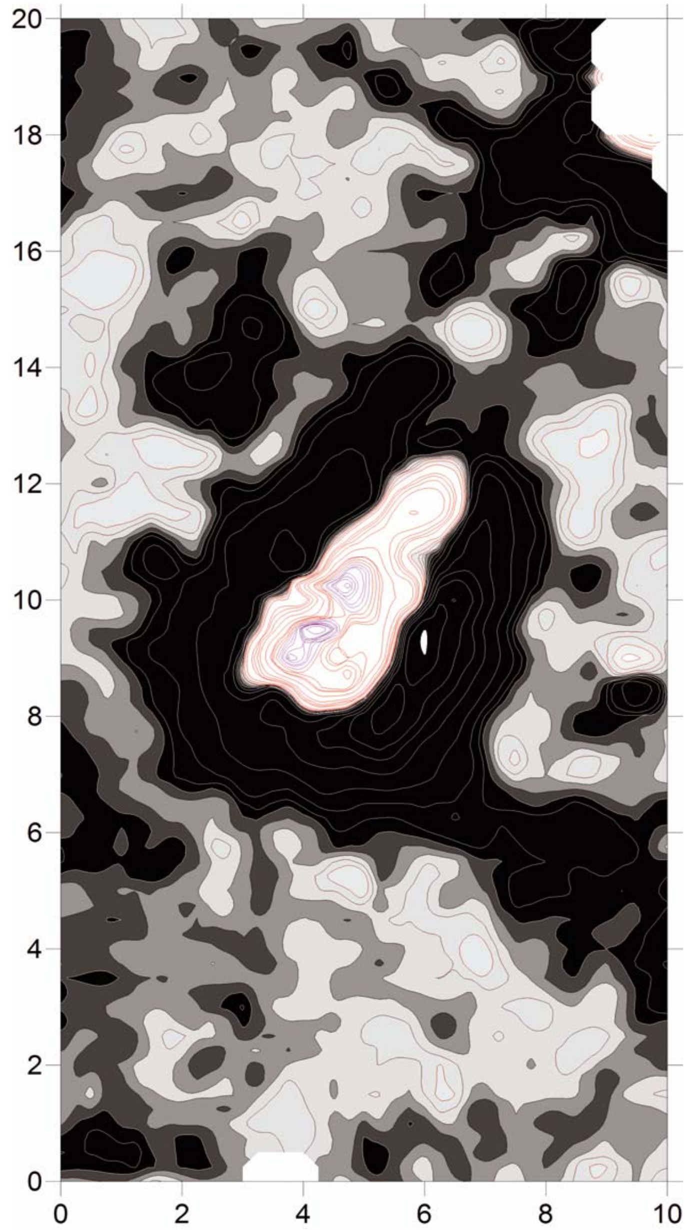

Fig. 7: Magnetic anomaly corresponding to the kiln

4.- Anomaly A, with maximums of +172/-91nT and a standard deviation of 33nT.
5.- Anomaly D, between -2 and -7nT.
6.- Anomaly H, between +2 and +4nT.
7.- Anomaly E1, between +2 and +7nT and Anomaly D2, between -2 and -8nT.
8.- Anomaly B, with maximums of +83/-35nT and a standard deviation of 12.5nT.

A lineal structure of important contrast[9] can also be made out on the southern side of the area that was surveyed. This magnetic anomaly presumably corresponds to the lineal structure, visible in surface, which extends beyond the surveyed area and has been identified as the outer wall of the oasis of Termez. Other magnetic anomalies run perpendicularly to this one (marked in orange on the graphic) but their identification is uncertain since their orientation is the same as that of the survey route and they could therefore correspond to an error of reading.

Finally, on the map of magnetic variations, a zone can clearly be made out (group F) to the south-west of the kiln where there are many variations of low contrast[10], which mark alignments which suggest the existence of an area with structures that followed the same orientation as that of the kilns.

Contrasting the Ceramic survey and Geophysical survey (Sala, R., Lafuente, M.,Ariño, E. and Gurt, J.-M.)

Figure 8 shows the results of the surface survey carried out in the same area as that of the magnetic survey and based on a 5x5 m grid, that did not include the previously excavated kiln or the spoil heaps situated around it.

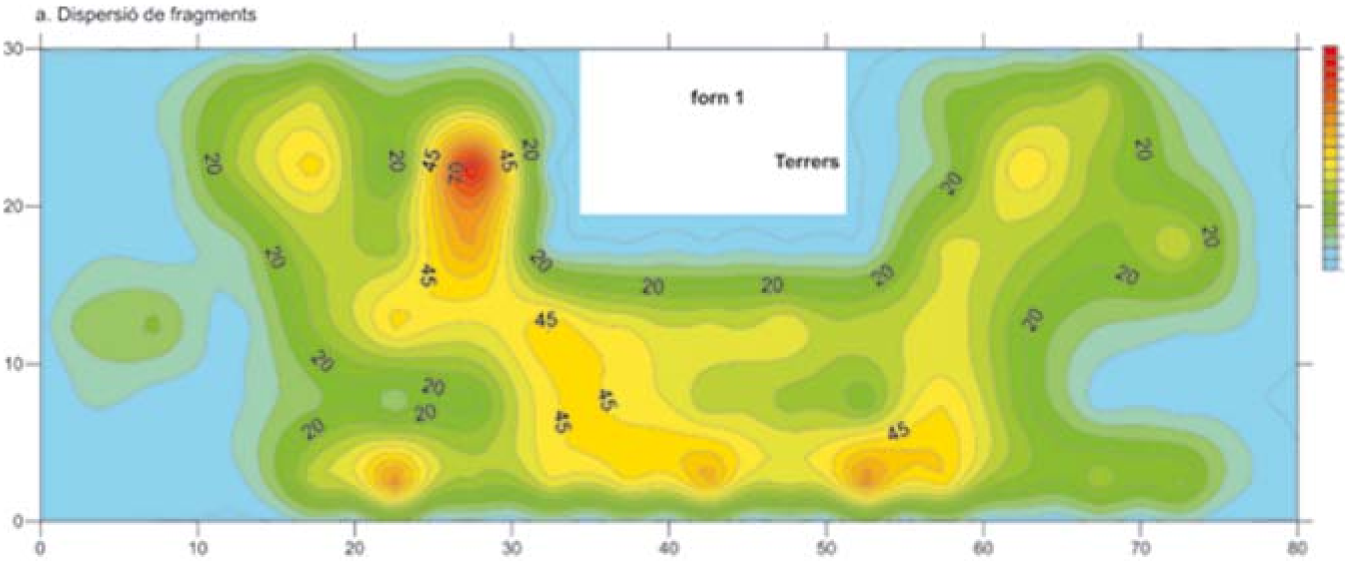

Fig. 8a

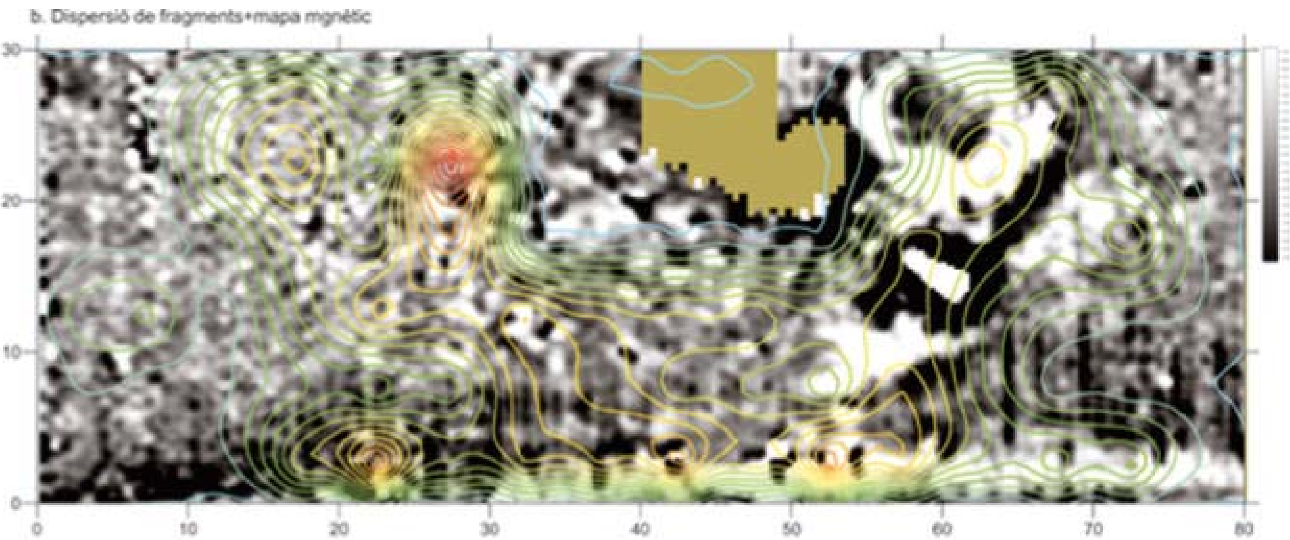

Fig. 8b

9.- Anomaly G, between +2 and +5nT with punctual anomalies of +7/-3nT (G1), +5/-6nT (G2) and +9/-3nT (G3).
10.- Between -/+1nT and -/+4nT.

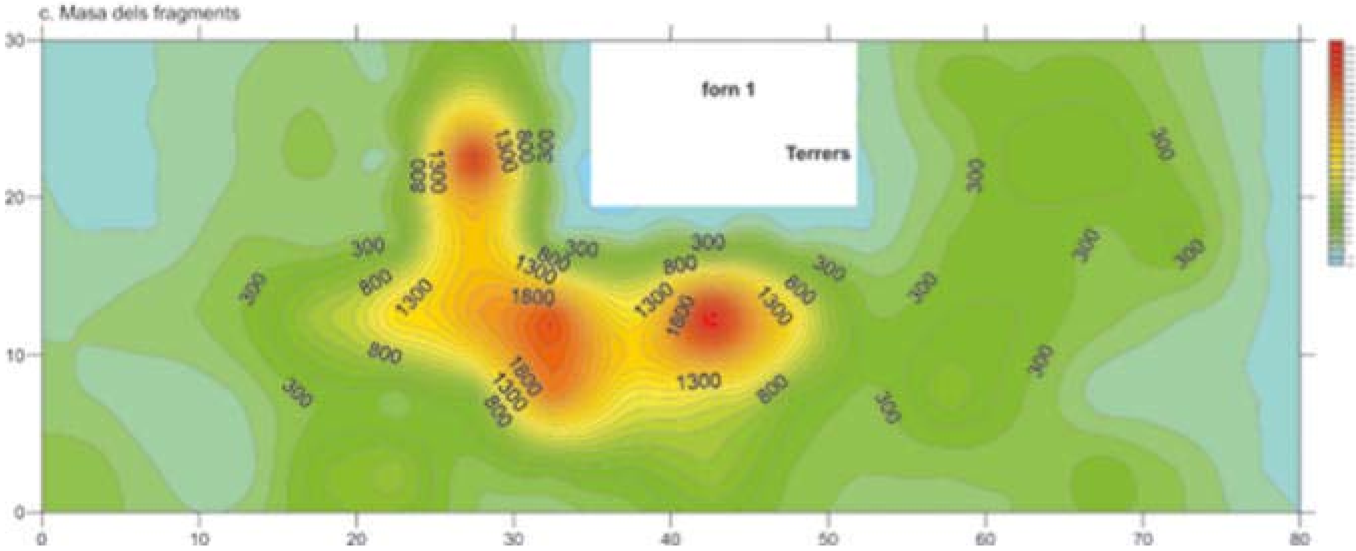

Fig. 8c

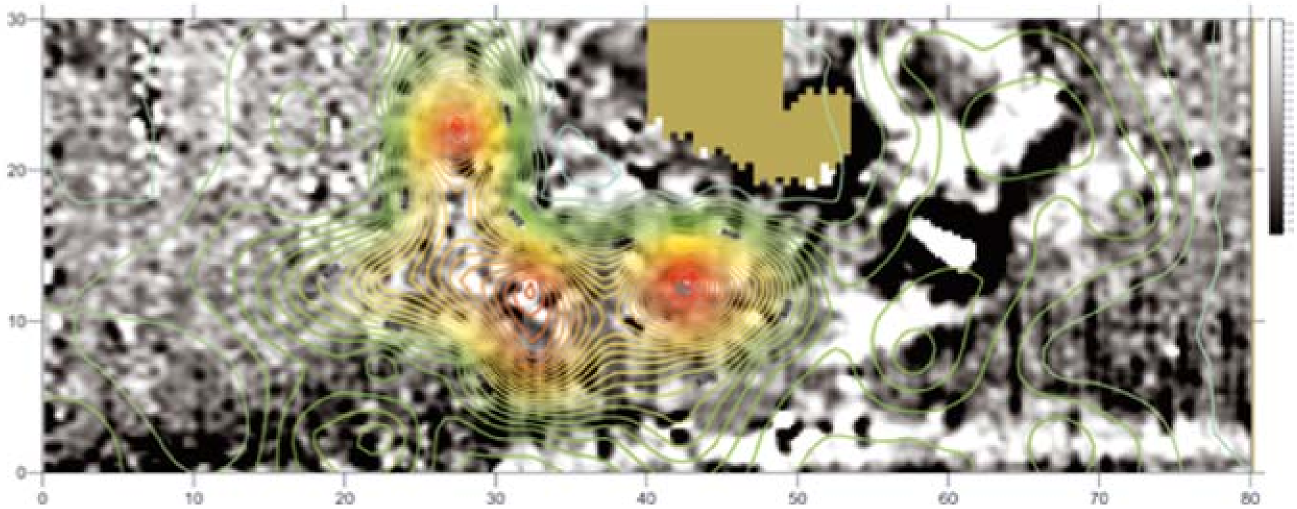

Fig. 8d

Fig. 8a-d: Maps showing the superposition of the results from the geophysical survey with those of surface survey

Fig. 8a shows the variation in the number of sherds and 8b the variation in weight. By observing the two graphs, one can make out a similar surface context but with a concentration of the heavier fragments in the central part and along the western band of the surveyed area (it is possible that this zone was distorted by the presence of sherds which came from the previous excavation of kiln 1).

Fig 8c and 8d were created by superposing the graphs of sherd density and sherd weight over the magnetic map obtained during the geophysical survey.

The superposition makes it possible to visualise how the greater concentration in number and mass of sherds does not correspond exactly to kiln 2 but to the group of structures F, and is clearly limited by the lineal structure G to the south-south-east.

This indicates a strong influence of the local microtopography in the distribution of sherds, which is confirmed by the weight graphs since the slope generated by anomaly G has caused a concentration of the heavier fragments at the base of this slope.

The high density detected over the group of anomalies F (interpreted as the remains of a structure) may indicate a relationship between this structure and the presence of sherds in surface.

The excavation (Ariño, E.)

Two area were selected for excavation: the previously excavated kiln and the largeanomaly in form of U detected by the geophysical survey and interpreted as a kiln.

TRENCH 1 (Kiln partially excavated by K. Kawasaki and Sh. Pidaev)

The previously excavated kiln was situated in squares 9.1-9.5 / A.1-B.1 and numbered Trench 1. In order to better determine its structure, we cleaned and recorded the whole kiln in addition to partially excavating its mouth which was the only part that had not been excavated previously.

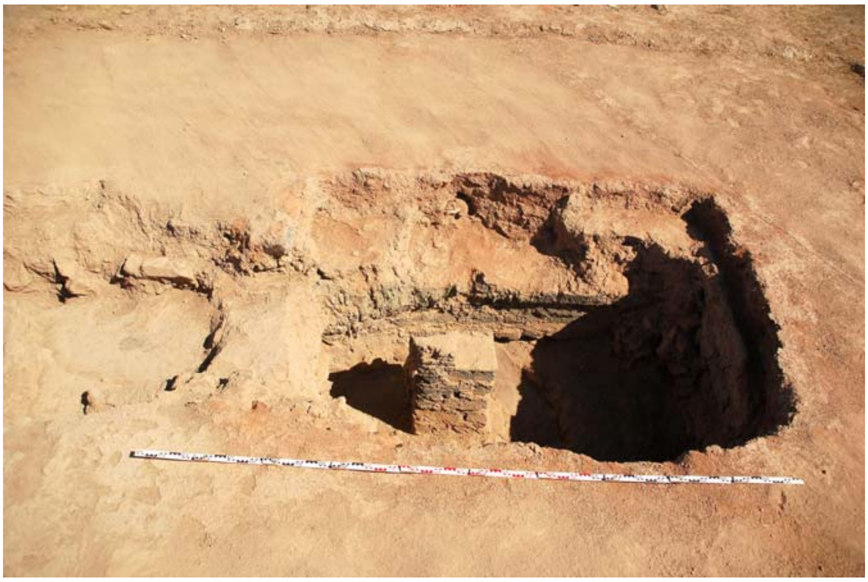

Fig. 9: The previously excavated kiln after having been cleaned

The first layer (U.E. 2[11]) was 10 to 20 cm deep and composed of loess with various fragments of fallen mud-bricks. This layer contained 94 sherds of which 57 were slipped and 37 common ware. It was interpreted as a level of infilling after the kiln was abandoned.

U.E. 3 was situated directly under U. E. 2 and was very similar in composition (loess with fallen mud-bricks) and formation but distinguishable in colour and texture. It was 20 to 30 centimetres deep and contained 31 sherds of which 18 were slipped and 13 common ware. It was also interpreted as a layer of abandon.

Under U.E. 3, we found a soil, possibly of natural origin and created by aeolian action (U.E. 4), which was not excavated.

Finally, two walls, corresponding to the door of the kiln were also discovered and numbered U.E. 5 and U.E. 6.

11.- The recordings were done in Spanish, hence the abbreviation U.E. for Statigraphical Unit. U.E. 1 corresponds to the interface with the excavation of K. Kawasaki and Sh. Pidaev. The term U.E. has been retained in order to minimize discrepancies between the fieldnotes and the published results.

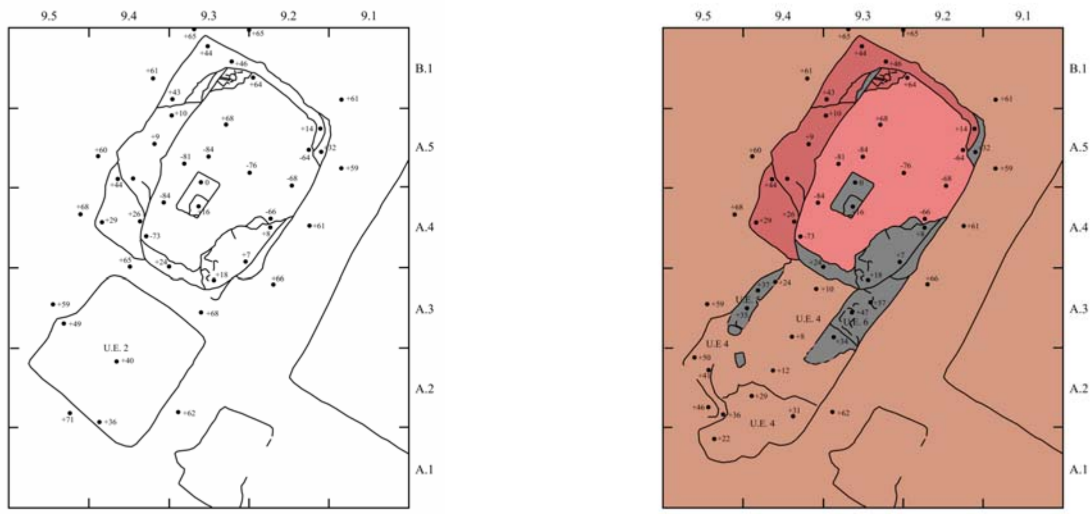

Fig. 10: Plan of the previously excavated kiln (on the left initial state, on the right after excavation of the mouth)

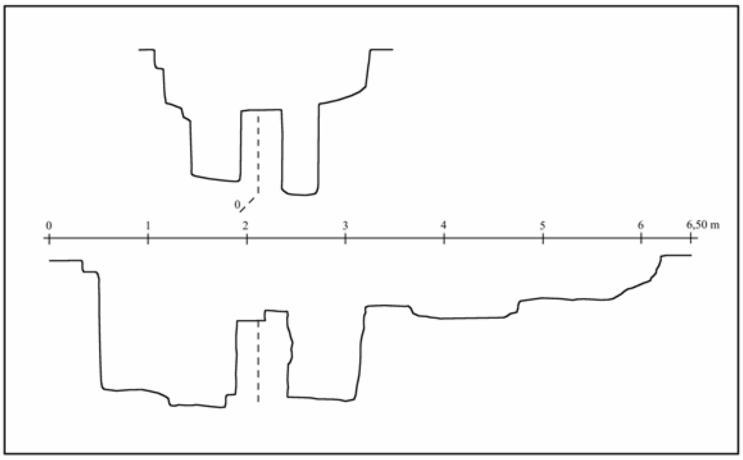

Fig. 11: Section across the previously excavated kiln

TRENCH 2

The excavation

Trench 2 was defined in order to coincide with the area where the geophysical survey indicated the highest probability of there being a kiln and was situated within squares 12.3-13.3 / C.1-D-5. The geomagnetic survey, as we have seen, detected a structure, which was interpreted as a kiln due to its shape. This interpretation was reinforced by the surface finds since the structure was localised in the area with the highest density of sherds and partially or totally vitrified bricks, which also corresponded to the centre of our area of investigation.

The surface layer (U.E. 1) was formed of aeolian loess with a few river pebbles of less than 5 cm in diameter. The layer contained 698 sherds of slip ware (5 kg) and 1581 sherds of common ware (12,7 kg). In addition, we found a clay cylinder and a clay lump probably related to ceramic producing activities.

Fig. 12: General view of the excavation

Below level U.E. 1 there were a number of burrows, probably of rodents (U.E. 2-6), which pierced a layer (U.E. 7) which seemed to have been affected by aeolian activity, since its surface was covered by a thin layer of small pebbles and sherds left over after the erosion of the finer particles. U.E. 7 was interpreted as a natural soil. We did not excavate this layer and can therefore not date it, however, it is clear that the layer preexisted the construction of the kiln since in the area adjoining the kiln, U.E. 7 is rubified, presumably due to the heat of the kiln.

Fig. 13: The rubefied area around the kiln

In the central area of the excavation there were a considerable number of vitrified fallen mud bricks, mixed with loess and defining a red area (U.E. 8). Here we found 100 sherds of slipped ware (1,2 kg), 176 sherds of common ware (3 kg) and 1 sherd of cookjng ware (<0,1 kg). There were also a number of artefacts related to ceramic producing activities: 5 fragments of clay lumps and one ring, which served as a firing support. We interpreted this layer as a level of destruction of the kiln, most probably caused by natural deterioration soon after its abandonment.

