AN ANALYSIS OF MAGNETIC GRADIOMETER SURVEYS
AT THE FORT CLATSOP NATIONAL MEMORIAL, OREGON

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INTRODUCTION

Fort Clatsop National Memorial near the town of Astoria, Oregon is the site of Fort Clatsop erected by Lewis and Clark in 1805. This site has been tested by excavation at various times. There is a reconstruction of the Fort at the Memorial but the precise location of the Fort is not known. As part of the ongoing archaeological study of the Fort, the Fort Clatsop National Memorial contracted to have a magnetic survey conducted over part of the site area in 1996. The survey covered about 600 square meters south-west and about 200 square meters north-east of the reconstructed fort. This is a report of that survey.

BACKGROUND

On November 7, 1805 the Lewis and Clark expedition reached the estuary of the Columbia River (Ferris, 1975). For several days, and in bad weather, they explored the north shore of the estuary for a suitable winter camp site. Finding the north shore inhospitable and lacking in game they crossed over to the south shore on November 26 and eventually on December 7 they located a site 3 miles up what is now known as the Lewis and Clark River. They started to build a fort Called Fort Clatsop after a local Indian tribe. It was a 50 feet by 50 feet enclosure with two rows of cabins inside facing each other. Although not finally completed until December 30 the men moved in on Christmas eve.

The Lewis and Clark expedition left Fort Clatsop March 23, 1806 for their return trip. The abandoned fort was all but gone by 1850’s. In 1852 a Mr. Shane, who built a cabin at the site, reported that there existed remains of two of the Lewis and Clark cabins. In June and July of 1948 Caywood conducted some exploratory excavations. He reported that there was evidence of “charcoal and then later some thin layers of orange-red burned earth and burned stones of about the size of baseballs and larger”. These excavation units are indicated on the GIS maps produced by Keith Garnett, 1996 (referred to here as the KG maps). Schumaker dug several trenches in 1956, 1957 and 1961. These are marked on the KG maps.

Today, in spite of several archaeological studies the exact location of the Fort is unknown. A replica of the fort was built on the site in 1958 by a local civic group. In 1958 the National Park Service acquired the site and named it the Fort Clatsop National Memorial.

James Bell (Bell, 1990) conducted some radar surveys at the fort site in 1990. In 1996 (Bell, 1996) he conducted a more extensive survey over regions south-west and north-east of the fort replica. These transects as well as areas of possibly significant reflections are marked on the KG maps.
MAGNETOMETER METHOD

In general a magnetic survey consists in measuring the magnetic field of the earth a few centimeters above the surface on a grid of evenly spaced points. Slight differences in concentrations of weakly magnetic iron oxides beneath the surface can give rise to anomalies in the mapped data. Such concentration differences can have anthropogenic causes such as filled pits, fired or burned earth, intrusive walls and cellars or privies (Weymouth, 1986).

There are two ways to measure the earth's field, total field or gradient. In the total field method the magnitude of the field, regardless of direction, is measured. In the gradient method the gradient of the field or the difference between two readings separated by a short vertical distance is measured. The fluxgate gradiometer measures the gradient of the vertical component of the field. Because the small anomalous field caused by a local concentration of magnetic soils decreases rapidly in strength with distance from the source the gradient is strongly influenced by sources near the gradiometer whereas the signal from more distance sources is almost canceled. Thus a gradiometer emphasizes near surface features.

A Geoscan Fluxgate Gradiometer, FM-36 was used in the survey. The lower sensor of the pair of sensors was about 30 cm above the surface while the upper sensor was 50 cm above the lower sensor. Measurements were made at 1/2 m intervals on traverses separated by 1/2 m. The surveyed region was separated into 10 m by 10 m blocks with 400 data points (or sometimes less) in each block. Each full block took 25 to 30 minutes to survey. Soon after data were obtained preliminary maps were generated using the Geoscan software Geoplot. Subsequently more complete maps were plotted using the programs Golden Surfer or Fortner Transform. Outlines of the anomalous areas extracted from the magnetic maps were passed to Keith Garnett and placed in the GIS map files for subsequent plotting.

RESULTS

Two areas were surveyed, Area 1 south-west and Area 2 north-east of the fort replica. Figure 1 shows the layout of the surveys blocks relative to the fort replica. Also on this figure are the positions of the grid points at which gradiometer values were obtained.

