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# Geochemical and Geophysical Anomalies in the Western Part of the Sheep Creek Range Lander County, Nevada

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# GEOCHEMICAL AND GEOPHYSICAL ANOMALIES IN THE WESTERN PART OF THE SHEEP CREEK RANGE, LANDER COUNTY, NEVADA

By Garland B. Gott and Charles J. Zablocki


### Abstract

Extensive geochemical anomalies are present along the west side of the Sheep Creek Range in Lander County, Nev. Anomalous concentrations of zinc, arsenic, mercury, silver, copper, lead, and to some extent gold, molybdenum, and antimony occur in iron-rich material along fracture planes and in quartz veins in Paleozoic formations.

A magnetic anomaly occurs over a pediment at the southern part of the range, close to one of the geochemical anomalies. Gravity and electrical resistivity measurements suggest that the magnetic anomaly is caused by an intrusive igneous mass rather than by a block of downfaulted basalt. A limited amount of shallow drilling would clarify the geochemical and geophysical data.


## INTRODUCTION

A geochemical reconnaissance of the west side of the Sheep Creek Range (fig. 1) was made by R. L. Erickson in 1965. Encouraging results from this survey prompted a more detailed investigation during the summer of 1967. Anomalous concentrations of several metals were found throughout an area in which Paleozoic cherts and quartzites are exposed. These metals—zinc, arsenic, mercury, silver, lead, copper, gold, molybdenum, antimony, tungsten, and tellurium—occur in such great concentrations as to suggest that they constitute a dispersion halo around or over a concealed mineral deposit. The outcrop belt of the Paleozoic rocks is limited to a narrow strip about 10 miles long on the west side of the range. The geochemical anomalies occur throughout this belt and may extend eastward under basalt and westward under alluvial cover.

Geophysical investigations were made in and around an anomalous magnetic feature previously observed on an aeromagnetic map of this area. Results of these investigations suggest a shallow exploration target.

After completion of the fieldwork involving both the geochemical and geophysical investigations a photogeologic base map was obtained from Knox-Bergman-Shearer, Photogeologists, Denver, Colorado (fig. 2). Neither Knox-Bergman-Shearer nor the writers have had an opportunity to check this map in the field, but the map suggests the presence of structures related to the geochemical anomalies.

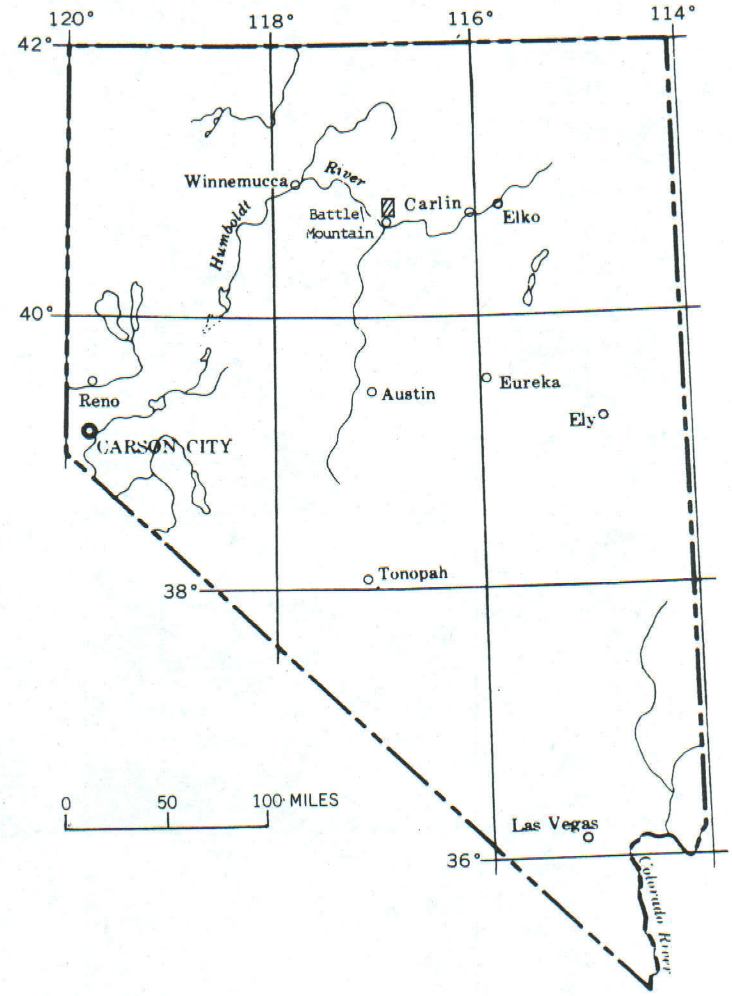



Figure 1.—Index map of Nevada showing area of this report.