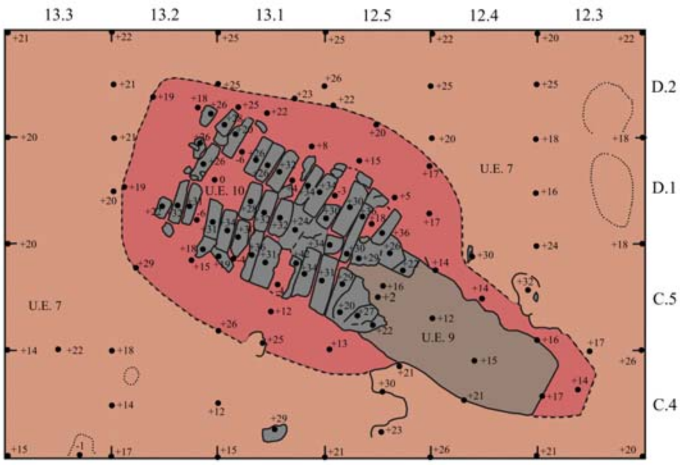

Fig. 14: Plan of U.E. 9 and 10.

Fig. 15: The grate of the kiln

The grade of the kiln's firing chamber (U.E. 10) was situated below U.E. 8. This grade was formed by vitrified mud-bricks of a green-grey colour. The bricks were in their original position and the grade was well preserved although the central part had disappeared. The grade was held up by little mud brick arcs, which had become vitrified and formed a molten block. The grade and the rubified area surrounding it clearly delimited the form of the kiln. The mouth of the kiln was well defined and infilled with a grey-brown layer (U.E. 9).

Fig. 16: Oenochoe from U.E. 11

The top part of the pottery firing chamber, just under the grate, was defined as U.E. 11. Once again, it was mainly composed of loess and also contained fragments of mud-brick in different stages of vitrification. It included 161 sherds of slipped ware (3,2 kg), 260 of common ware (6,8 kg), 4 fragments of cooking ware (<0,1 kg) and 28 fragments of clay lumps presumably used as firing supports (1,1 kg). Amongst the pottery, there were 3 very large sherds of common ware and one almost complete slipped oinochoe. Their size means that they were necessarily deposed within U.E. 11 through the holes of the grade of the kiln's firing chamber.

It should also be noted that small pebbles were scattered on the surface of U.E. 11, almost in contact with the vault of the kiln, indicating aeolian erosion within the firing chamber. U.E. 11 thus appears to have been formed by a combination of the action of local inhabitants deposing objects within the firing chamber and aeolian action.

U.E. 9, as has been said, formed the infill of the mouth of the kiln and continued into the firing chamber, under U.E. 11. It was formed of loess mixed with mud bricks in different stage of vitrification and contained large quantities of sherds (slipped ware: 598 frags. -8,9 kg-; common ware: 878 frags. -26,5 kg; cooking ware: 58 frags. -1 kg), aeolian, ash and bones as well as various artefacts related to the production of pottery. Amongst these, special mention should be made of a potter's tool made of ceramic, shaped to fit comfortably in the hand and presumably used to burnish the pottery before firing. Another interesting discovery was that of a limestone column base in a fallen position, which had been thrown into the oven along with the rest of the objects.

Fig. 17: Limestone base from UE 9

U.E. 9 can be interpreted as a layer formed by domestic rubbish. This seems confirmed by the shape of the layer, with a strong dip within the oven due to the way in which objects were thrown inside. Finally, both the bones and some of the sherds were partially blackened by fire, probably because they were thrown into the hearth after having been used.

At the back of the kiln's firing chamber, below U.E. 11 and U.E. 9, layer U.E. 12 was formed by loess and fallen mud bricks presenting different firing stages, from low fired (and crumbling when touched) to completely vitrified. The ceramic material included slipped ware (206 frags., 4 kg), common ware (267 frags., 8,6 kg) and cooking ware (14 frags., <0,1 kg). There were also, as in the other layers, rings and clay lumps associated with the ceramic production process. We interpret this layer as having been formed immediately after the abandonment of the kiln by the collapse of part of the structure, the deposition of Aeolian loess and that of sherds and other material deposited as rubbish.

U.E. 14 is similar to U.E. 12 but situated in the mouth of the kiln. It is fairly thin (10 to 15 cm) and was presumably formed just after the abandon of the kiln. It contained slipped ware, (35 frags. [0,9 kg.]), common ware (30 frags. [1 kg.]) and a few fragments of clay lumps and rings.

Below U.E. 12 and 14, there was a level of very compact, completely white, ash of some 10 cm. This level was present both in the mouth of the kiln (U.E. 17) and in the interior of the firing chamber (U.E. 16). Both layers were separated by a 30 to 40 cm high step made with two limestone block, situated in the middle of the firing chamber, which was presumably built to elevate the ground level of the inner part of the chamber.

These blocks were placed on the bedrock (U.E. 18), which was also visible at the entrance of the mouth of the kiln and below the mud brick walls of the kiln (U.E. 13). Finally U.E. 15 corresponds to the trench excavated in U.E. 7 in order to build the kiln and reaches the bedrock (U.E. 18) in a number of points.

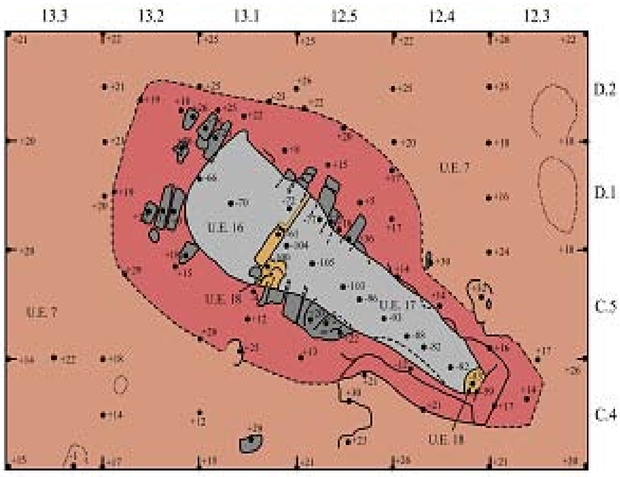

Fig. 18: Plan of the kiln after completion of the excavation

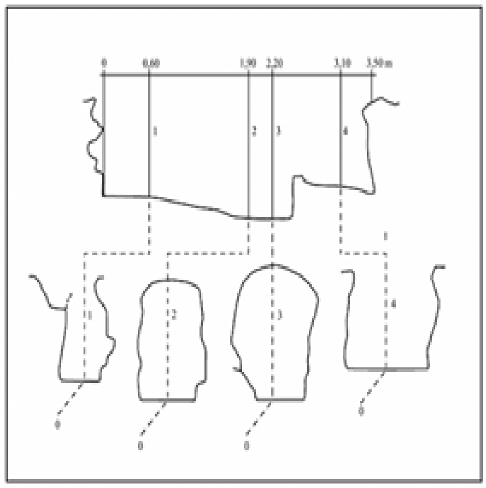

Fig. 19: Sections across the kiln

The structure of the kiln

The kiln is some 3,50 meters long and shaped like a bottle. The width of its mouth varies from 0,50 to 0,60 m and the firing chamber is about 1 m wide by 2 m deep. The walls are built in mud-brick and sustain little arcs on which the grate is placed. The kiln has a number of interesting features such as the presence of an inner step within the chamber to which we have already alluded, as well as the presence of two holes in the wall at the end of the firing chamber near the angles. These holes are situated in the upper part of the wall and continue towards the interior of U.E. 7. We do not know were they finish since we have not yet excavated U.E. 7 and their function is difficult to determine, although they may have been linked to the circulation of air.

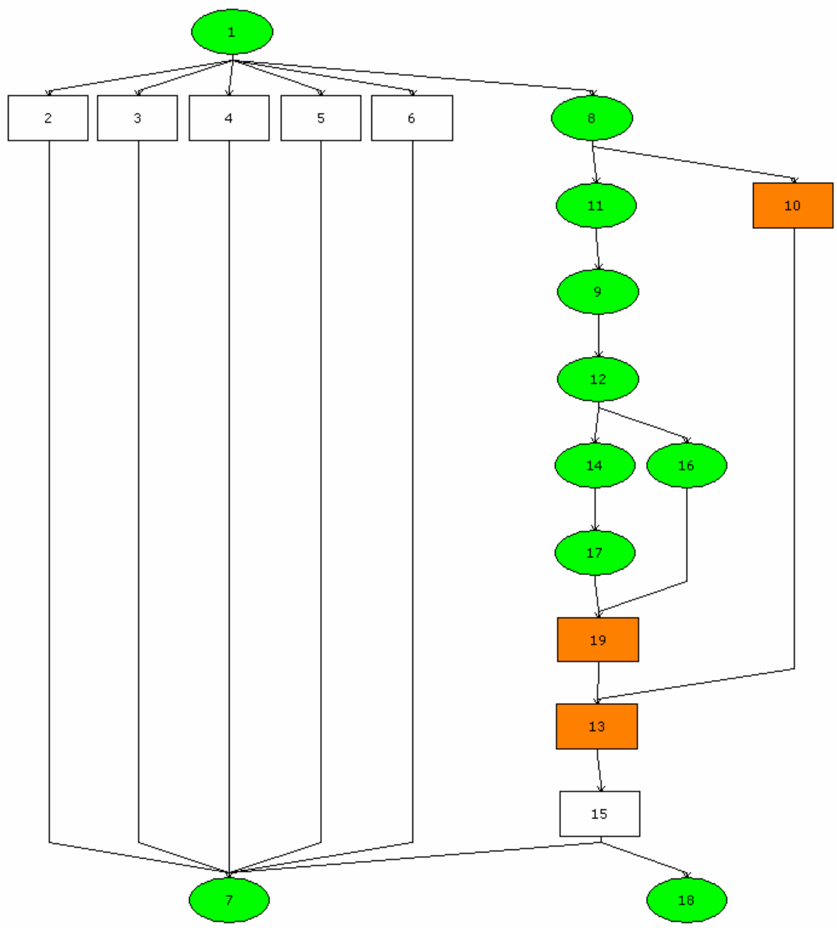

Fig. 20: Matrix of the excavation

Fig. 21: The kiln after excavation

Datation, comparisons and ceramics

Three samples (from UE 9, 12 and 14) have been taken for radiocarbon dating. The ceramics have not yet been studied but a preliminary selection of drawings is included at the end of this chapter (pags. 30-43)

A number of ceramic kilns from the Kushan period[12] have been excavated in the Surkhan Darya province, notably on the sites of Ajrtam (Turgunov 1973), Dal'verzin Tepe (Pugachenkova 1978), Khatyn Rabat and Kampyr Tepe.

Earlier ceramic kilns (from the Greco-Bactrian period and early Kushan period) are known from the sites of Saksanokhur in Southern Tajikistan (Mukhitdinov 1968 ; Litvinskij, Mukhitdinov 1969, p. 161), Aï Khanum in Northern Afghanistan (Bernard 1968, p. 273), Dal'verzin Tepe (Voskovskij 2001) and Kampyr Tepe (Bolelov 2001) in the Surkhan Darya Province.

The best studied Kushan period kilns are those from Dal'verzin Tepe, which are reproduced below for the purpose of comparison.

12.- Apart from the references given for each site, see also Pugachenkova 1973 (major article), Pugachenkova 1973a, p. 84 (mainly about the vaults), Masson 1985 (p.263) and Litvinskij 1999 (pp.90-91)

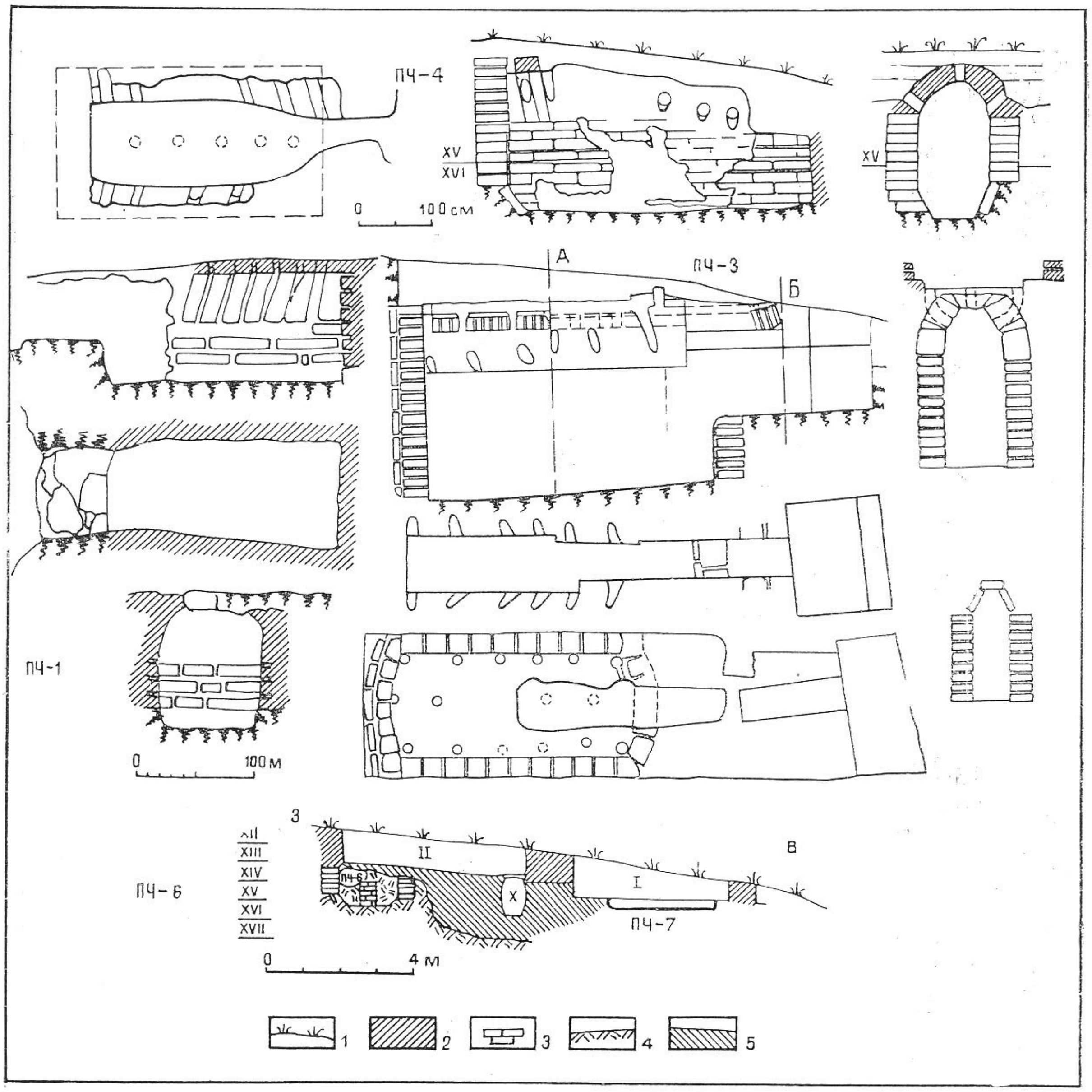

Fig. 22: Kilns 1, 3, 4, 6 and 7 at Dal'verzin Tepe [Pugachenkova 1978, p. 117, ill. 82]

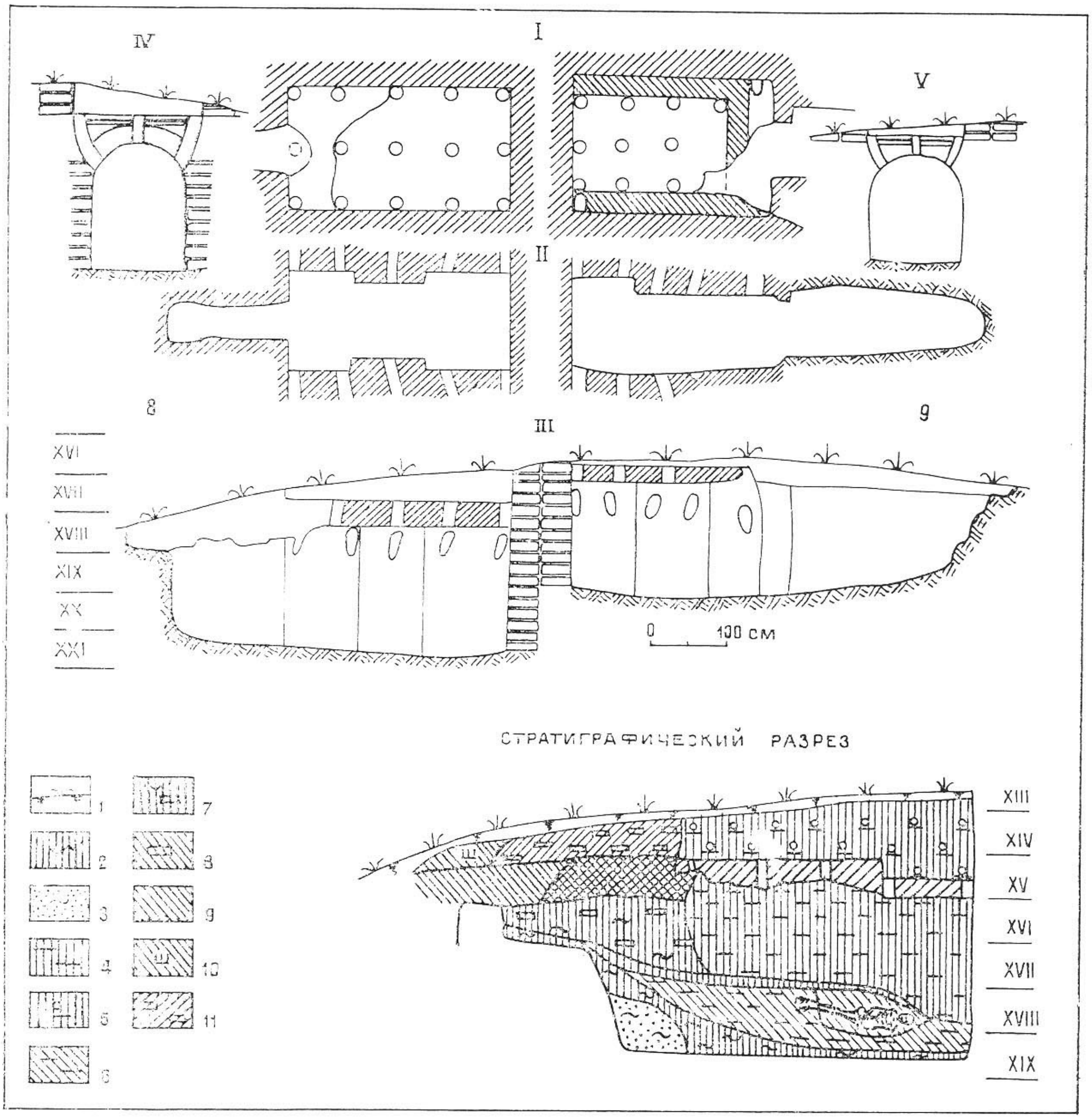

Fig. 23: Kilns 8 and 9 at Dal'verzin Tepe [Pugachenkova 1978, p. 118, ill. 83]

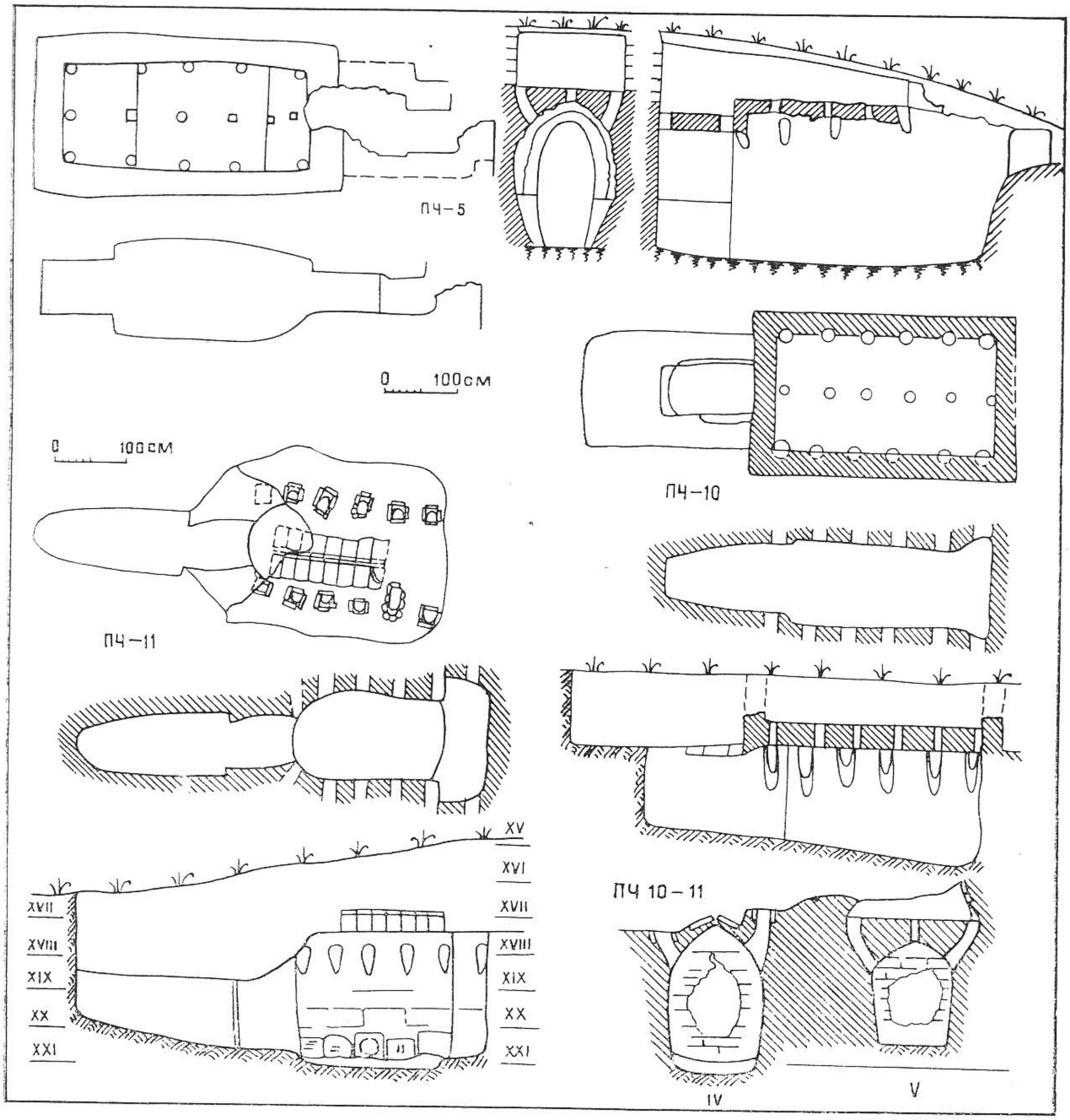

Fig. 24: Kilns 5, 10 and 11 at Dal'verzin Tepe [Pugachenkova 1978, p. 119, ill. 84]

