

**A MAGNETIC SURVEY AT THE CEMETERY OF
THE PONCA TRIBE OF NEBRASKA**

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INTRODUCTION

The cemetery of the Ponca Tribe of Nebraska is near Niobrara, Nebraska. The Tribe plans to erect a gate structure at the entrance to the cemetery. In so doing they wished to avoid impinging on any unmarked graves in the gate area. I was asked to see if it was possible to detect any such graves using geophysical methods commonly employed in archaeological investigations. This is a report of the attempt to answer that question.

LOCATION AND ENVIRONMENT OF THE SURVEY

The Ponca Tribe cemetery is located five miles northwest of the town of Niobrara, Nebraska. It is roughly 200 meters square in area, lies in rolling hills and is surrounded by a barbed wire fence. To the east and north of the cemetery is a field containing a buffalo herd owned by the Ponca Tribe. Figure 1 shows the cemetery entrance with the Niobrara River in the background.

We divided the area of interest into squares or blocks 20 meters on edge. Blocks A and B covered the gate construction area. Blocks C and D covered areas of marked graves. We chose these latter areas in order to have survey signals or anomalies characteristic of graves to use as controls against which to compare possible signals of unmarked graves. Figure 2 is a layout of the survey blocks with certain standing markers indicated: a telephone pole, the south end of the east fence and the flagpole. A transit was used to sight in the markers. The three positions used by the transit are marked in Figure 2. The details of the sightings are listed in the Appendix.

Figure 3 is a picture of the survey crew in the middle of Block B. The south end of Block A was against the south fence. The east edges of Blocks A and B was next to the east fence.

Control Block C was contiguous with Blocks A and B and included a group of trees and some marked, as well as unmarked, graves. The area covered by Block C is in the upper right corner of Figure 3. Figure 4 is a view of the survey crew in Block C. Control Block D lies 80 meters up the hill from Block C in the next group of trees and also contains some marked and unmarked graves.

FIELD METHODS

Working with a crew of three generously supplied by the Midwest Archeological Center, National Park Service, Lincoln, Nebraska, we had planned to utilize two geophysical methods, magnetic survey and ground resistance survey. Unfortunately the resistance equipment failed in the field so we were restricted to magnetic survey. In this method the total magnetic field of the earth is measured about 30 cm above the surface on a grid of

points over the area of interest. This is a very sensitive instrument. The unit of field strength in this study is the "nano Tesla" or nT. In these units the field of the earth in this area is roughly 57,000 nT while the sensitivity of the magnetometer is about 0.03 nT. This is a sensitivity of about 2 parts in a million of the earth's field.

Differences in the iron mineralogy of the soils within the first meter or so of the surface can be detected and can produce "anomalies" in the data when plotted as contour lines of equal magnetic field strength. Such mineralogical differences can be natural. They can also result from excavations in the soil that replace the natural profile of the subsoil with intrusive amounts of topsoil or by placing into the subsoil objects of a different iron content. The natural or geological differences tend to be long range while the intrusive changes are shorter range. Iron metal objects produce anomalies that are relatively strong and can usually be recognized as metal.

The instrument used was a Geometric G858 Cesium Gradiometer. In this instrument two cesium vapor sensors are placed one above the other with the upper reading subtracted from the lower reading. The lower sensor was 0.3 m above the surface. The upper sensor was 1.2 m above the lower sensor. Because of the large sensor separation the difference readings approximate a total field reading. This operation cancels out time changes of the magnetic field as well as suppressing long-range trends in the background field.

The blocks were marked with non-magnetic ropes. Readings were taken every 1/2 meter on traverses separated by 1/2 meter. Thus each 20 m by 20 m block contained 1600 readings. In Block D, for lack of time, the grid unit used was 1 m by 1 m, which resulted in 400 readings for the block. All readings were then entered into a computer for the plotting of maps.

RESULTS

Figure 5 is a color map with line contours of the three blocks A, B and C. In preparing this map and others of Blocks A and B some of the strong data points near the fence were removed in order to decrease the strong effect of the iron in the fence. It can be seen immediately that there are many more anomalies in Block C than Blocks A and B. That is because Block C contains graves. Figure 6 is a line contour map of Block C with grave markings that we could see at the time of the survey. The very strong anomaly at E8.5,N13 is caused by an iron rod standing at this position. The question that has to be examined is whether the anomalies in A and B are possible graves. We will come back to that question shortly.

