FIGURE 1

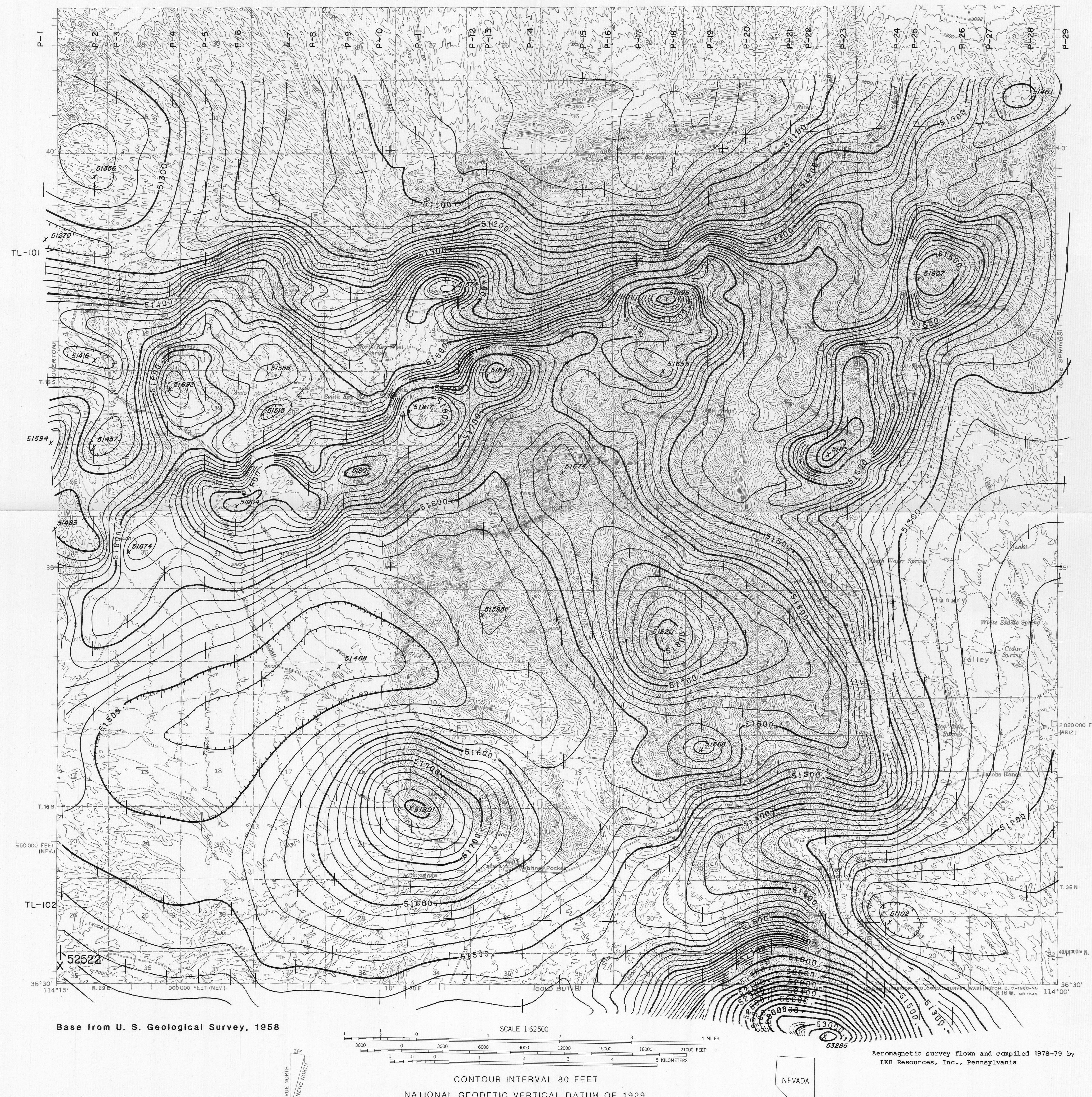