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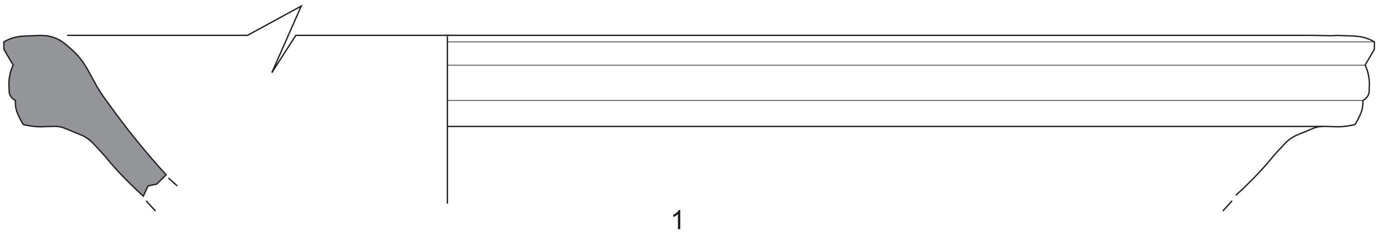

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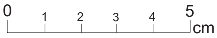

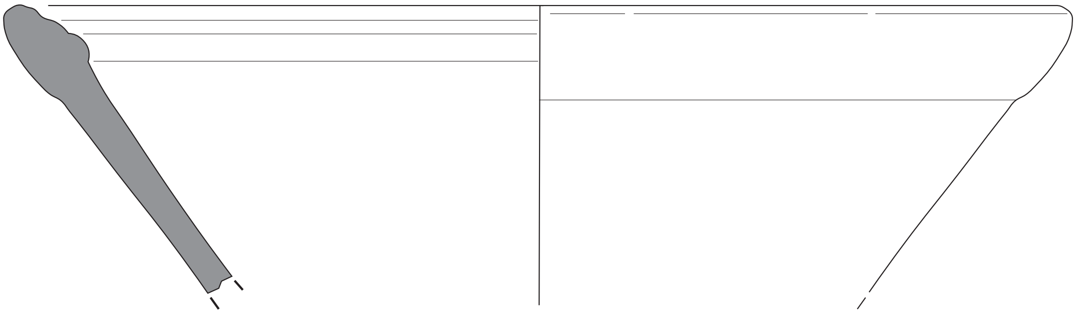

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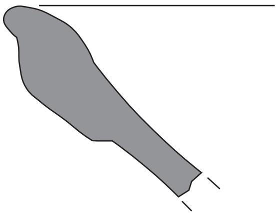

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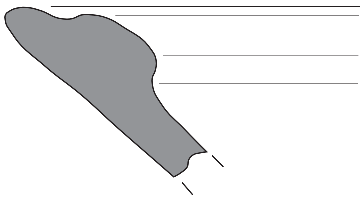

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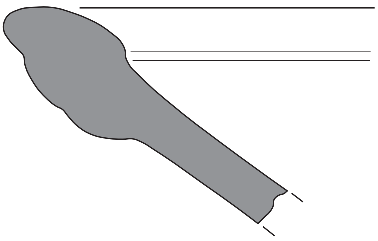

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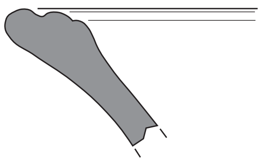

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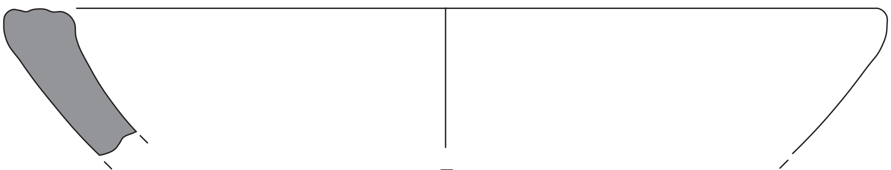

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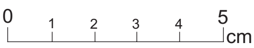

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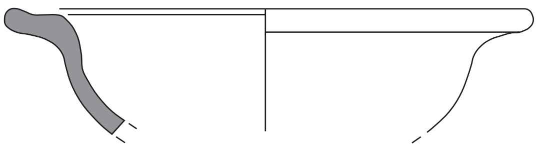

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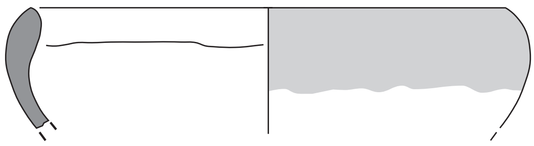

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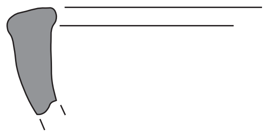

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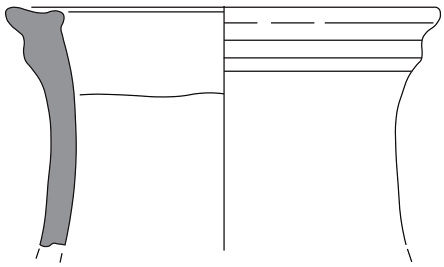

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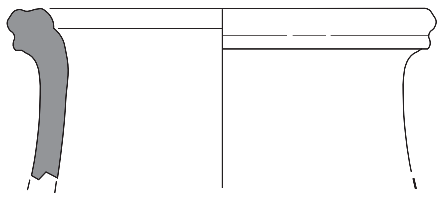

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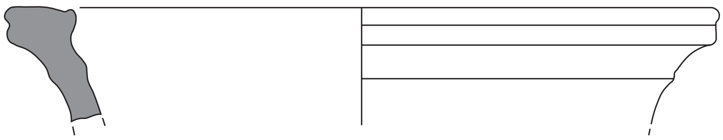

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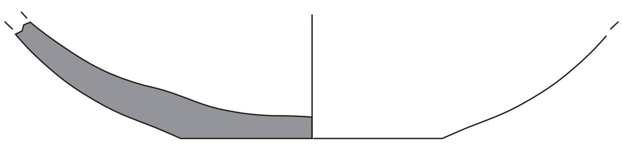

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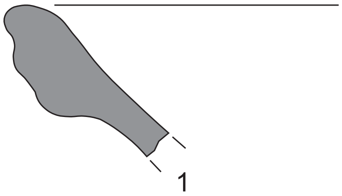

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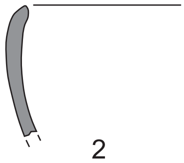

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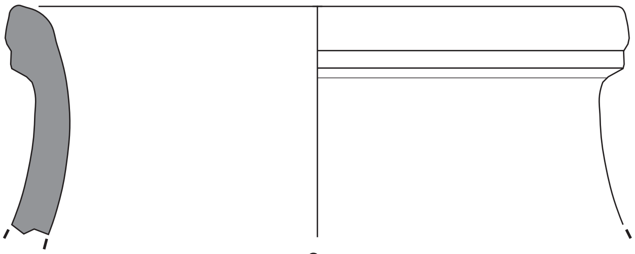

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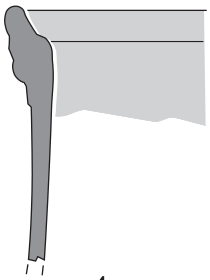

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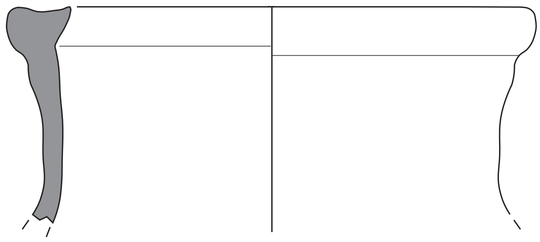

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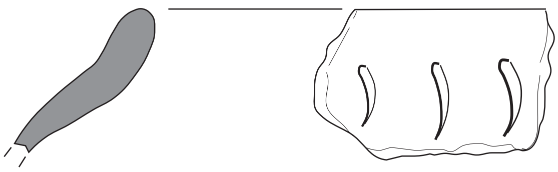

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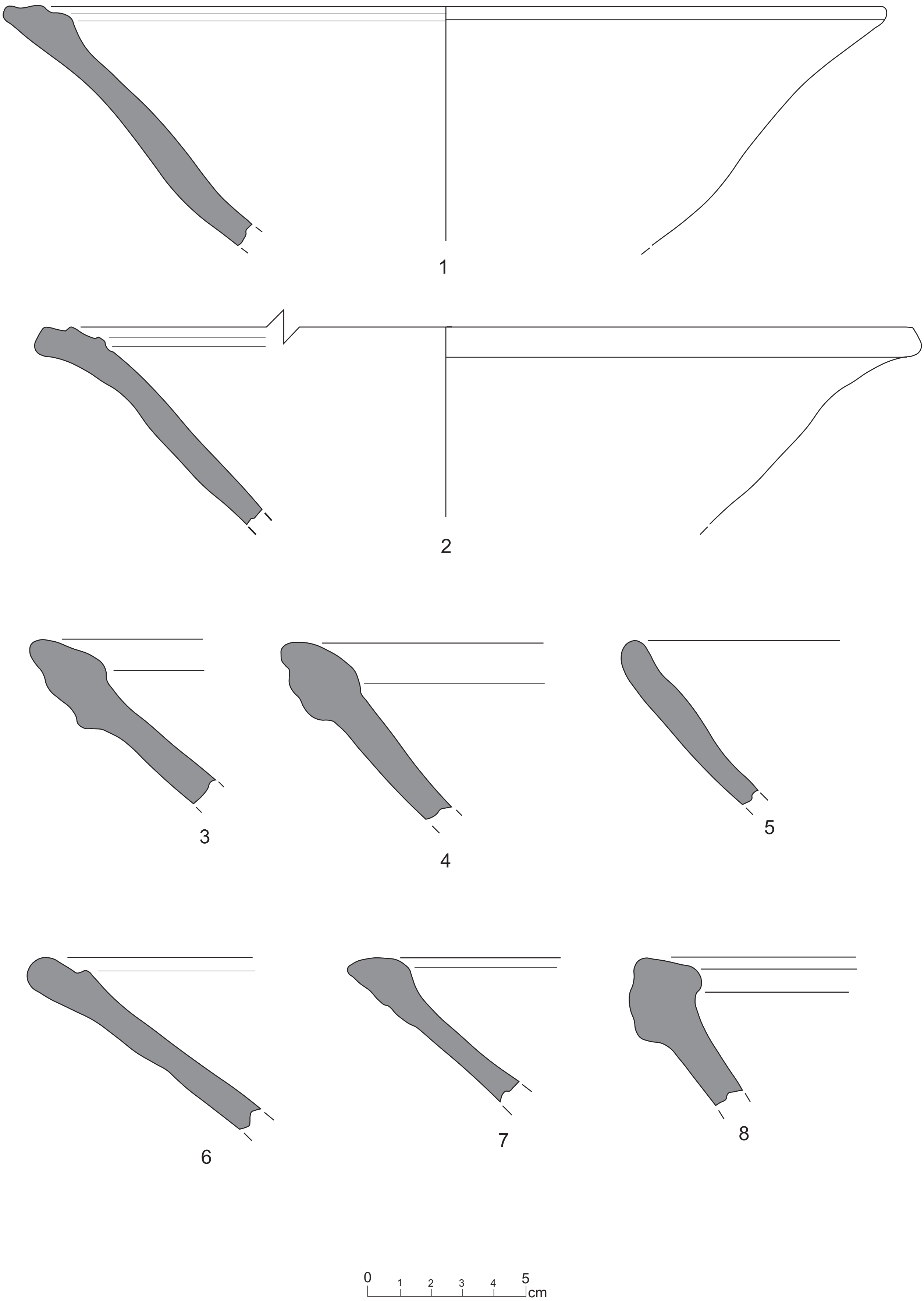

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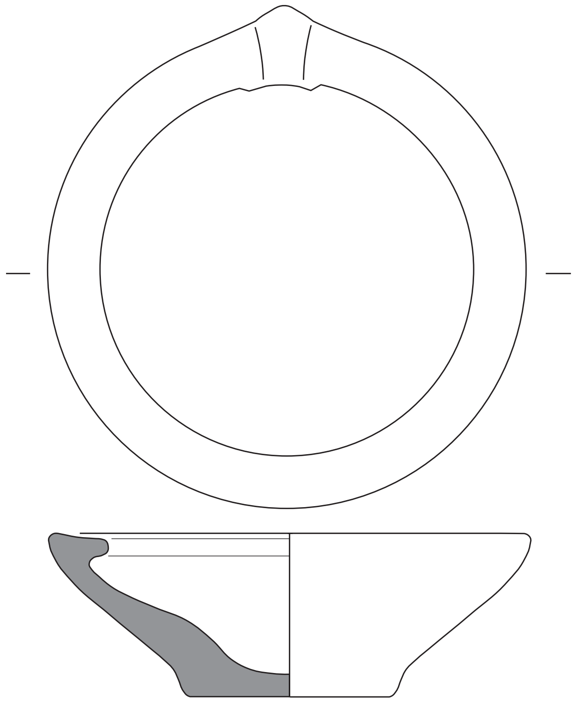

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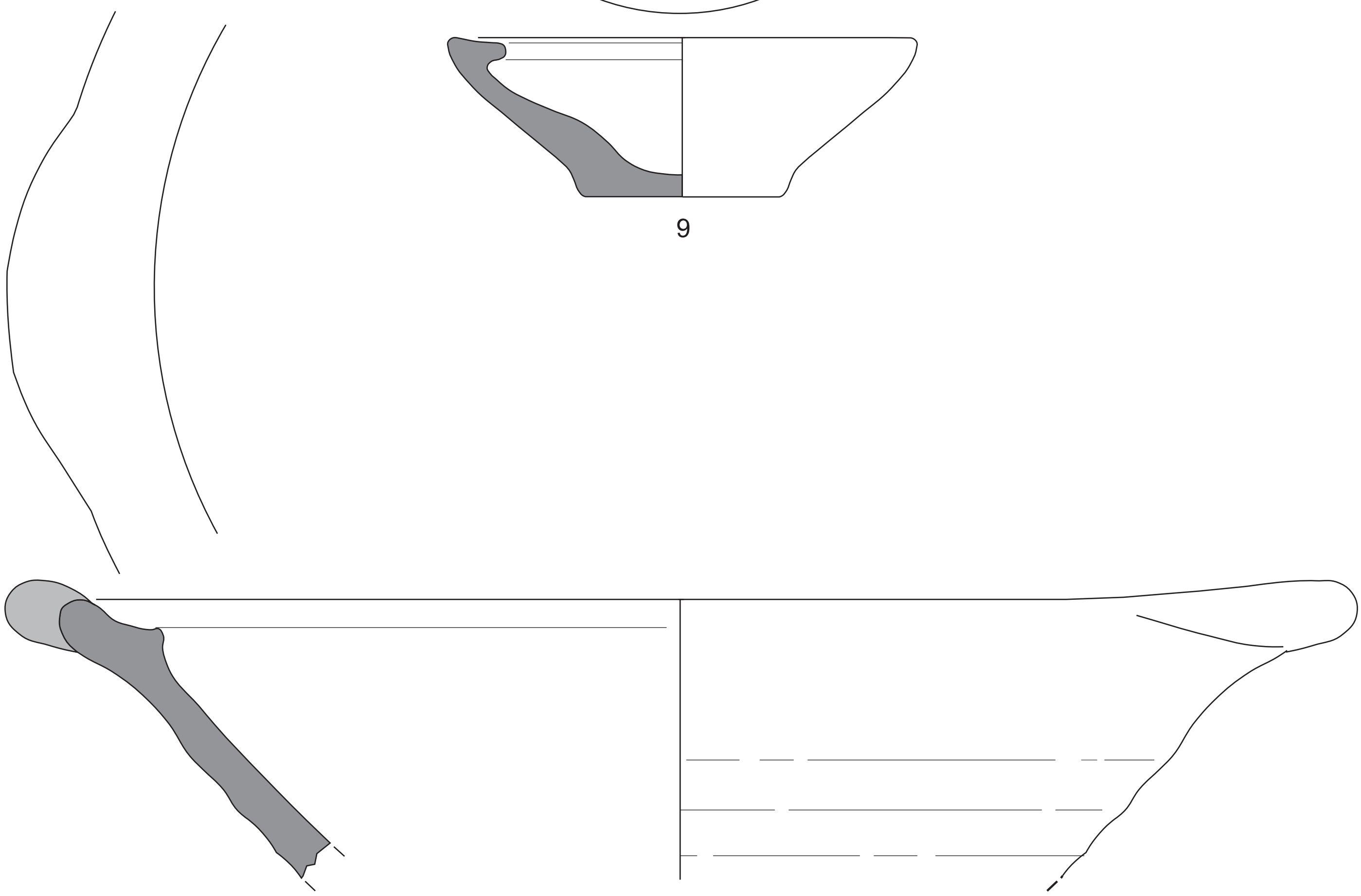

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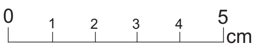

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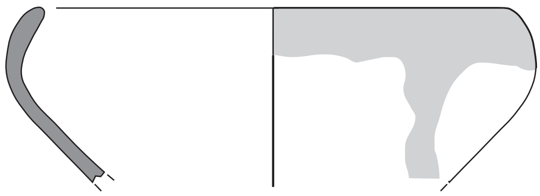

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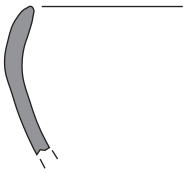

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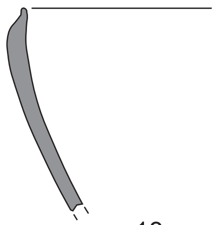

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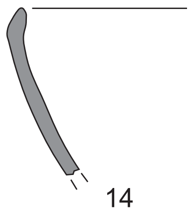

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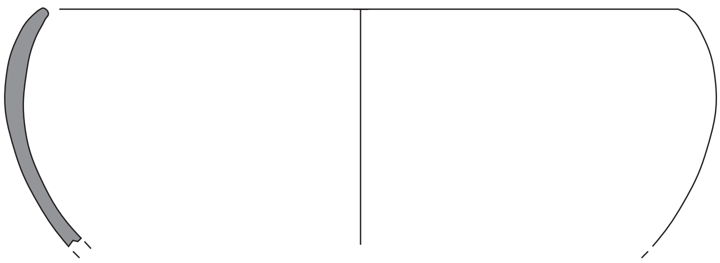

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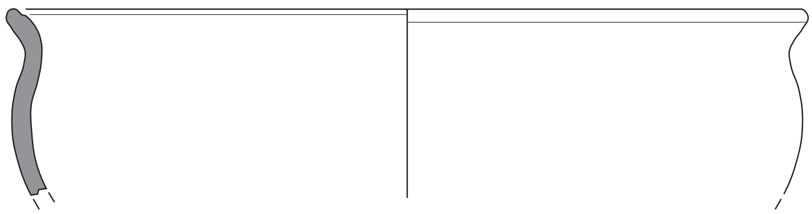

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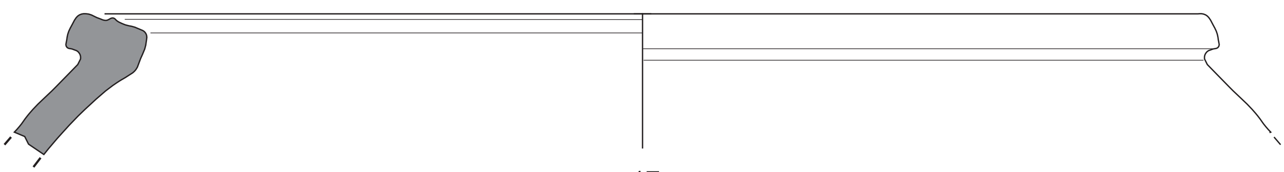

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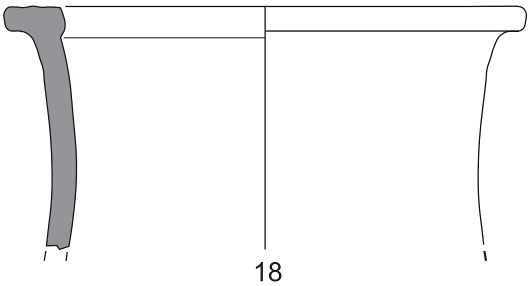

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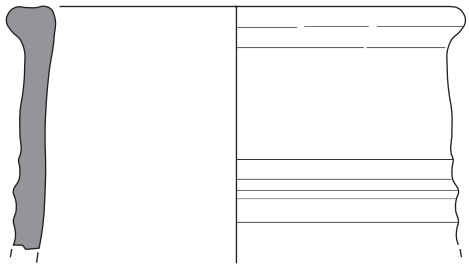

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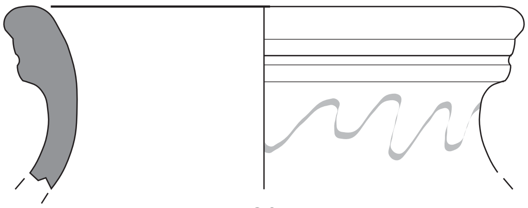

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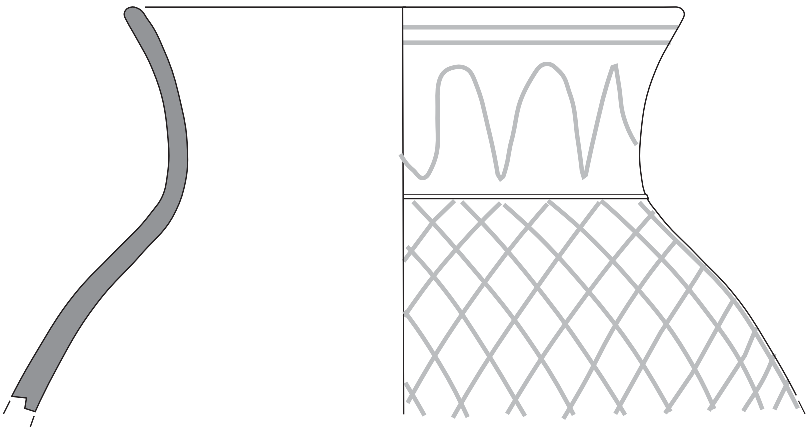

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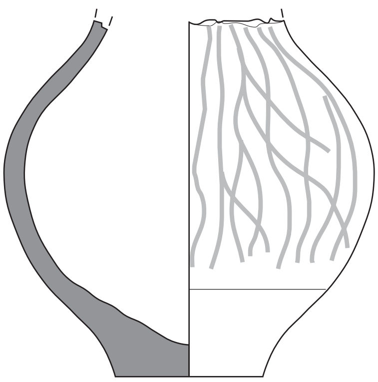

