AEROMAGNETIC INTERPRETATION OF THE DANFORTH AREA, MAINE

By
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Introduction

The aeromagnetic survey covering the Danforth area was made during 1956, 1957, and 1958 by the U.S. Geological Survey as part of a program of aeromagnetic investigations in Maine. The magnetic measurements were made by a continuously recording AN/ASQ-3A airborne magnetometer installed in a twin-engined aircraft. North-south traverse lines were flown approximately 500 feet above the ground at one-quarter mile intervals. The flight path of the airplane was recorded by a gyrostabilized 35 millimeter continuous-strip camera. The height above the ground was continuously recorded using an APN-22 radar altimeter. An earlier aeromagnetic survey mapped a portion of this area (Trefethen, 1953, and Forsyth, 1955).

The magnetic anomalies result from variatiofs of a few percent in the content of magnetic minerals. These minerals are disseminated throughout large volumes of rock in amounts rarely exceeding 5 percent. The magnetic lows on the north sides of many of the magnetic highs are a normal feature in these magnetic latitudes. The magnetic highs associated with topographic highs are primarily caused by changes in lithology, and to a much lesser extent are caused by the topography.

In the Danforth area outcrops are scarce and assignment of an outcrop to a particular rock unit may be uncertain. In the geologic mapping the aeromagnetic data was of considerable assistance in determining the geologic patterns and in correlating rock units and isolated outcrops. Several geologic contacts have been located by interpretation of the aeromagnetic data and are assigned a particular symbol on the map. Many of the aeromagnetic data have served to confirm and strengthen conclusions based on geologic or topographic evidence.

Aeromagnetic interpretation

The aeromagnetic map is discussed in terms of the successive geologic units, each of which has a characteristic aeromagnetic expression.

Ordovician siltstone, graywacke, and slate (Oc and Oss).—These rocks are characterized by a flat magnetic pattern and must have a very low magnetic susceptibility.

Ordovician slate and siltstone with interbedded tuff (Os).—Low-amplitude elongate magnetic highs are associated with ridges of resistant tuffaceous sedimentary rocks. The magnetic mineral is thought to be pyrrhotite. The fault and the repetition of this unit on the west edge of the Danforth quadrangle are indicated by the magnetic data.

Silurian limestone conglomerate (Sl).—This unit is very thin and has no magnetic expression on the aeromagnetic map.

Silurian slate and siltstone (Sss).—The Silurian gray slates and siltstones are associated with a remarkably uniform magnetic pattern, especially throughout most of the Wytopitlock quadrangle. Very flat aeromagnetic patterns of such wide areal extent have been observed elsewhere in Maine only over great thicknesses of Devonian slates, siltstones, and subgraywackes (Boucot and others, 1960). In the Wytopitlock quadrangle the magnetic level increases to the west, and flattens west of long. 68°10′ W. This feature may be the east half of a broad magnetic high. Similar magnetic highs occur over the synclinoria of Devonian sedimentary rocks in the Moose River and Allagash River areas (Boucot and others, 1960) and are believed to be caused by a deeply buried magnetic unit.

The small anomaly centered on the town of Danforth is caused by a source (Ordovician tuff?) buried 500–1000 feet below the surface.

Silurian quartzite and slate (Ssq).—This unit contains the most highly magnetized rocks of any in the area. It is generally associated with elongate magnetic highs which occur over magnetite-rich rocks. The highs in the Danforth and Wytopitlock quadrangles appear to be located over the upper portion of the unit. The irregular distribution of magnetic highs indicates that the magnetite-rich rocks occur as discontinuous lenses. The large high (3352 gammas) in the northwest corner of the Danforth quadrangle occurs at a minor fold which has duplicated the magnetic layer. R. W. Bromery, U.S. Geological Survey, surveyed two vertical-intensity ground-magnetometer traverses across the fold and mapped a magnetic anomaly interpreted to be caused by a steeply dipping bed 60 to 70 feet wide (not shown on map). The magnetic high (2292 gammas) at the eastern edge of the Wytopitlock quadrangle is less elongate and is not in the same stratigraphic position as the other highs. The association of the anomaly with a prominent hill suggests that the proximity to the diabase dike (see below) is probably a coincidence and that the anomaly is also caused by magnetite-rich beds in the quartzite and slate (Ssq).

In the eastern half of the Danforth quadrangle the unit has no characteristic magnetic and topographic expression.

Several contacts of this unit have been determined from the aeromagnetic data. As the unit is composed mainly of sedimentary rocks, the aeromagnetic contacts may not be precisely located. The linear magnetic highs in the southeast corner of the Forest quadrangle are believed to be associated with the quartzite unit, outcrops of which have been observed north of the anomalies.