Figure 7 is a color map with line contours and grave markings of Block D. Because of shortness of time we used a grid interval of 1 m instead of 1/2 m that was used in all the other blocks. There is a distinct difference in the anomalies in Block D; the anomalies are much stronger and broader. The breadth is partially a result of using a large grid interval, but that does not explain marked difference in the strength of the anomalies. Compare the contour interval used in Figure 7 with that in Figure 6. The difference is a

result of some feature of the graves in this area. I suspect that these graves, as distinct from the graves in Block C, were internments that used vaults. I believe that only one grave in Block C, the one in the Northwest corner, used a vault. The marked difference in the anomalies in Block D prevent us from using this block in comparing the anomalies with those in Block A and B.

INTERPRETATIONS AND RECOMMENDATIONS

Getting to the fundamental question: are there unmarked graves in Blocks A and B. We show in Figure 8 Block A and in Figure 9 Block B. These are line contour maps without color. Also the anomalies are marked with identifying numbers. Table I is a list of the anomalies in Blocks A and B with number, location and comment. The average and standard deviation of all the listed anomalies in blocks A and B is 38 +/- 36 nT. In comparison the average and standard deviation for the anomalies in block C is 162 +/- 435 nT which is considerably larger with a greater scatter.

TABLE I
Ponca Tribe Cemetery
Magnetic Anomalies in Blocks A and B

ANOMALY	NORTH	EAST	SIZE nT	PROFILE WIDTH, COMMENT	POSSIBLE?
A1	23.5	15	90	1 m, wide	yes
A2	29	12	65	1/2, narrow	no
A3	33.5	11	69	1 m, wide	yes
A4	38.5	13.5	110	1/2 m, near fence	
A5	23.5	8.5	25	1/2 m	no
A6	26.5	9	25	1/2 m	no
A7	31	5	-25	1/2 m, negative	no
A8	35.5	1.5	25	1/2 m	no
B1	21	30.5	15	1/2 m, negative, very narrow	no
B2	23.5	32	70	1 m, complex	yes
B3	21	36	10	1/2 m, small	no
B4	38.5	36	40	1/2 m, near fence	no
B5	35	31	15	1/2 m, small	possible
B6	35	29.5	21	1/2 m, small	possible
B7	29	20.5	10	1 m, pile of dirt	no

Several of the anomalies in Blocks A and B have sources that are very near the surface, as determined by the north-south profiles. The significance of that is that an object near the surface will produce an anomaly that has a narrow south-north profile. Such an object is usually a small piece of iron and is therefore not significant. I have examined all the profiles of the marked anomalies and have concluded that a few of them

could possibly have sources that are unmarked graves, although I have strong doubts. The most significant anomalies in A and B are A1, A3 and perhaps B2.

To determine if these indicated anomalies are possibly graves two or three or them should be tested with careful excavation by qualified archaeologists. If none of the tests result in indications of graves then it is reasonably safe to assume that there are no unmarked graves in the area of the cemetery next to the entrance.

ACKNOWLEDGEMENTS

This survey was made possible by the generous support of the Midwest Archeological Center, National Park Service in Lincoln, Nebraska. Dr. Mark Lynott, the director provided three of his employees to carry out the fieldwork. The tedious fieldwork was very ably carried out by William Volf, Ann Bauermeister and Meghan Sittler of the Midwest Center.

Many thanks are due Rob Huggins of Geometries, Inc who saw to it that we were able to obtain the G858 Cesium Gradiometer free of rent.



