J. Humanities (2006) Vol. 13 (3): (31 - 49)

Tepe Ghabristan: Geophysical Survey Report

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Abstract

In March 2004, a fluxgate gradiometer survey was conducted over Tepe Ghabristan, covering approximately 6ha of ground. It identified further areas of the Iron Age cemetery with possible grave pits (Areas B and C). In addition, an irrigation channel was discovered which could be contemporary to these Iron Age graves (Area D). The anomalies in Area E can be interpreted as buried structural remains, possibly linked to metalworking.

Key word: Geophysical Survey, Fluxgate Gradiometer Survey, Ghabristan, Cemetery, Chalcolithic, Iron Age

[DOR: 20.1001.1.25382640.2006.13.3.5.7]

Introduction

The Department of Archaeological Sciences in the University of Bradford; Institute of Archaeology in the University of Tehran and Cultural Heritage Organisantion and Turism of Iran carried out a geophysical survey at the site of Tepe Ghabristan, Qazvin Province, in NW Iran (approx. 49.96° E, 35.85° N in WGS84). In the wide Qazvin Plain, the Sagzabad Cluster consists of three prehistoric tells, located within 2km of each other and forming a settlement sequence. The tells of Zagheh (early chalcolithic, 6th and 5th millennium BC), Ghabristan (late chalcolithic, 4th millennium BC) and Sagzabad (Iron-age, 2nd millennium BC) lie 52km south of Qazvin and 132km west of Tehran in the Qazvin Plain, which forms the western part

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of the Central Iranian Plateau. The plain is bounded in the south by the Ramond Mountains from which, since prehistoric times, downwash has led to considerable soil deposition in the plain. Excavations have shown that at Zagheh the virgin soil is 6m below the current level. There, the top of the mound, 0.5m above the plain, dates from the fifth millennium BC. Malek Shahmirzadi (1977:35) reports that at Sagzabad 5m of alluvium have been deposited since the 3rd millennium BC. On the tell of Ghabristan, Iron Age graves were found about 1.5m below the current surface. These findings demonstrate the complexity of the stratigraphic sequences, encountered between and on the tell mounds. Figure 1 provides a simplified section through the tells of Ghabristan, Sagzabad and Zagheh (from left) and the presumed alluvial deposits between them.

It was initially reported that “the archaeological strata in these three mounds complete each other” and that “Ghabristan was occupied when Zagheh was deserted” (Neghaban 1977), but their relationships were not explored to further extent. Recent radiocarbon dating (Fazeli et al. in press) has revealed indications for a shift of occupation from Zagheh to Ghabristan, without much overlap at around 4200 BC (occupation in Zagheh from 5370-5070 BC to 4460-4240 BC, in Ghabristan from 4200 BC to 3200-3000 BC). However, the site of Sagzabad seems to have been occupied only from 2100 BC onwards, leaving a gap of 900 years to the apparent abandonment of Ghabristan. In contrast to these recent radiocarbon results, earlier reports stated (Neghaban 1977) that archaeological layers of the late second millennium BC were found both at Ghabristan and Sagzabad and may be related to the use of Ghabristan as a burial ground for Sagzabad. Since then alleviation, seems to have slowed down so that the graves are only about 1.5m below the current ground level.

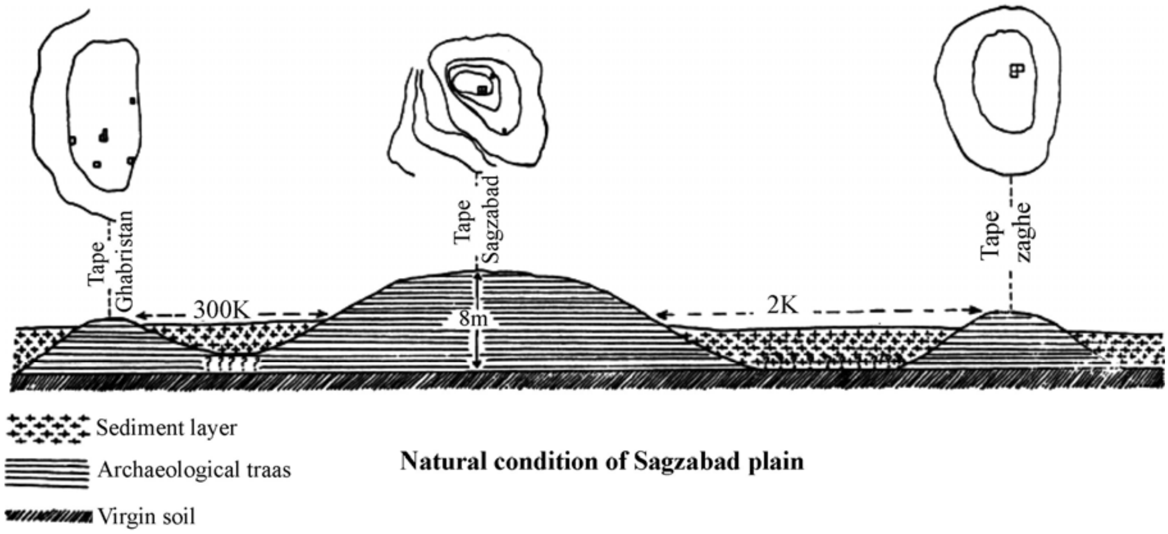

Figure 1 Diagrammatic section through the tells of Ghabristan, Sagzabad and Zagheh (from left) (from Neghaban 1977: Plan 5)

Excavations in the 1970s revealed structural remains of some of the tell's buildings as well as a pre-Bronze Age copper workshop (approx. 4500 BC). The excavations yielded crucibles, molds, a tuyere, some sort of furnace, and a deep bowl with more than twenty kilograms of copper ore in nut-sized pieces. Due to the large amount of alluvial deposits, the former tell is now hardly recognisable as the surrounding agricultural landscape has merged with the site. The fine textured alluvial soil in the plain is fertile and when irrigated, extensive agriculture can be sustained. Even some dry-farming has been reported (Malek Shahmirzadi 1977:29), which may also have been practised in prehistoric times. In recent years, a large number of the Iron Age graves were looted leaving a crater landscape amidst the alluvial plane (Figure 2).

Figure 2 Looted Iron Age graves on tell, surrounded by alluvial plane

The area investigated in this study covers the tell site itself as well as some of the surrounding fields (see Figure 3). It can be subdivided into three major zones:

(i) agricultural areas planted with serial crop; ploughed areas; and bare ground,

(ii) parts of the Iron Age cemetery where looters dug robber pits and

(iii) areas of the 1970s excavations, with deep trenches or stripped topsoil.

The latter zone can also be clearly identified in the Digital Elevation Model of the site (Figure 4) derived from a topographical survey (see below) using Natural Neighbours Interpolation (the height of Station 1 was arbitrarily set to 1000m). The narrow curvilinear ridge in the SW is part of the excavations' spoil heaps. Agriculture is currently sustained through controlled irrigation and several channels cross the survey area (Figure 5).