The pair of prominent broad magnetic anomalies outlined by the 1900-gamma contour line in the west center of the Forest quadrangle are very similar in pattern and amplitude to anomalies observed elsewhere in Maine over small granitic and mafic stocks (Boucot and others, 1960). Mafic plutonic rocks occur in discontinuous fashion along the contacts of many granitic intrusives in Maine. It is believed that this complex magnetic anomaly is caused by a mafic stock buried not more than 500–1000 feet below the surface. The wide magnetic gradient on the south side of this feature indicates a southerly dip of the buried igneous contact and is typical of such stocks. The smaller magnetic highs and lows on the north side of the prominent pair of anomalies may be caused by magnetite which has developed locally in this rock unit by contact metamorphism.

Silurian slate, siltstone, and quartzite (Sss).—Relatively flat magnetic patterns are observed over this unit. A few small magnetic highs occur in the eastern portion of the Danforth quadrangle.

Devonian granite (Dg).—In general a moderately flat but irregular magnetic pattern is typical over the granite, both on this map and adjacent New Brunswick (Geological Survey of Canada, 1953). Exceptions to this are the magnetic anomalies in the Spednick Mountain Walls Hill area of the Forest quadrangle. The 140-gamma magnetic high over Spednick Mountain is probably caused by a lithologic contrast because a similar elevation, Walls Hill, has no magnetic expression. The proximity of these anomalies to the complex anomaly to the south suggests that additional magnetite has been developed in the granite by assimilation of more ferruginous rocks from either the Silurian quartzite or the postulated buried stock.

Along the contact of the granite are numerous magnetic anomalies associated with the hornfels of the metamorphic aureole. Where there are no anomalies a slight increase of 20–40 gammas in magnetic level is observed on passing from granite to hornfels. The contact west of Butterfield Landing in the northern part of the Danforth quadrangle was located by R. W. Bromery by means of a vertical-intensity ground-magnetometer traverse. Contact metamorphism by the granite tends to increase the magnetization of the adjacent sedimentary rocks, possibly by conversion of iron sulfides to magnetite.

Diabase dike (db).—A linear magnetic high associated with a diabase dike crosses the Wytopitlock and Danforth quadrangles. The strike averages about N. 65° E. with variations of 15°. Some of the local variations in strike are introduced by slight errors in location of the aeromagnetic data. Interpretation of the aeromagnetic data indicates the dike to be steeply dipping (Allingham, 1960) and at most a few hundred feet wide.

On this map the dike can be traced for 25 miles. It is interpreted to extend at least 7 miles farther east on strike into Canada (Geological Survey of Canada, 1953). To the west there is an 8 mile gap in the aeromagnetic data and then a similar narrow linear aeromagnetic high extends 34 miles to the southwest (Wing, 1959). Two outcrops of a similar diabase have been located on strike with the magnetic lineament and are respectively 10 and 23.5 miles farther to the southwest (oral communication, G. H. Espenshade, 1960). No other diabase outcrops are known in this part of the state. The diabase dike may have a total length in excess of 199 miles.

References

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Geological Survey of Canada, 1953, Fosterville, York, and Carleton Counties, New Brunswick: Geophysics Paper 139, aeromagnetic map, Ottawa.
Trefethen, J. M., 1953, Airborne magnetometer survey, Forest City area, eastern Maine: Maine Geol. Survey, scale 1:62,500.
Wing, L. A., 1959, An aeromagnetic and geologic reconnaissance survey of portions of Penobscot, Piscataquis and Aroostook Counties, Maine: Maine Geol. Survey GP and G. Survey No. 4.

EXPLANATION

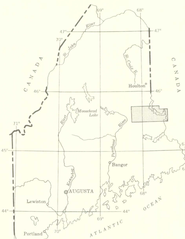
Magnetic contours showing total intensity magnetic field of the earth in gammas relative to arbitrary datum
Hachured to indicate closed areas of lower magnetic intensity; dashed where data are incomplete