Figure 1: Ponca Tribe Cemetery, Entrance View

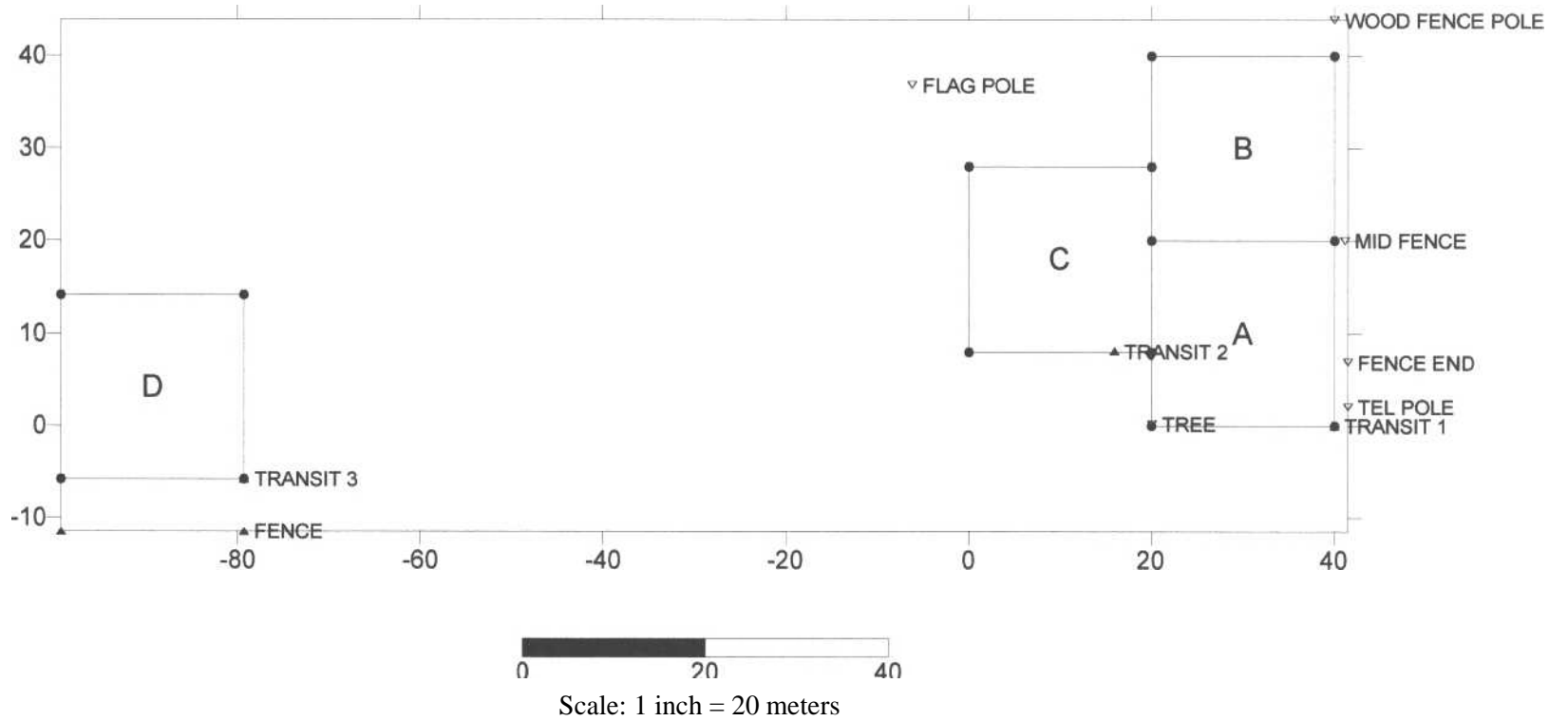


Figure 2: Ponca Tribe Cemetery, Magnetic Survey, Block Layout Including transit positions and other data points