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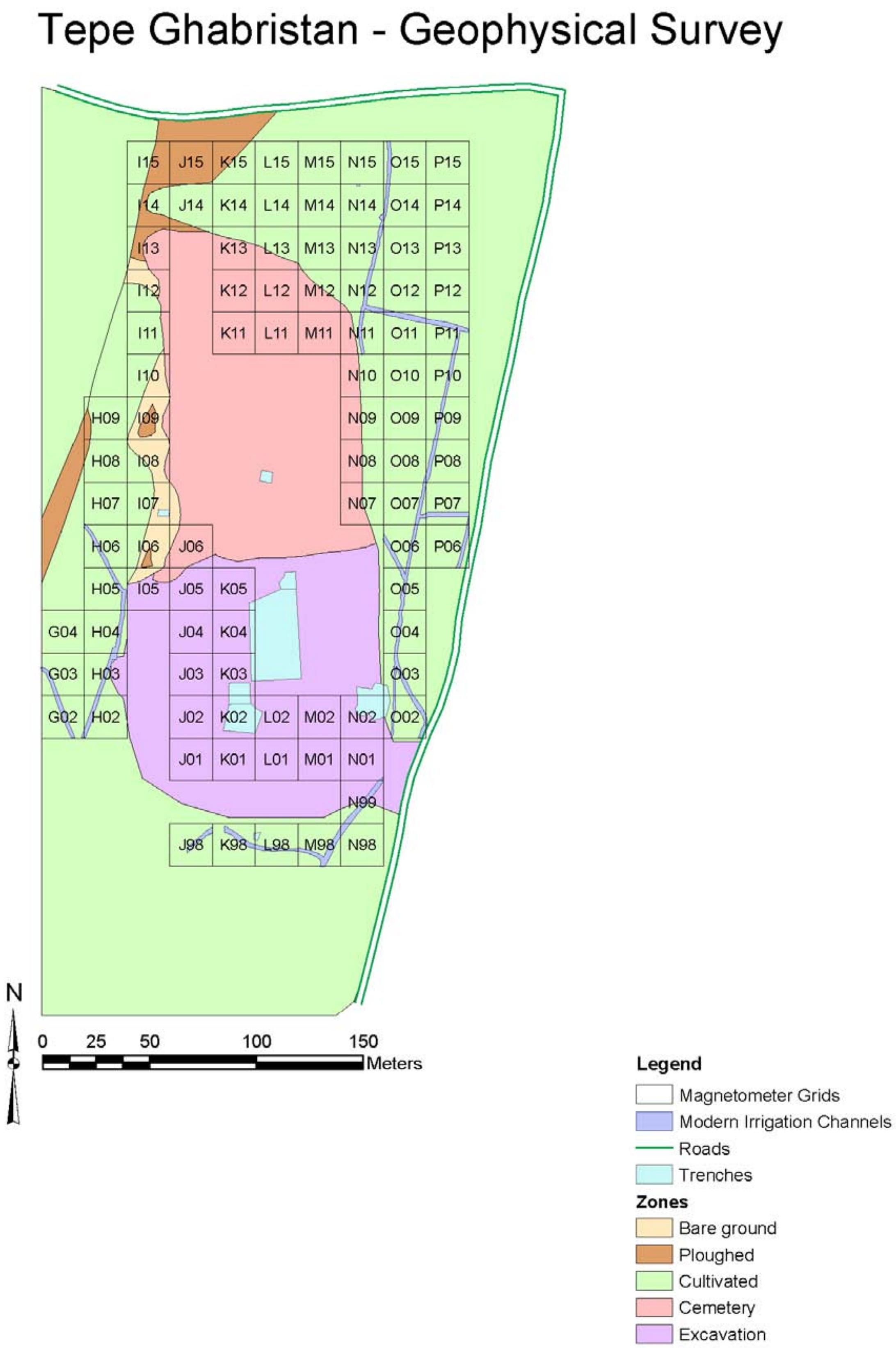

Figure 3 The site with its zones and modern irrigation channels. The geophysical grids are indicated.

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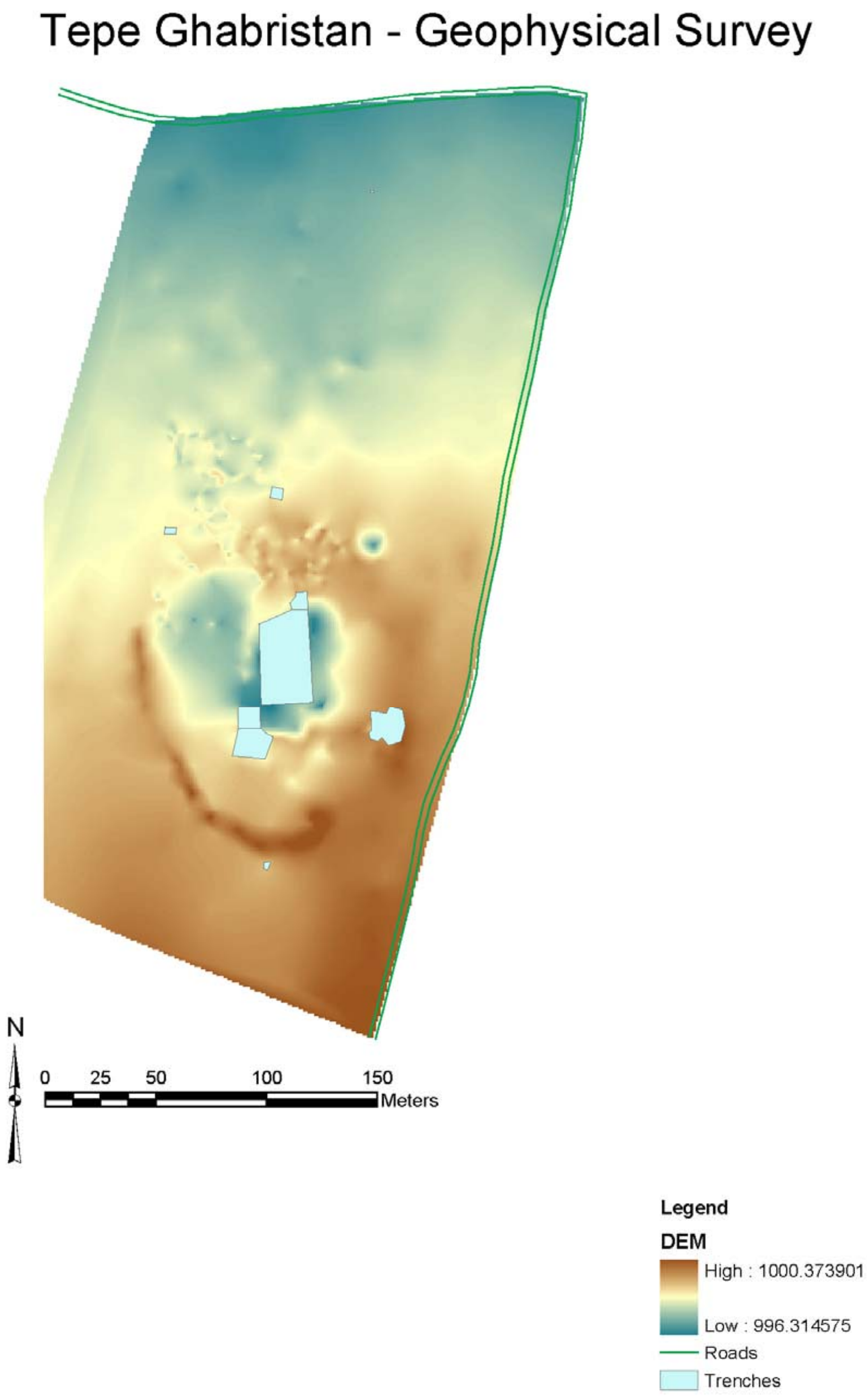