Measured maximum or minimum intensity within closed high or closed low

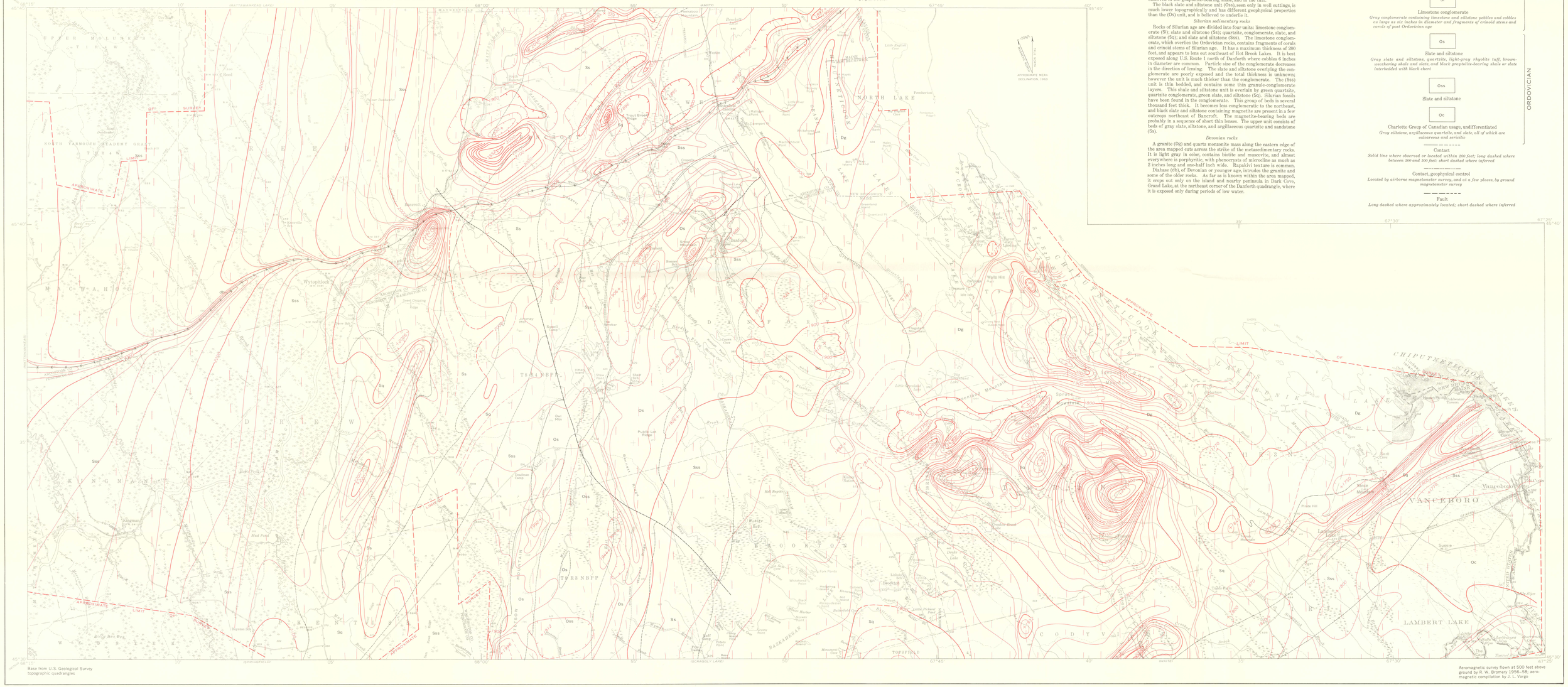
Flight path
Showing location and spacing of data

NOTE

Aeromagnetic data are obtained and compiled along a continuous line, whereas ground magnetic surveys are made at separate points. Errors within the normal limits of any magnetic measurement may cause slight discrepancies between flight lines in an aeromagnetic map, which would be more obvious than similar discrepancies between points in a ground magnetic map. For this reason as much care should be exercised in evaluating magnetic features that appear as elongations along a single aeromagnetic traverse as in interpreting an anomaly indicated by a single ground station



MAP OF MAINE SHOWING AREA OF THIS STUDY (SHADED)



Base from U.S. Geological Survey topographic quadrangles

Aeromagnetic survey flown at 500 feet above ground by R. W. Bromery 1956–58; aeromagnetic compilation by J. L. Vargo

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—49143

BEDROCK GEOLOGY OF THE DANFORTH AREA, MAINE

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Geologic mapping in the Danforth area is hampered by scarcity of outcrops and fossils. Most of the geologic contacts, therefore, are shown on the map as smooth lines, although it is recognized that the rocks are tightly folded. Only reconnaissance work has been done in the Wytopitlock quadrangle. Except for the granite (Dg), geologic boundaries are subject to minor correction, especially in the southeastern part of the area mapped.

Most of the area is underlain by low-grade metasedimentary rocks of Ordovician and Silurian age. The rocks are tightly folded, and the fold axes strike northeast; overturning of beds is common. A granite of Devonian age has intruded these rocks along the eastern margin of the area mapped. A contact metamorphic aureole about 4,000 feet wide occurs along most of the granite contact. Major variations in the strikes of the metasedimentary rocks are most common in the inner 2,000 feet of this aureole. A fault with strong topographic expression occurs in the southwestern part of the Danforth quadrangle. The relation of the fault to the diabase dike has not been determined. A less noticeable fault occurs along the southeastern side of the anticline of rocks of Ordovician age at their intersection with granite. A second, minor fault not shown on the map intersects the same anticline in the limestone conglomerate unit; it is roughly parallel with and along U.S. Route 1.

