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A MAGNETIC ANOMALY OF POSSIBLE ECONOMIC SIGNIFICANCE IN SOUTHEASTERN MINNESOTA

Prepared in cooperation with the Minnesota Geological Survey

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United States Department of the Interior

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ABSTRACT

An aeromagnetic survey in southeastern Minnesota by the U. S. Geological Survey in cooperation with the State of Minnesota has revealed a high-amplitude, linear, and narrow magnetic feature that suggests a possible source of Precambrian iron-formation of economic value.

For the past few years the U. S. Geological Survey has been conducting detailed geophysical studies of the midcontinent gravity anomaly—a broad, high-amplitude feature that extends from Lake Superior through the States of Minnesota, Iowa, Nebraska, and part of Kansas. As part of this study an aeromagnetic survey of the southern part of the State was made in cooperation with the State of Minnesota during the summer of 1963, in which a linear high-amplitude anomaly of the order of 4,000 gammas was discovered. Because of the high amplitude, the linearity, and the narrowness of the magnetic feature, it is believed the source may be Precambrian iron-formation of possible economic value.

The anomalous area is in Fillmore County, approximately between the towns of Lanesboro and Peterson in the extreme southeastern part of the State. (See figures 1 and 2.)

At the site of the anomaly, Cambrian sedimentary rocks occur in the valley of the Root River, and Ordovician rocks (nearly flat lying) mantle the upland areas. The uplands are largely covered by glacial deposits, which are relatively thin (Paul K. Sims, written communication, 1964). Depths to the Precambrian are estimated to range from 500 feet to 1,000 feet below the surface.

The aeromagnetic map shown in figure 2 was compiled from continuous magnetic profiles made along east-west flight lines 1,000 feet above ground, and spaced approximately 1 mile apart. Contour intervals of 20, 100, and 500 gammas were used depending on the intensity. The instrument for the survey was a flux-gate type magnetometer (AN/ASQ-3A) which measures total-field variations.

The contour map displays variations in magnetic pattern which are typical of shallow Precambrian rocks. Anomalies of the order of 1,000 gammas are shown along the east and west edges of the map. The outstanding feature is the previously mentioned linear positive anomaly that trends northeast and reaches a peak of 3,960 gammas. The positive anomaly is contoured from data on four consecutive profiles, but only two show high amplitudes. The high-amplitude anomalies along traverses 1 and 2 are shown in figure 3. Depth calculations suggest that the source of the anomaly lies about 1,000 feet below the surface. Assuming a dikelike source and magnetization resulting entirely from induction in the earth's field, several calculations were made in an attempt to fit the magnetic profile taken along the line AA' (see figs. 2 and 4), considered to be a typical cross-section of the magnetic anomaly. Comparisons are shown between observed and computed profiles. The fixed parameters used were (a) distance from detector to source of 2,000 ft; width of dike of 5,000 ft; dip of dike of 75°, 90°, 105°, and 120°, as shown. The best fit occurs when the dike is vertical or dips 75° to the southwest. For these cases, the susceptibility, k, is computed to be 0.016 c.g.s. units, and is comparable to $k = 0.02^{+}$ calculated by Bath (1962) for the relatively unmetamorphosed iron-formation of the Main Mesabi district in Minnesota where the induced magnetization was most likely the dominant magnetization. If the dominant magnetization for the anomaly in Fillmore County were remanent rather than induced, the economic importance of the anomaly would be greatly reduced.

This anomaly seems sufficiently promising to warrant further geologic and geophysical investigation. Detailed ground magnetic and electrical studies would be useful to delineate the feature. In the final analysis, however, the presence of iron-formation can be determined only by the drill.

REFERENCES

Bath, Gordon D., 1962, Magnetic anomalies and magnetizations of the Biwabik iron-formation, Mesabi area, Minnesota: Geophysics, v. 27, no. 5, p. 627-650.

Craddock, Campbell, Thiel, E. C., Gross, Barton, 1963, A gravity investigation of the Precambrian of southeastern Minnesota and western Wisconsin: Jour. Geophys. Research, v. 68, no. 21, p. 6015-6032.