Figure 3: Ponca Tribe Cemetery, Survey Crew in Block B



Figure 4: Ponca Tribe Cemetery, Survey Crew in Block C

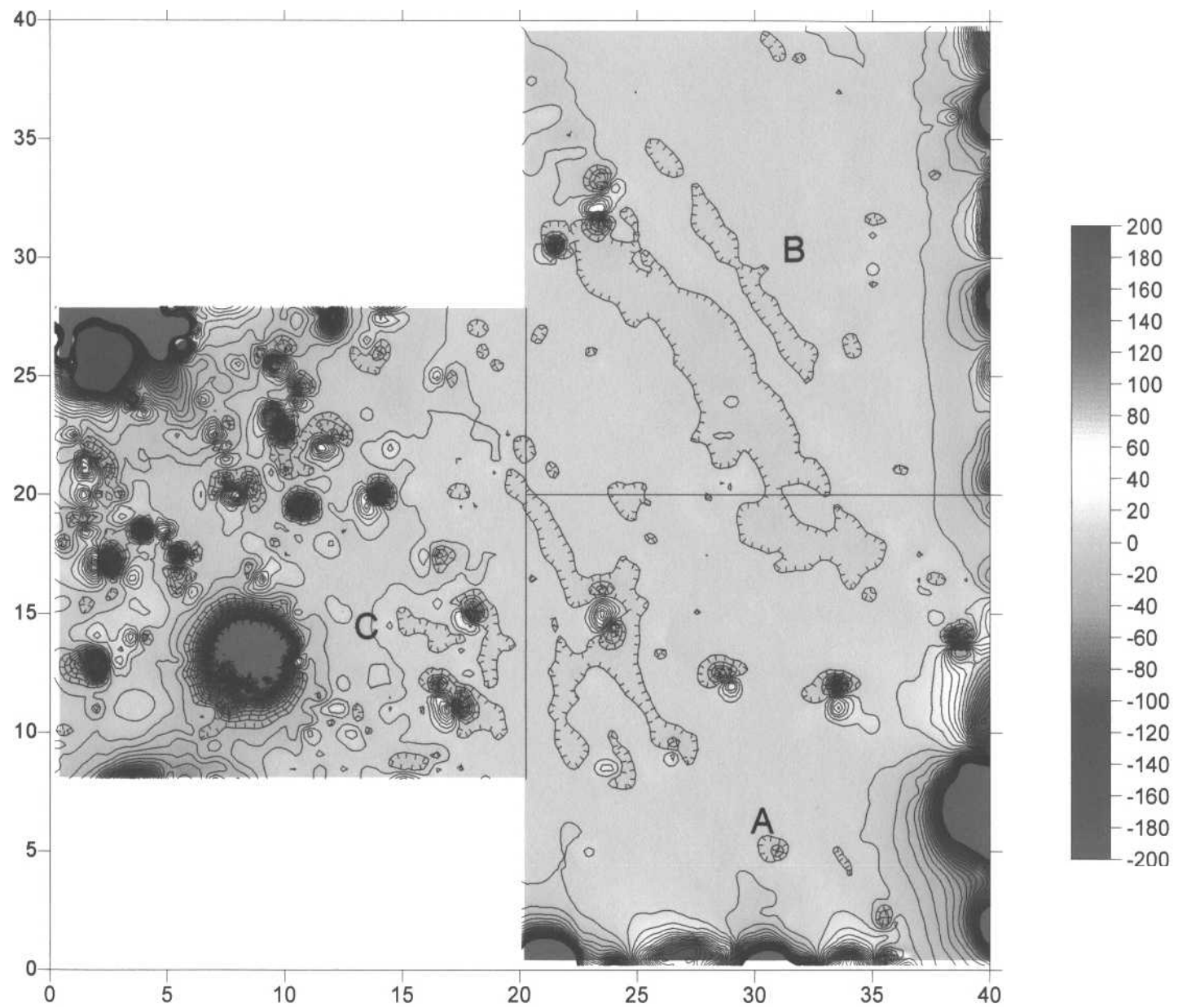


Figure 5: PONCA TRIBE CEMETERY, MAGNETIC SURVEY
Blocks A, B and C, interval 10 nT, clipped +/- 200 nT

