Exploratory geophysical traverses in the Oakfield Hills area, Smyrna Mills quadrangle, Maine

by

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U.S. Geological Survey

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Abstract

Ground magnetic, gravity, and electromagnetic measurements in the Oakfield Hills area have delineated a series of steeply dipping, dikelike rock units with high apparent susceptibility, high density, and often high conductivity. The measurements were made to investigate the source of a 3000-gamma aeromagnetic anomaly. The rock units are apparently a series of lenticular beds of manganese-bearing iron formation which have been thermally metamorphosed by a nearby intrusion. Some of the electromagnetic anomalies are probably caused by the presence of sulfides.

Introduction

Ground geophysical measurements were made in the Oakfield Hills area to investigate the source of an aeromagnetic anomaly (Dempsey, 1962) which has a residual amplitude greater than 2000 gammas. Analysis of the aeromagnetic data indicates that the magnetic unit causing the anomaly is near-surface, dikelike in shape, and has a maximum width of about 500 feet. If the possibility of remanent magnetism is ignored, the calculated susceptibility for a unit with these dimensions is about 0.04 cgs unit.

Geophysical measurements

Ground magnetic, gravity, and electromagnetic measurements were made along several traverses (fig. 1) in the vicinity of the anomaly. Traverses A-B, H-C, and H-E were directed approximately normal to the aeromagnetic trend; the remainder were connecting and exploratory traverses. Station spacing for ground magnetic and gravity stations was about 100 feet along profile A-B which crosses the central part of the aeromagnetic anomaly, and variable on the remainder of the traverses, although usually it was about 500 feet.

Vertical-intensity ground magnetic measurements were made with a hand-held Jalander flux-gate magnetometer. Base stations were read at about 3-hour intervals to determine the combined instrument drift and diurnal variation. The field precision of the magnetometer is estimated to be better than 10 gammas. Gravity measurements were made with a Worden gravimeter with a scale factor of about 0.2 milligal per dial division. Stations were set with a looping procedure where the base station was read every 3 hours for drift control. The gravity data are reduced for the standard corrections, including that for terrain effect. Electromagnetic measurements were made by the slingram technique with the coils oriented horizontal and coplanar. The coil separation was 200 feet, and measurements were made at 100 foot intervals. A single frequency of 2000 cycles per second was used.

Interpretation

Ground-magnetic measurements along profile A-B (fig. 2) which crosses the center of the aeromagnetic anomaly detected 6 peaks (the 16,932-gamma peak appears to be an on-strike measurement over the same unit causing the 29,046-gamma peak) with amplitudes higher than 2000 gammas. The 29,046-gamma peak anomaly was located by using the magnetometer as a hunting device. Analysis of this latter anomaly indicates that it is caused by a steeply dipping, dikelike unit about 50 feet wide, with the top buried 50 feet below the ground surface. The computed susceptibility, ignoring remanent magnetism, is 0.3 cgs unit. The shape and spacing of the other five magnetic anomalies suggest narrow, steeply dipping units.

Gravity anomalies ranging from 0.3 to 1.0 milligals were detected along profile A-B over the magnetic features. The anomalies also indicate steeply dipping, dikelike units that are 50 to 100 feet wide. The units seem to be about 1.0 g per cm^3 denser than the rock enclosing them. The central highest-amplitude part of the gravity profile may be the merged effect of several rock units. Electromagnetic measurements along profile A-B detected one notable out-of-phase anomaly which occurs at the northwest end of the series of magnetic and gravity anomalies. By comparison with model curves, the anomaly appears to be caused by a dikelike body, dipping to the southeast and having a width of 100 feet or less.

Part of a regional gravity low is apparent on the east end of profile E-F-H (fig. 3) and the south part of profile H-C (fig. 4). The low is probably caused by a felsic intrusion (Kane and Peterson, 1961). Smaller gravity, magnetic, and electromagnetic anomalies which correlate with each other are present near the margin of the intrusion. The units causing the anomalies seem to be similar in size and shape to those along profile A-B.

No significant anomalies were noted on traverse C-D-E (fig. 5) where only gravity and magnetic measurements were made.

The ground magnetic data for the highly anomalous area (fig. 1) were compiled into a contour map (fig. 6). The 29,046-gamma anomaly appears to be continuous across profiles E-F-H and H-C, but with reduced amplitude. The spacing of the profiles is not ideal for contouring but the proposed continuity is based partly on the trend of the aeromagnetic anomaly (Dempsey, 1962) and the geology (Louis Pavlides, oral communication, 1962).

Large electromagnetic anomalies are present on profiles F-G and L-K (fig. 7). The in-phase component is not shown on the profiles because it is usually less than noise level. For the two double-peaked anomalies on the central part of profile L-K, the in-phase component is larger than the out-of-phase component. ~~The large~~ Locally positive out-of-phase anomalies on both profiles indicate that the strike of the conductors is at an acute angle to the traverse direction. The anomalies are believed to be caused largely by sulfide-bearing hornfels which was observed to be present in the area (Louis Pavlides, oral communication, 1962). No significant anomalies were observed on profile H-J.

Summary

The anomalies detected by the ground measurements indicate the presence of narrow, steeply dipping, dikelike units that are highly magnetic, dense, and often conductive. Along profile A-B the apparent high susceptibility and high density would indicate a magnetite content of about 50 percent but the lack of electromagnetic expression over much of the profile would not seem to bear this out. Remanent magnetization may be the cause of this discrepancy, in which case the magnetite content could be considerably lower. The high density could be caused by hematite or some other equally dense mineral. Some of the electromagnetic anomalies appear to be caused by the presence of sulfides.

The location of the anomalies at the boundary of a felsic intrusion suggests that the anomalous rock units might be differentiates from the intrusion. However, lenticular beds of maganese-bearing iron formation are known to be present in nearby areas (Pavlides, 1960) and they are a much more likely source of the anomalies for the area as a whole. Presumably the hematite in these beds has been altered to magnetite by the intrusion.

The station spacing of the present survey was not close enough to adequately define most of the anomalies. Considerably more information about the anomalous rock units would be gained from detailed surveys.

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