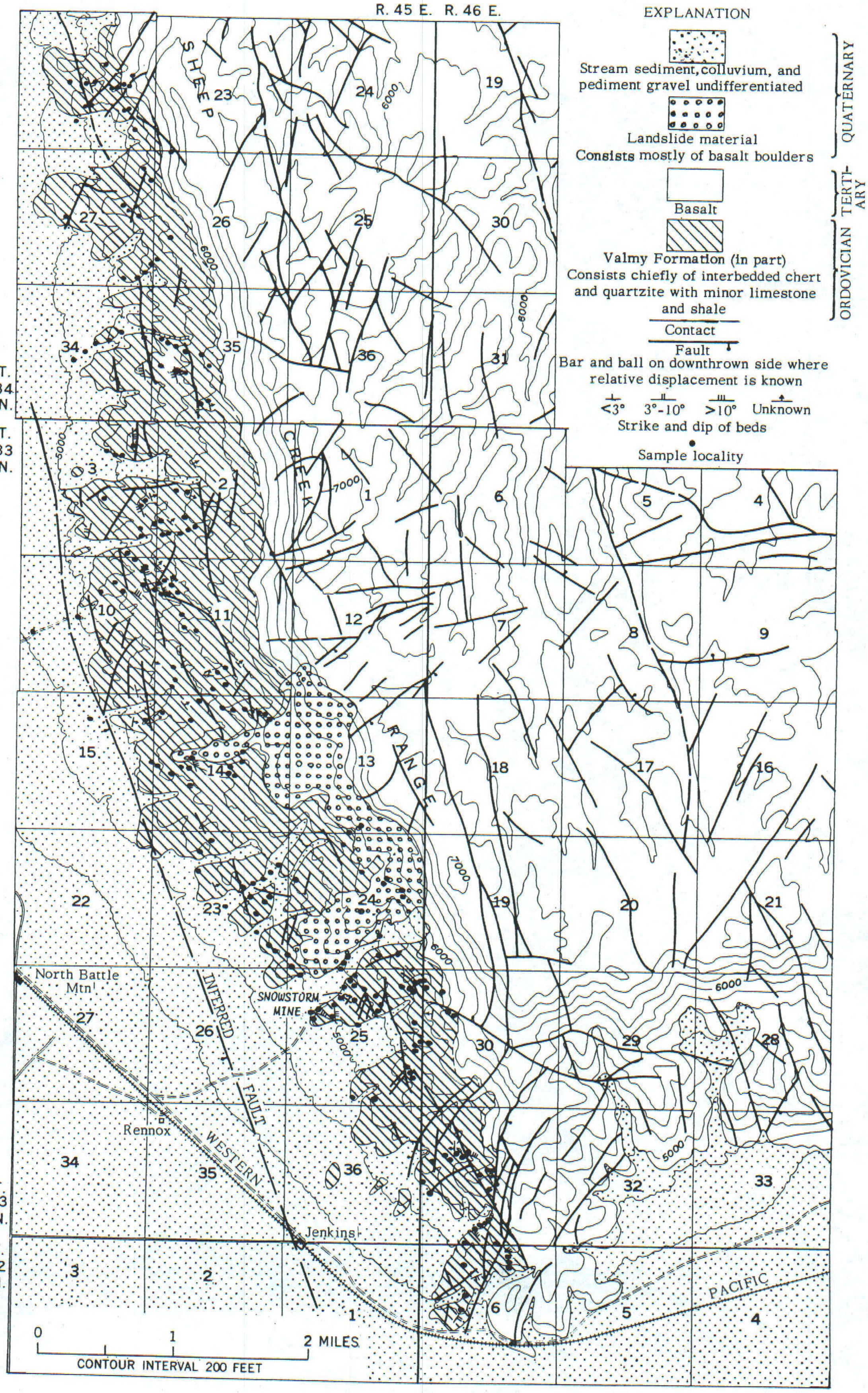



FIGURE 2.—Photogeologic map of part of the Sheep Creek Range, Lander County, Nev., showing sampled localities and area of figures 3–10. Photogeology modified from map prepared by Knox-Bergman-Shearer, Denver, Colo., 1967.