Figure 4 Digital Elevation Model derived form topographic survey

Figure 5 Modern irrigation channels

Survey objectives and method used: The objectives of the survey were to delineate the Iron-Age cemetery on the tell and to test whether any other buried features could be detected with geophysical surveys. A fluxgate gradiometer survey was carried out on the site. The choice of this method was based on the ease of operation and the expected magnetic signature from the graves and possible metal working features on the site.

Methods

Dates of fieldwork: Fieldwork was carried out from 26 March to 4 April 2004 by Armin Schmidt and Timothy Horsley with the help of Hassan Fazeli and Abul-Fazel Ali. ***Grid location:*** A topographical survey had been carried out by Immam Kolli on the site before and four reference stations had been left, marked with metal pegs set in concrete. These were used to establish a site grid (Table 1).

Table 1: Station coordinates within the site grid

Station	X	Y
Stn 1	2000.000	3000.000
Stn 2	1883.078	3049.780
Stn 3	1894.453	3215.393
Stn 4	1987.091	3183.500

A dumpy level was used with these stations to set out a geophysical grid coincident with the site grid. Grids were laid out with a size of 20m × 20m, mainly using tapes to establish right angles. The arrangement of these grids is shown in Figure 3.

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Some mismatch between grid positions was encountered where grids were laid out from different baselines. For example when a chain was laid out along paths 1 and 2 (Table 2) the mismatch at point (1880/3060) was found to be 2m. Grid H5 was therefore laid out in a way that its northern part was aligned with Chain 1 and its southern part with Chain 2. As a result, the spatial accuracy of geophysical anomalies varies across the site from 0.1m (close to reference stations) to 2m.

Table 2 Measurement chains from different baselines

Chain	X	Y
1	1980	3180
	1880	3180
	1880	3060
2	2000	3000
	1880	3000
	1880	3060

In total 89 grids of 20m × 20m were surveyed (3.6 ha), covering the most important part of an 180m × 340m area (6.1 ha).

Geophysical instruments used: The instrument used was a Geoscan Research FM36 fluxgate gradiometer

Sampling intervals: The survey was undertaken along lines, parallel to the grid edges, walking west to east, starting from the NW corner of each grid. The grid size was 20m × 20m, data were recorded every 0.25m along the lines which were 1m apart (20m × 20m @ 0.25m × 1m).

Equipment configurations: The fluxgate gradiometer was set to a recording sensitivity of 0.1nT.

Methods of data capture: Fluxgate magnetometer data were recorded walking with an automatic sample trigger. For most grids, the lines were walked in the same direction (‘parallel’). Only for the first seven grids of the first survey day (K11, K12, L11, L12, M11-M13) ‘zigzag’ surveys were used. The required data processing (see below) suggested that the more time consuming ‘parallel’ data acquisition was preferential and was used for all subsequent grids. In addition, grid M11 (covering exclusively robber pits) was resurveyed in stationary mode where the magnetometer was kept still at each station while a reading was taken. The survey resolution for this repeat survey was 0.5m × 1m. After completion of each grid the drift of the equipment was logged at a reference position and the electronic and mechanical setup of the instrument adjusted.

Methods of data processing: Data were downloaded and processed using *Geoplot*. The first seven grids (see above) required destriping and destaggering. All other data only required a ‘Zero Mean Grid’ background subtraction due to the use of different reference positions for each survey area. The quality of the data was very high and no further processing was required.

Methods of data presentation: The data were imported as floating point grid into ArcGIS 9 and displayed as greyscale diagram (black is high) together with supporting feature data. These were partially derived from the original topographical survey (e.g. road, major trenches) in the form of an AutoCAD drawing, and partially by digitising field sketches, recorded by the geophysics team.

Results

Overall Description: The overall results of the magnetometer survey are presented in Figure 6 (left: data, right: data with interpretation diagram). The modern irrigation channels are clearly visible as linear features in the data and are traced to show their layout more clearly. They are also shown in Figure 3 together with the zones of land, use. The detailed interpretation of results focuses on five areas (*A-E*) that are outlined in Figure 7.

Area A: Figure 8 shows the magnetometer data for grid M11, which were collected as stationary readings (see above), after interpolation and weak lowpass filtering. The plot is overlaid with the outline of depressions that were recorded on the surface (see also Figure 2). It is clear that there is a direct correlation between each robber pit and a strong negative anomaly. This can be explained by a strongly magnetic soil that leads to negative readings where it is dug out and the magnetometer is lowered into it while surveying, mainly being influenced by the sides of the cut. The data show that there are very few other anomalies that can be detected in this area and it was subsequently decided not to survey other areas of the looted graveyard (see also Figure 3).

Area B: Figure 9 shows an area just to the north of the looted graves (delineated by the Zone Boundary) where a cluster of negative anomalies has been identified. In their appearance and distribution they are very similar to the visible robber pits. They are weaker and slightly broader than the latter indicating a greater depth and coverage with a soil layer. They are hence interpreted as excavations, most likely for graves. It is therefore suggested that this area is a continuation of the Iron Age cemetery that is as yet undisturbed.

Area C: To the west of the survey area, in agricultural land and outside of the disturbed zone are further negative anomalies (Figure10) that are similar to those identified in *Area B* but less clear and not as well clustered. It is possible that these are also outliers of the Iron Age cemetery.

Area D: It is clear from the overall data visualisation (Figure 6) that many anomalies form linear segments (either positive or negative), very similar to the modern irrigation channels. Hence it is assumed that all of them are part of previous irrigation systems. It is not possible to assign a date to them but most of them are as straight as the modern ones.