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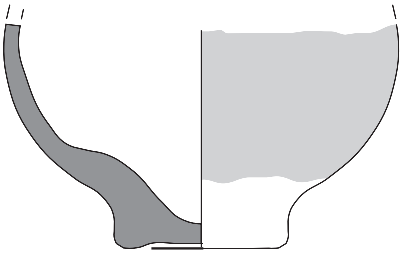
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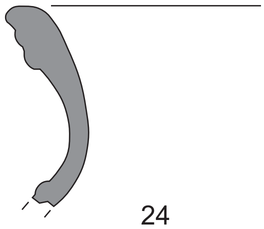
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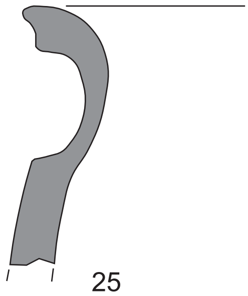
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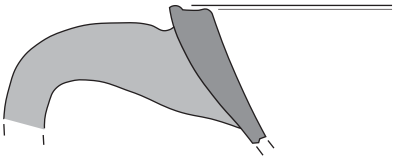
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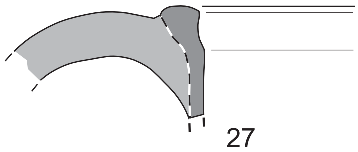
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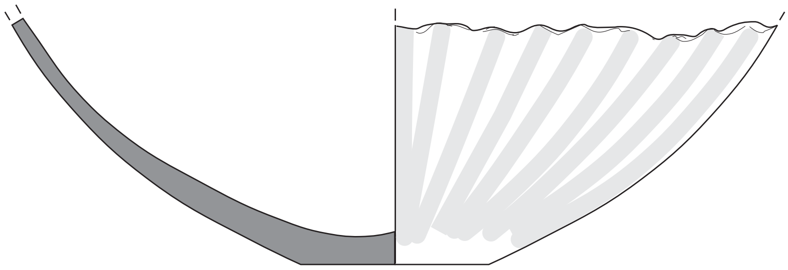
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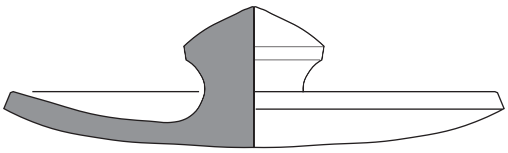
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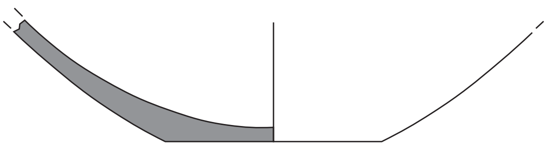
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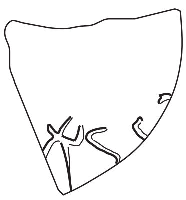
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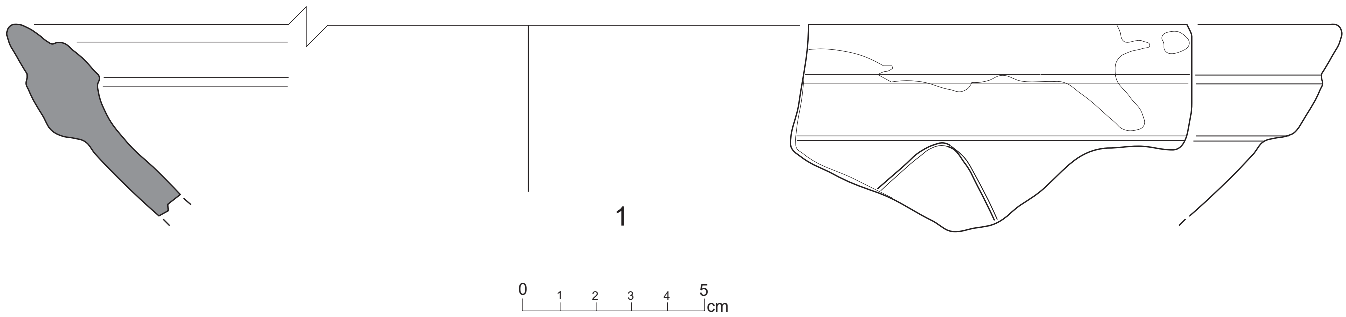
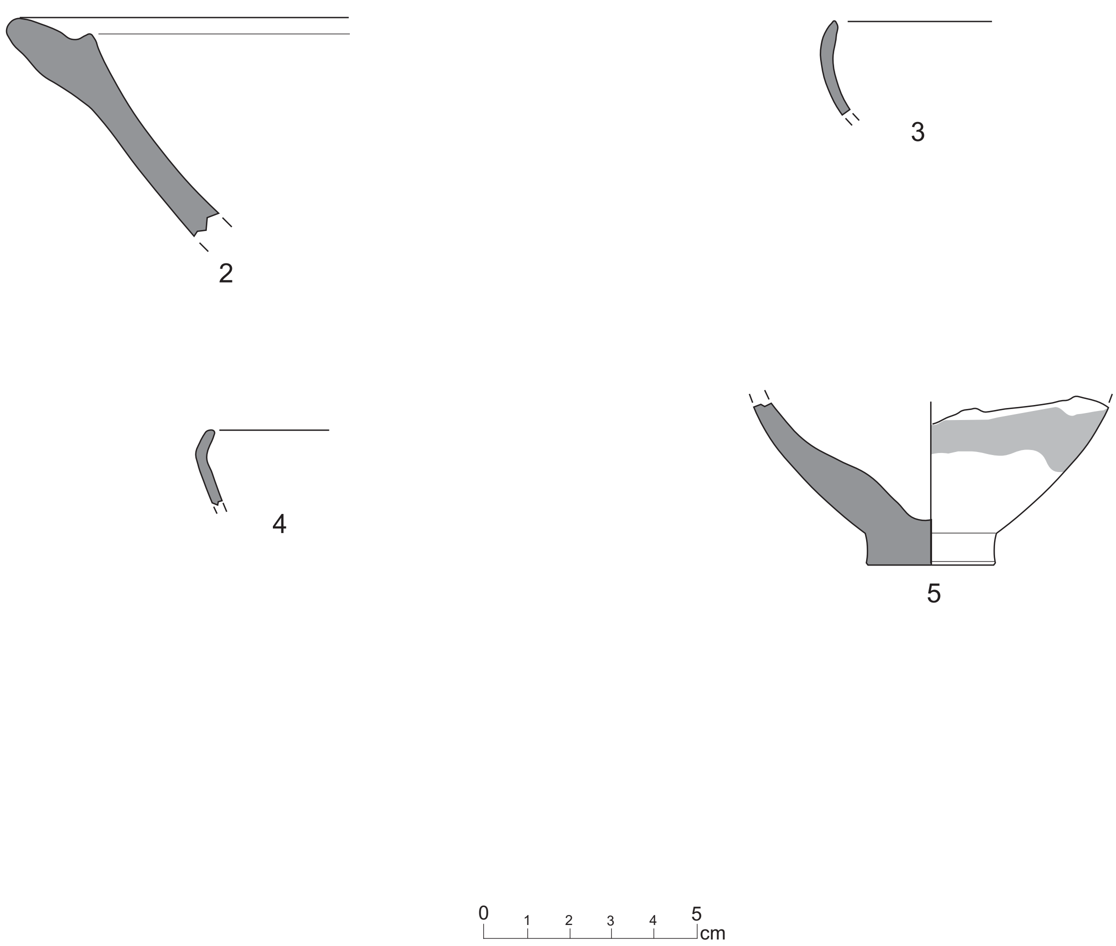
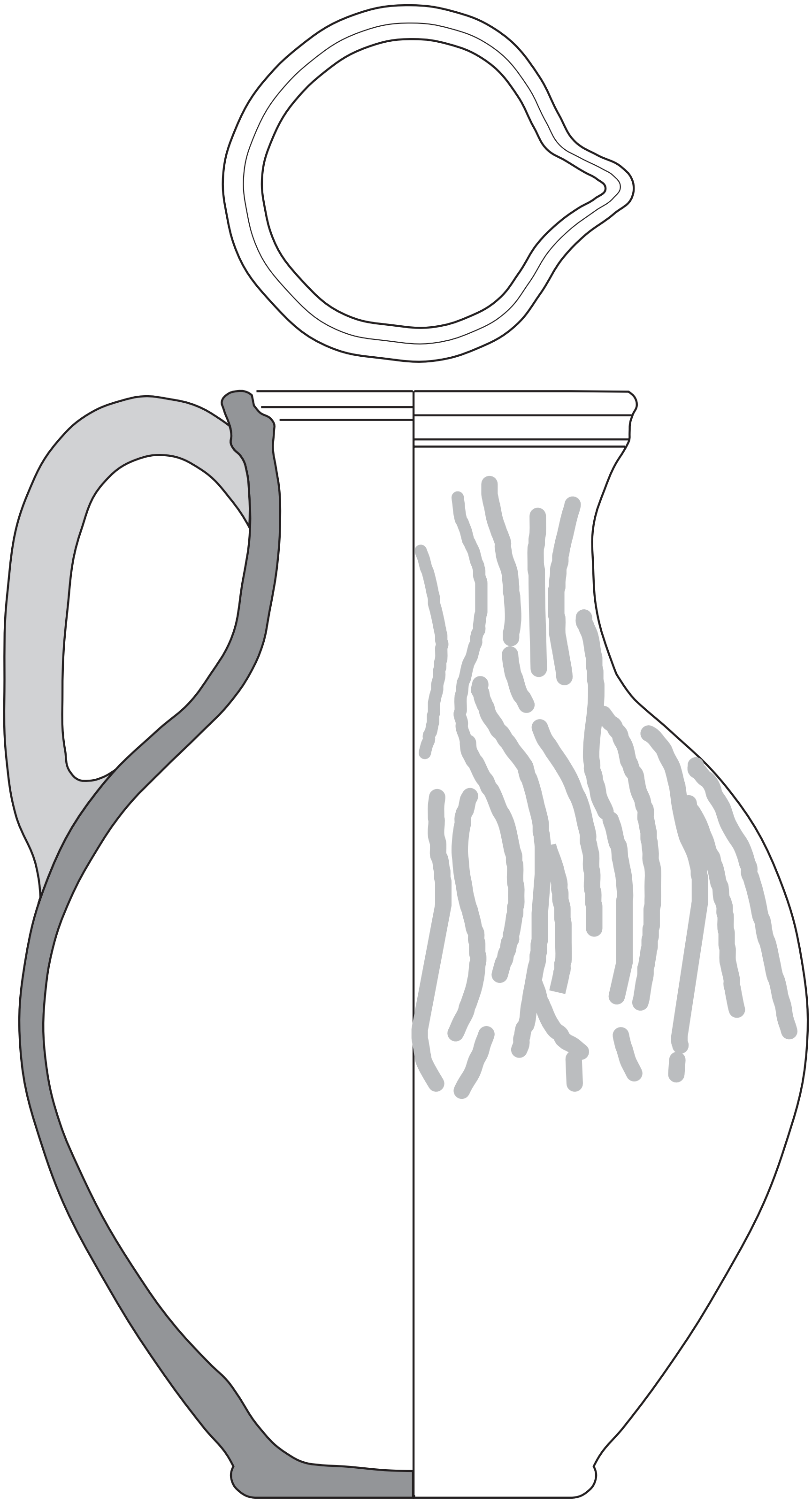
UE 11





UE 11



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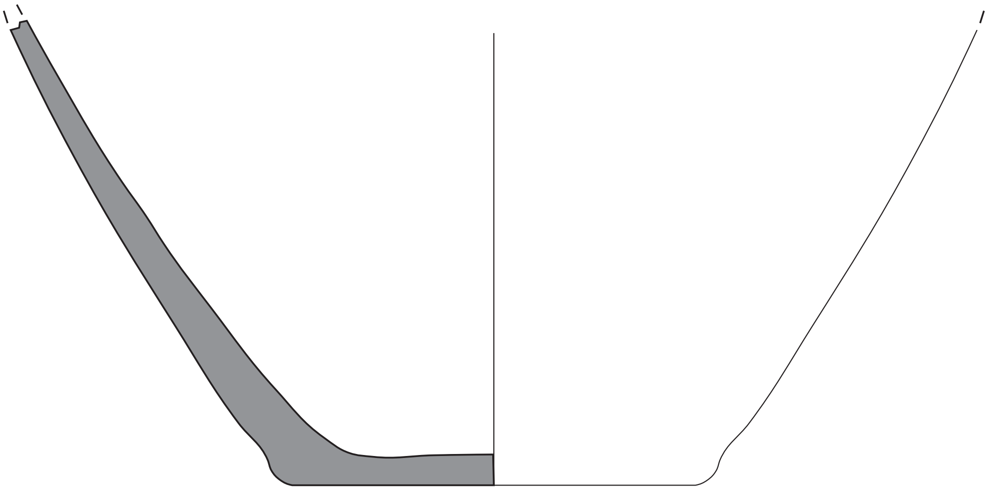
UE 11



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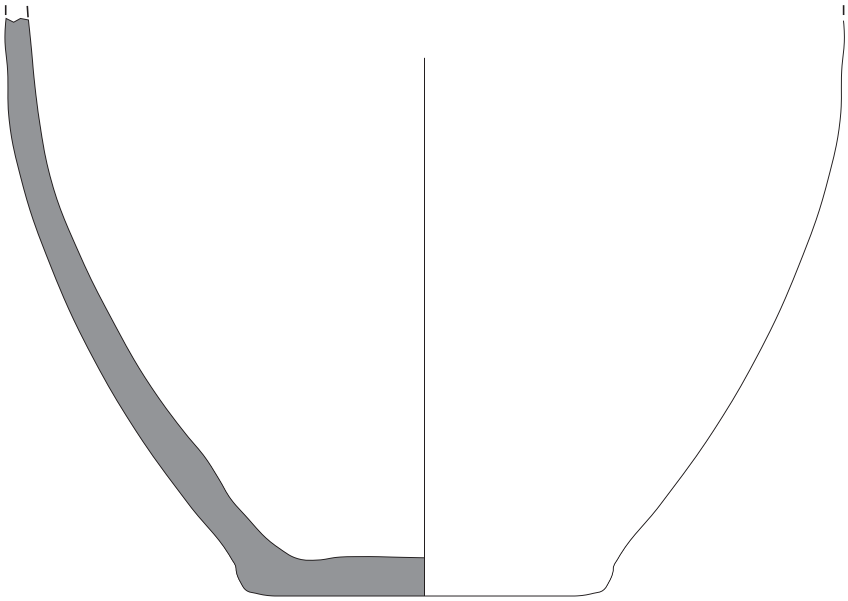

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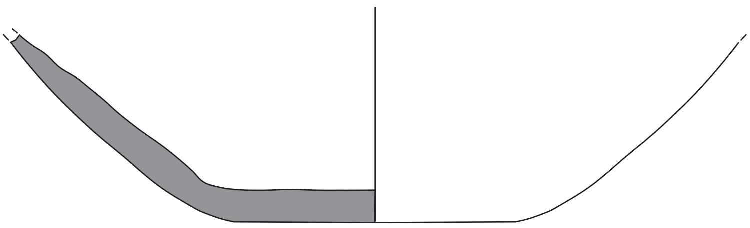

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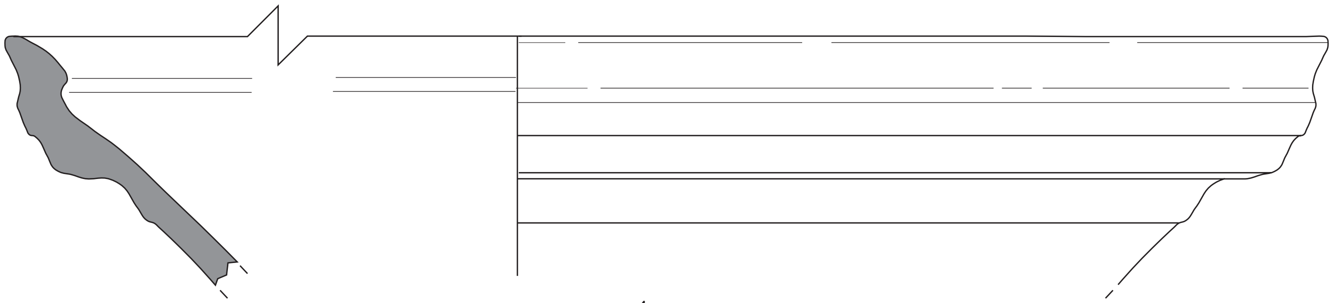
UE 12



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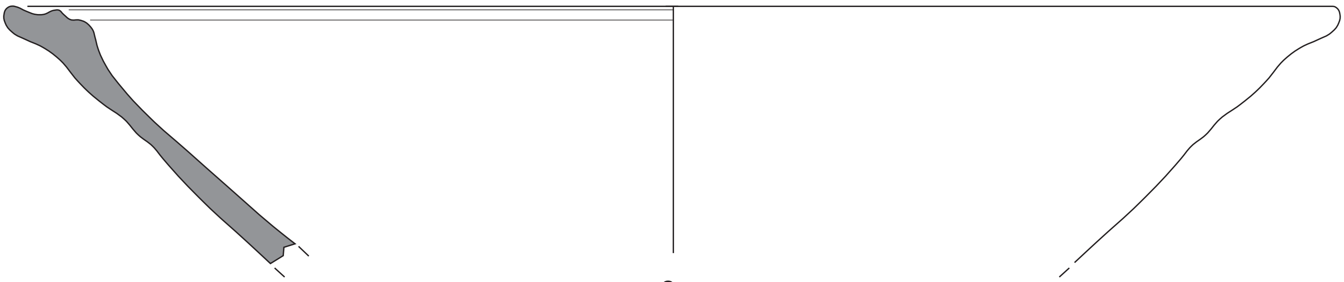

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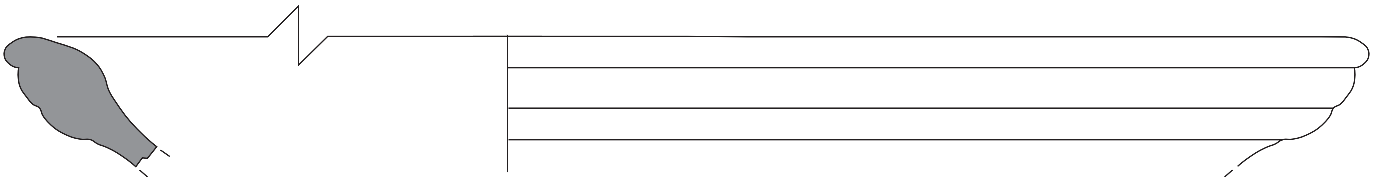

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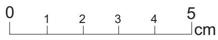

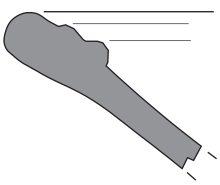

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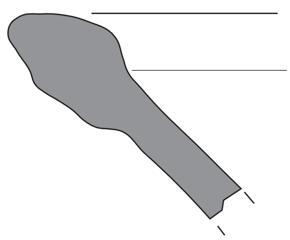

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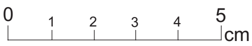

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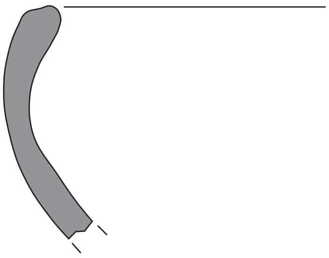
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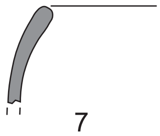
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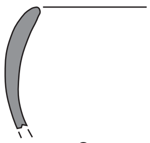
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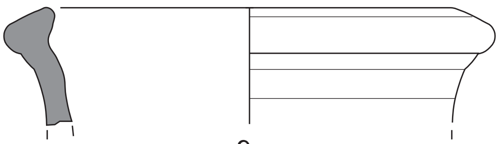
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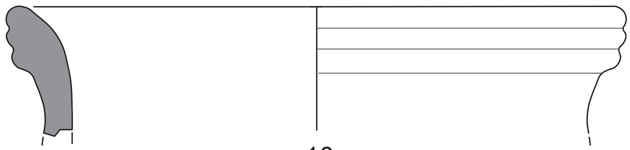
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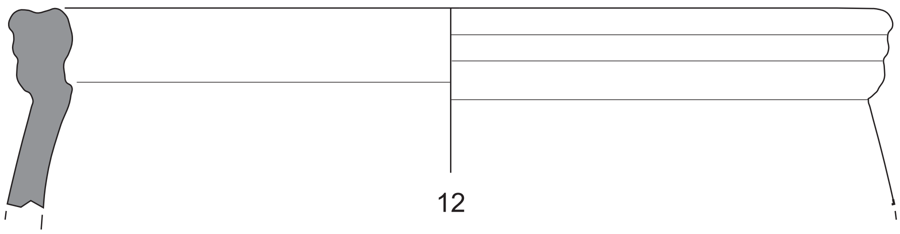
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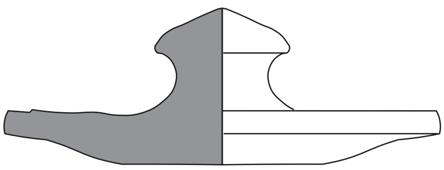
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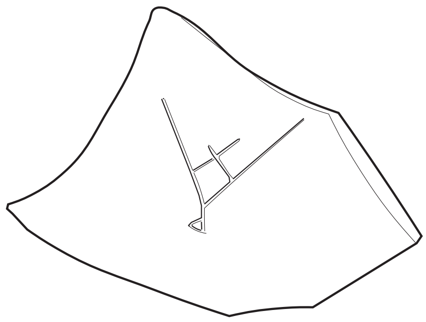
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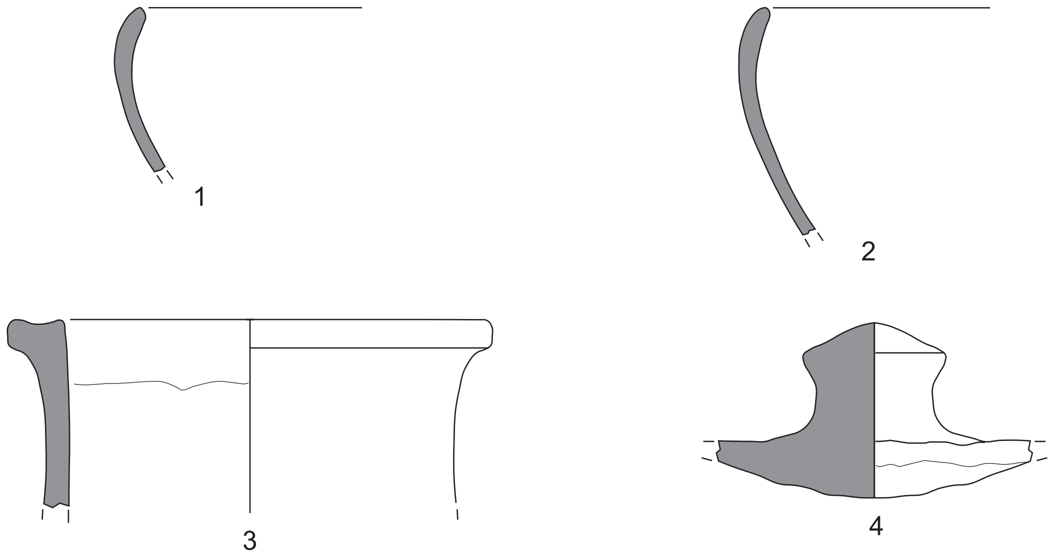
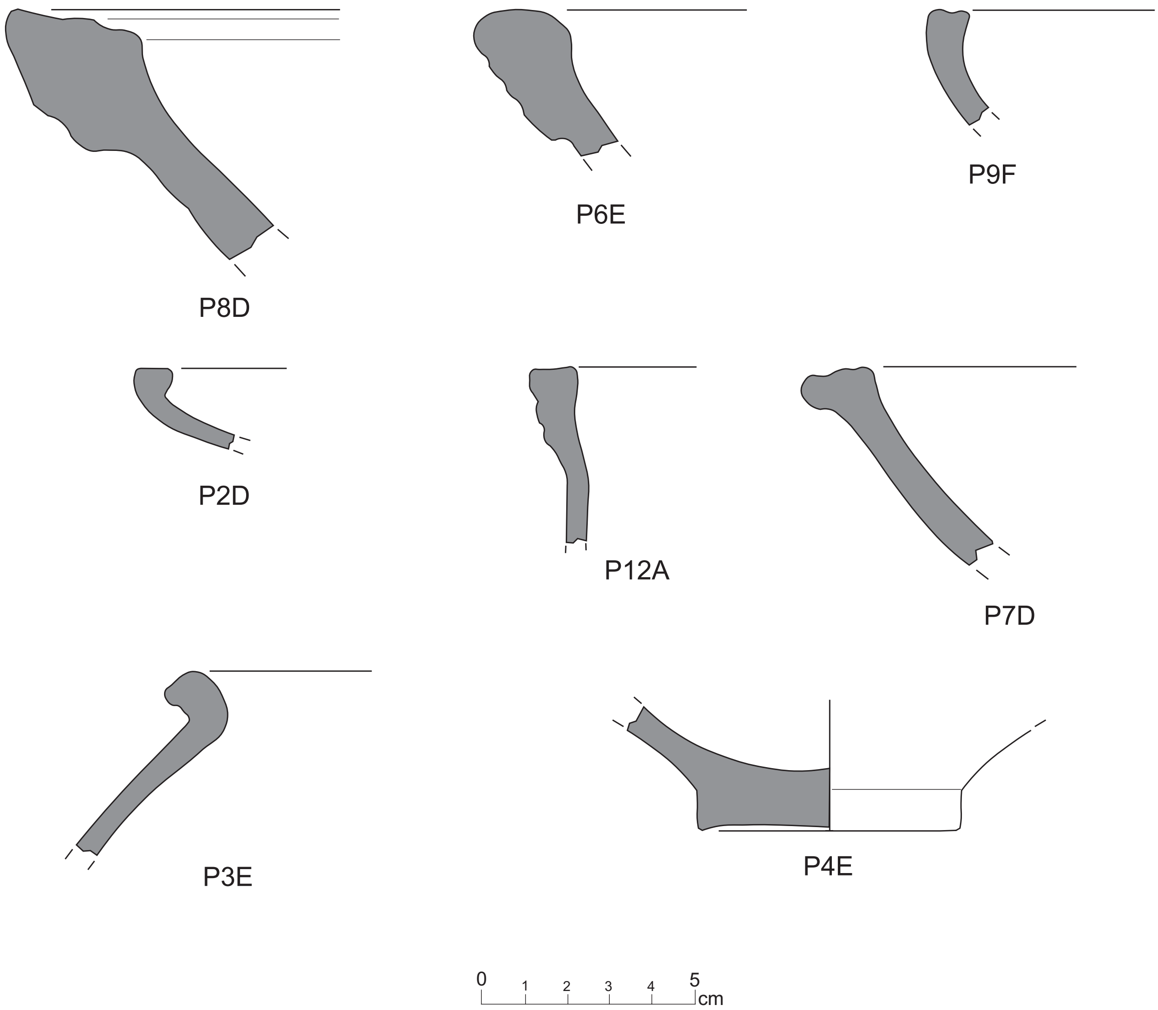
UE 14