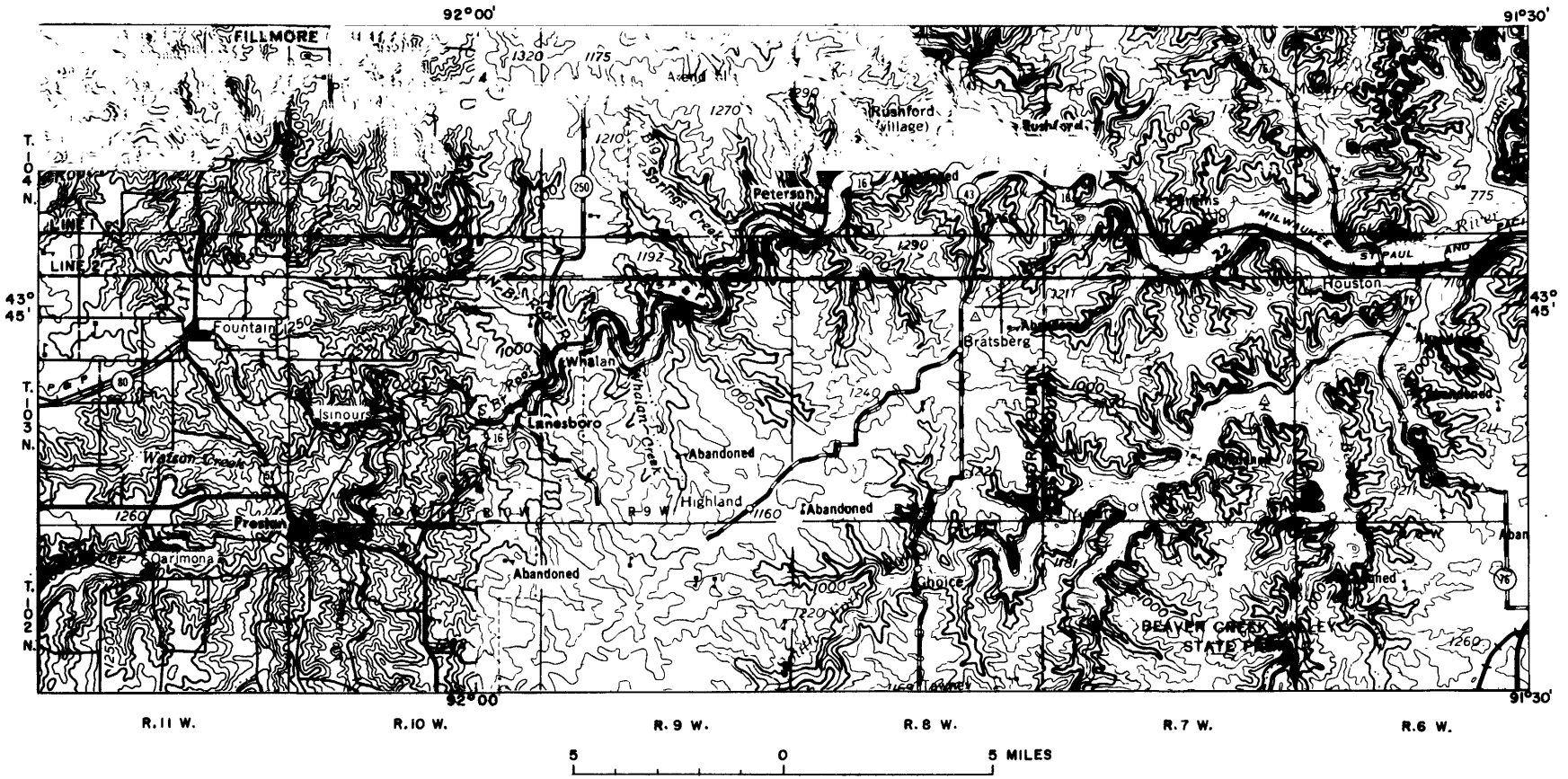

Figure 1. Topographic map of parts of Fillmore and Houston Counties, Minnesota.