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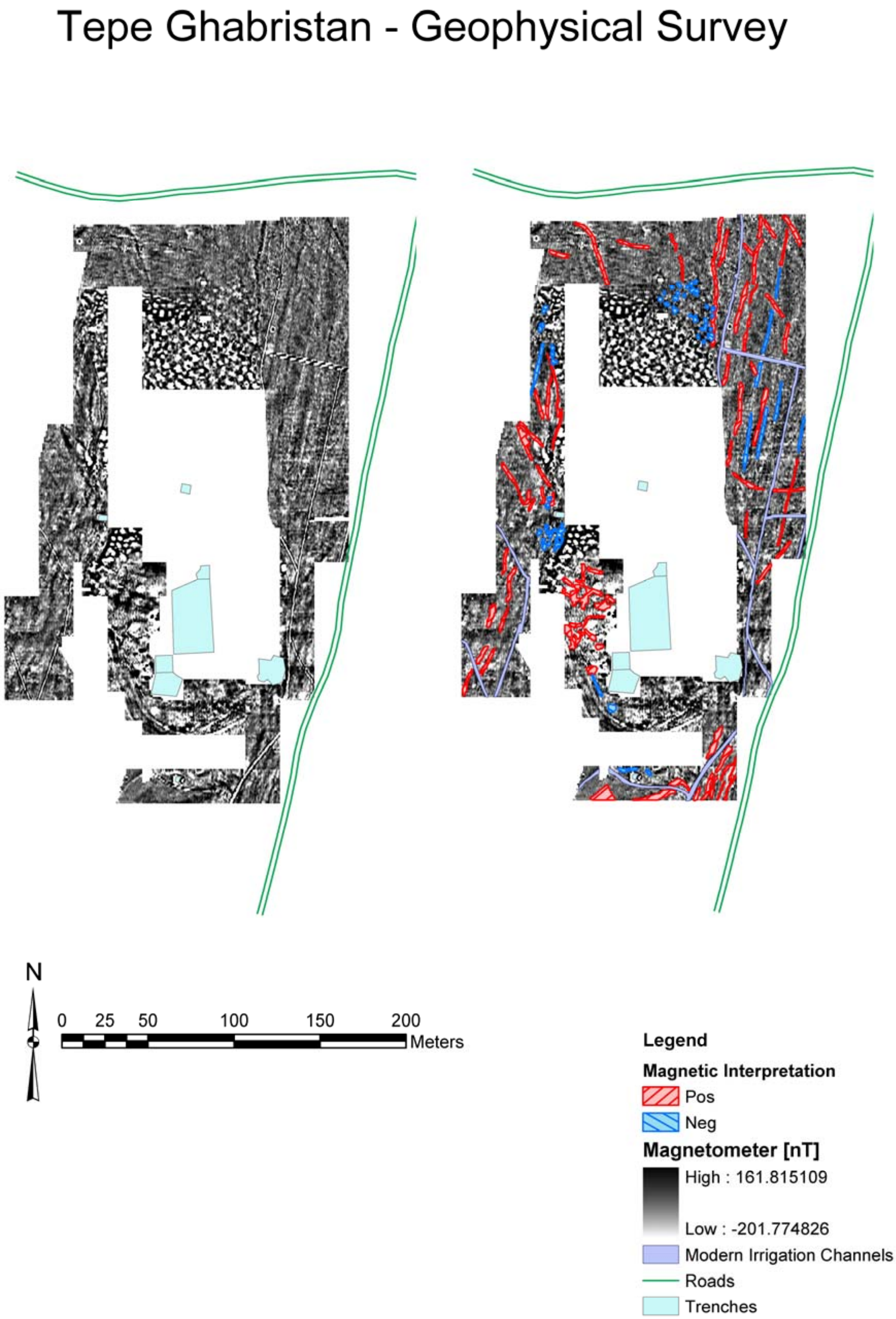