## GEOLOGIC ENVIRONMENT

One of the major structural features in north-central Nevada is the Roberts Mountains thrust fault (Roberts, 1964; Gilluly and Gates, 1965). This fault has thrust a western facies of Paleozoic siliceous rocks eastward over a carbonate facies of the same age. Ore deposits in many mining districts of this region are confined to the shattered and crushed rock along the thrust plane or to the carbonate rocks below the thrust plane.

The Paleozoic rocks that are exposed on the west side of the Sheep Creek Range are part of the western siliceous facies of the upper plate of the thrust fault. They consist of interbedded cherts and quartzites with some limestones and shales (fig. 2). The center of the range is capped by Tertiary basalt flows as much as 1,000 feet thick. Trains of basalt boulders derived from the basalt cap cover the Paleozoic rocks in many areas, and colluvial materials cover the lower slopes. A pediment thinly mantled by alluvium lies along the southwest base of the range.

Some of the interbedded chert and quartzite sequence was identified by R. J. Roberts (oral commun., 1967) as part of the Valmy Formation of Ordovician age, but other Paleozoic formations may also be present. In general the beds strike about N. 35° W. and dip about 45° NE. The exposed chert-quartzite sequence is probably several thousand feet thick.

The cherts are mainly gray and grayish brown although some are red, green, or gray-red mottled. The quartzite beds are predominantly light gray and of high purity. Both the cherts and quartzites are highly brecciated and fractured.

Carbonate facies Paleozoic rocks are not exposed on the west side of the Sheep Creek Range, but on the basis of present knowledge of the structure in nearby areas, the Roberts Mountains thrust fault can be inferred to be present at depth in this area.

## GEOCHEMICAL INVESTIGATIONS

### MATERIALS SAMPLED

The principal objective of this investigation was to evaluate the possibility that metals were localized near the thrust plane in either the upper or the lower plate. Samples were collected, therefore, that seemed most likely to represent introduced material such as vein quartz and iron minerals in fractures and vugs. An effort was made to include such material in all samples collected, but chert with iron oxide-stained fractures constitutes the bulk of the samples. Where more than one sample was collected at the same locality the highest value was used to construct the geochemical maps.

### ANALYTICAL PROCEDURE

Gold, silver, and tellurium were determined by a wet chemical method using atomic absorption. Mercury was determined instrumentally by an atomic-absorption technique (Vaughn and McCarthy, 1964). Arsenic, antimony, and zinc were determined by wet chemical methods (Ward and others, 1963). The remainder of the elements were determined by a semiquantitative spectrographic method (Ward and others, 1963).

### DISTRIBUTION OF METALS IN THE PALEOZOIC ROCKS

Several metals occur in unusually high concentrations along the outcrop belt of Paleozoic rocks. The most extensive anomalies are of zinc, arsenic, mercury, and silver (figs. 3–6). Lead, copper, and gold (figs. 7–9) are present in highly anomalous concentrations but the anomalies are less extensive. Isolated anomalies of tungsten (fig. 10), antimony, molybdenum, and tellurium are also present. The principal concentrations of all the metals are with iron oxide on fracture planes and with vein quartz. The most consistent anomaly for all the metals is, expectably, near the Snowstorm mine (figs. 3–10).