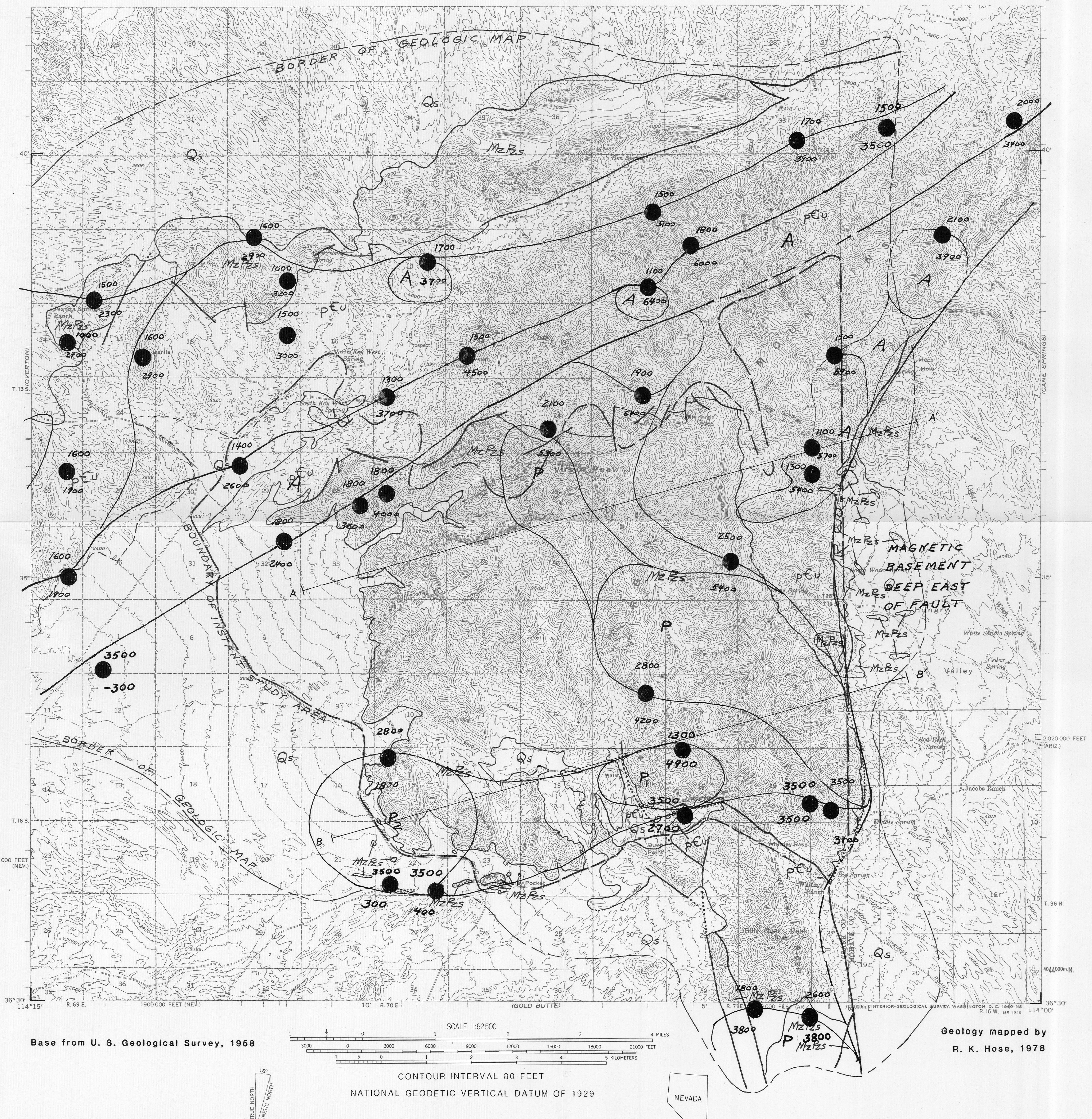
