

Preliminary Geophysical Investigation of a Large Scale Magnetic Anomaly in Suffolk County, New York

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ABSTRACT

Aeromagnetic surveys of Long Island reveal the occurrence of two large-scale linear anomalies (Zietz et. al. 1981). The first anomaly is located on the north shore of Nassau County in the vicinity of Hempstead Harbor. It is approximately 20 kilometers long with a trend of 045° . The second anomaly is located in the middle of Suffolk County and is approximately 25 kilometers long with the same trend of 045° . A preliminary investigation of the anomalies was performed using a ground-based magnetometer to determine the feasibility of performing surface magnetic surveys on Long Island, in light of its population density, level of infrastructure, and randomly oriented boulders, many of which are likely to be magnetized.

The initial surveys were carried out on the anomaly located on the north shore of Nassau County and immediately demonstrated the limitations of ground-based magnetic surveys conducted in densely populated areas. A power plant is situated directly over the axis of the anomaly in Nassau and underground telephone lines are located throughout the area making a ground-based survey impossible. A suitable survey area containing virtually no anthropogenic electromagnetic interference was then located in Suffolk County in Connetquot State Park. The survey conducted in the park reproduced the gradients found on the aeromagnetic survey. This suggests that it is possible to use ground-based magnetometers to resolve deeper, long-wave magnetic fields in the presence of overlying local fields that would be expected to result from glacial sediments, which contain magnetized boulders and cobbles. This initial success has led to further surveys, currently under way, which are intended to resolve the anomaly in greater detail.

INTRODUCTION

The New York metropolitan area has been the focus for many years of a great deal of geophysical investigation and interpretation, with the glaring exception of Long Island. The occurrence of large-scale magnetic anomalies revealed by aeromagnetic surveys underscores the need for further geophysical investigations of this area. It was with this idea in mind that a preliminary ground-based magnetic study of the anomalies first identified in aeromagnetic surveys was planned. The first question that was addressed was the feasibility of carrying out ground-based magnetic surveys in densely populated areas like Long Island, with its associated infrastructure and a subsurface dominated by magnetized glacial sediments. The second question that is being addressed is what additional information or insight can be gained from ground-based investigations beyond what we can infer from the aeromagnetic surveys.

BACKGROUND

The Earth generates a magnetic field with a dominant dipole component that resembles, in a very general sense, the magnetic field generated by a bar magnet. This magnetic field intersects the Earth's surface at varying angles, or inclinations, depending on the latitude at which the intersection occurs. At lower latitudes the field lines extend out of the Earth's surface at a lower angle (inclination) than at higher latitudes. Any magnetized body will have its own similar magnetic field that when summed with the Earth's field will produce a magnetic anomaly. The interaction of the two fields causes variations in the total scalar magnetic field strength, which is what is measured by the magnetometer. By examining the effect of a magnetized body on the Earth's field, a great deal of information about subsurface structures and features can be inferred.

RESULTS/DATA

Upon inspection, the anomaly in Nassau County appeared to hold the most potential for the initial survey. As can be seen in Figure 1, the Nassau County anomaly has a much steeper gradient than the Suffolk County anomaly. It was thought that the steeper gradient of this anomaly would be less likely to be obscured by shallow, short-wave interference resulting from the magnetized glacial sediments and infrastructure. Hempstead Harbor Beach was chosen as the survey area due to the number of parks and open fields that are present there, and the fact that it transects the axis of the anomaly. However, it quickly became obvious that this area was unsuitable for surface magnetic surveys. The parks in this area have multiple conduits for telephone and power lines running underneath them and a Long Island Power Authority power plant that is located directly over the axis of the anomaly across from Hempstead Harbor Beach. The electromagnetic interference from the power plant and the underground lines completely obscured the deeper, long-wave signal.

It was then decided to take a closer look at the Suffolk County anomaly. Connetquot State Park, located on the south shore of the island, was identified as being the best area to look at the Suffolk County anomaly. Connetquot is a park and nature preserve with minimal infrastructure that is centrally located, leaving large portions of the park open and free of anthropogenic electromagnetic "noise". Because the park is south of both the Harbor Hill and Ronkonkoma Moraines, there is expected to be less short-wavelength interference from subsurface cobbles and boulders in this area, as compared with the north shore, due to the different types of sediment at each location. On the north shore one would expect to find more poorly sorted morainal material with cobbles and boulders, whereas the south shore is comprised of outwash sediments that are better sorted and contain finer grained material. Furthermore, there are many miles of trails and fire lanes that run throughout the park, allowing for extensive access, roughly parallel and perpendicular to the axis of the anomaly (see Figure 2). As can be seen from the map the Twin Lines fire road, on the northeastern perimeter of the park, and Cordwood Road, located in the center of the park, both lie virtually perpendicular to the anomaly. Between these two roads lie several fire lanes that are situated roughly parallel to the axis of the anomaly. This arrangement of survey lines allows for multiple transects at varying angles to the anomaly, resulting in a much finer resolution of the anomaly than is possible with an aeromagnetic survey.

A survey was performed along the section of Twin Lines Road indicated with arrows in Figure 2 and along the indicated section of the fire lane connecting Twin Lines Road with Cordwood Road. The Twin Lines Road survey line is approximately 1.5 kilometers long and contains readings taken at 20 meter intervals (see Figure 3). This survey line was found to have a maximum horizontal magnetic gradient of approximately 0.22 nT/m^{-1} over the last 920 meters of the line. The aeromagnetic survey (Zietz et. al. 1981) indicates an essentially identical gradient over this same line at an altitude of 500 feet. The fact that 150 meters vertically separate the two surveys and record essentially the same gradient suggests the source is relatively deep. This is supported by well logs that put the depth to basement in this area at approximately 480 meters (Smolensky et. al. 1989). Figure 3 also shows the survey recorded along the fire lane connecting Cordwood Road and the Twin Lines Road. This transect is approximately 840 meters long and also contains readings taken at 20 meter intervals. This second survey line was found to have a maximum gradient of only 0.09 nT/m^{-1} over the north-easternmost 540 meters. It does not lie parallel to the axis, but at some small angle to it: hence the smaller gradient.

CONCLUSION

If deep long-wave signals are to be discerned, ground-based magnetic surveys require open areas with little in the way of subsurface infrastructure. Areas such as these on Long Island are far and few between. As a result, ground-based magnetic surveys have a limited but important role to play in geophysical investigations of large-scale subsurface features on Long

Island. Despite these limitations, the surface surveys can provide essential information about subsurface features and in far greater detail than aeromagnetic surveys. Based on the results of this preliminary investigation, it is clear that surface magnetic surveys can be carried out on Long Island. However, to study the subsurface features on Long Island to any real extent requires the use of magnetic surveys in conjunction with other geophysical methods, such as gravity and seismic surveys.

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