The following comparison of the average crustal abundance of 11 metals with their concentration in the Sheep Creek Range illustrates the magnitude of these anomalies:

| | *Average concentration in the earth's crust* (*ppm*) | *Range of concentration in the Sheep Creek Range* (*ppm*) |
|---|---|---|
| Zn | [1]80 | <25 – 800 |
| Cu | [1]70 | <10 – 15,000 |
| Pb | [1]16 | <10 –>20,000 |
| As | [1]5 | <10 – 1,500 |
| Mo | [1]2.3 | <5 – 200 |
| W | [1]1.0 | <50 – 1,000 |
| Sb | [1]1.0 | 1 – >100 |
| Hg | [2].06 | <.1 – 30 |
| Ag | [1].02 | <.2 – 260 |
| Au | [3].002 | <.02– 1.3 |
| Te | [1].002 | <.1 – 17 |

[1] From Goldschmidt (1958).
[2] From Green (1959).
[3] From DeGrazia and Haskin (1964).

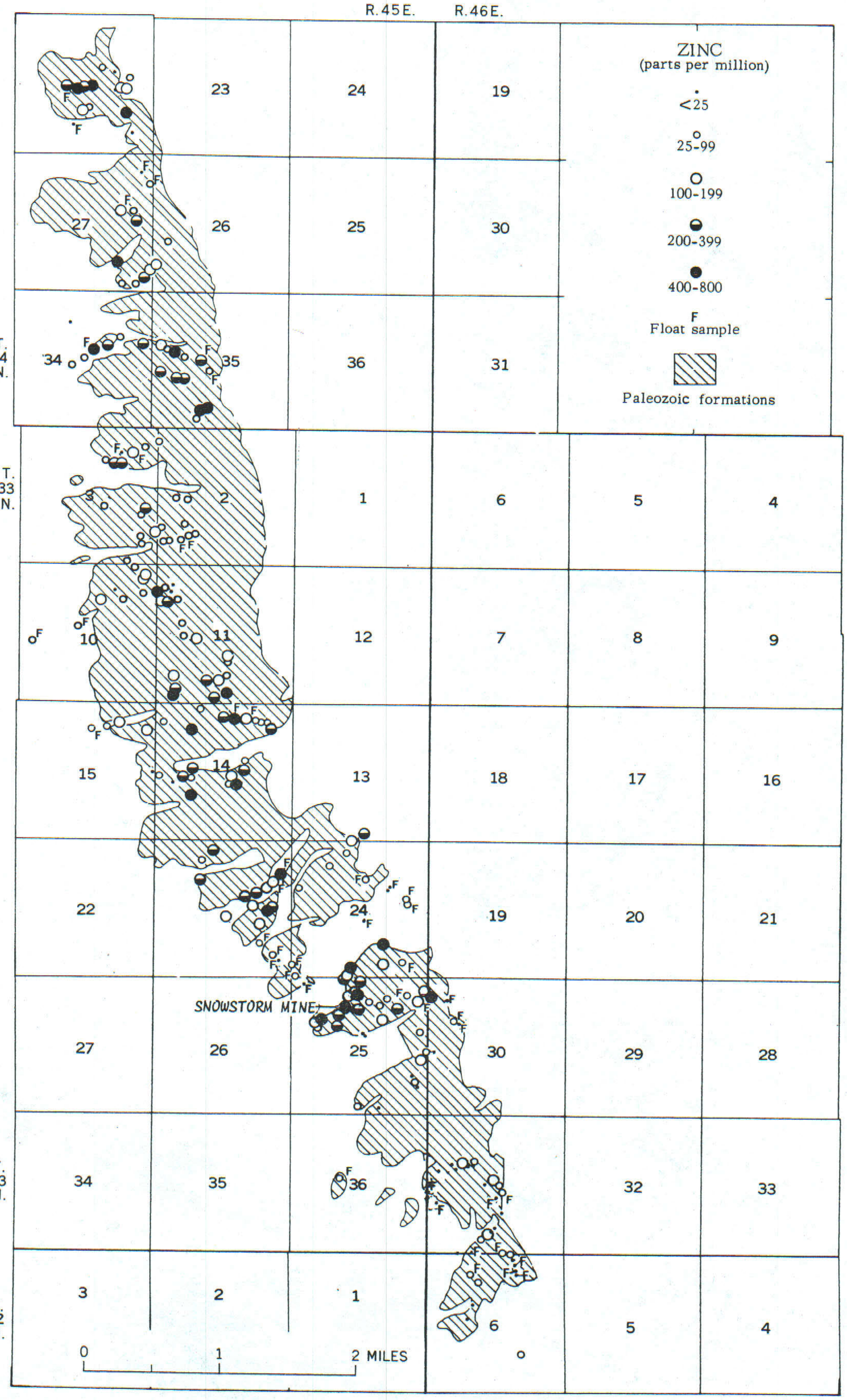



FIGURE 3.—Zinc distribution, highest concentration at each locality.