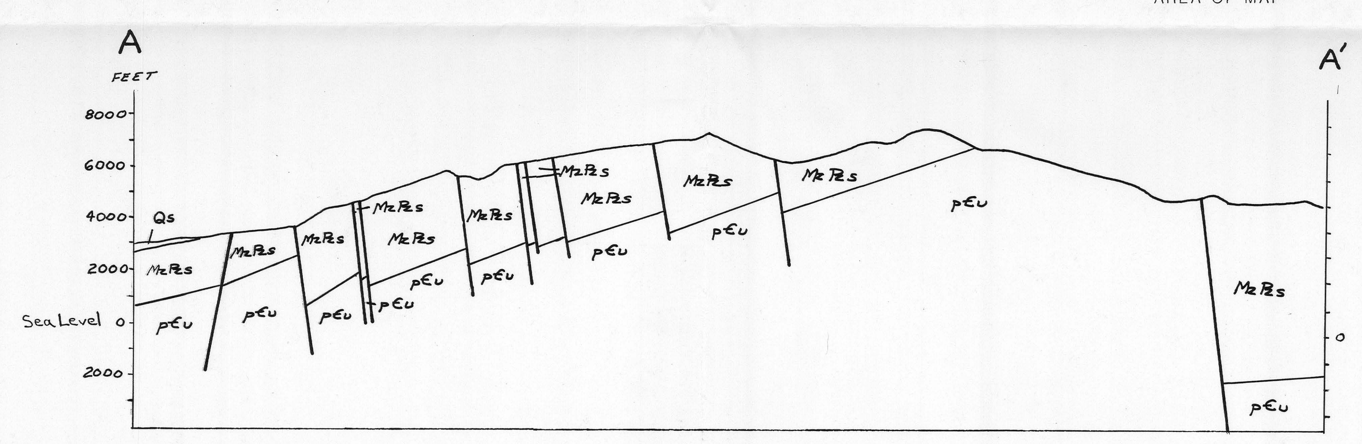