Figure 6 All magnetometer data

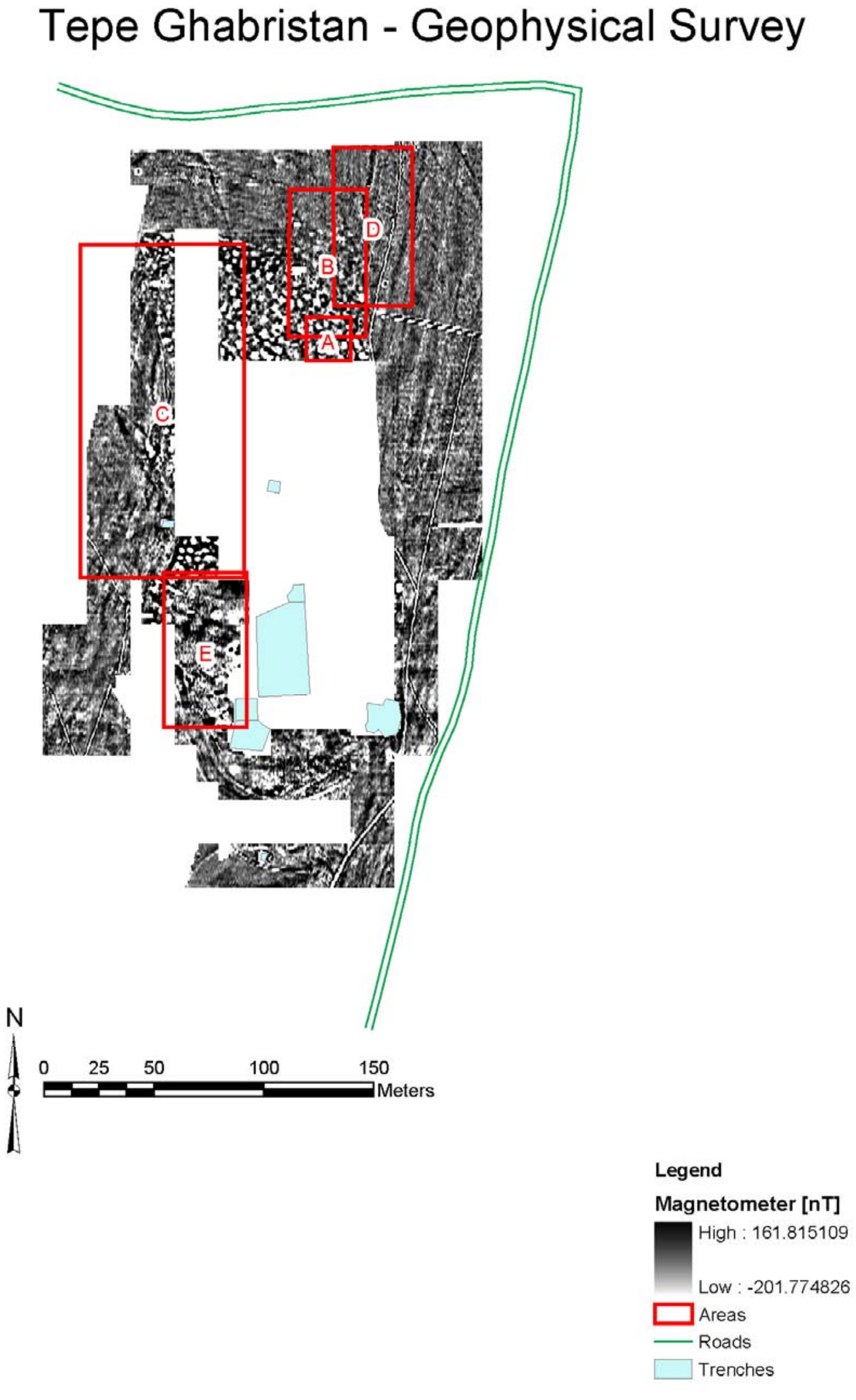

Figure 7 Areas of detailed interpretation

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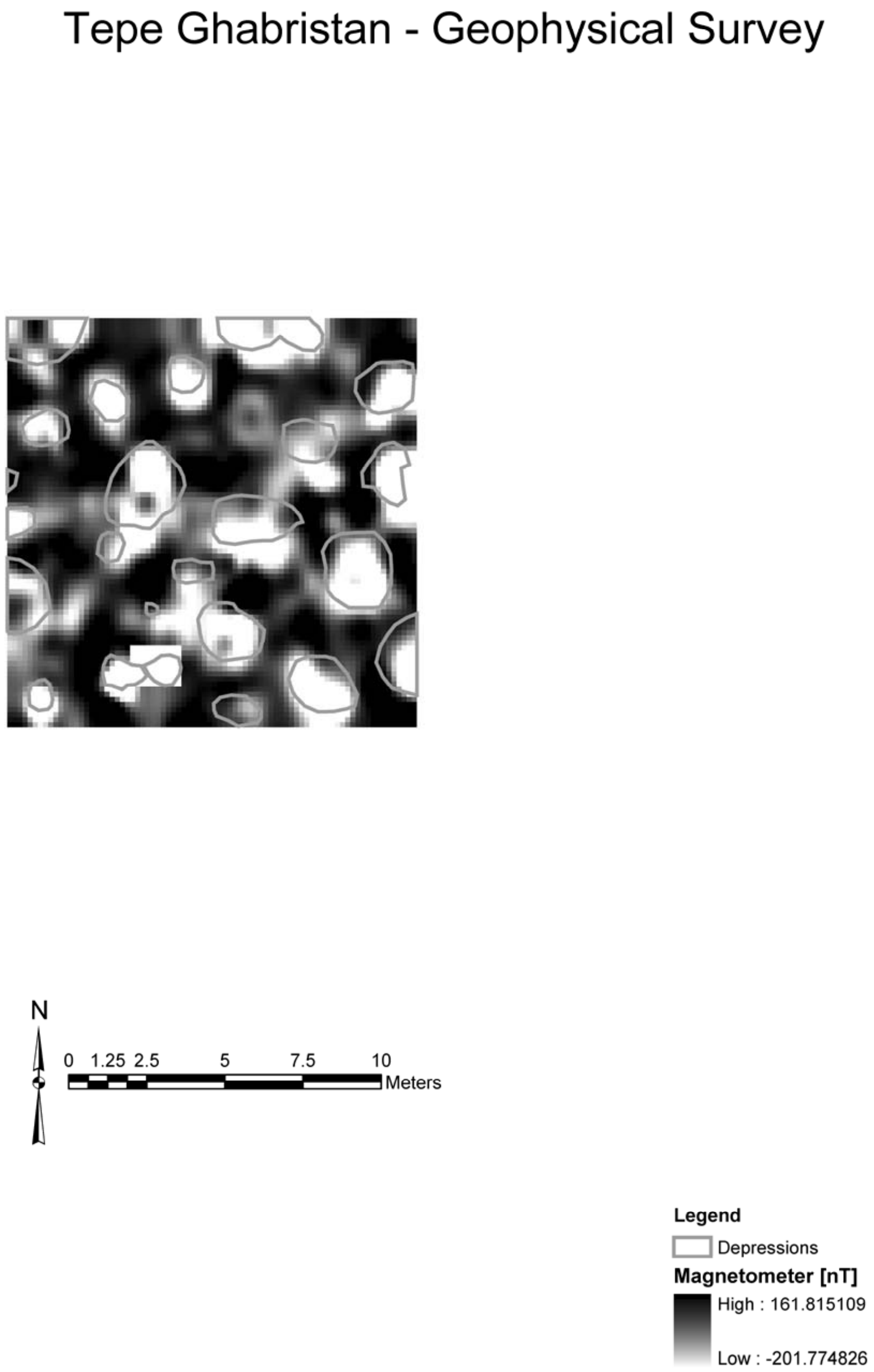

Figure 8 *Area A*

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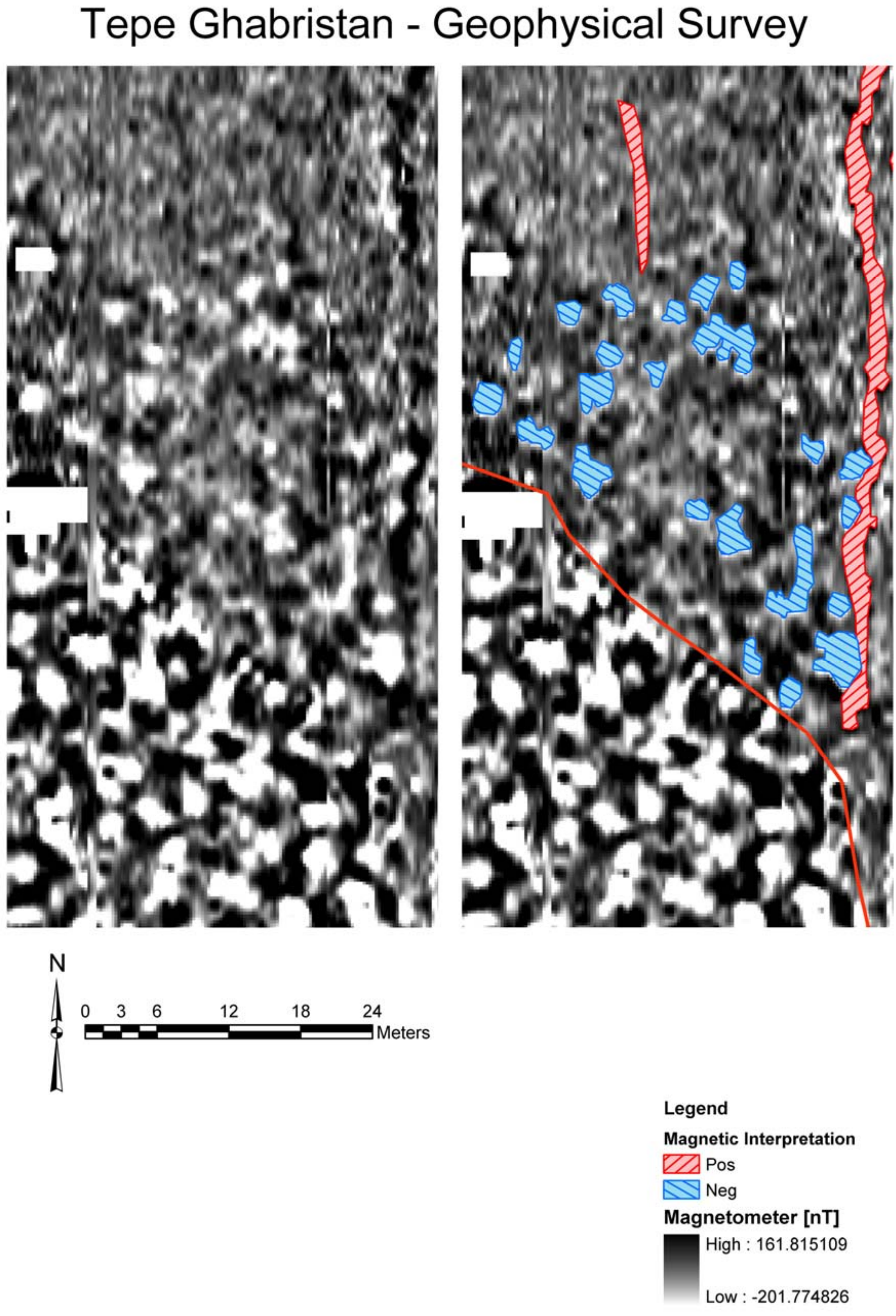