PROSPECTION



Preliminary results of the Geophysical survey of Tchingiz Tepe

R. Sala, M. Lafuente

Fig. 1: Satellite view of Tchingiz Tepe

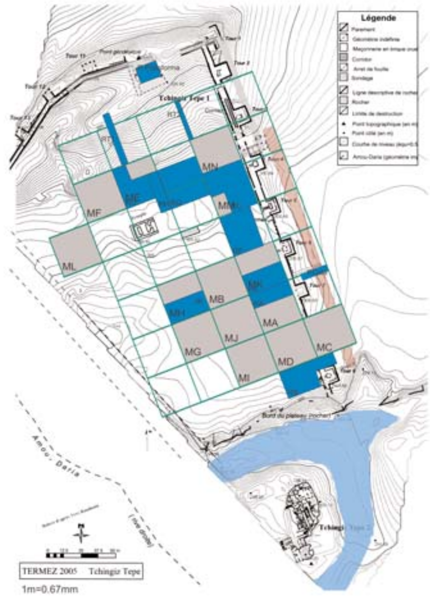


Fig. 2: Grid and surveyed area in Tchingiz Tepe

The geophysical survey of Tchingiz Tepe took place during the last two weeks of September 2006[1]. The area surveyed included Tchingiz Tepe intramuros and a small sector beyond the fortifications (Fig. 1).

The survey was based on a 30x30 m^2 grid, which was not oriented in exactly the same way as the excavation grid of the Franco-Uzbek archaeological Mission in order to facilitate the acquisition of results with different sensors in the vicinity of preserved structures.

Methodology

Within the grid, 14 squares of 30 x 30 m^2 were surveyed with a magnetic gradiometre FM256 from Geoscan Research (Graphic 1). In certain areas, a georadar (GPR) was also used and some of the squares of the grid were surveyed, either completely or partially, with both systems enabling a comparison of the results. The surfaces explored are indicated on the fig. 2 where they are superposed over a topographical plan of Tchingiz Tepe.

Georadar

The georadar works by emitting and receiving electromagnetic impulses of known characteristics towards the subsoil. A central unit generates the impulses that are emitted via an antenna, that detects the reflections generated by the changes of composition of the subsoil. The graphical expression of the results of this is a radargram (KVAMME, 2000; CONYERS, 1997) (Fig. 3).

During the survey of Tchingiz Tepe, we used a technique known as Time-Slicing, which consists in covering an area with parallel radargrams and then generate maps of the subsoil at different depths from the data obtained. This way it is posible to obtain graphics that represent the possible remains of structures within the subsoil (SALA, 2005; SALA, 2006; GAFFNEY, 2003; GOODMAN, 2004; proceedings, 2005).

1.- The geophysical survey of the ceramic production area next to Kara Tepe is described in the previous article.

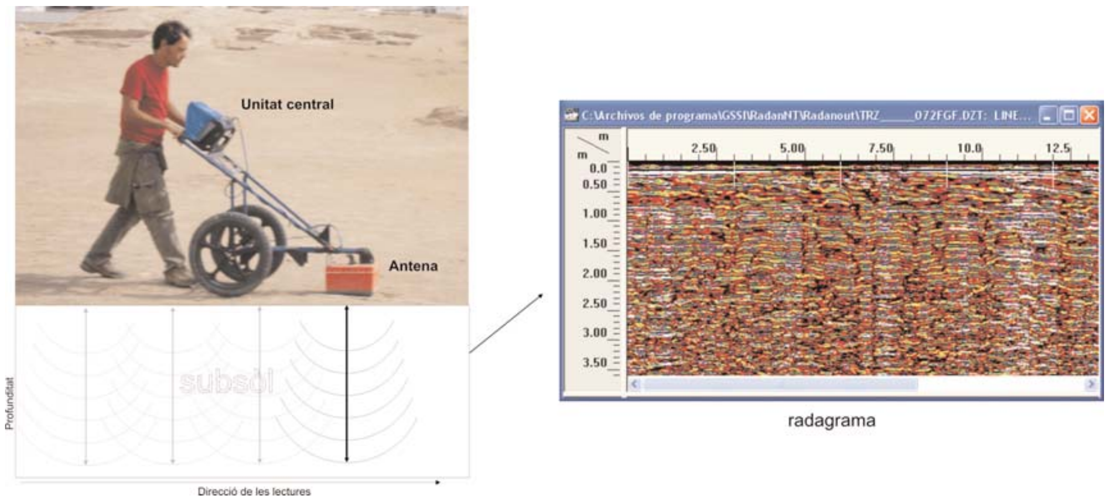


Fig. 3: Georadar GSSI SIR-3000 with a 400MHz antenna. Example of a radiogram of Tchingiz Tepe

Magnetic gradiometer

The magnetic gradiometer measures the small variations in the intensity and orientation of the earth's magnetic field in the surveyed area so as to obtain a map of magnetic variations (Gaffney 2003, Clark 1990). The interpretation of the magnetic anomalies recorded on this map enables the identification of areas which may correspond to archaeological remains (Proceedings 2005).

The depth of readings does not exceed 1 m 70 and therefore we assume that all detected anomalies are situated between 0 and - 1,70 m. Measures were taken every 50x25 cm.

Methodological challenges

The main conditioning agents in the case of Tchingiz Tepe are the geology of the subsoil, in particular it's aridity, and the type of structures. These are generally in mud brick or pahsa and their physico-chemical composition is very similar to that of the sediments that surround them. This makes working in Termez both a challenge and an opportunity for exploring the different types of sensors and software which can be applied to the geophysical survey of archaeological remains.

Because of their composition, walls built in mud brick or adobe tend to progressively disintegrate and deposit themselves in horizontal layers on either side of the original structure. The reparation and successive reuse of structures built in this way give rise to the so called tepes (tells in a Near Eastern context). Thus not only is the geophysical difference between mud bricks, adobe and soil initially very low but the surrounding sediments are themselves often of identical nature to the structures and differences in geophysical proprieties and humidity content can be almost nil.

It is therefore not surprising that the results of the georadar and the magnetic gradiometer survey indicate a low contrast between the structures and the surrounding sediment.

The values of the structures detected with the magnetic gradiometer are very close to the limit of perception of the system used (0,1 nt) throughout a large part of the intramuros area of Chingis Tepe. However, within this area a number of strong magnetic alterations, presumably associated with baked brick constructions, metallic objects and the remains of combustions were detected. The archaeological data available[2], according to which nearly all Kushan structures are in mud brick, means that most of these structures are probably post-Kushan, either Medieval or modern (associated with the contemporary military use of the area). The only possible exceptions are ovens and/or kilns.

The results obtained with the georadar are more promising thanks to the possibility of measuring them in relative and not absolute terms. Relatively few applications of this technique, developed in the 1990's, have been carried out on sites with mud-brick structures (PIPAN, 2005). This makes it necessary to assess the methodology and to take into account the characteristics of the area being explored and the remains that need to be identified when interpreting the results.

2.- Bilan de campagne 2004-2005

Preliminary Results

Magnetic gradiometer survey

The map of magnetic variations obtained after the survey and the maps of standard deviation generated from this map show the existence of three strong magnetic alterations (Z1, Z2 and Z3) in the southern part of the surveyed area, one major anomaly in the northern part and punctual anomalies of high intensity throughout the area that may correspond to ovens, structures associated to combustions of different type and large metallic objects (Graphics 1 and 6).

The presence of small metallic objects, both on the surface and in the first layers of soil and the large accumulations of metal in the vicinity (Graphic 3A) has complicated the detection of relevant remains in these areas. The main disturbances are indicated as a positive/negative dipole of high intensity (+/- 100 nT) and large dimensions (> 2 m of diametre) and are situated in squares MC, MH, MB and ML (Graphics 2A-2B, 4A-4B and 5).

Recent earthworks conducted on Tchingiz Tepe have meant that some areas could not be surveyed (A 10, Graphic 4A).

Z1, situated in front of towers 7 and 8 of the fortification wall (Grids MA and MK), is one of the areas with the highest magnetic alterations (Graphic 2A-2B). It includes punctual focuses that correspond to small metallic fragments and a number of short lineal anomalies (2x1 m of average), oriented E-W and N-S, with a standard deviation of 8 SD[3] and maximum values of -33/+75 nT[4]. These could correspond to the remains of structures in baked brick, an interpretation reinforced by the fact that structures of this type are visible on the surface of Grid D.

In grid C, outside the fortification wall, the zone Z2 (Graphic 2A-2B), does not include any clearly defined structures, but is marked by a high magnetic contrast with maximum values of +11 nT.

Finally zone Z3, between grids B and H and close to the large anomaly A8-A10-F3 has important magnetic contrasts (maximums of -15/+22 nT) but none of a clearly defined form.

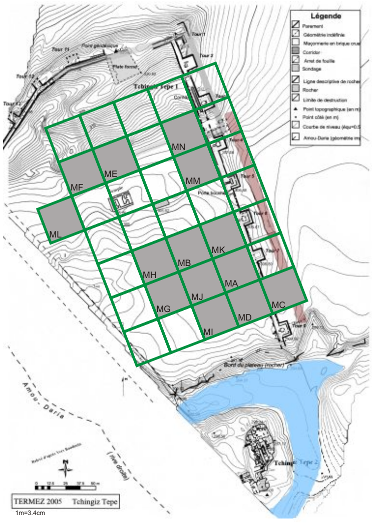
Various punctual anomalies of high intensity can be distinguished. Some of the large anomalies (F1, F2, F3 and F4) are similar in shape and intensity to the kiln detected and then excavated at Kara Tepe. They are U shaped, with the U corresponding to the mouth of the structure and have a maximum intensity of -91/+172 nT. In addition the orientation of these structures is similar to that of the kilns of Kara Tepe (F1 is oriented to the North-East, F2 to the North and F3 and F4 to the North-West whilst at Kara Tepe, the surveyed kiln was oriented North-West and the kiln excavated by Sh. Pidaev is oriented North-East). For this reason, we have considered these four anomalies as potential kilns.

One of the main anomalies (A8-A10-F3 in grid B) is composed of a series of dipoles of high magnetic contrast[5], a possible kiln[6] and a high contrast lineal positive/negative/positive anomaly, that could correspond to a trench of some type[7]. The position of this structure corresponds to two lineal elevations which are visible in surface (Graphic 4A-4B).

Large dipoles appear in a number of points of the surveyed area (A1-A12), usually with values superior to +/-100 nT. These could correspond to large combustions or metallic objects, and may mark the location of the remains of armament abandoned in the military camp (Graphic 2A-2B, 4A-4B and 5).

Finally, magnetic anomalies of lesser contrast have been detected throughout the surveyed area but they do not seem to mark recognisable forms. This makes them difficult to interpret and they need to be compared to the results from the georadar survey in order to establish relevant similarities.

3.- SD =Standard Deviation compared to the Average.
4.- In areas where the average is close to 0nT, values > -/+20nT correspond to highly altered magnetic elements such as metals or combustion material.
5.- A8= maximum values of -258/+226nT.
6.- F3= maximum values of -255/+238nT.
7.- A10= maximum values of -27/+41nT.