FIGURE 2

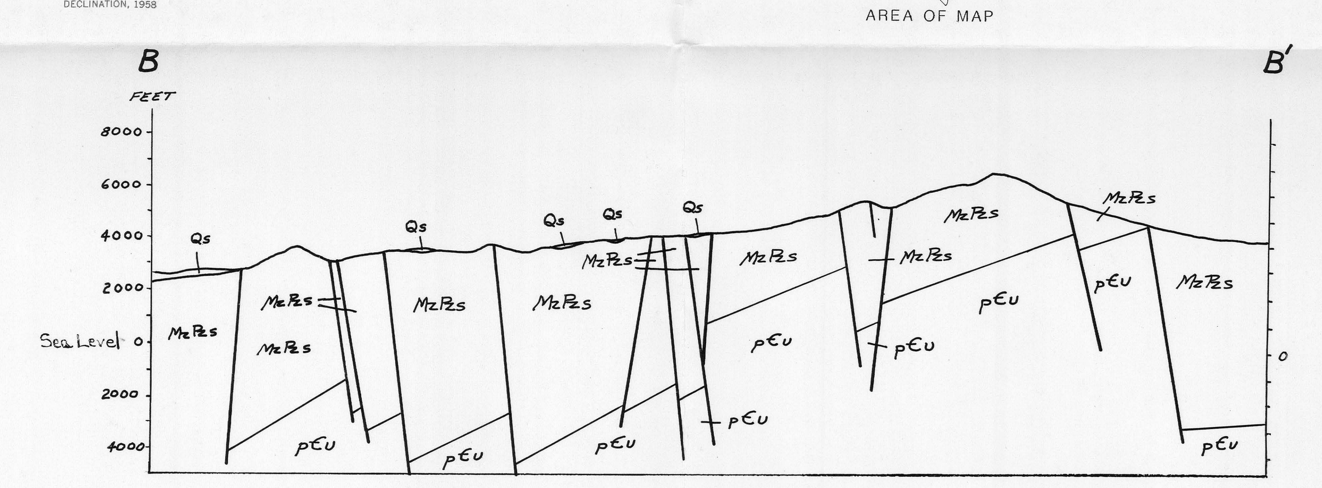




Mineral Surveys
Related to Bureau of Land Management
Instant Study Areas

In accordance with the provisions of the Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976), the Geological Survey and the Bureau of Mines have conducted mineral surveys on certain areas, which formally had been identified as "natural" and "primitive" areas prior to November 1, 1975. This report discusses the results of a mineral survey of the Virgin Mountains Instant Study Area, Clark County, Nevada.

Cross-sections A-A' and B-B' are generalized from similar cross sections in Hose (1980) and here been extrapolated downward to the Precambrian unconformity using his measured stratigraphic section.



EXPLANATION

[Geology generalized from Hose (1980) and Seager (1966)]

DESCRIPTION OF GEOLOGIC UNITS

Qs — Alluvium — QUATERNARY

MzPzs — Sedimentary rocks, undivided — MESOZOIC and PALEOZOIC

pЄu — Igneous and metamorphic rocks, undivided. Includes schist, gneiss, amphibolite, and granitic rocks — PRECAMBRIAN

GEOLOGIC SYMBOLS

Contact --Dashed where uncertain

Fault -- Dotted where concealed

AEROMAGNETIC INTERPRETATION SYMBOLS

Boundary between more magnetic and less magnetic rocks

Fault - Dashed where location uncertain

P_2 — Magnetic anomaly probably caused by plutonic rocks (P). All other linear magnetic highs probably caused by amphibolite (A). Subscripts for purposes of discussion in text.

1000 / 2900 — Depth determination - Dot is located at place on magnetic profile from which depth determination was made using horizontal width of steepest gradient. Upper (northern) number is distance in feet below aircraft to top of magnetic mass. Lower number is elevation above sea level of top of magnetic mass

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. Contour intervals are 20 and 100 gammas.
Flight line direction and number indicated by long dashes P-1 to P-29 and TL-101 to TL-102.
Flight line spacing, 0.5 mile (0.8 km)
Flight altitude, 1000 ft terrain clearance
A constant value of 51300 gammas is added to data
Observed total field reading x51468

The regional field removed is IGRF 1975 updated to the month flown

The grid interval for computer contouring is 175 m N-S and 400 m E-W

Aeromagnetic data and interpretation methods

The data for the aeromagnetic map (fig. 1) of the Virgin Mountains Instant Study Area were collected in 1978 and compiled at a scale of 1:62,500. North-south traverses were spaced at 0.8-km intervals at an altitude of about 300 m above the surface of the ground. The contour interval is 20 and 100 gammas, depending upon the steepness of local magnetic gradients in the Earth's magnetic field. A regional field (the International Geomagnetic Reference Field-1975) of approximately 5-6 gammas/km was removed from the data before contouring by computer.

The local topographic relief for much of this area is commonly 500 to 1000 m, and the valleys are generally narrow and steep sided. Accordingly, the fixed-wing aircraft that performed the survey did not maintain a constant altitude of 300 m above ground and may have been as low as 200 m above ridges and as high as 700 m above the valley floors. Continuous-recording altimeter data are available for each traverse. Comparison of the magnetic map with the topographic map indicates very little correlation between magnetic anomalies and topography, so that in general the variations in aircraft height above ground are not very important in their effect on the contoured magnetic data.

The magnetic anomalies and patterns on the magnetic map are caused by variations in the amount of magnetic minerals, commonly magnetite, in the various rock units and are therefore closely related to geologic features. The sources of the magnetic anomalies in this map area are certain of the igneous and metamorphic rocks of Precambrian age.