Figure 9 *Area B*

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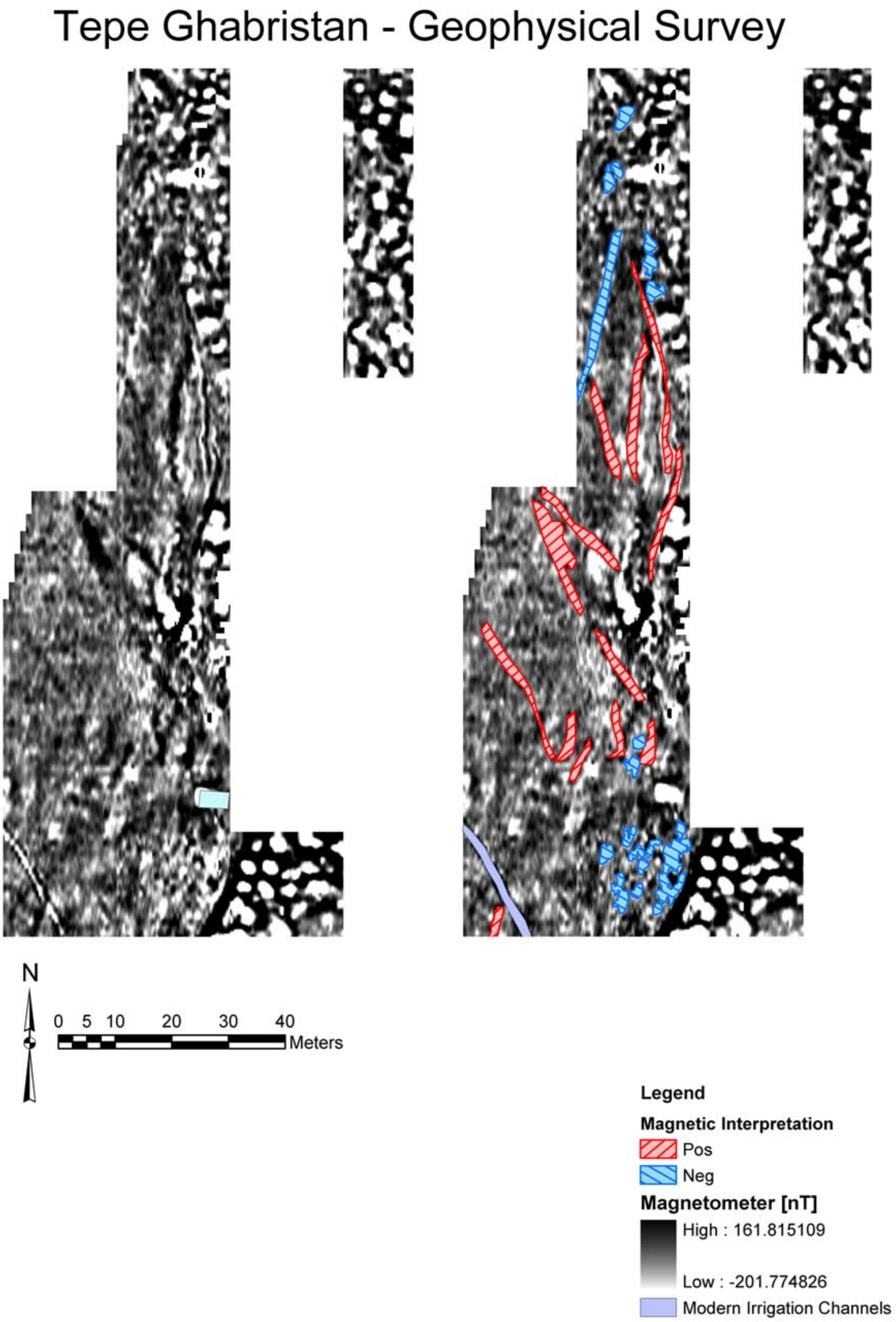