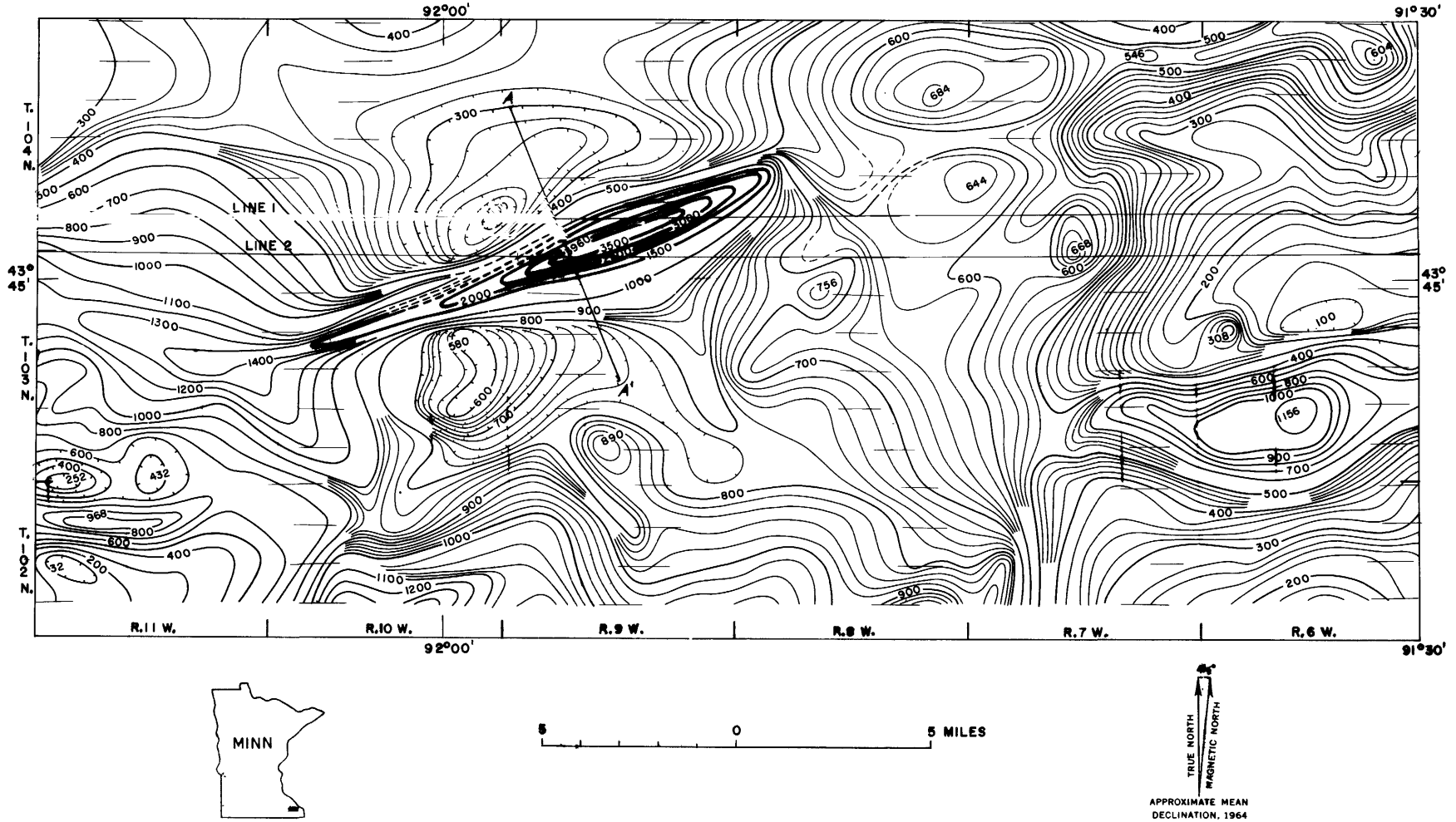

Figure 2. Aeromagnetic map of parts of Fillmore and Houston Counties, Minnesota. Values are total magnetic intensity relative to an arbitrary datum. Contour interval is 20, 100, and 500 gammas. Flight level is 1,000 feet above the ground. Magnetic survey was flown under the direction of P. W. Philbin. Compilation was made by Francis Gilbert.