Boundaries between magnetic and relatively less magnetic rock units are in general located approximately at the steepest gradient on the flanks of the magnetic anomaly because at these magnetic latitudes the inclination of the Earth's magnetic field is relatively steep. The interpretation map (fig. 2) contains many such boundaries drawn around characteristic magnetic anomalies, and these boundaries were drawn without reference to geologic information. Major linear boundaries, associated with steep gradients and showing significant changes in magnetic patterns on each side, are interpreted as faults. Some magnetic lows, such as the one on the north side of the large magnetic anomaly in the southeast corner of figure 1, are caused by the polarizing effect of the inclined magnetic field upon the magnetic objects south of the lows and do not represent separate magnetic rock units.

A series of depth determinations were calculated from the magnetic map using the method of Vacquier, Steenland, Henderson, and Zietz (1951). This technique utilizes the horizontal length of the steepest gradient on the side of an anomaly as a measure of the depth of the magnetic source below the magnetometer in the aircraft. To ensure accuracy, the measurements are made only along flight lines where continuous data are available. Accuracy is commonly within 20 percent, although larger errors are possible if the shape and magnetic properties of the magnetic sources do not meet the simplifying assumptions of the method. The results of the measurements are shown on figure 2.

Geologic discussion

The geologic map of this area is generalized from the work of Hose (1980) for the instant study area and the work of Seager (1966) for the surrounding region. For the purposes of magnetic interpretation, the geology has been simplified to only three generalized units.

The Precambrian crystalline basement rocks of this area (the first unit) are composed of schist, gneiss, amphibolite, and granitic rocks and are exposed in the north half and southeast corner of the map area. Overlying the crystalline rocks with profound unconformity are the rocks of the second unit, sedimentary rocks of Paleozoic and Mesozoic age. The sedimentary and crystalline rocks are both cut by numerous major and minor faults, most of which have relatively steep dips. Thrust faults appear to be of relatively minor importance. Unconformably overlying all of these rocks are the unconsolidated surficial deposits of the third unit, shown as Quaternary alluvium on figure 2, but including a small amount of Tertiary sedimentary rocks near the north border of the map.

Aeromagnetic interpretation

Examination of the patterns on the aeromagnetic map provides some general information concerning the configuration of the upper surfaces of the magnetic sources. Where the patterns are most steep and irregular, the sources are the most shallow, and comparison with figure 2 indicates that these shallow sources have depths comparable to the ground elevation within the areas of exposed Precambrian rocks. Thus the Precambrian basement contains magnetic rocks that crop out at the surface, and therefore magnetic Precambrian rocks probably also occur directly beneath the basement unconformity where it is overlain by various thicknesses of younger sedimentary rocks and sediments.

Another characteristic pattern of the aeromagnetic map (fig. 1) is the extremely smooth areas where magnetic sources lie at relatively great distances below the magnetometer. Smooth areas occur along the north border of the map, along the east border, and in the southwest quadrant. These smooth areas are all underlain by sedimentary rocks (fig. 2), and the Precambrian basement unconformity must lie at substantial depth below the surface.

The specific Precambrian rocks causing the magnetic anomalies are not known with certainty but some additional information is provided by the shape in plan of the magnetic features shown on the interpretation map (fig. 2). The larger anomalies that are nearly circular in plan with wide marginal gradients have forms similar to anomalies caused by plutonic rocks elsewhere and the great width of the marginal gradients indicates outward-dipping contacts. Accordingly, such anomalies on the aeromagnetic map (fig. 1) are tentatively interpreted as having plutonic rock sources and are labeled "P" on the interpretation map (fig. 2). Two relatively linear magnetic highs occur over exposed Precambrian rocks in the north half of figure 1 and trend approximately S.35°W. and S.65°W. from the northeast corner, the boundaries being indicated on figure 2. The linear form of these features suggests that the source may be a tabular unit, such as an amphibolite, and they are labeled "A".