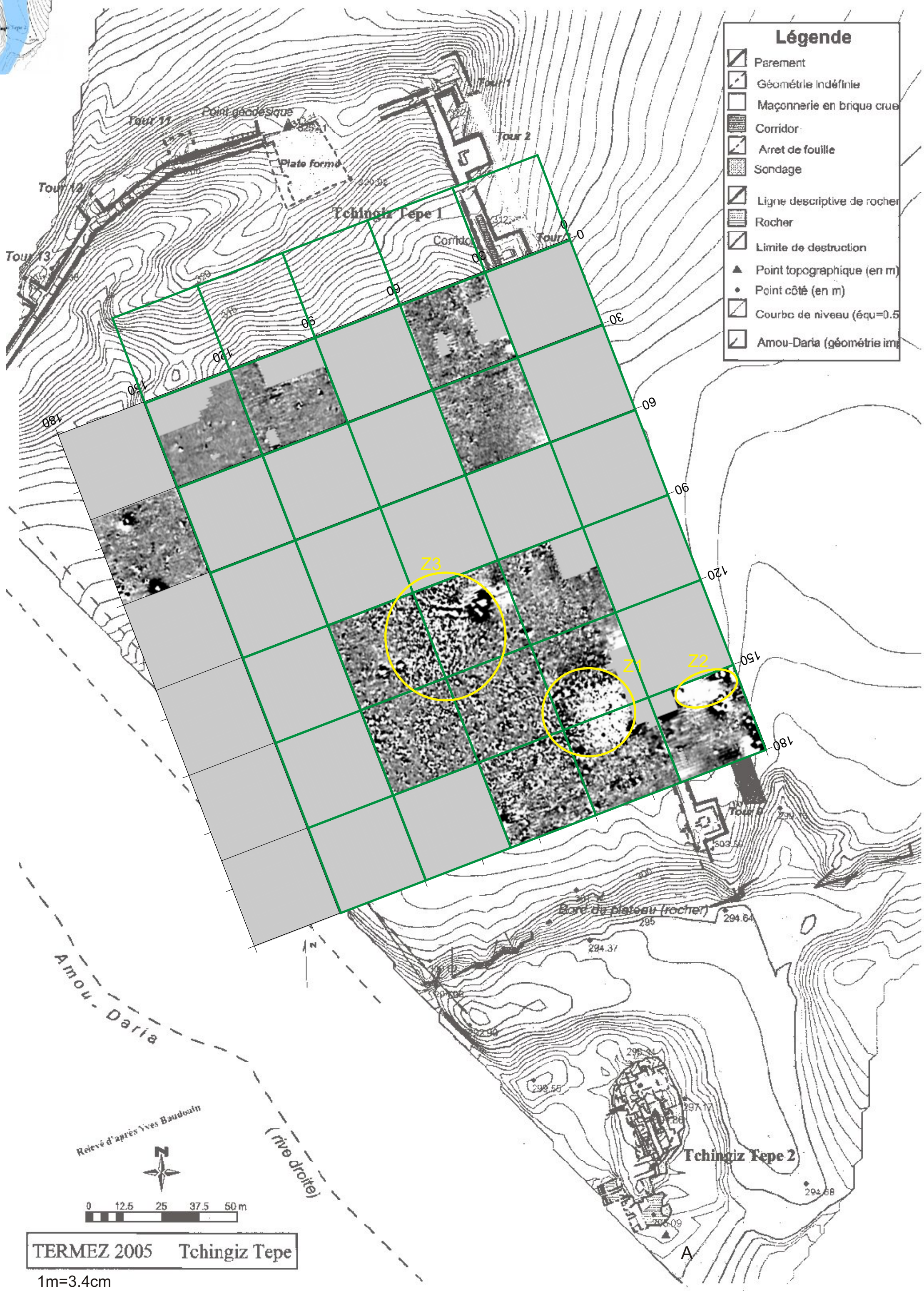


CHINGIZ TEPE (TERMEZ, UZBEKISTAN)
Results magnetic gradiometer prospection

A. Explored areas

B. Magnetic variations map obtained from the prospection

Areas with greater magnetic alteration



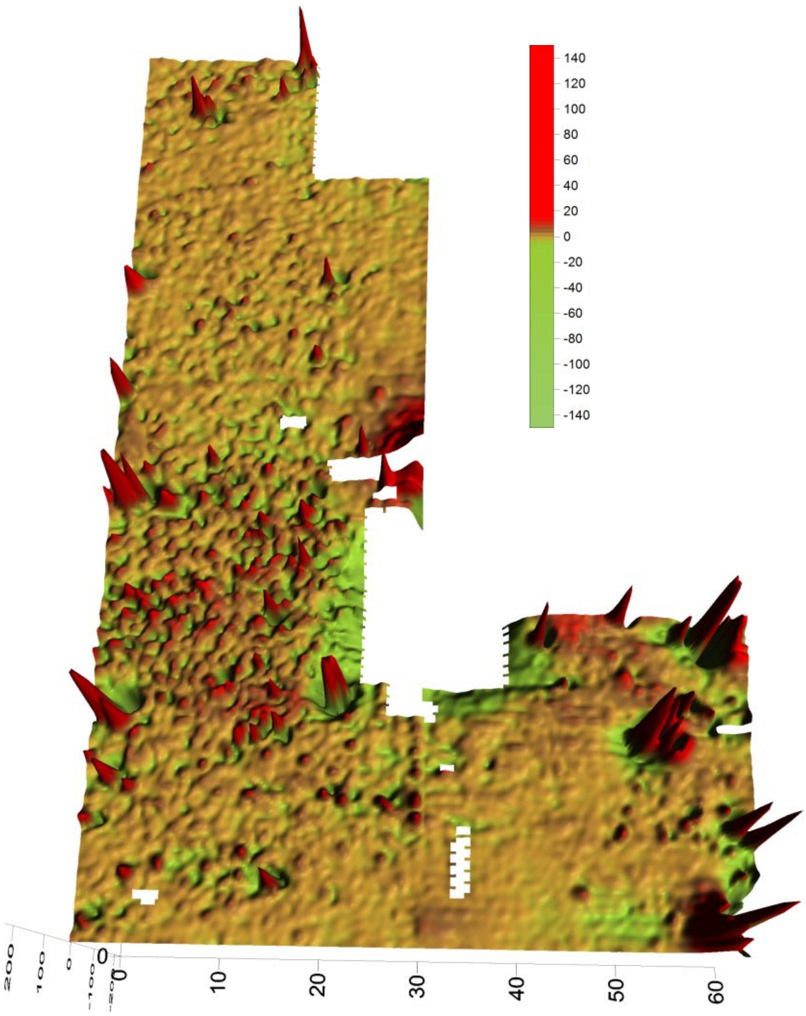
A

B

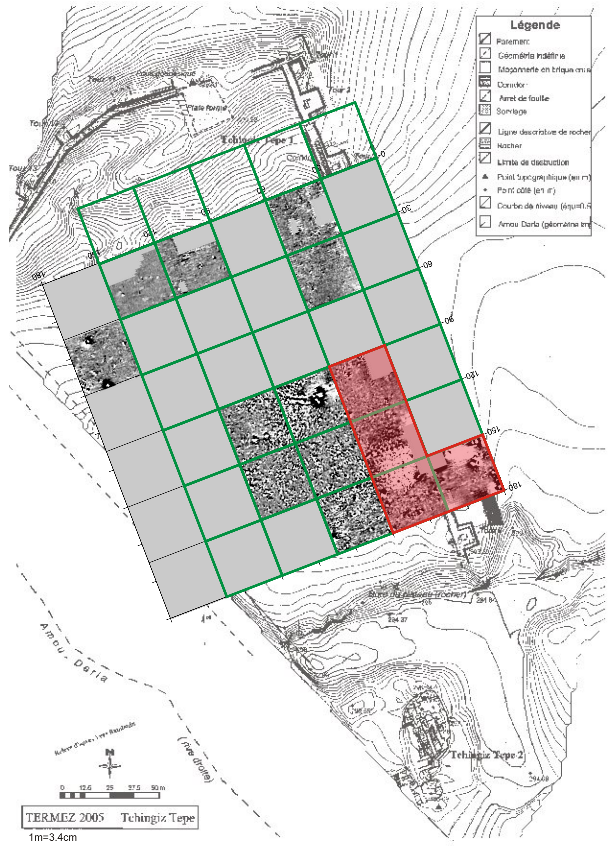
Graphic 1

CHINGIZ TEPE (TERMEZ, UZBEKISTAN)
Results magnetic gradiometer prospection

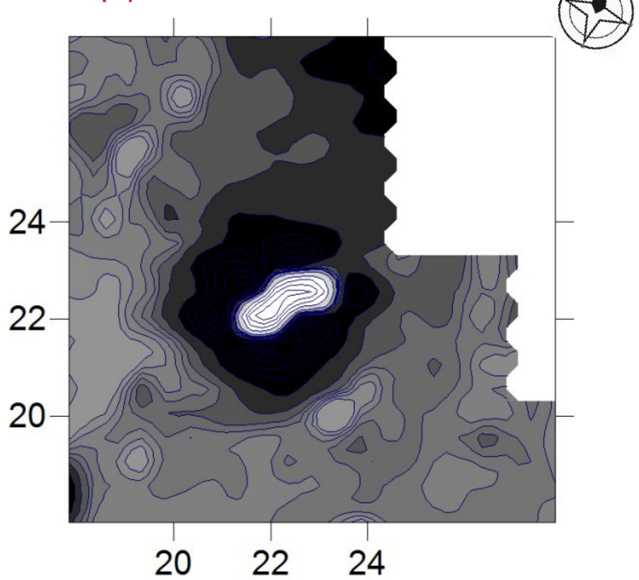
GRIDS MC-MD-MA-MK



Pseudo 3D plot of magnetic anomalies

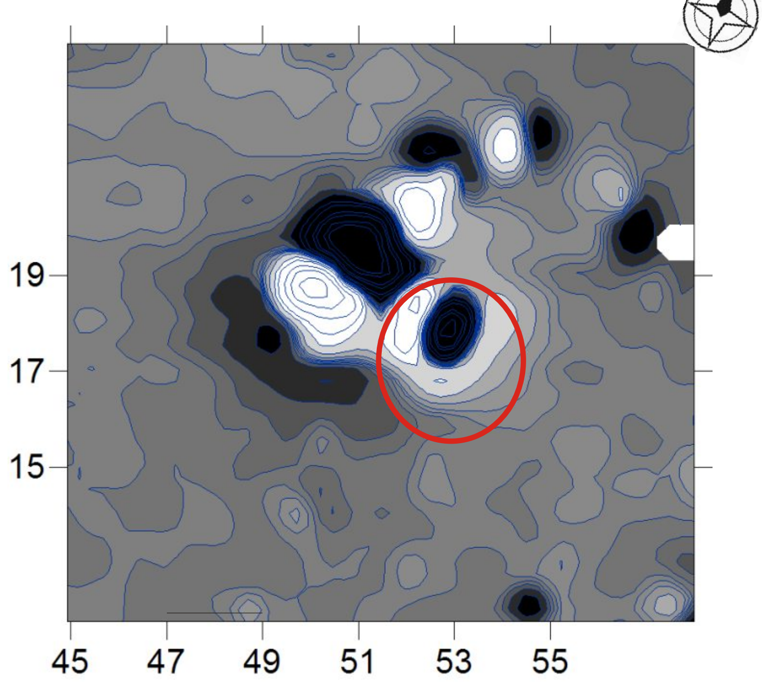


F1

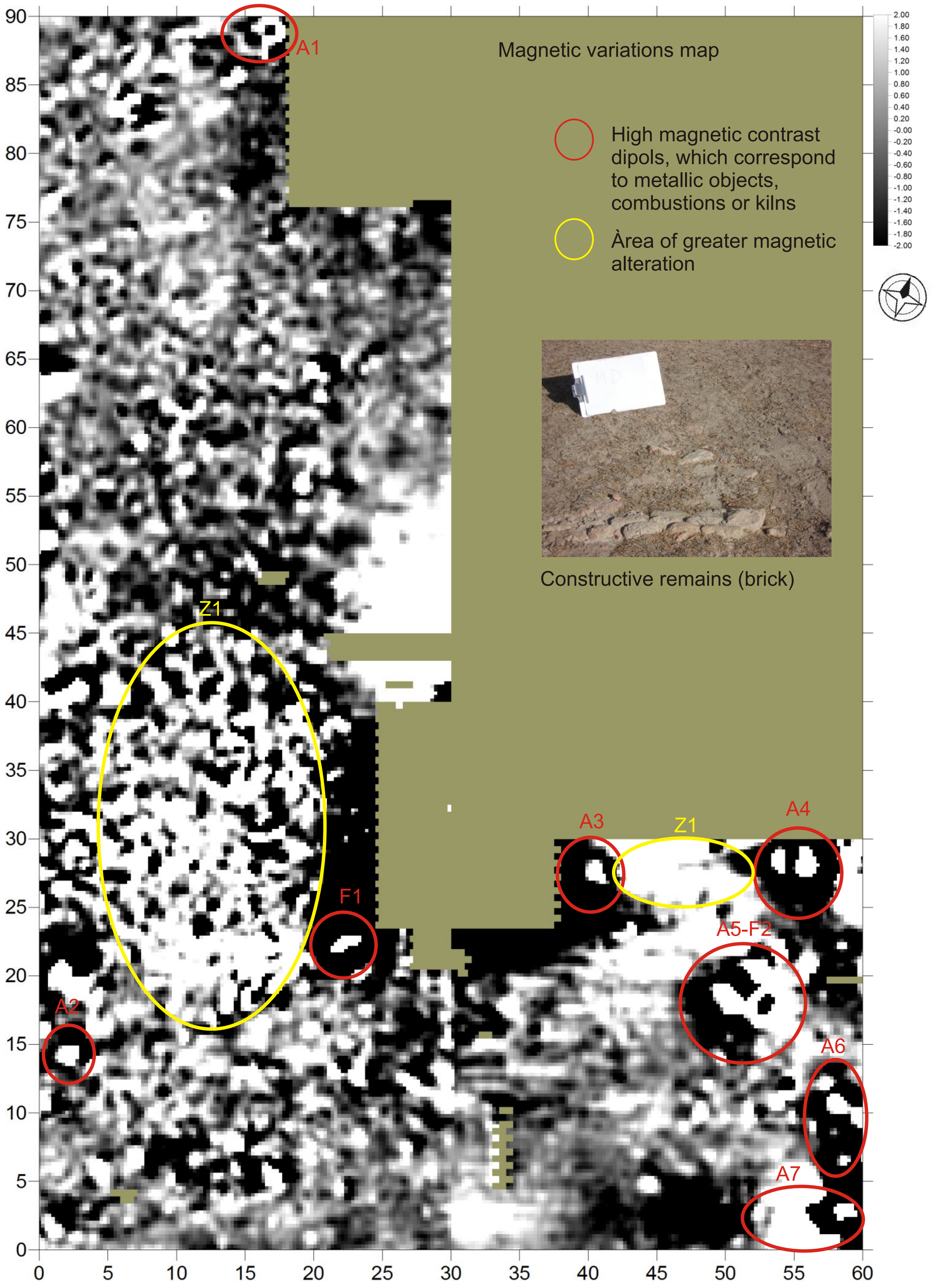


Detail of kiln 1

F2



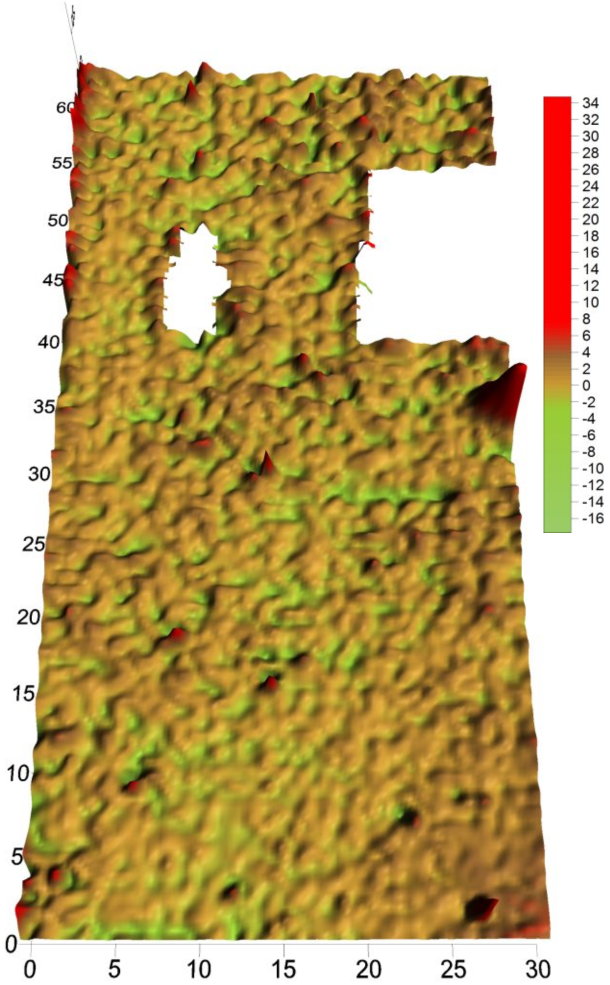
Detail of metallic objects and possible kiln 2


Magnetic variations map
High magnetic contrast dipols, which correspond to metallic objects, combustions or kilns
Àrea of greater magnetic alteration
Constructive remains (brick)
A1
A2
A3
A4
A5-F2
A6
A7
Z1
Z1
F1

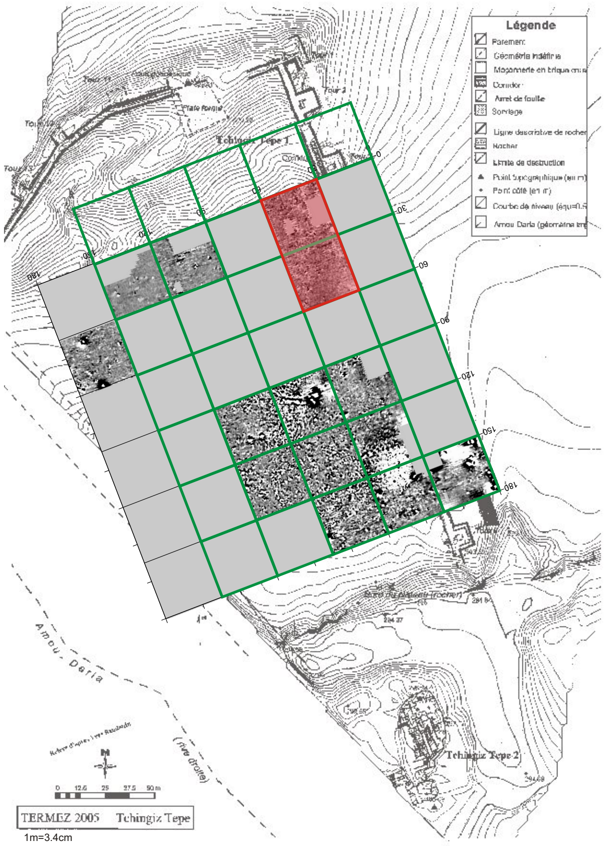
Graphic 2B

CHINGIZ TEPE (TERMEZ, UZBEKISTAN)
Results magnetic gradiometer prospection

GRIDS MM i MN

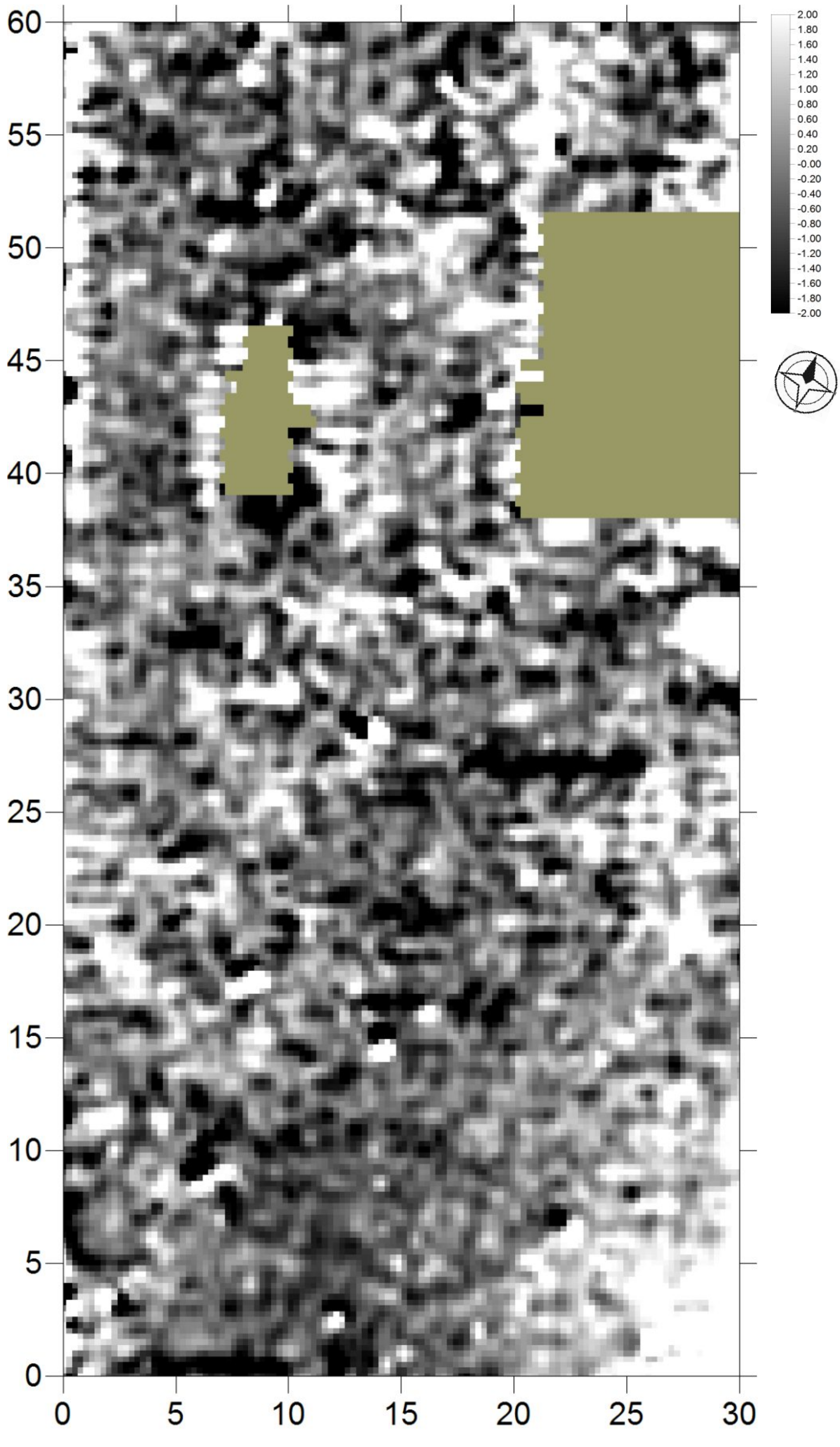


Pseudo 3D plot of magnetic anomalies



Chingiz Tepe Wall.
Iron made rails which were
an obstacle for prospection

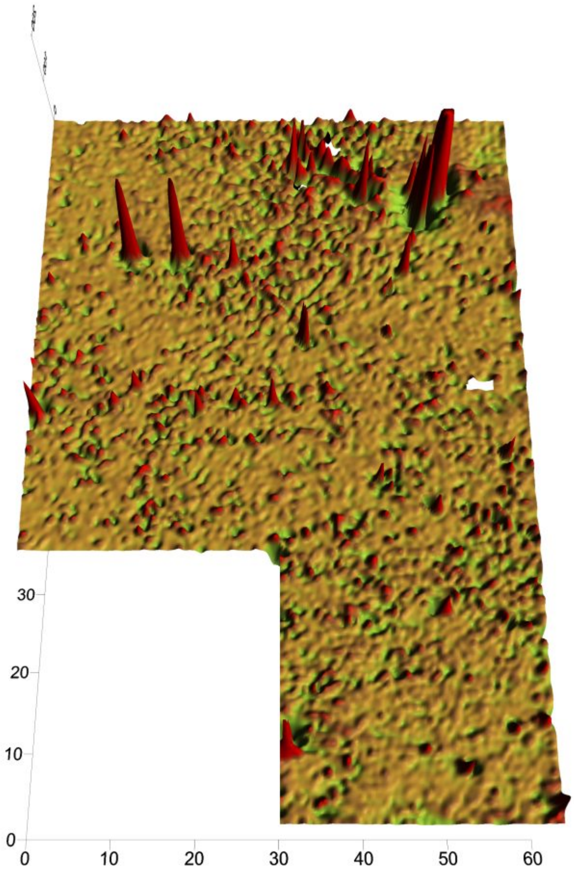
Magnetic variations map



Graphic 3B

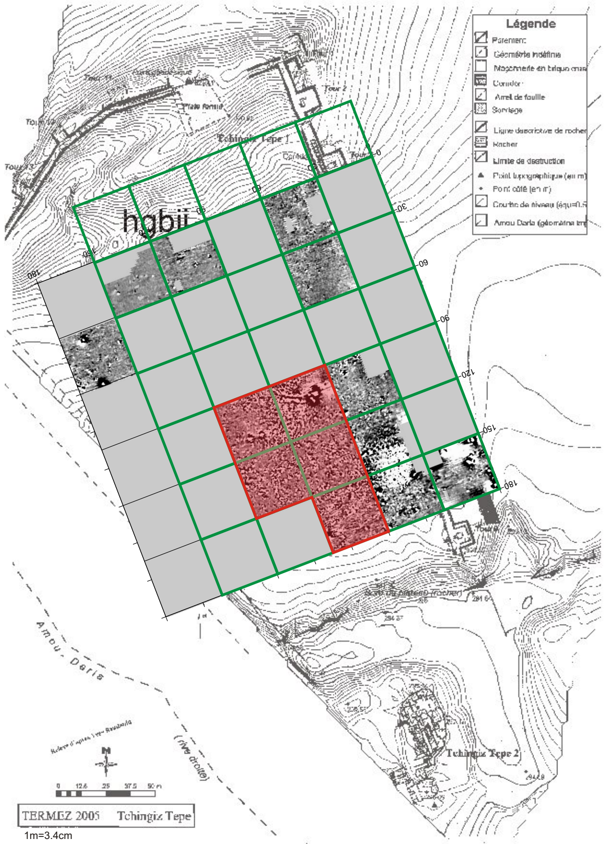
CHINGIZ TEPE (TERMEZ, UZBEKISTAN)
Results magnetic gradiometer prospection

GRIDS MI-MJ-MB-MG-MH

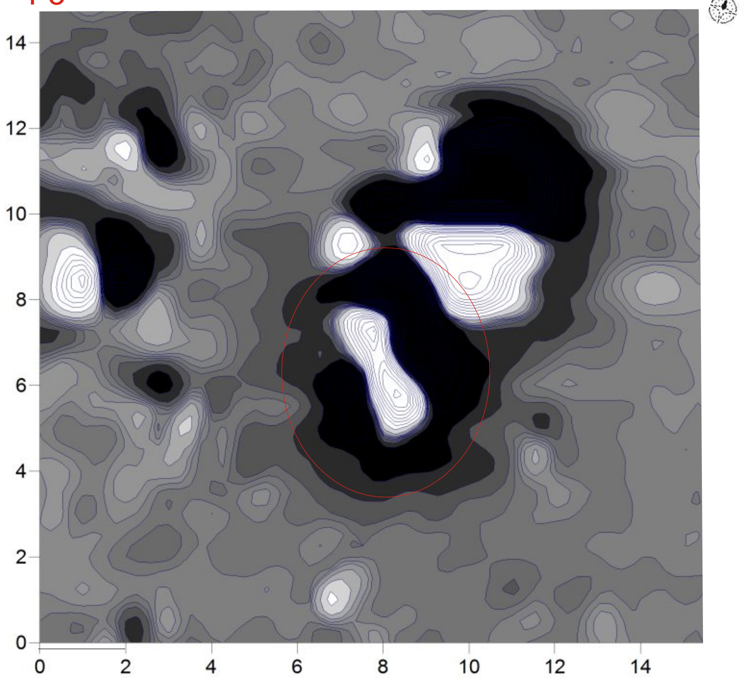


Pseudo 3D plot of magnetic anomalies

3



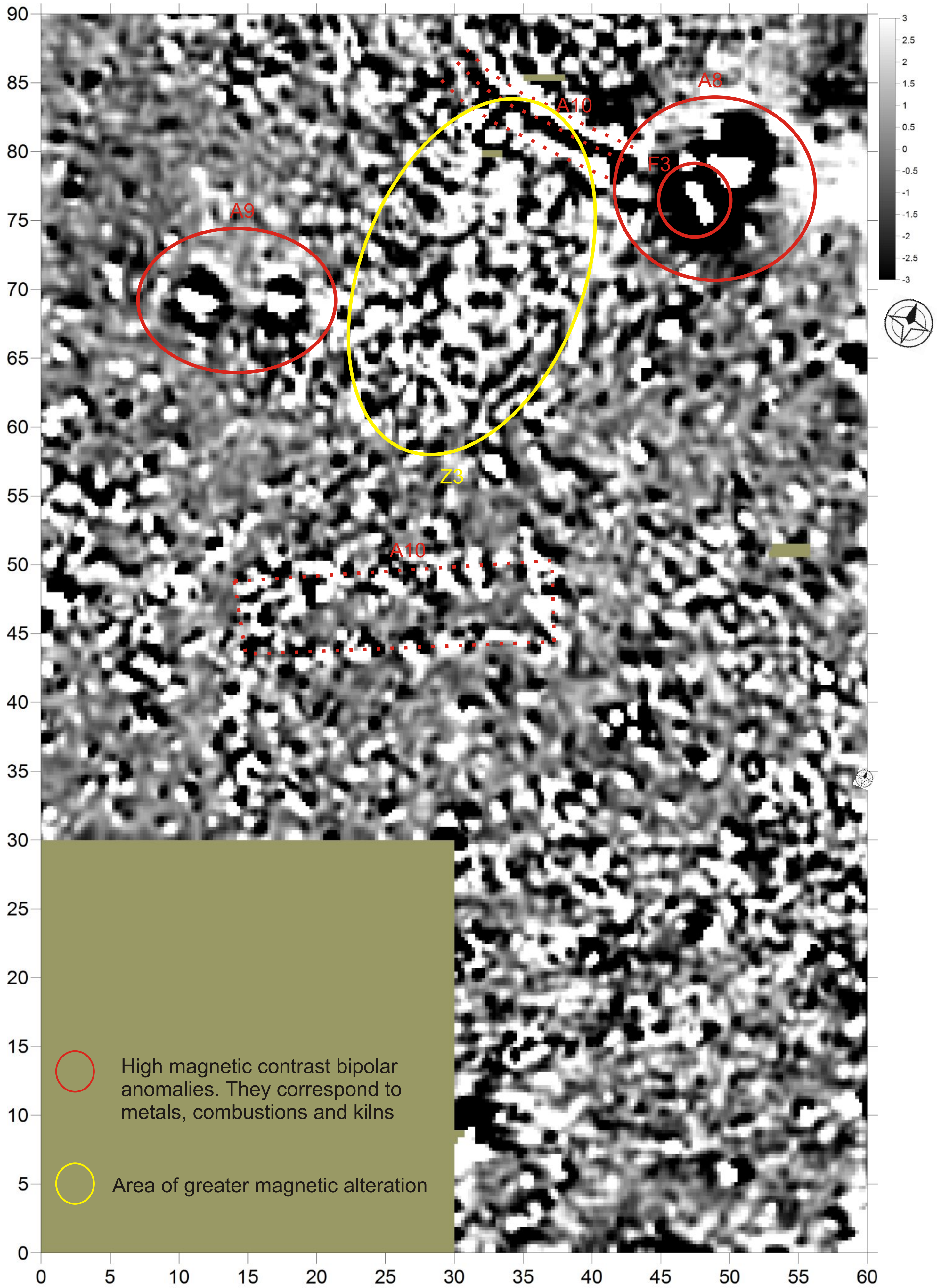
F3



Detail of magnetic dipols.
The dipol in the circle corresponds to the possible kiln 3

Earthworks at Grid B

Magnetic variations map

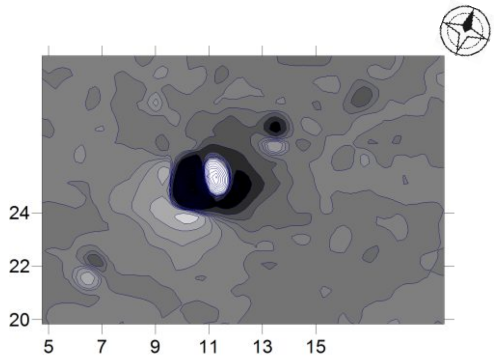


Graphic 4B

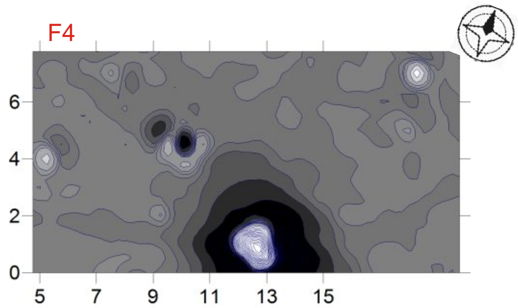
CHINGIZ TEPE (TERMEZ, UZBEKISTAN)

Results magnetic gradiometer prospection

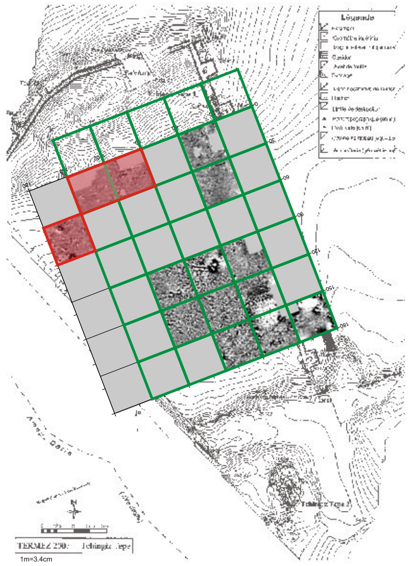
Magnetic variations map of grids ML-MF i ME.