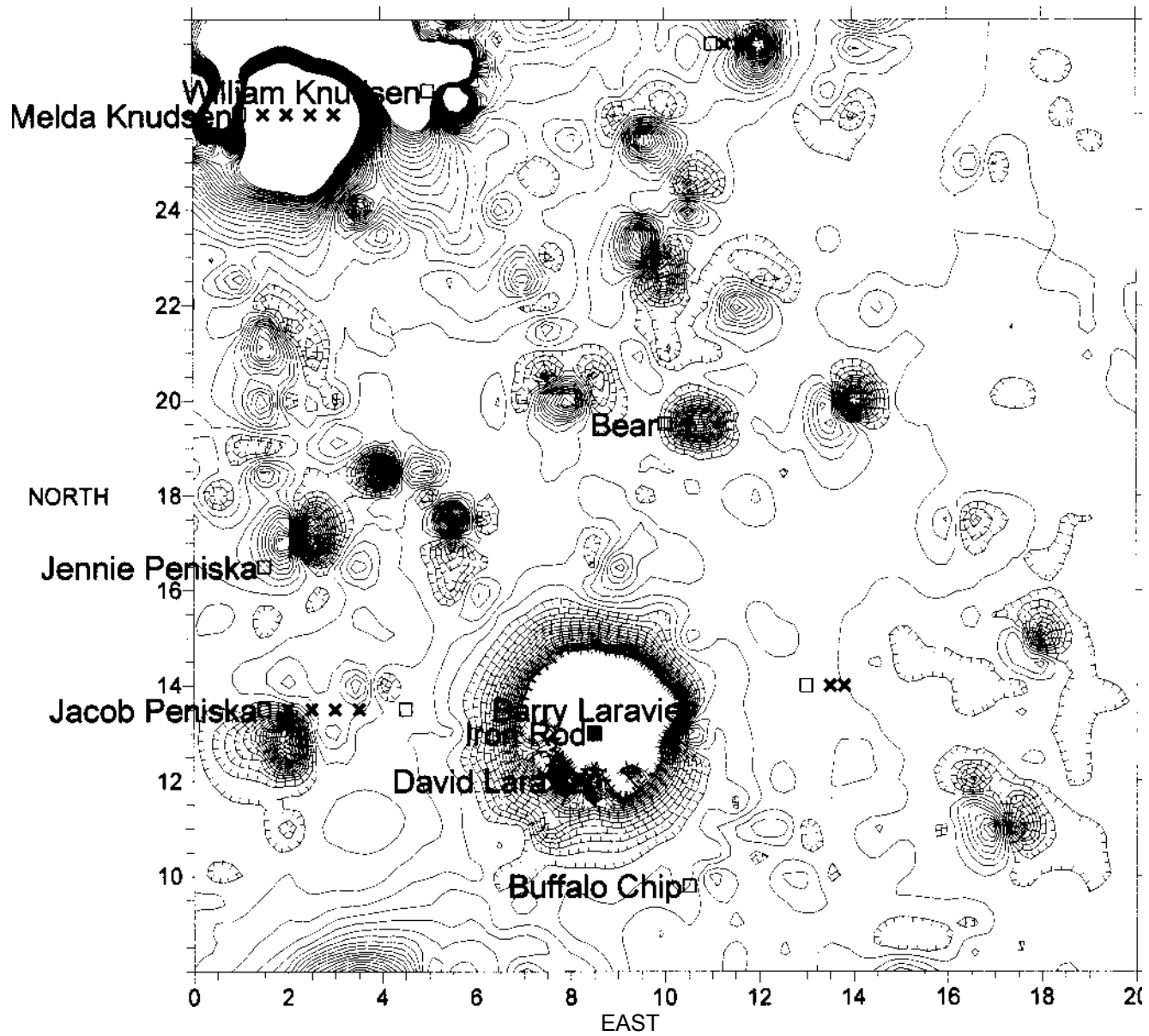


Figure 6: PONCA TRIBE CEMETERY, BLOCK C, MAGNETIC MAP WITH GRAVE MARKS
 Contour Interval 10 nT, Clipped +/- 200 nT
 Mounds Marked with "x", Stones Marked with Square

