Geomagnetic variations at Kilbourne Hole, New Mexico

J. N. Towle and D. V. Fitterman, 1975, pp. 281

in:

Las Cruces Country, Seager, W. R.; Clemons, R. E.; Callender, J. F.; [eds.], New Mexico Geological Society 26th Annual Fall Field Conference Guidebook, 376 p.

This page is intentionally left blank to maintain order of facing pages.

GEOMAGNETIC VARIATIONS AT KILBOURNE HOLE, NEW MEXICO

by
J. N. TOWLE and D. V. FITTERMAN
U.S. Geological Survey
Denver, Colorado 80225

Geomagnetic variations having periods of 1 minute to greater than 1 hour were recorded at six locations in the vicinity of Kilbourne Hole, New Mexico, between 2 April and 7 April 1975. The locations of sites occupied by this investigation are indicated on Figure 1.

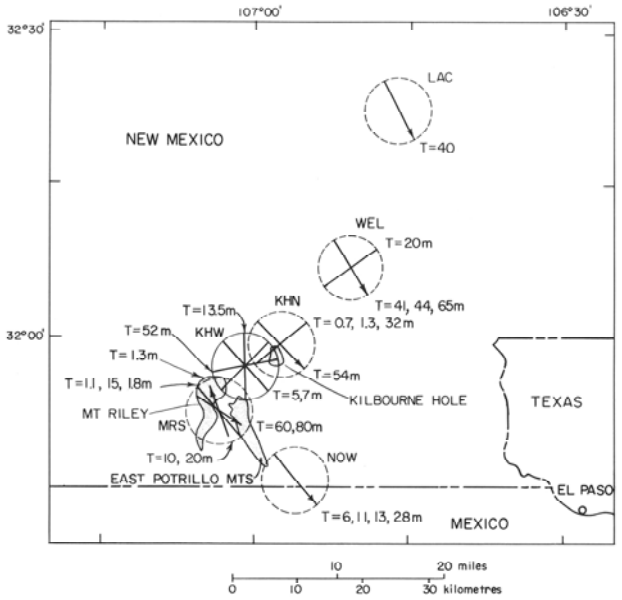

Figure 1. Geomagnetic station locations showing polarization of geomagnetic variations. Arrowheads indicate direction of upward polarization. T is variation period in minutes.

Variations in the geomagnetic field are caused by changes in electric currents flowing in the ionosphere and magnetosphere. These time-varying electric currents induce eddy currents in the earth which are controlled by the electrical conductivity structure of the earth's crust and upper mantle. The total geomagnetic field associated with the combined ionospheric and telluric current systems is diagnostic of the earth's electrical conductivity structure. The magnetic field of a system of electric currents can be calculated from a straightforward application of Ampere's Law. Laterally uniform current flow in a homogeneous conductor is characterized by an absence of vertical magnetic field. Lateral conductivity variations cause vertical magnetic fields having an upward polarization in the direction of regions having increased conductivity. Thus, a magnetometer placed on the flanks of a telluric current concentration will record variations in the vertical component of the geomagnetic field. The depth and lateral extent to which eddy currents are induced in the crust and upper mantle are also important considerations in the interpretation of geomagnetic variometer studies. This depth and lateral extent of induction are determined by the electrical conductivity of the earth and by the frequency of geomagnetic variations. Variations having periods greater than 1 hour are controlled by deep crust and upper mantle structure.

Schmucker's (1964) investigation of geomagnetic variations in the southwestern United States indicate anomalous induction between stations located at Las Cruces, New Mexico and Cornudas, Texas, 96 km east of El Paso. A highly conductive zone at a depth of 100 km between Las Cruces and Cornudas was postulated to explain the observed induction anomaly. Reinterpretation of Schmucker's data by J. F. Hermance (1975, oral communication) suggests that electrical conductivity variations within the crust are the cause of this anomaly. Our observations support this reinterpretation. Geomagnetic variations having periods of from 40 to 80 minutes at LAC, WEL, KHN and MRS all indicate the presence of increased electrical conductivity to the southeast of Kilbourne Hole. The strike of this conductor seems to be northeasterly. Short-period variations at NOW (10 to 30 minutes) indicate that this conductor may be located close to NOW and thus further to the west and more shallow than indicated by Schmucker's more widely spaced observations.

This study has also identified two shallow current concentrations in the immediate vicinity of Kilbourne Hole. Short-period variations at MRS appear to be due to channeling of telluric currents between Mount Riley and the East Potrillo Mountains. Similarly, horizontally polarized short-period variations at KHN and KHW indicate current flow to the northwest near Kilbourne Hole, probably due to an increased thickness of conducting sediments to the east of the East Potrillo Mountains.

REFERENCES

Schmucker, U., 1964, Anomalies of geomagnetic variations in the southwestern United States: Jour. Geomagnetism and Geoelectricity, v. 15, p. 193-221.