Figure 10 *Area C*

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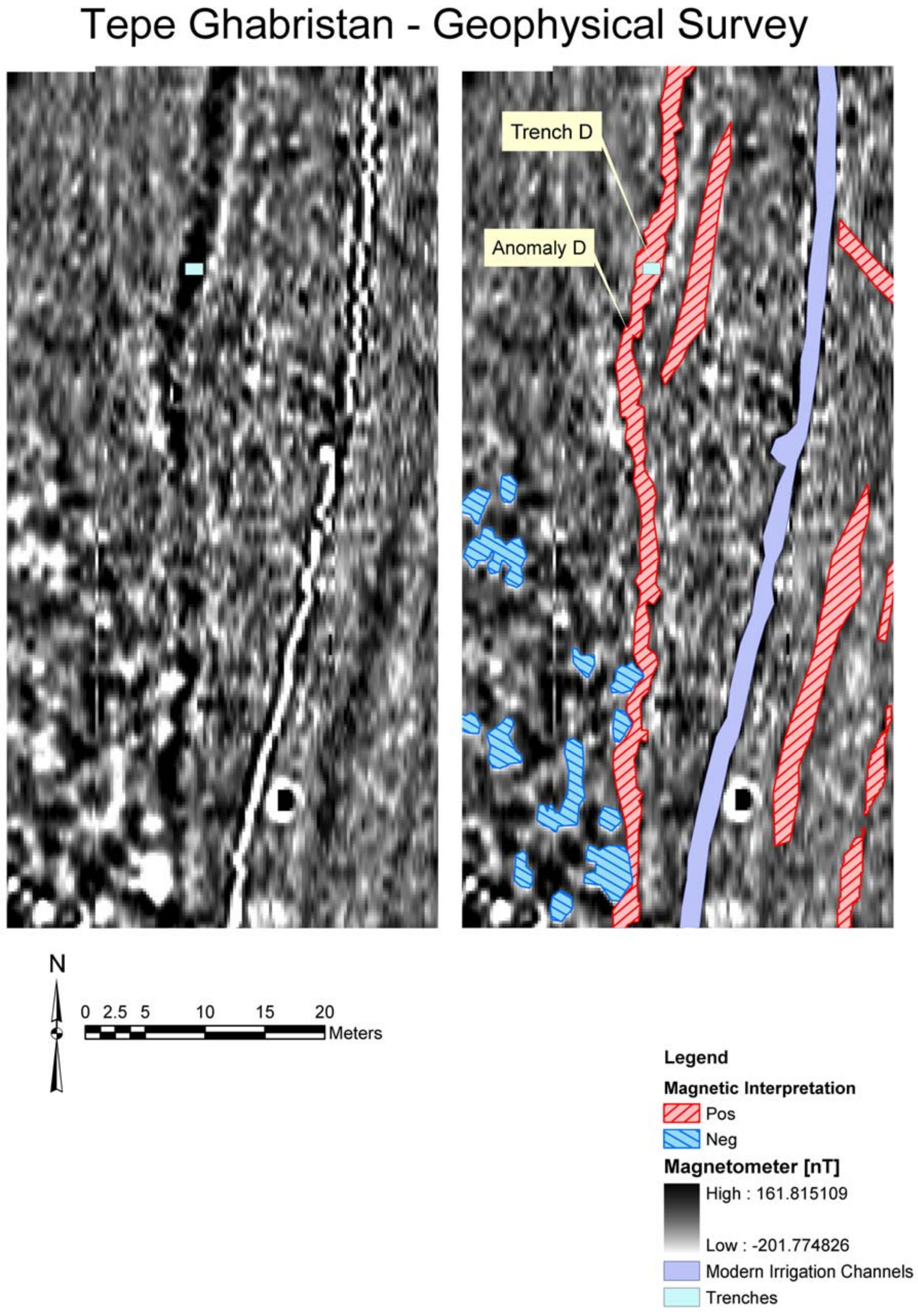

Figure 11 *Area D*

A notable exception is the segment of high magnetic readings that is much more irregular in shape (Figure 11, *Anomaly D*). This may be taken as an indication that it is an older irrigation channel that was possibly used in prehistoric time. At its southern end, it seems to be cut into by the negative anomalies identified in *Area B*. If these are caused by Iron Age graves, as argued above, then this irrigation channel has to be contemporary or earlier than the Iron Age graves. Further, to test the nature of this anomaly, a small test trench was dug across it (*Trench D*, see Table 3 for coordinates). A sketch of the section through this channel is given in Figure 12.

Table 3 Corner coordinates of Trench D

Corner	X	Y
SW	1987.5	3259.0
NE	1989.0	3260.0

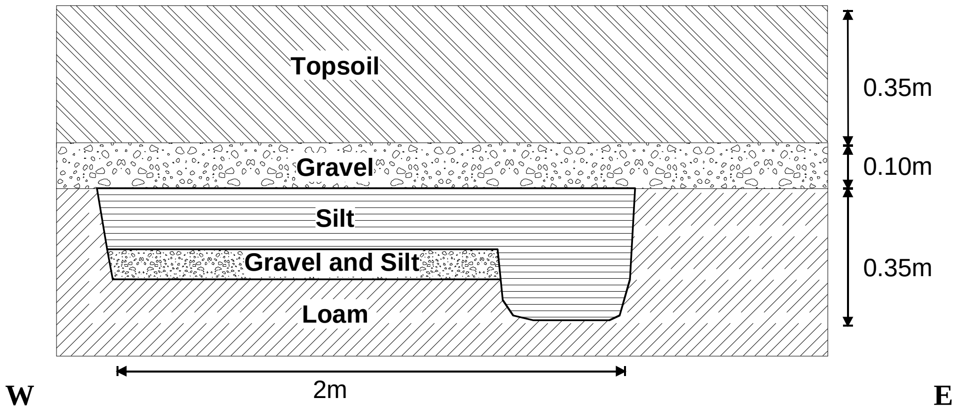

Figure 12 Sketch drawing of excavated irrigation channel in Trench D

The excavation clearly showed that the channel had been re-worked several times: the initial flat bottomed channel was flooded leaving it filled with gravel and silt; it was then re-cut with a deeper gully at its eastern side; after this re-cut channel had silted up, it was once again flooded and buried under a thick layer of gravel; on top of this gravel layer is the modern topsoil. The bottom of the initial channel is about 0.7m below the current surface, which explains clearly in the magnetometer data. Such depth is broadly compatible with the Iron Age graves, which are estimated to be dug to about 1-1.5m below the current highest ground.

Area E: Just west of the large excavation trenches of the 1970s, topsoil had been removed and the magnetometer survey was done close to possible buried features (see Digital Elevation Model of the site, Figure 4). The positive magnetic anomalies in the northern part of *Area E* (Figure 13, *Anomalies E*, cross hatched symbols) have a rectilinear appearance aligned to WNW – ESE. They are similar to the building remains uncovered in the 1970s excavations and can hence be interpreted as buried rectilinear buildings. To the NE and SW of this anomaly complex lies a large (5m) negative and a strong positive (+75nT) anomaly, respectively. Especially, the latter could be caused by thermoremanent magnetisation and it is hence possible that the structural remains may be associated with copper metalworking, similar to that identified in some of the excavated buildings. To the south of this identified complex further positive anomalies can be seen although they are less distinct. Some are curvilinear and others localised, some of the latter are related to dense pottery scatters on the ground.