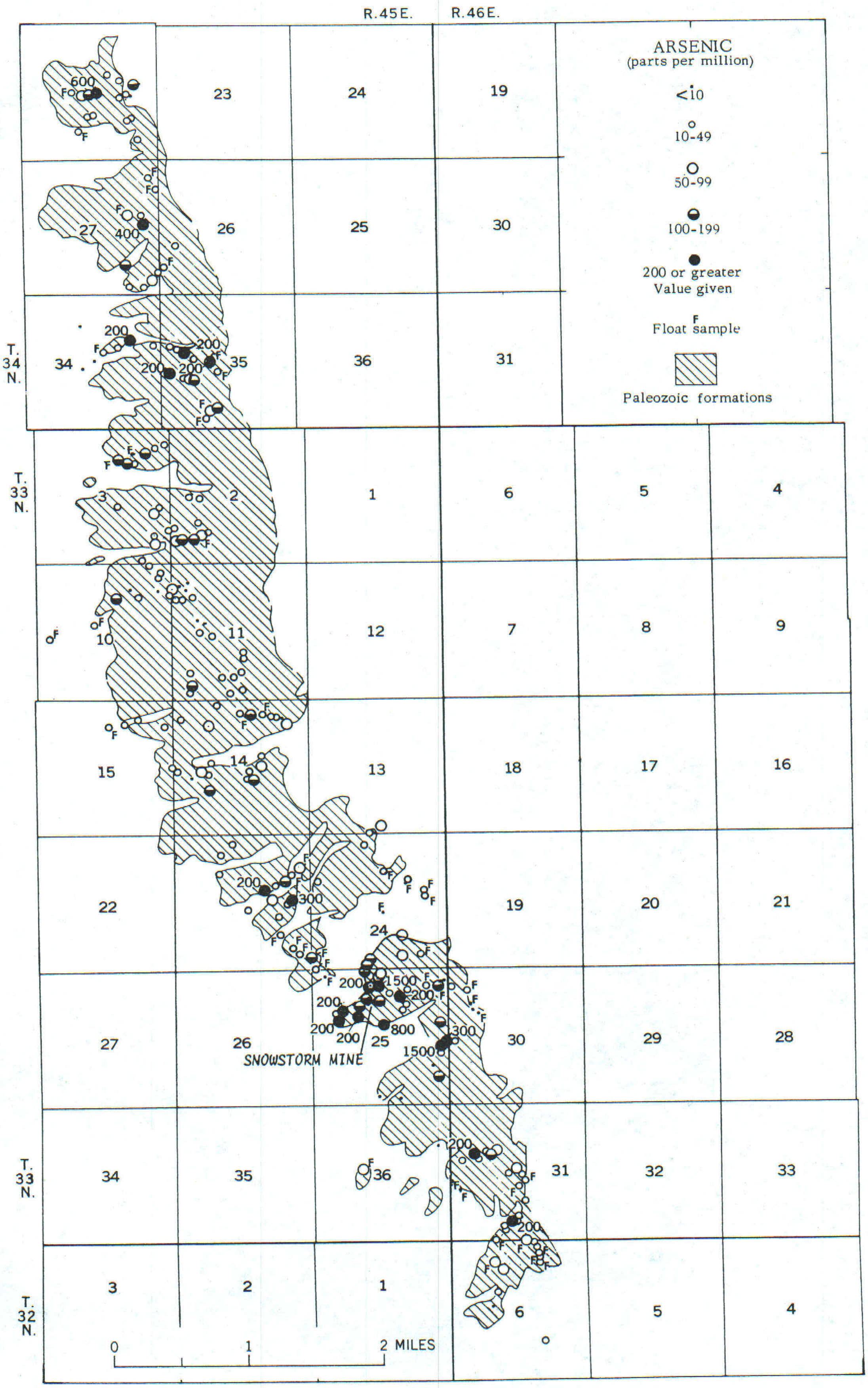



FIGURE 4.—Arsenic distribution, highest concentration at each locality.

