PRELIMINARY INTERPRETATION OF TOTAL INTENSITY AEROMAGNETIC PROFILES OF THE KOYUKUK AREA, ALASKA

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U. S. GEOLOGICAL SURVEY

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Introduction

In 1954 and 1955, the U. S. Geological Survey flew reconnaissance aeromagnetic traverses in the Koyukuk area to aid geologic mapping of the area and to obtain a better knowledge of the configuration and depth of a possible sedimentary basin. Fifteen traverses were flown approximately 2 miles apart at a barometric elevation of 2,500 feet from the margin of the Kaiyuh Mountains to approximately the Kiwalik River south of Kotzebue Sound. In addition, six traverses were flown approximately north-south from the Kaiyuh Mountains to the Baird Mountains in the Brooks Range. Aeromagnetic profiles obtained on these flights were released on open file June 10, 1957, and are entitled respectively "Total intensity aeromagnetic profiles of Koyukuk, Alaska" by W. J. Dempsey, J. L. Meuschke, and G. E. Andreasen (2 sheets), and "Total intensity aeromagnetic profiles of West Hogatza, Alaska" by W. J. Dempsey, J. L. Meuschke, and G. E. Andreasen, (1 sheet).

Analysis of the profiles obtained in 1954 and 1955 indicated that the use of aeromagnetic data could play an important role in interpreting the geology of the area and that additional surveying would be warranted. Consequently, 11 long lines were flown at a barometric elevation of 2,500 feet in the summer of 1958. Results of the 1958 survey are included with this report (figs. 2-7). The survey covers

the area north and west of the Yukon River, north of the Shaktolik River and south of the Selawik River. The area is bounded approximately by the latitudes 64° and 66° N and by longitudes 154° and 162° W.

Geology

The area covered by both aeromagnetic surveys is part of the Koyukuk Cretaceous basin, a 60,000 square mile tract of west-central Alaska underlain, in large part, by sedimentary rocks of Middle Cretaceous age. Since 1954 the U. S. Geological Survey has been carrying out surface geological field investigations in various parts of the basin. During the 1958 season the field mapping was chiefly in the Candle and Kateel River quadrangles (1:250,000 topographic) and the aeromagnetic traverses flown in 1958 were designed to supplement these studies. The 1958 field mapping and some of the earlier mapping in contiguous areas to the south are the basis for the generalized geologic map shown in figure 1.

Four major lithologic units crop out in this area. The oldest rocks, Mesozoic volcanic rocks (Mzv on figure 1), include a thick sequence of highly folded and somewhat altered andesitic or basaltic flows, tuffs, and breccias. These volcanic rocks appear, for the most part, to underlie the Shaktolik group (Ksg) but there are indications locally that some of these rocks may be equivalent to or even younger than the Shaktolik group. The Shaktolik group is composed of a thick section of folded and faulted sandstone, siltstone, and shale of mid-Cretaceous age. East of the Koyukuk River flats the rocks of the Shaktolik group have been invaded by numerous small intrusive

bodies of felsic and intermediate composition, which are not shown on figure 7. In the northwestern part of the mapped area, the Mesozoic volcanic rocks and the Shaktolik group are capped by basalt flows (Cv) of late Tertiary or Quaternary age. The basalt is unaltered and flat-lying or very slightly tilted. The extensive flats that border the Koyukuk River are mantled by unconsolidated deposits of silt and sand (Qal).

Magnetic interpretation

It is assumed that magnetic anomalies are generally caused by both igneous and metamorphosed rocks and that the sedimentary rocks are essentially nonmagnetic. The method used for calculating depths to magnetic sources is patterned after the techniques described by Vacquier and others (1951). For large amplitude anomalies, covering large areas, the horizontal extent of the steepest slope will give a good representation of the depth to the magnetic source; the steeper the magnetic gradient, the closer the magnetic rocks are to the surface. For small amplitude anomalies, the distance between half-maximum values is a probable estimate of the maximum depth; rapid oscillations of the field therefore indicate magnetic units closer to the source than smooth, gentle anomalies.