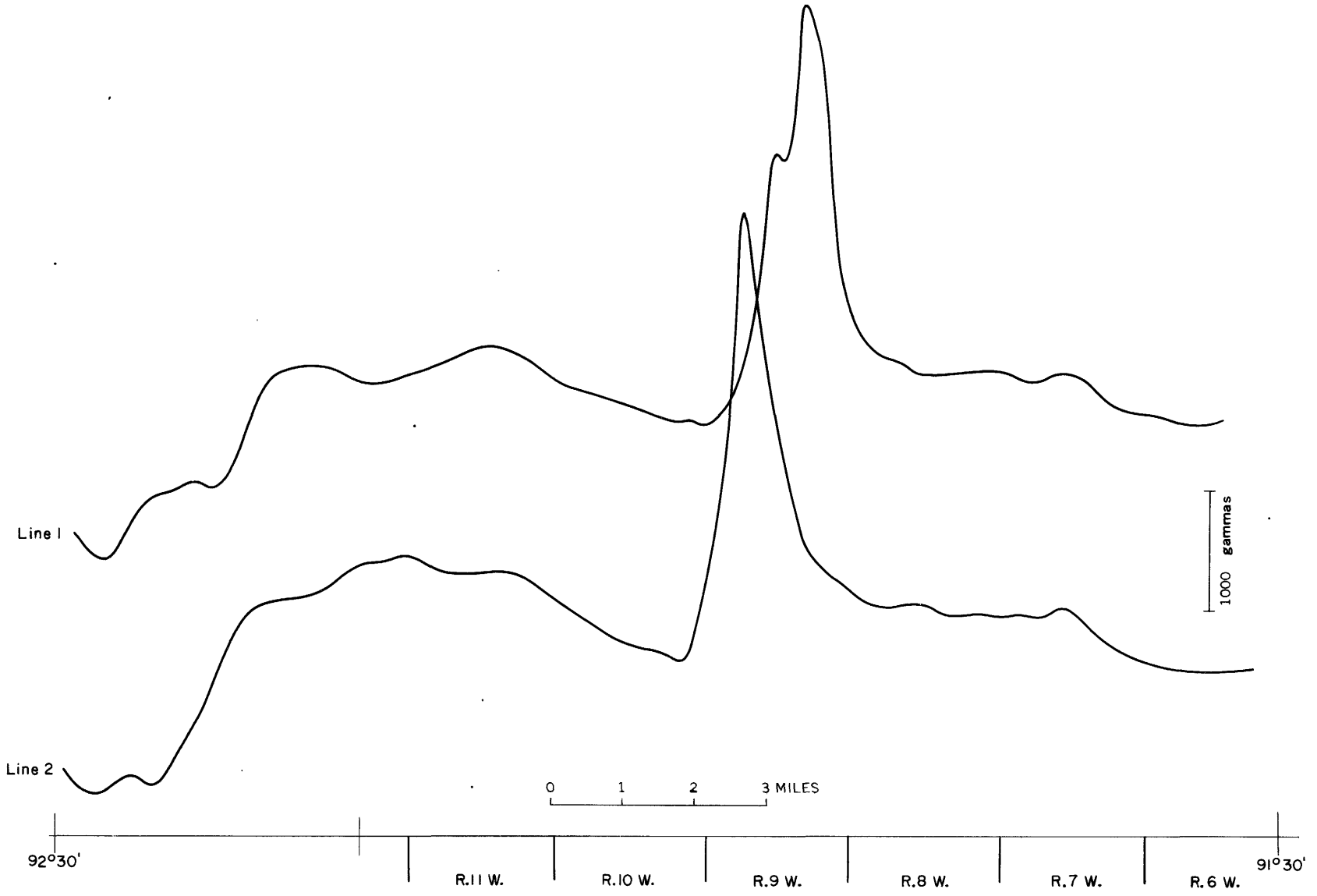

Figure 3. Aeromagnetic profiles for parts of Fillmore and Houston Counties, Minnesota.