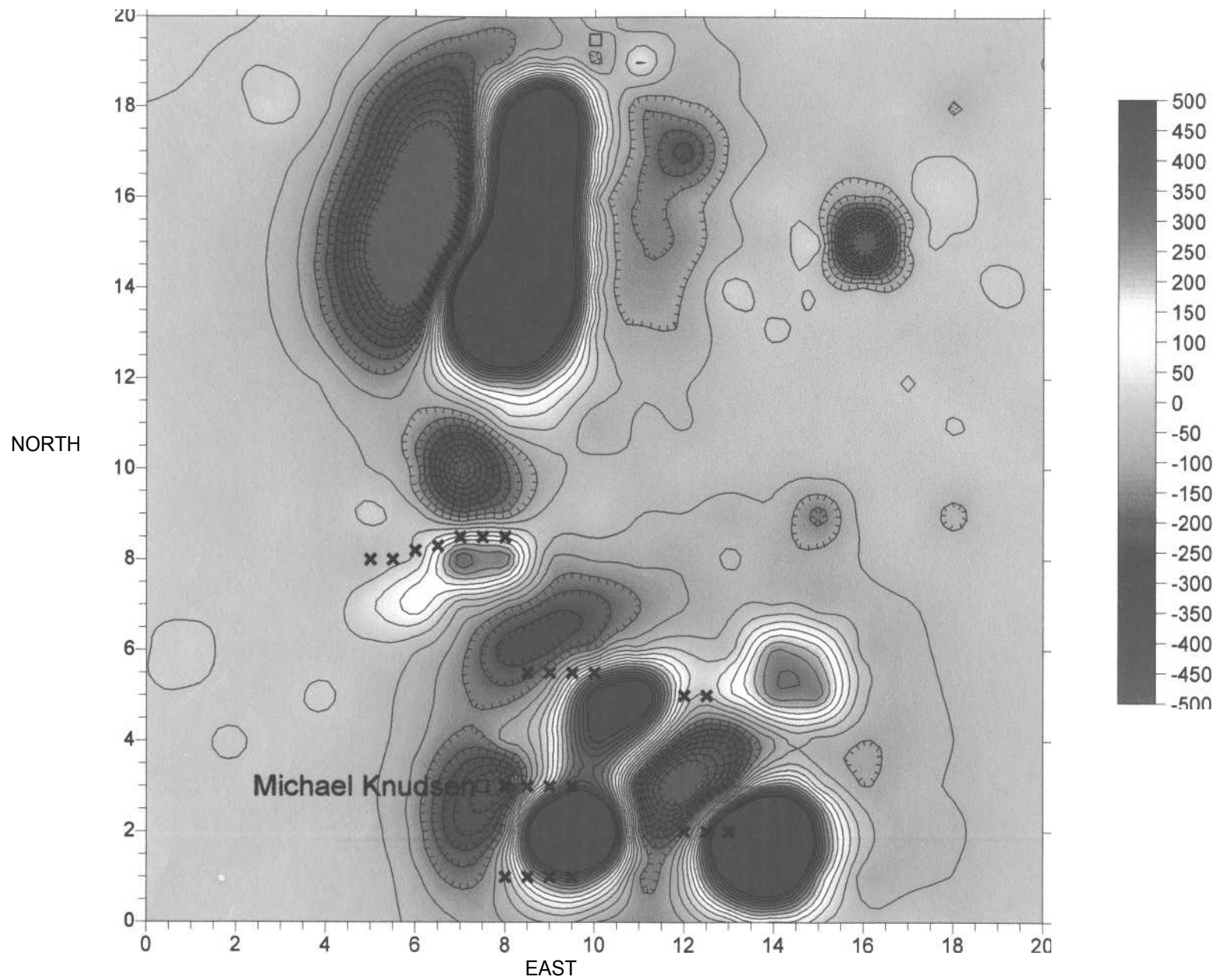


Figure 7: PONCA TRIBE CEMETERY, BLOCK D, MAGNETIC MAP WITH GRAVE MARKS
Contour Interval 50 nT, Clipped +/- 500 nT
Mounds Marked with "x", Stones Marked with Square