There is good correlation between the large amplitude, steep gradient anomalies and the areas mapped as Mesozoic volcanic rocks. This thick sequence of volcanic rocks invariably gives rise to anomalies which are computed to be at the surface. This is a partial but strong confirmation of the procedures for depth computations utilized in this area. Where Cenozoic volcanic rocks directly overlie

the Shaktolik group, they have little or no magnetic expression on the magnetic profiles (fig. 3; Flight 6A near check point 33; Flight 6B near check point 85). Therefore, anomalies of large amplitude and steep gradient occurring over Cenozoic volcanic rocks are attributed to Mesozoic volcanic rocks underneath a veneer of the younger Cenozoic basalt flows.

Most of the magnetic profiles display striking magnetic contrasts. Profile 6A (figs. 2 and 3) may be considered typical. At the northwest and southeast ends of the profile, steep-gradient and high-amplitude anomalies are observed, indicating that magnetic rocks are at or near the surface. The central portion of the profile, recorded over rocks of the Shaktolik group, is smooth and practically featureless indicating that magnetic rocks are probably located at great depths. The abrupt change in character of the magnetic profile near the northwest and southeast ends of traverse 6A is interpreted to represent the contact between the Mesozoic volcanic rocks and the rocks of the Shaktolik group. It affords a method of outlining the extent of the sedimentary basin in areas covered by Cenozoic volcanic rocks or alluvium. The abruptness of the change suggests either that the sedimentary rocks wedge out very abruptly at the margin of the basin or that the contact is a fault. The contact, as deduced from the magnetic data, is shown by the dashed line on figure 1. There is general agreement in the location of the contact mapped at the surface and the contact inferred from the aeromagnetic data. Locally, however, the aeromagnetic contact is displaced basinward as much as 15 miles. Where this occurs, the section of sedimentary rocks covering the volcanic rocks is apparently relatively thin. Using the Koyukuk open file report of 1957 (sheet 2),

it is estimated that the thickness of sedimentary cover at the contact near the Ungalik River, 4 miles east of point 22 on traverse 2, is 1,500 feet. At a point on traverse 4, 17 miles west of point 45, calculations indicate the thickness is 2,500 feet. Calculations show that the large linear magnetic feature just east of the Yukon River, 4 miles east of point 60 on line 6, is probably caused by an igneous mass buried at a depth of about 1 mile. It is estimated that depths to the magnetic rocks underlying the Shaktolik group in the central basin area are 3 miles or more. If these underlying rocks are similar to the Mesozoic volcanic rocks cropping out east and west of the basin, an additional method of calculating their depth may be used. In the northwest corner of the area where Mesozoic volcanic rocks are presumably present at shallow depths, beneath a layer of Cenozoic volcanic rocks, a portion of the magnetic profile 6B (fig. 3) was projected mathematically to altitudes 1, 3, and 5 miles above the plane of observations. The resulting profiles are compared with a typical profile (4C) over the basin area. The projected and observed profiles (fig. 8) compare favorably at the projected altitude of 5 miles. Because sedimentary rocks are nonmagnetic, this analysis signifies that if the "basement" rocks in the basin area have the same physical properties as the volcanic rocks to the west, a thickness of approximately 5 miles of sedimentary rocks (Ksg) would be present. This figure should be considered as a maximum because of the assumptions inherent in the method of projection.

Of particular interest are the anomalies of large amplitude and steep gradient shown in the profiles that cross the Koyukuk flats and the belt of Shaktolik rocks that lie east of the flats. The anomalies

in the belt of Shaktolik rocks are probably attributable to many small bodies of intrusive rock. The anomalies over the flats suggest that the unconsolidated deposits (Qal) are probably underlain at shallow depths by either Mesozoic volcanic rocks, Shaktolik rocks with intrusive rocks, or both. The exposures of Mesozoic volcanic rocks near the center of the flats and along the western side indicate that a large part of the flats is probably underlain by volcanic rock. Apparently the flats are not underlain by a substantial thickness of sedimentary rock, free of intrusive rock, such as occurs west of the Koyukuk River.

Reference

Vacquier, Victor, Steenland, N. C., Henderson, R. G., and Zietz, Isidore, 1951, Interpretation of aeromagnetic maps: Geol. Soc. America Mem. 47, 151 p.