Area 1

Figure 2 is a line contour magnetic map of Area 1 with a contour interval of 2 nT/m clipped at +/- 50 nT/m to suppress the large iron anomalies. Also shown on this figure is the location of the fort reconstruction. Figure 3 is a gray scale map of the same data. To identify the various anomalous regions Figure 4 was drawn with the anomalies outlined and with a contour interval of 10 nT/m so as not to complicate the map.
The large iron anomalies on the west end were caused by a water pipe. The areas of interest are the two complex regions centered around N106,E65 and N110,E72 and the linear anomalies north of N113. It is difficult to say what the complex regions contain. The one centered at N106 has some iron sources. The more northern one may contain a burned earth area. The linear anomalies are very subtle but can be established by carefully examining gray scale or color maps and profiles. These linear features are perpendicular to the direction of the traverses so are not artifacts of the survey. Although there are some radar "hits" in the complex areas the correlation is not strong because there are several other places which also gave radar responses. Perhaps the most promising region is the complex centered at N110,E72.

Area 2

Figure 5 is a line contour map of Area 2 with a contour interval of 1.5 nT/m. In addition anomalous area are outlined on this map with bold lines and the two 1996 excavation units are outlined with dashed lines. Figure 6 is a gray scale map of the same data.

Most of the indicated anomalies are in the 2 to 5 nT/m range with one area, centered at N103,E107, having a maximum of about 20 nT/m. The anomaly at N106.5,E109.5 is in the 70 to 80 nT/m range. This most probably has a metal source. All the other anomalies could be from burned earth or other anthropogenic disturbances. Several of the subtle anomalies appear to lie along a linear alignment. Figure 7 is a repeat of Figure 5 but with a 5 nT/m contour interval and a line drawn through this alignment. There is one radar anomaly in this alignment and three others near it. These are marked on the KG maps. The large square outlined in Figure 7 is the regions within Area 2 that was covered by radar. Thus it can be seen that no radar traverses were done directly north of the region covered by the gradiometer. It should be noted that the excavation unit 1996.2 or Q2 had a feature at the north-west corner. A "sharp edge feature, a possible structure" (communication from Ken Karsmizki). This would place the feature next to one of the anomalies in the alignment. In addition a wooden stake was found in this unit at a 18 to 20 inch depth.

CONCLUSIONS

Two areas in the vicinity of the Fort Clatsop reconstruction have been surveyed with a fluxgate magnetic gradiometer at a 1/2 m by 1/2 m interval. Area 1 south and west of the reconstruction covered 600 square meters which is pretty much the accessible space. It contained several non-historical anomalies. The areas of interest are two complex regions and three linear anomaly groups. The most promising regions for further excavation testing are probably the complex centered at N110,E72 and the linear anomalies. The next place to do a magnetic survey is probably north of the present survey area just west of the fort reconstruction.
Area 2 north-east of the fort reconstruction seems more promising. Two hundred square meters were covered here. A string of small anomalies suggest a linear feature. Excavation unit 1996.2 probably just touched on this linear feature and should be extended west. Other anomalies in this alignment should be tested. Both the magnetic survey and the radar survey should be extended north of the present survey to see if the linear feature continues or turns. Although it may not be germane to the present study it would be interesting to extend the magnetic survey into the area where it is presumed that Shane had his house.
REFERENCES

Bell, James W.

1996 Personal communication and recorded on GIS maps, Garnett, 1996

Caywood, Louis R.

Ferris, Robert G., Ed.,

Garnett, Keith

Weymouth, John W.
Figure 1. Layout of magnetic survey blocks, Fort Clatsop, with grid points marked where magnetic data were obtained.
Figure 2. Line contour magnetic map of Area 1, Fort Clatsop. Contour interval is 2 nT/m clipped at +/- 50 nT/m, Fort Reconstruction is included.
Figure 3. Gray scale magnetic map of area 1, Fort Clatsop
Figure 4. Line contour magnetic map, Area 1, Fort Clatsop. Contour interval is 10 nT/m, Anomalous areas are outlined.
Figure 5. Line contour magnetic map, Area 2, Fort Clatsop. Contour interval is 1.5 nT/m, anomalies are outlined with bold lines, excavations units are outlined with dashed lines.
Figure 6. Gray scale magnetic map, Area2, Fort Clatsop
Figure 7. Line contour magnetic map, Area 2, Fort Clatsop. Contour interval is 5 nT/m, region of radar traverses in larger square box.