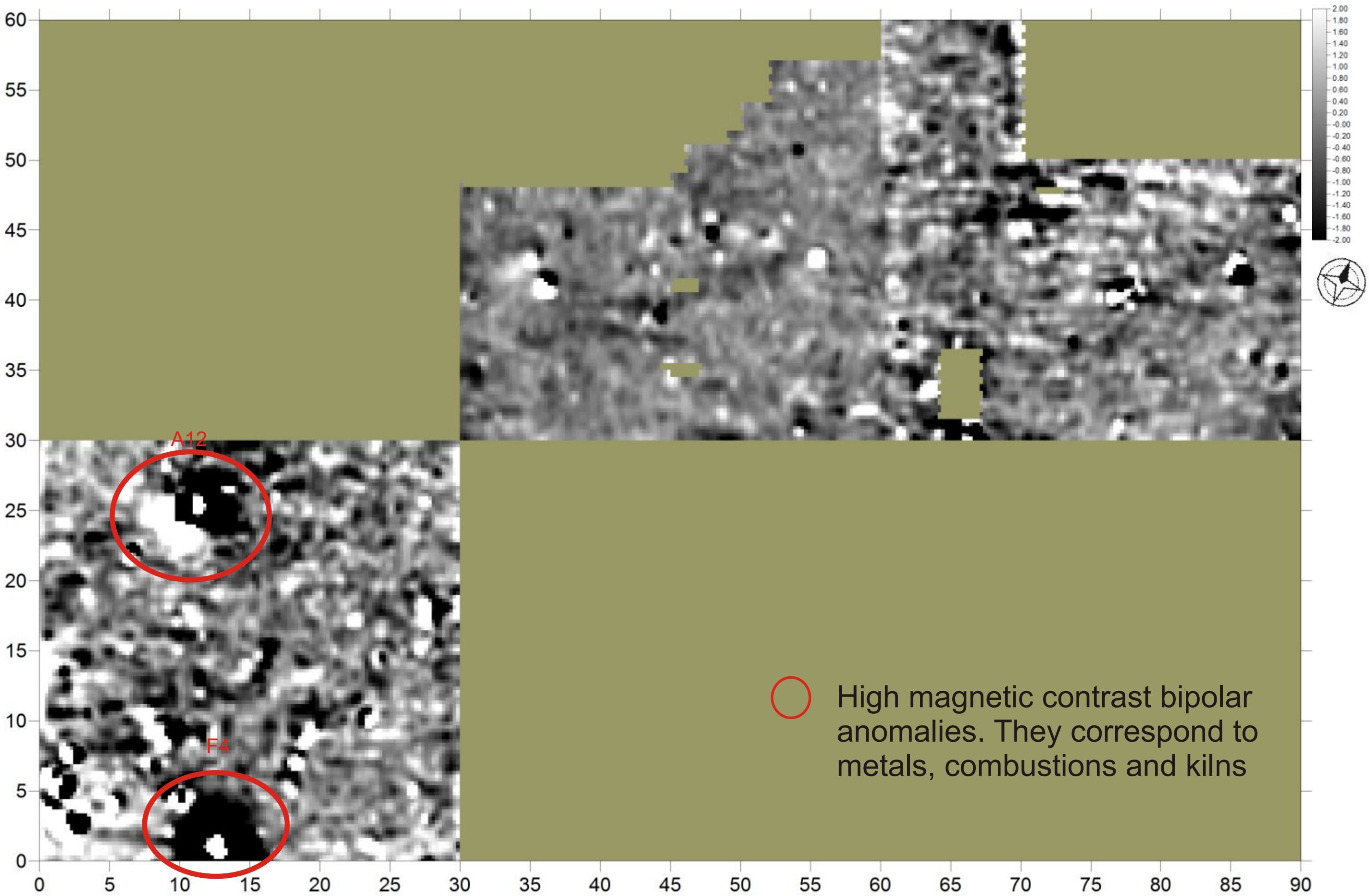


Detail of a high magnetic contrast dipol which corresponds to a metallic object



Detail of a high contrast magnetic anomaly which corresponds to kiln 4

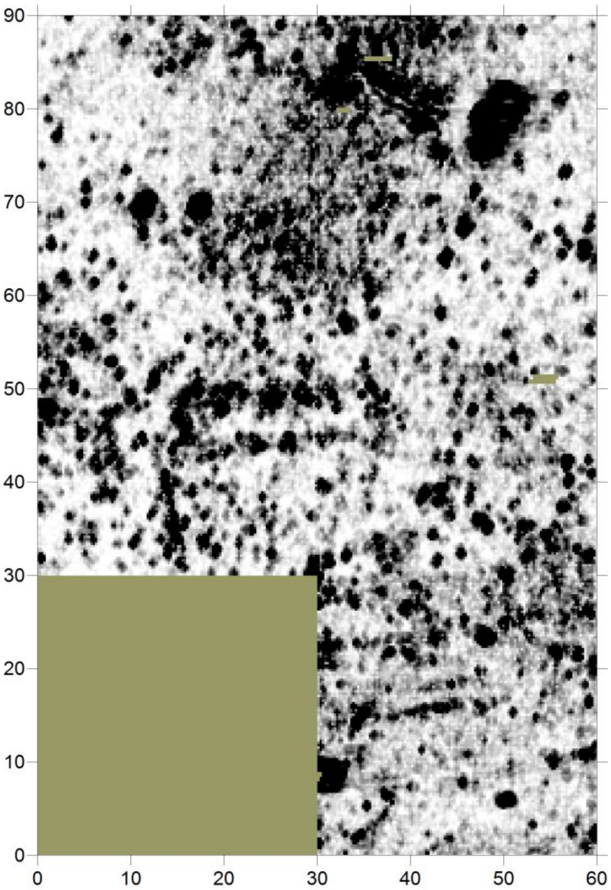




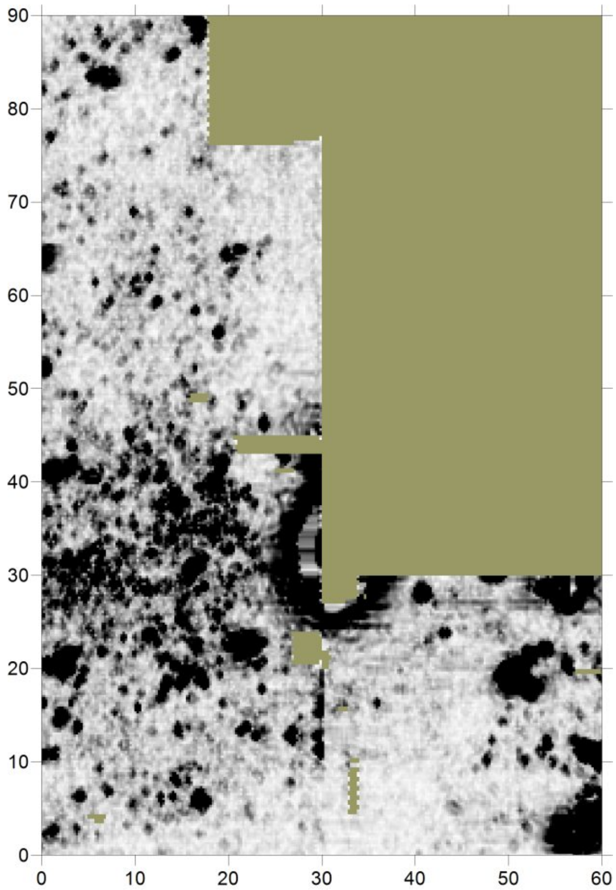
Graphic 5

CHINGIZ TEPE (TERMEZ, UZBEKISTAN)
Results magnetic gradiometer prospection

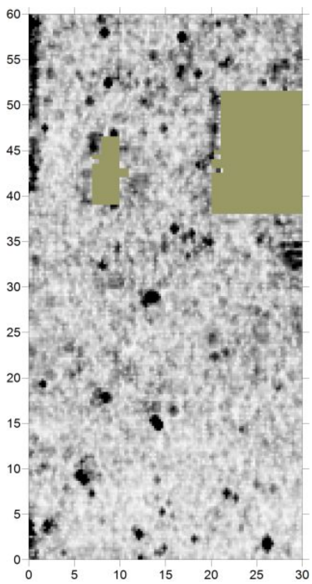
Standard deviation maps



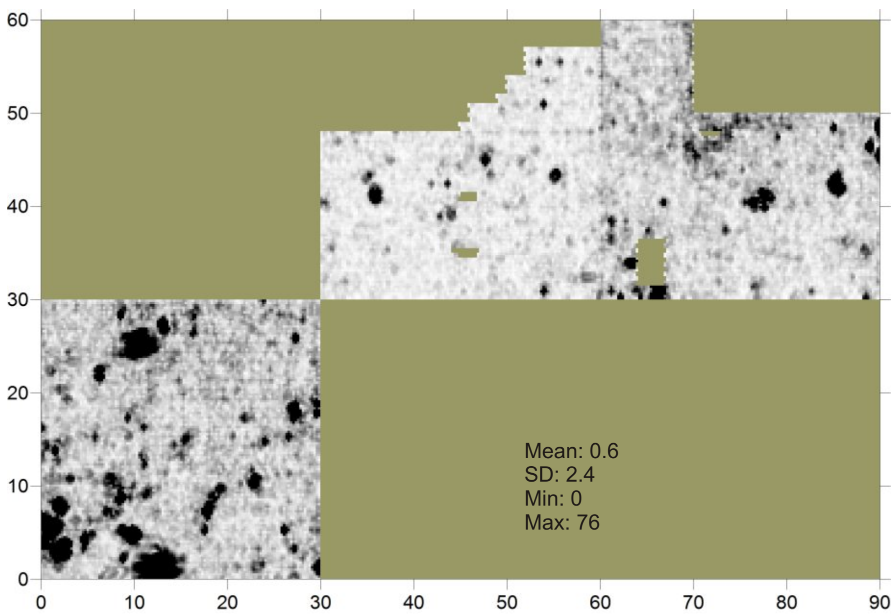
Mean: 1.8
SD: 2.4
Min: 0
Max: 93



Mean: 1.9
SD: 4.9
Min: 0
Max: 123.4



Mean: 0.5
SD: 0.5
Min: 0
Max: 15



Mean: 0.6
SD: 2.4
Min: 0
Max: 76

Graphic 6

Georadar survey: Grid RB, next to tower 9

The most interesting results were obtained in grid RB, situated within the fortification wall, next to tower 9 (Fig.4).

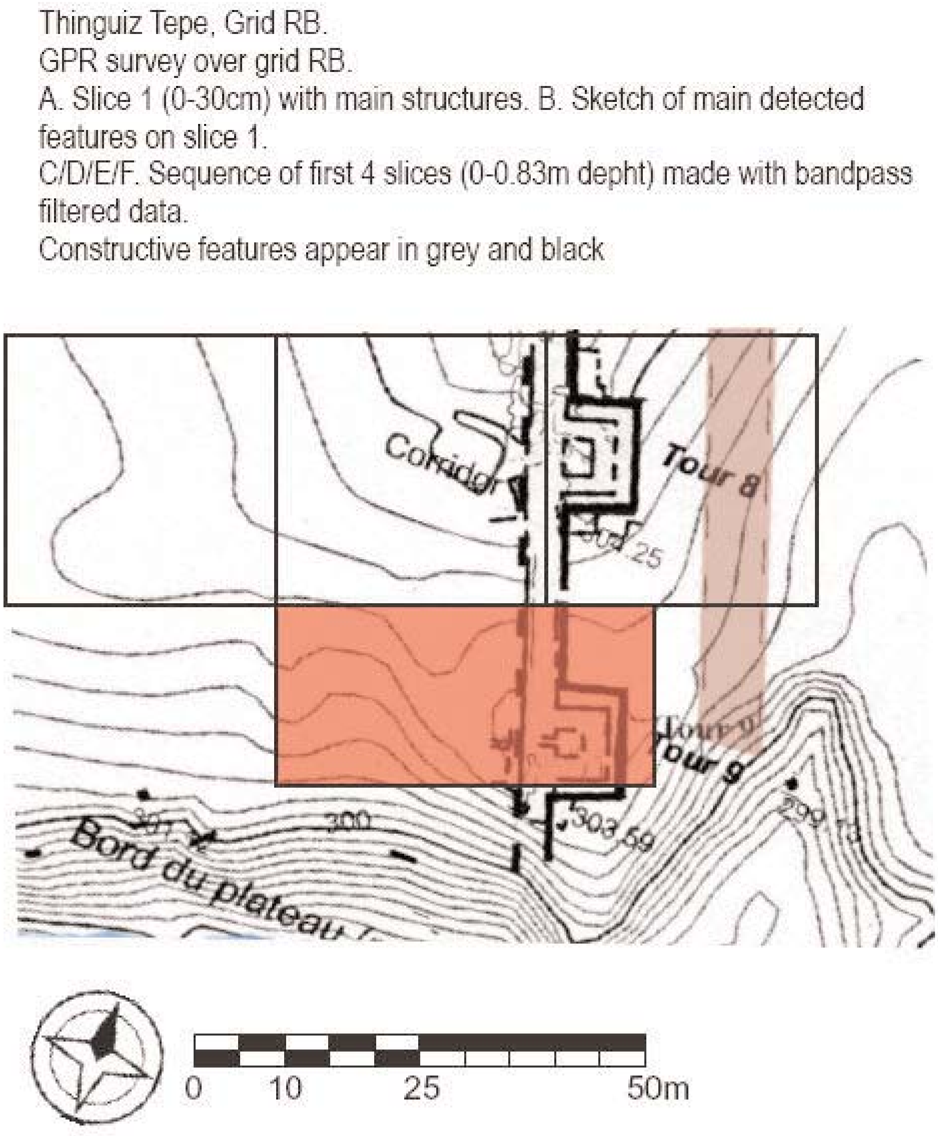


Fig. 4: Results of the geophysical survey in square RB

In grid RB, an irregular area of 30x42 m was explored with the georadar (Fig. 4). We read one radargram every 0,5 m with a time of exploration of 80 ns, which can be translated as a maximal depth of 5,5 m. However we only obtained clear results for the first 2 m below the surface.

The graphic A in Figure 4 illustrates the results of the first horizontal section (0-30 cm) and indicates the structures that were detected and the position of Tower 9. The signals emanating from constructive structures are indicated in dark colours, whilst the areas of sediment are indicated in lighter colours.

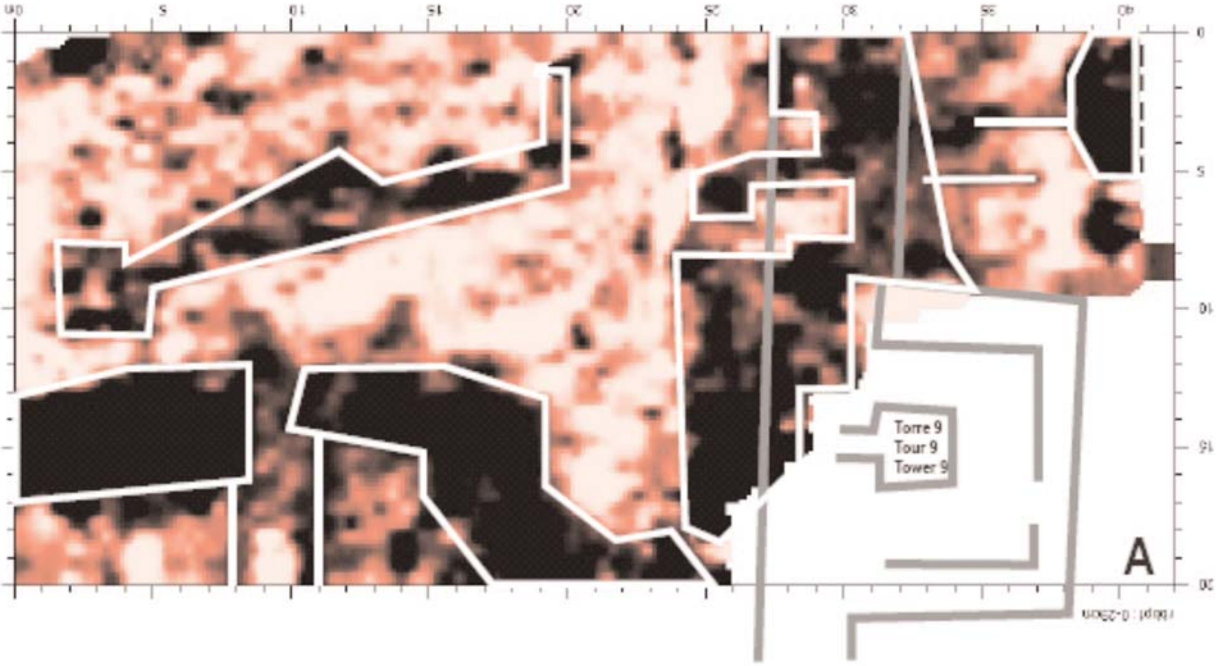


Fig. 4 A: Results of the geophysical survey in square RB

Illustration B shows the structures that were detected in schematic manner. According to our interpretation, the first 60 cm under the surface are characterised by the presence of structures associated with the fortification wall and tower 9. This would appear to correspond to the south east angle of the fortification wall which veers at right angles at this point and continues with an E-W direction (RB1).

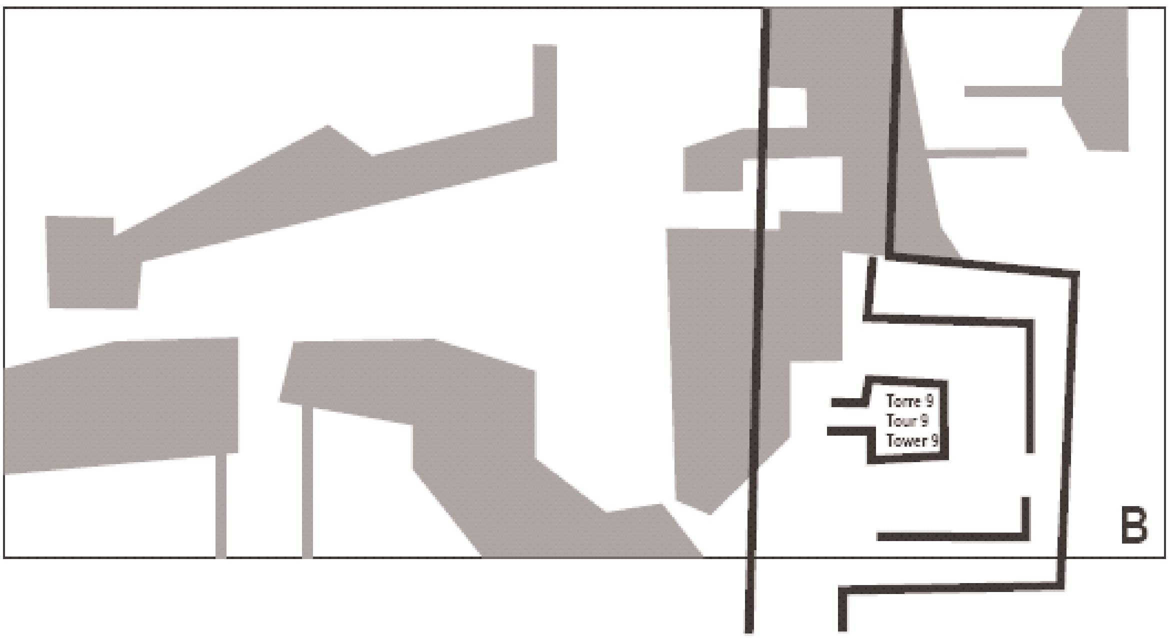


Fig. 4 B: Results of the geophysical survey in square RB

There also seems to be some kind of projecting structure towards the south between structures RB2 and RB3, presumably associated to the angle of the fortification wall.