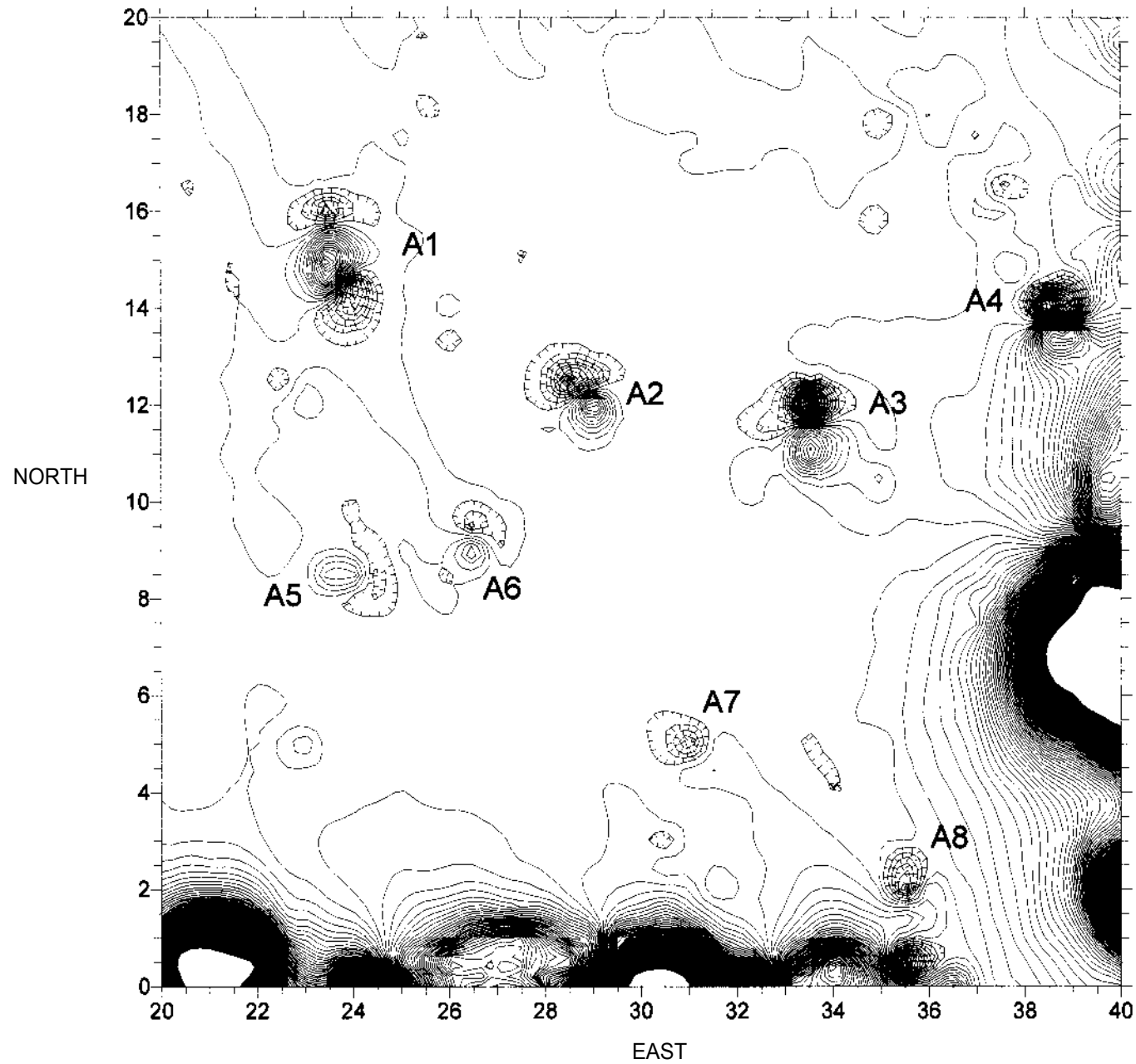


Figure 8: PONCA TRIBE CEMETERY, BLOCK A, MAGNETIC MAP WITH ANOMALIES MARKED
Contour Interval 5 nT, Clipped +/- 500 nT