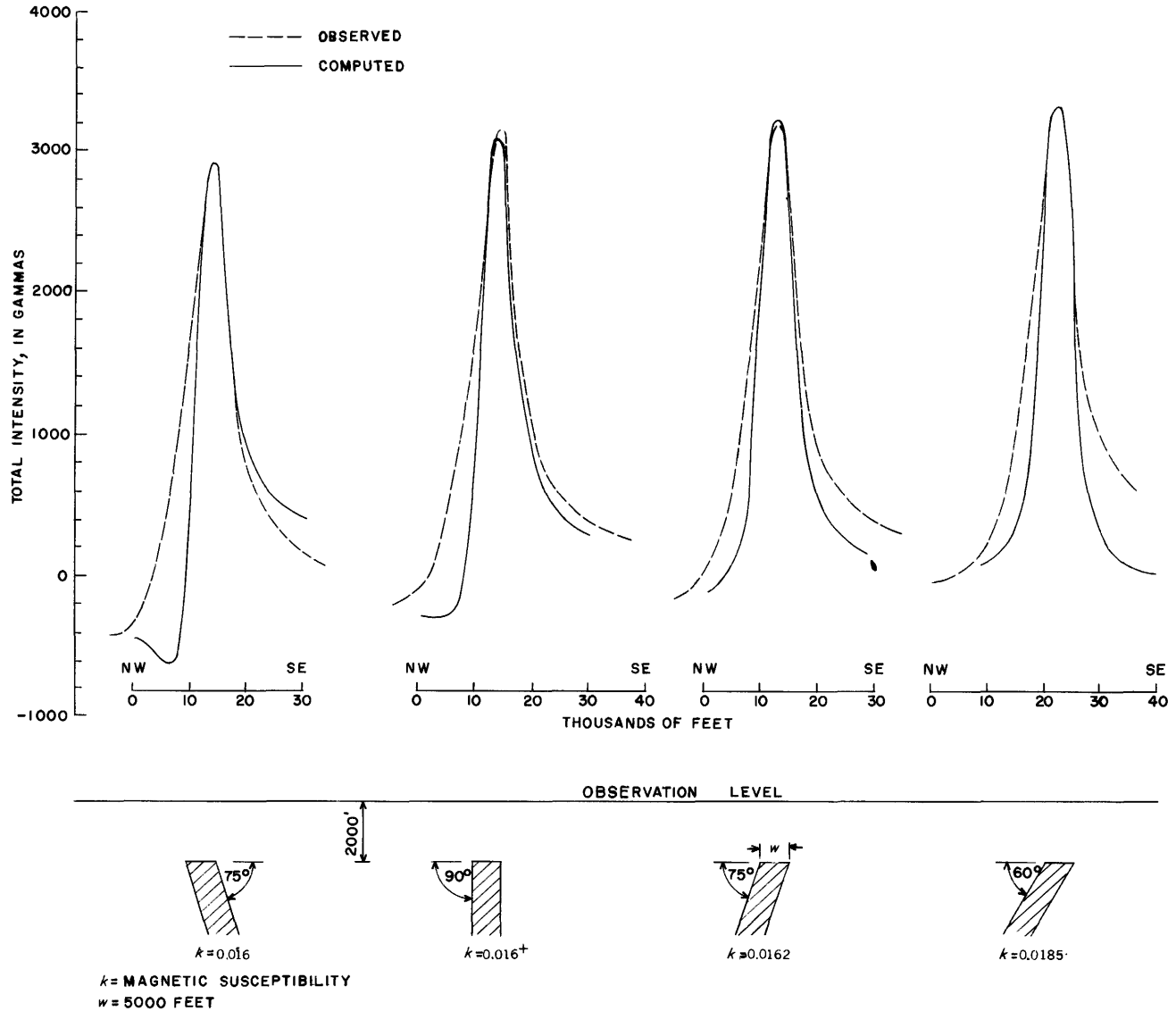

Figure 4. Comparison of observed and computed profiles for line A-A' in figure 2. Calculations by G. E. Andreasen.