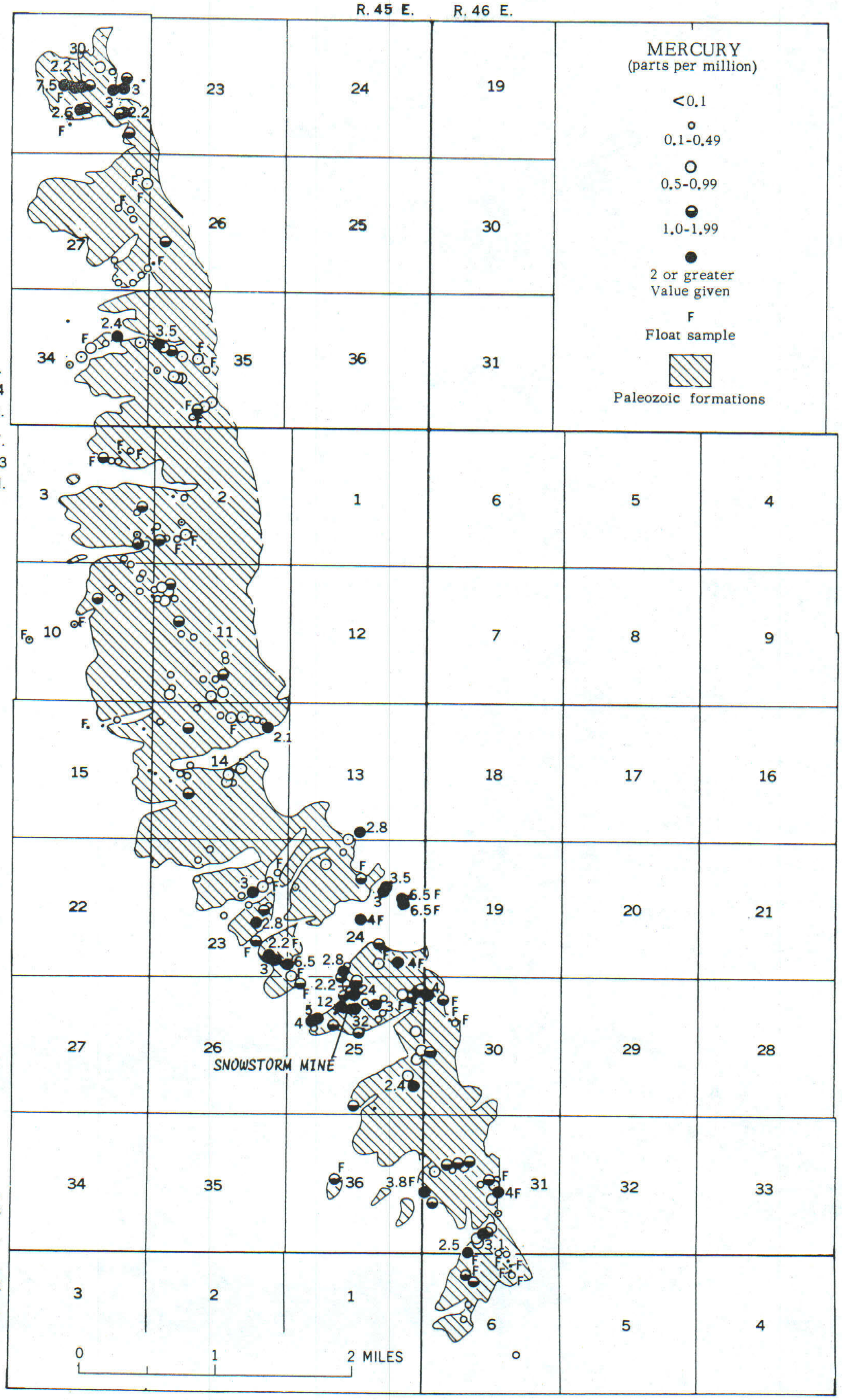



FIGURE 5.—Mercury distribution, highest concentration at each locality.