Some structural features are implied by the aeromagnetic data. The boundaries of the linear magnetic high (caused by amphibolite?) extending S.65°W. from the northeast corner of the map (fig. 1) are interpreted to be faults because of their rather linear form in a terrane of metamorphic and igneous rocks. The west boundary of the eastern smooth magnetic area is considered to be a fault and corresponds well to a major fault shown on the geologic map (fig. 2). The south boundary of the northern smooth magnetic area is likely an unconformity dipping to the north, both because of the relative irregularity of the contact and because of the wide gradients, but there are indications that the Precambrian rocks of this same area are only weakly magnetic so that the interpretation is not especially strong, even though in general agreement with the geologic map (fig. 2).

Magnetic features within the central study area all have calculated source depths (fig. 2) that lie below the surface except for the regions of exposed Precambrian rocks. These calculated depths are in general consistent with the elevation of the basement surface as shown in the two geologic cross sections (A-A' and B-B') of Hose (1980) and tend to be increasingly deep to the southwest. The results are important to the mineral assessment of the area because on the basis of known geology any economic mineral deposits are most likely to be present in the crystalline basement rocks. The general depths of these rocks below the sedimentary rocks of the study area are thus independently confirmed both by the geologic interpretation of Hose (1980) and the geophysical interpretation of this report.

Another possibility is that mineral deposits may be associated with a hypothetical young igneous intrusion situated up in the sedimentary rocks but not exposed at the surface. Such an intrusion would most likely be composed of magnetic rocks that would be detected on the aeromagnetic map as a magnetic anomaly too shallow to be located solely within the Precambrian basement rocks. Two magnetic anomalies (P_1 and P_2 on figure 2) appear to be somewhat shallow relative to the presumed depth (Hose, 1980) to Precambrian crystalline rocks.

Anomaly P_1 on its north side yields from the original analog record (the contour map is not accurate in depicting gradients) a calculated depth such that the magnetic source should nearly crop out at the surface. Examination of the detailed geologic map and cross section B-B' (Hose, 1980) in this area reveals that a relative basement high does indeed exist locally, and the high is shown extending up in the subsurface to an elevation of about 3000 ft on cross section B-B'. This elevation is nevertheless well below the elevation of 4900 feet calculated from the aeromagnetic data and implies a depth below the aircraft of 3200 ft, a result 2.5 times the calculated depth of 1300 ft. The magnetic anomaly is probably caused by Precambrian rocks because the shallow magnetic depth determination correlates with a concealed local basement high deduced from the geologic mapping. However, the geophysical interpretation places the basement much nearer to the surface than does the geologic interpretation.

Magnetic anomaly P_2 is exactly centered over the west end of cross section B-B' (Hose, 1980). Extrapolating the cross section downward to basement by adding the known stratigraphic thicknesses of the Cambro-Ordovician sedimentary rocks yields a local basement high extending upward to about 1000 ft below sea level. Assuming this depth of about 5000 ft below the aircraft, the magnetic source is approximately twice as wide as it is deep. Magnetic sources of such small size (in terms of depth to the top) are not good subjects for the depth method of Vacquier, Steenland, Henderson, and Zietz (1951) because such sources yield calculated depths that are far too shallow. Accordingly, as an alternative method, the magnetic fields of a series of simple models were calculated and compared with the observed magnetic field of anomaly P_2. Several simple magnetic models with their tops at an elevation of 1000 ft below sea level generate magnetic fields similar in form and gradient to the observed magnetic field of anomaly P_2. Therefore, the source of this anomaly is also considered to be within the Precambrian crystalline rocks.

In summary, the aeromagnetic interpretation of figure 1 is generally in good agreement with the geologic map of Hose (1980) with the exception that the source of anomaly P_1 appears to be somewhat too shallow relative to the geologic interpretation. If the concealed Precambrian magnetic sources labeled "P" are plutons, and if similar nearby plutons can be shown to be mineralized, then the anomalies might be of economic interest, but these source rocks are in general buried at substantial depths below the surface, with the possible exception of anomaly P_1.

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MAPS SHOWING AEROMAGNETIC SURVEY AND INTERPRETATION OF THE VIRGIN MOUNTAINS INSTANT STUDY AREA, CLARK COUNTY, NEVADA

by
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1980