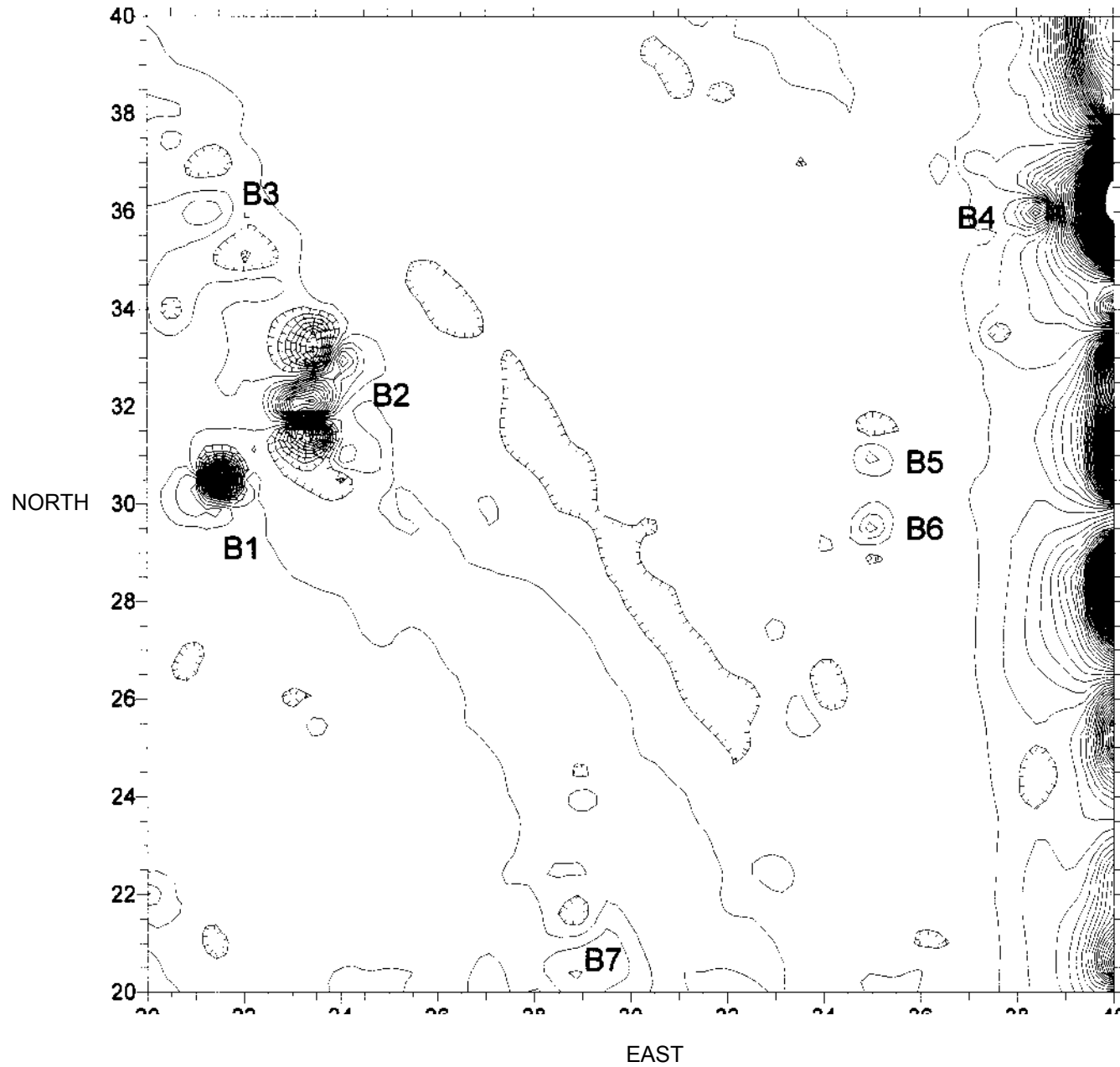


Figure 9: PONCA TRIBE CEMETERY, BLOCK B, MAGNETIC MAP WITH ANOMALIES MARKED
Contour Interval 5 nT, Clipped +/- 500 nT

APPENDIX
Ponca Tribe Cemetery
Bearings to Permanent markers

STATION	DESCRIPTION	COMPASS BEARING	DISTANCE IN m
From Transit 1	At SE Corner of East Fence		
To	Telephone Pole	36.53	2.56
To	South End of East Fence	12.27	7.06
To	Wood Fence Pole near NE Corner Block B	0.07	43.9
To	Transit 2	288.58	25.37
From Transit 2	On South Edge of Block C, X=16,Y=8		
To	Flag Pole	322.45	36.24
From Transit 3	At SE Corner of Block D		
To	Flag Pole	59.77	No measure
To	Telephone Pole	86.27	No measure