Ordovician rocks

Rocks of Ordovician age tentatively have been placed in three lithologic map units as follows: gray siltstone, argillaceous quartzite, and slate, all of which are sericitic and calcareous (Oc); black slate and siltstone (Oss) recognized only from cuttings from a drill hole east of Stetson Mountain, near the southwest corner of the Danforth quadrangle; black graptolite-bearing shales and slate (Os) interbedded with thin black chert, light-gray rhyolite tuff (in places containing lenses and balls of gray chert), brown-weathering shale, and siltstone, and gray slate and siltstone. Traces of pyrite and pyrrhotite have been observed in the graptolite-bearing shale, and in the tuff.

The black slate and siltstone unit (Oss), seen only in well cuttings, is much lower topographically and has different geophysical properties than the (Os) unit, and is believed to underlie it.

Silurian sedimentary rocks

Rocks of Silurian age are divided into four units: limestone conglomerate (Sl); slate and siltstone (Ss); quartzite, conglomerate, slate, and siltstone (Ssq); and slate and siltstone (Sss). The limestone conglomerate, which overlies the Ordovician rocks, contains fragments of corals and crinoid stems of Silurian age. It has a maximum thickness of 200 feet, and appears to lens out southeast of Hot Brook Lakes. It is best exposed along U.S. Route 1 north of Danforth where cobbles 6 inches in diameter are common. Particle size of the conglomerate decreases in the direction of lensing. The slate and siltstone overlying the conglomerate are poorly exposed and the total thickness is unknown; however the unit is much thicker than the conglomerate. The (Sss) unit is thin bedded, and contains some thin granule-conglomerate layers. This shale and siltstone unit is overlain by green quartzite, quartzite conglomerate, green slate, and siltstone (Ssq). Silurian fossils have been found in the conglomerate. This group of beds is several thousand feet thick. It becomes less conglomeratic to the northeast, and black slate and siltstone containing magnetite are present in a few outcrops northeast of Bancroft. The magnetite-bearing beds are probably in a sequence of short thin lenses. The upper unit consists of beds of gray slate, siltstone, and argillaceous quartzite and sandstone (Sss).

Devonian rocks

A granite (Dg) and quartz monzonite mass along the eastern edge of the area mapped cuts across the strike of the metasedimentary rocks. It is light gray in color, contains biotite and muscovite, and almost everywhere is porphyritic, with phenocrysts of microcline as much as 2 inches long and one-half inch wide. Rapakivi texture is common.

Diabase (db), of Devonian or younger age, intrudes the granite and some of the older rocks. As far as is known within the area mapped, it crops out only on the island and nearby peninsula in Dark Cove, Grand Lake, at the northeast corner of the Danforth quadrangle, where it is exposed only during periods of low water.

EXPLANATION

DEVONIAN OR YOUNGER

db — Diabase dike
Location determined primarily from aeromagnetic data

DEVONIAN

Dg — Granite and quartz monzonite

SILURIAN

Ss — Slate and siltstone
Gray and black slate and siltstone; some thin-bedded gray sandstone

Sq — Quartzite, conglomerate, slate, and siltstone
Chloritic argillaceous quartzite, quartzite conglomerate, gray and green slate; are the thin lenses of red and purple slate and thin beds of tuff and argillaceous sandstone. Magnetite-bearing black slate and siltstone ("iron formation") are occasionally present

Sss — Slate and siltstone
Thin-bedded gray slate and siltstone; some thin granule conglomerate

Sl — Limestone conglomerate
Gray conglomerate containing limestone and siltstone pebbles and cobbles as large as six inches in diameter and fragments of crinoid stems and corals of post Ordovician age

ORDOVICIAN

Os — Slate and siltstone
Gray slate and siltstone, quartzite, light-gray rhyolite tuff, brown-weathering shale and slate, and black graptolite-bearing shale or slate interbedded with black chert

Oss — Slate and siltstone

Oc — Charlotte Group of Canadian usage, undifferentiated
Gray siltstone, argillaceous quartzite, and slate, all of which are calcareous and sericitic

Contact
Solid line where observed or located within 200 feet; long dashed where between 200 and 500 feet; short dashed where inferred

Contact, geophysical control
Located by airborne magnetometer survey, and at a few places, by ground magnetometer survey

Fault
Long dashed where approximately located; short dashed where inferred

AEROMAGNETIC INTERPRETATION AND PRELIMINARY GEOLOGY OF THE DANFORTH AREA, MAINE

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SCALE 1:62 500

1 ½ 0 1 2 3 MILES

1 .5 0 1 2 3 KILOMETERS

CONTOUR INTERVALS 20, 100, AND 500 GAMMAS

1963

For sale by U.S. Geological Survey, price 50 cents