Within the area RB, there is another lineal structure of about 18 m of length, situated at a slightly oblique angle to RB1.

The tower 9, that flanks the entrance to Tchingiz Tepe at its southernmost point, extends towards the interior of the site and to the north of the perimeter (RB3) and slightly more modest anomalies of difficult attribution were also recorded outside the fortification wall to the N-E (RB5).

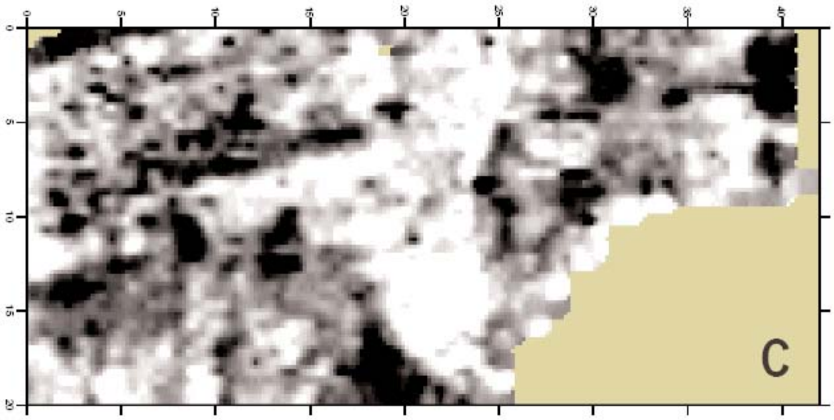


Fig. 4 C: Results of the geophysical survey in square RB

The illustrations D and E show the horizontal sections or plans, obtained respectively at 40 and 83 cm below the surface and furnish more fragmentary data with different structures, of which only RB2 and RB4 appear to retain the same disposition.

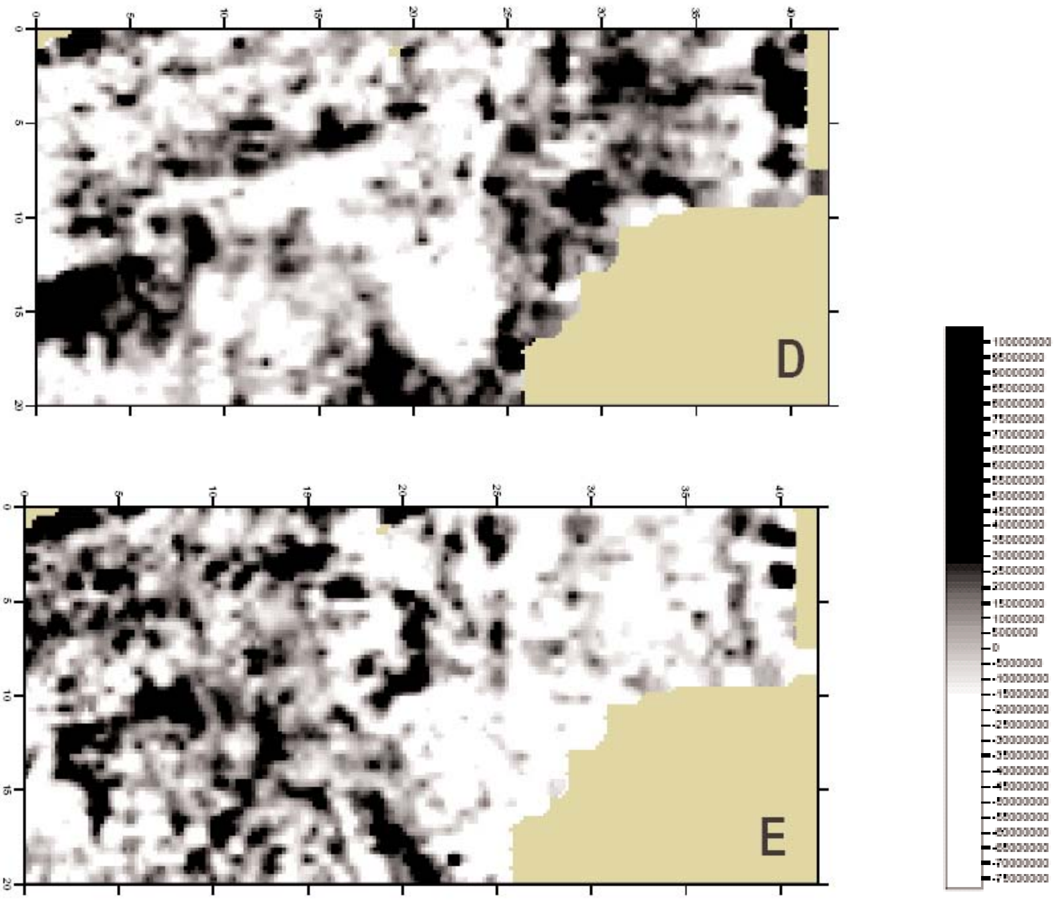


Fig. 4 D, E: Results of the geophysical survey in square RB

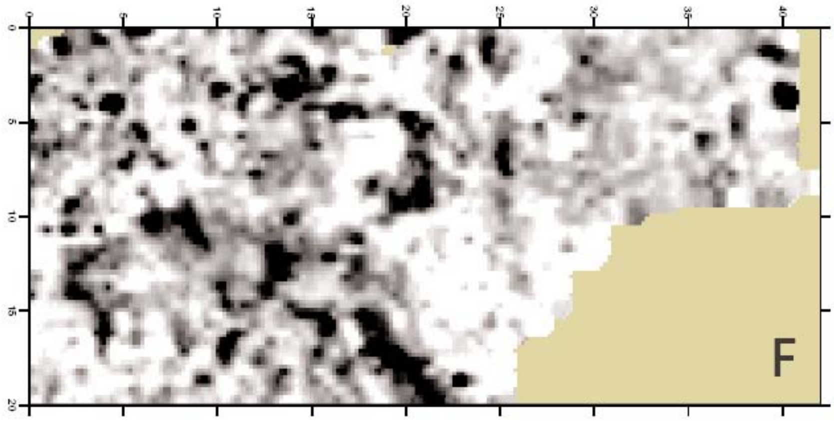


Fig. 4 F: Results of the geophysical survey in square RB

We can thus conclude that the structures associated with the defensive walls and the interior divisions of these structures can be clearly detected in square RB, even if they have a vertical projection of almost 50 cm. Under these structures, we can also make out smaller structures, almost in contact with the geological bedrock, that is situated about 1 m under the surface in the southern part of the area surveyed.

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Archaeometrical study

E. Tsantini, V. Martinez, Sh. Pidaev and S. Stride[1]

Introduction

Archaeometry is a science that studies the provenience and technological aspects (Figure 1 and 2) of ancient ceramic manufacture. It is based on the study of chemical and mineralogical composition and combines different analytical techniques.



Figure 1: Manufacture of different kind of ceramics: modelling and firing (photo: www.connecticut.backpage.com)

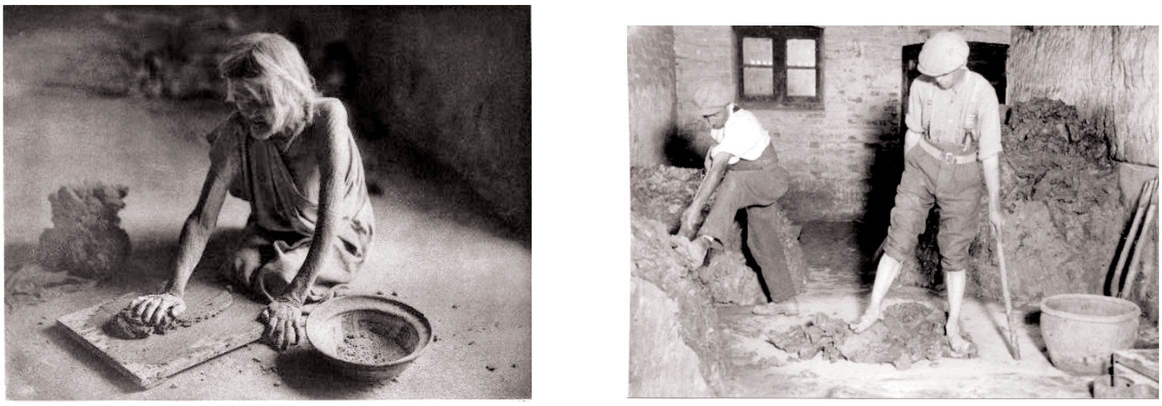

Figure 2: Pottery paste preparation; decanting and mixing (photos: www.collectionscanada.ca; www.fluryco.com)

In Uzbekistan a number of archaeometrical studies were done during the 1980's and early 1990's using chemical and spectral analysis, notably by S. V. Vivdenko and A. Abdurazakov. The first analysed shards from a number of sites, mostly dated to the Iron Age but also from the Kushan period at Jalangtush Tepe [Vivdenko 1987, 1987a, 1993] but ended up specialising on questions related to the technology and conservation of clay sculpture [Vivdenko 1990, 1992, 1994, 1996]. The second was a

1.- The main text is by V. Martinez and E. Tsantini. Sh. Pidaev and S. Stride completed the introduction and the remarks on the material from Termez.

specialist on glass [Abdurazakov, Bezborodov et alii. 1963, Abdurazakov 1988, Abdurazakov 1996] who also analysed a few sherds, mainly dated to the Bronze Age but including some from the Kushan period at sites such as Mirzakul' Tepe and Talashkan Tepe [Abdurazakov, Dzhalalova 1986, Abdurazakov 1987].(Fig.3).

Таблица 3

Химические составы бытовой керамической посуды Сурхандарьинской области (весовой процент)

№	Наименование предмета	Датировка	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	ппп	MnO	SO_3	TiO_2	Сумма
1	Керамическая тагора из Мирзакультепе	I в н. э.	47,82	18,68	5,19	10,65	4,32	3,34	3,90	5,00	0,11	0,29	0,35	99,55
2	Тарелка из Мирзакультепе	—"—	60,17	15,27	4,47	6,72	1,84	4,27	2,94	3,29	0,11	0,48	—	99,52
3	Чаша —"—	—"—	56,39	16,26	4,19	7,92	1,36	4,81	3,60	3,99	0,09	0,33	0,50	99,73
4	Миска —"—	—"—	54,14	16,51	4,97	8,45	2,02	3,17	3,48	5,32	0,07	0,92	0,38	99,43
5	Чаша из Талашкантепе	I в до н. э. I в н. э.	59,44	16,04	4,35	7,61	2,61	3,37	2,50	4,10	0,12	0,29	0,20	99,73
6	Тарелка —"—	—"—	58,05	16,60	4,86	7,94	2,02	3,72	2,97	3,62	0,06	0,80	0,05	99,98
7	Ваза —"—	—"—	60,85	14,60	5,13	8,59	0,41	2,74	3,78	3,52	0,07	0,34	—	100,36
8	Чаша —"—	—"—	56,39	15,38	5,92	10,86	1,79	2,74	3,30	4,29	0,12	0,89	—	99,98
9	Чаша —"—	—"—	60,43	15,88	4,10	6,52	2,23	4,01	3,37	3,31	0,10	—	—	99,95

Fig. 3: The results of the analysis of the chemical analysis of sherds from Mirzakul' Tepe and Talashkan Tepe [Abdurazakov, Dzhalalova 1986, p.209, tabl. 3]

The laboratory of the Institute of Archaeology has a room for ceramic analysis but this has not been used since the mid 1990's and, because of the rapid evolution of archaeometrical techniques, work carried out up 15 years ago is of limited comparative value. This is all the more true in that we have chosen to concentrate our work on provenience studies in order to attempt to locate the origin or the production site where the pottery was made [Picon, 1984; Buxeda et al.,1995] (Fig. 4), rather than on technology, which was the main axis of research at the laboratory of the Institute of Archaeology.

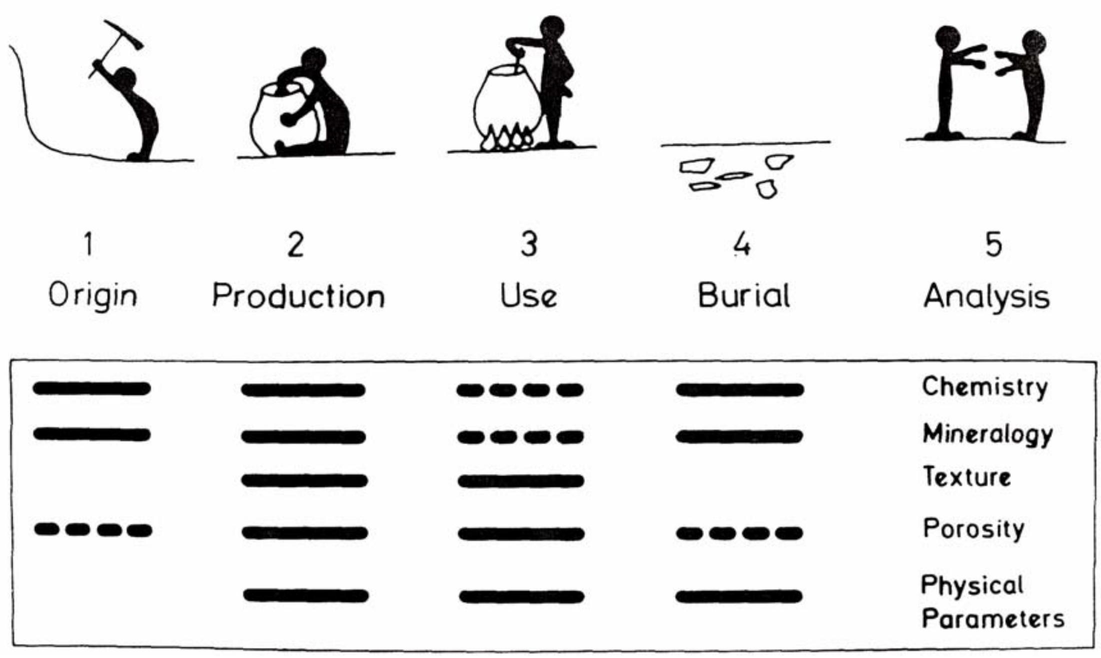

Figure 4: *Five different states during the production, use and burial of pottery and the information each analytical method can be offer on each of these states (Maggetti 1982, pp. 122).*

Generalities

In the process of ceramic manufacture not only modelling and firing are involved (Fig. 1), but also other processes. Frequently before the modelling the clay is decanted or different kind of clays coming from different sources are mixed (Bennet et al., 1989a) or temper is added depending on the final function of the pottery (Steponaitis, 1984; Arnold, 1992). Finally the firing process causes significant chemical changes to the mineralogical composition of the ceramic product. (Maggetti, 1981; 1982; Heimann, 1982; 1989),including the microstructure (Maniatis et al., 1981; Kilikoglou et al., 1988). Thus the chemical composition of the ceramic product isn't necessary directly related to the composition of the raw material. For these reasons, many aspects must be taken into account in order to identify the origin of a sherd. Therefore provenience studies have focused their attention on the identification of ceramic productions which can be archaeologically related to kiln sites or production sites (**reference groups**). When **reference groups** can not be identified because the ceramic material is unrelated to a specific kiln only the **Paste Compositional Reference Units** can be identified by the chemical analysis. In this case, individuals with a very similar chemical composition are grouped. These groups represent productions which can not be archaeologically assigned to a kiln.

Another aspect of archaeometrical studies is the technological process of ceramic manufacture (Figure 2). During the firing, the increase in temperature and the prevalent atmosphere (oxidising, reducing) causes mineralogical changes to take place, which also lead to changes in colour and texture (Figure 5). These changes are related to the new minerals developed during the fabrication process. By X-Ray Diffraction (XRD) it is possible to distinguish between the primary mineral phases (minerals present in the raw material before firing), the firing phases (minerals developed during firing) and the secondary faces (developed after burial). It is also possible to determine the Equivalent Firing Temperature based on the kind of minerals detected. Therefore the aim in XRD studies is to determine Mineralogical Fabrics which can be related to a certain range of temperature.

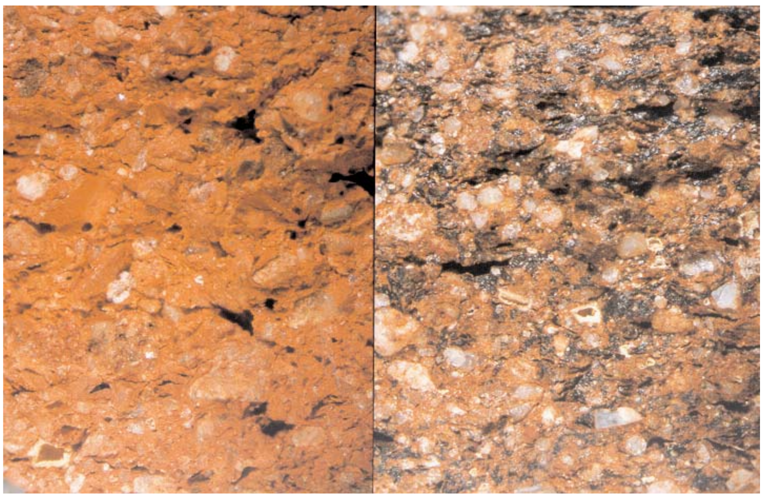

Figure 5: Texture and colour (under binocular microscope) of two different fabrics representing two different temperature which correspond to the same production. (picture M. A. Cau i Ontiveros: ERAUB)

Methodology

X Ray Fluorescence

X Ray Fluorescence analysis will be done using a Phillips PW 2400 spectrometer with an Rh excitation source (Figure 6). After mechanically removing the surfaces, a portion of at least 10 g of powder will behomogenized and dried at 105°C for 12 h. Major and minor elements will then be determined by preparing duplicates of glassy pills using 0.3 g of this powdered specimen in an alkaline fusion with lithium tetraborate at 1/20 dilution. Trace elements and Na_2O will be determined by powder pills made out of 5g of this specimen mixed with Elvacite synthetic resin placed over boric acid in an aluminum capsule and pressed during 60 s at 200 kN in a Herzog press. The quantification of the concentrations is going to be obtained using a calibration line based on 60 standards (International Geological Standards: ANRT, BCS, CCRMP, CRPG, IGGE, IWG-GIT, MISC, NIST, NIM, SABS, NRC, USGS). The elements determined will include Fe_2O_3 (as total Fe), Al_2O_3, MnO, P_2O_5, TiO_2, MgO, CaO, Na_2O, K_2O, SiO_2, Ba, Rb, Mo, Th, Nb, Pb, Zr, Y, Sr, Sn, Ce, Co, Ga, V, Zn, W, Cu, Ni and Cr. The loss on ignition (LOI) is going to bedetermined by firing 0.3 g of the dried specimen at 950ºC for 3 h.

Figura 6: Phillips PW 2400 spectrometer

Figura 7:
D-500 Diffractometer

X Ray Diffraction

X Ray Diffraction measurements will be performed using a two different diffractometers: *Siemens D-500* and *PANalytical X'Pert PRO alpha1* (radius = 240 millimetres). The conditions settings for the *Siemens D-500* diffractometer (Figure 7) are going to be the following: working with the CuKα radiation (λ=1.5406 Å), at 1.2 kW (40 kV, 30 mA), and using a graphite monochromator in the diffracted beam. Spectra will be recorded from 4 to 70°2Q, at 1°2q/min (step size=0.05° 2θ; time=3 s). The diffractometer *PANalytical X'Pert PRO alpha1* are going towill work function with the same radiation (CuKα radiation: λ=1.5406 Å) at working powder of 45 kV and 40 mA., using a Ni filter in the diffracted beam. The sample spinning will be preformed set at 1 revolution per second. Variable automatic divergence slit will be applied to get an illuminated length in the beam direction of 10 millimetres. The mask defining the length of the beam over the sample in the axial direction was of will be 12 millimetres. The incident and diffracted beam will pass via *soller* slits of 0.04 radians. Spectra will be recorded from 4 to 70°2θ with step size of 0.017º and measuring time of 50 seconds per step. In both cases the evaluation of crystalline phases will be carried out using the DIFFRACT/AT program by Siemens, which includes the Joint Committee of Powder Diffraction Standards (JCPDS) data bank. The samples will be prepared by pressing manually 1gr of pulverised and homogenised sample in a standard cylindrical bases (PW1811/27) of a 27 mm in diameter and 2,5 mm in height.

Scanning Electron Microscope (SEM)

A JEOL JSM-840 study Scanning Electron Microscope (SEM) (Fig. 8) equipped with Secondary Electron (SE) detector and Energy Dispersive X-ray Micro Analyser (EDXA) is going to be used for the study of the microstructure and the sinterisation state. The observations will be done under vacuum on the external surface of fresh fractures and the secondary electron image will be taken at 2000x magnification. In some cases X-ray microanalysis will also be carried out, with an acceleration voltage equal to 20kV and an intensity of $3x10^{-9}$ A. The fresh fractures of the samples will be fixed upon a standard metallic base of 1 cm in diameter with silicon and in order to insure continuous conductivity between the sample and its base and to avoid the overloading of the fresh fractures these will be covered with silver and afterwards with carbon.

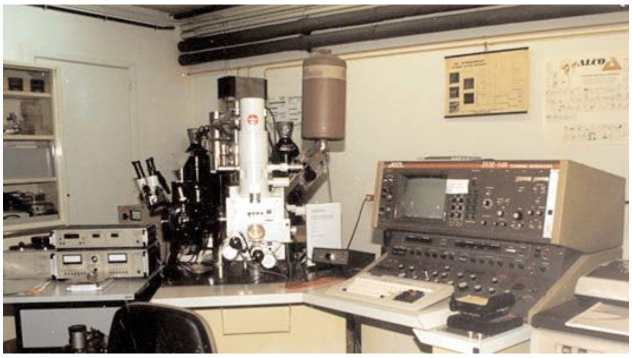

Figura 8: JEOL JMS-840 Electronic Scanning Microscope

The material from Termez

After the excavation of the kiln directed by E. Ariño a careful selection of 50 sherds was done and the IPAEB obtained the permit to export these sherds from the Uzbek authorities. The sherds reached Barcelona in January 2007 and work on them started immediately so as to ensure that we obtain preliminary results before the 2007 field season.
If the results prove convincing, the study will be enlarged to include:
- Material fired in the kilns themselves. The material studied comes from a secure context associated to the infilling of kiln 2 after it was abandoned. However we can not be certain that this material comes from another kiln or is simply domestic waste and will therefore carefully survey the zone in search of areas where badly fired or broken pots were dumped.
- Material from well dated stratigraphical levels from the rest of Ancient Termez, including the citadel, Tchingiz Tepe and Kara Tepe.
- Material from small sites in the vicinity of Termez.
- Material from sites situated at a slightly larger distance from Termez.

If the results are positive, then by building up a comprehensive collection of archaeometrical material from Termez and its region we may be able to obtain valuable insights into the local, regional and eventually global commercial networks linking Termez with other areas. This is particularly important because so far we have almost no comparable material for the Kushan Empire as a whole and therefore no way of testing the different hypothesis which have been proposed as to its functioning.

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