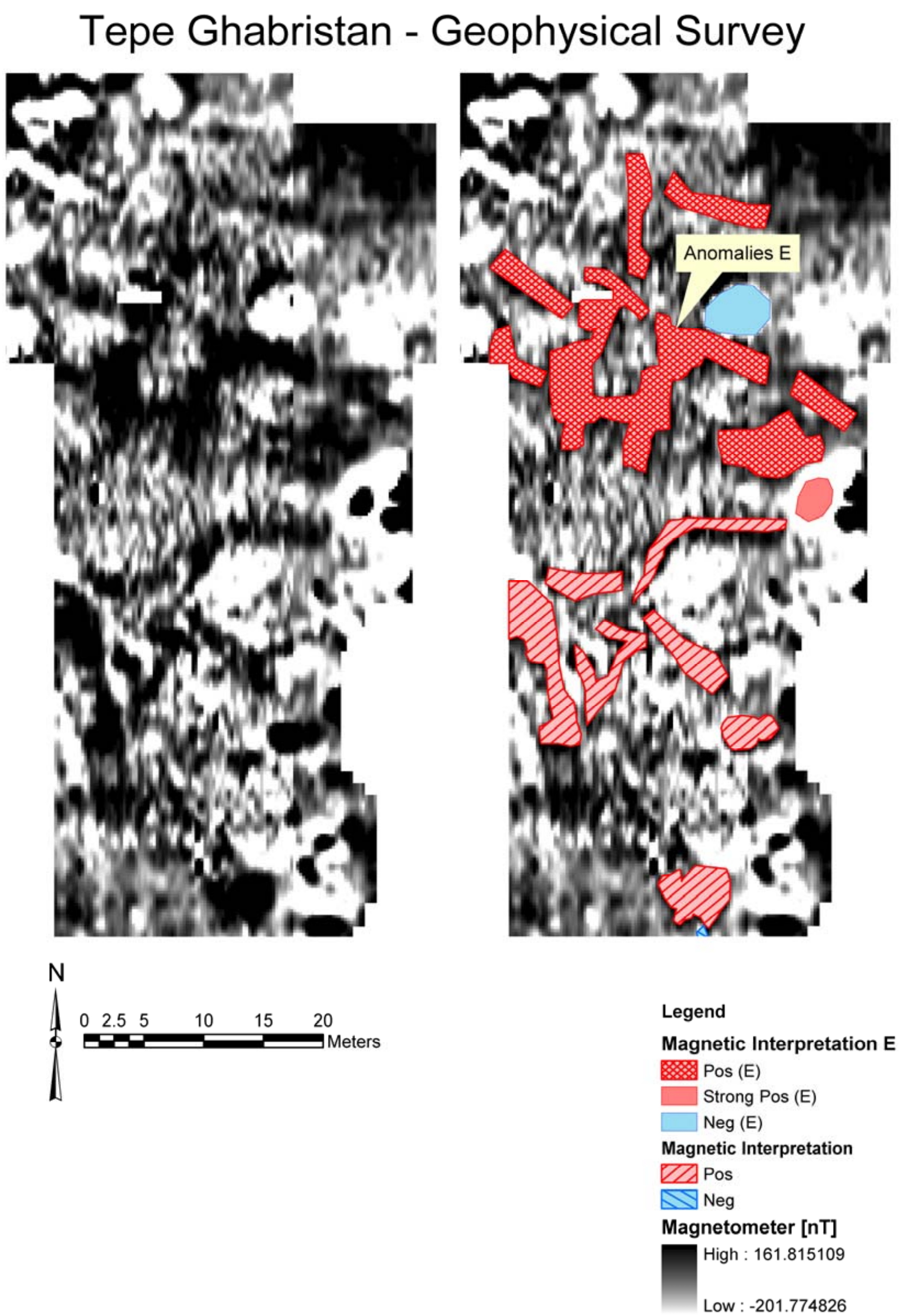

Figure 13 Area E

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Conclusions

Summary of results: The survey identified further areas of the Iron Age cemetery with possible grave pits (*Areas B* and *C*). In addition, an irrigation channel was discovered which could be contemporary with these Iron Age graves (*Area D*). The anomalies in *Area E* can be interpreted as buried structural remains, possibly linked to metalworking.

Degree of achievement of objectives of the survey: The survey was hence able to fulfil its aim of delineating the extent of the Iron Age cemetery and it detected additional buried features.

Implications: The findings allow to target the remaining areas of the cemetery with rescue excavations. A detailed geoarchaeological and environmental study of the old irrigation channel (*Anomaly D*) may provide evidence for the ancient agricultural and environmental regime, which could be supported by radiocarbon dating of organic remains there. If further excavations were to take place at Ghabristan, the identified structural remains (*Feature E*) would form an interesting target.

Geophysical research value: In addition to the archaeological results, the survey has shown how some information about the temporal sequence of buried features can be obtained from careful investigation of the intersecting anomalies and from the specific feature shapes.

Recommendations: It is recommended out of the results that rescue excavations are instigated for the remainder of the Iron Age cemetery. A more detailed archaeological investigation of the ancient irrigation channel (*Anomaly D*) will reveal further insight into past agricultural practices.

Archiving: The results of this survey (electronic and paper report) were handed to the client. The contractor will ensure the report's archiving as well as that of the acquired data.

Statement of Indemnity

The results and subsequent interpretation of geophysical surveys should not be treated as an absolute representation of the underlying features. It is normally possible only to prove the nature of anomalies through intrusive means, such as trial excavations.

Acknowledgements and Contacts

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Technical Information

Fluxgate Gradiometer Survey

The fluxgate gradiometer indirectly measures the magnetic susceptibility of underground material, and also detects features exhibiting remanent magnetisation. The instrument contains two fluxgate sensors. The upper sensor mainly detects variations in the Earth's magnetic field due to geology and secular variation, while the lower sensor detects variations due to the geology, the secular variations *and* any variations due to buried features. When the upper reading is subtracted from the lower reading, only the variations due to subsurface features remain. For the sensors to work in tandem correctly, both must be as vertical as possible. If the sensors are not entirely vertical, the instrument has a slight directional dependence, which can lead to errors on surveys walked zigzag (for a more technical discussion of the techniques, see Scollar *et al*, 1990, 422-516, or Clark, 1996, 64-98). These problems were avoided by careful adjustments to the instrument before measurements of each individual grid.

Fluxgate gradiometer surveys are most effective when searching for areas of high magnetic enhancement, such as metallic objects, burnt areas, or areas of thicker topsoil, such as ditches and pits.

تپه قبرستان: گزارش نتایج بررس ژئوفیزیک

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تپه قبرستان در فروردین ۱۳۸۳ به وسعت شش هکتار مورد بررسی ژئوفیزیک قرار گرفت. هدف از تحقیقات ژئوفیزیک شناسایی قبور عصر آهن و بخشهای صنعتی هزاره چهارم قبل از میلاد در محوطه مورد اشاره بوده است. این طرح به طور مشترک بین سازمان میراث فرهنگی و گردشگری، موسسه باستان شناسی دانشگاه تهران و دپارتمان علوم باستان شناسی دانشگاه برادفورد به انجام رسید. در این پژوهش تیم تحقیق موفق به شناسایی کانالهای کشاورزی عصر آهن، قبور هزاره اول و شناسایی بخشهای صنعتی هزاره چهارم قبرستان شدند. نتایج این بررسی از آن جهت مهم است که راه را برای تحقیقاتی آتی دانشگاه تهران در دشت قزوین را هموار کرده است. مقاله حاضر به بحث درباره اهداف، روشها و برخی از نتایج ژئوفیزیک تپه قبرستان پرداخته است.

واژگان کلیدی: تپه قبرستان، بررسیهای ژئوفیزیک، قبر، کانالهای کشاورزی، عصر آهن، کالکولیتیک، عصر آهن

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