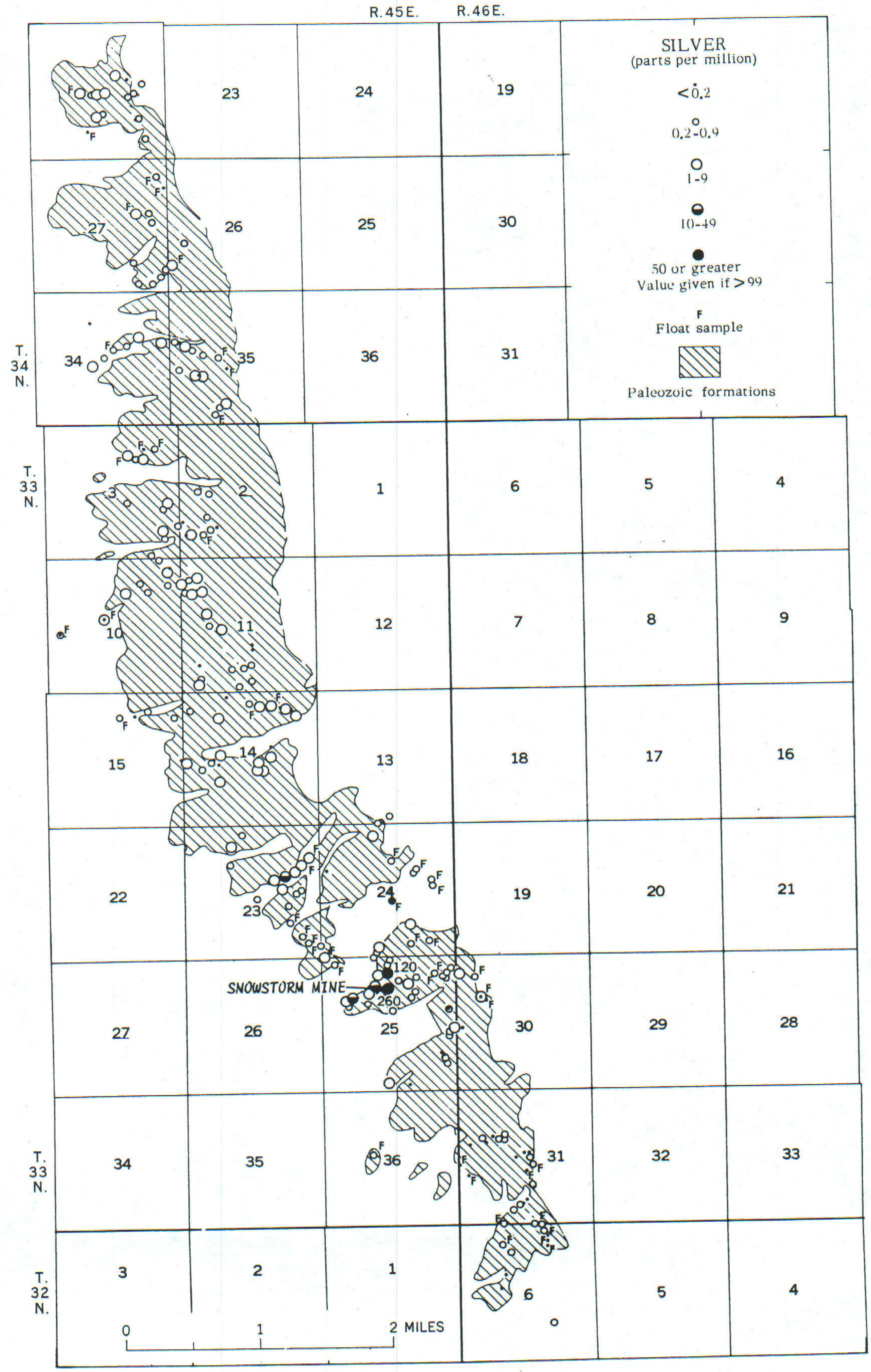



FIGURE 6.—Silver distribution, highest concentration at each locality.

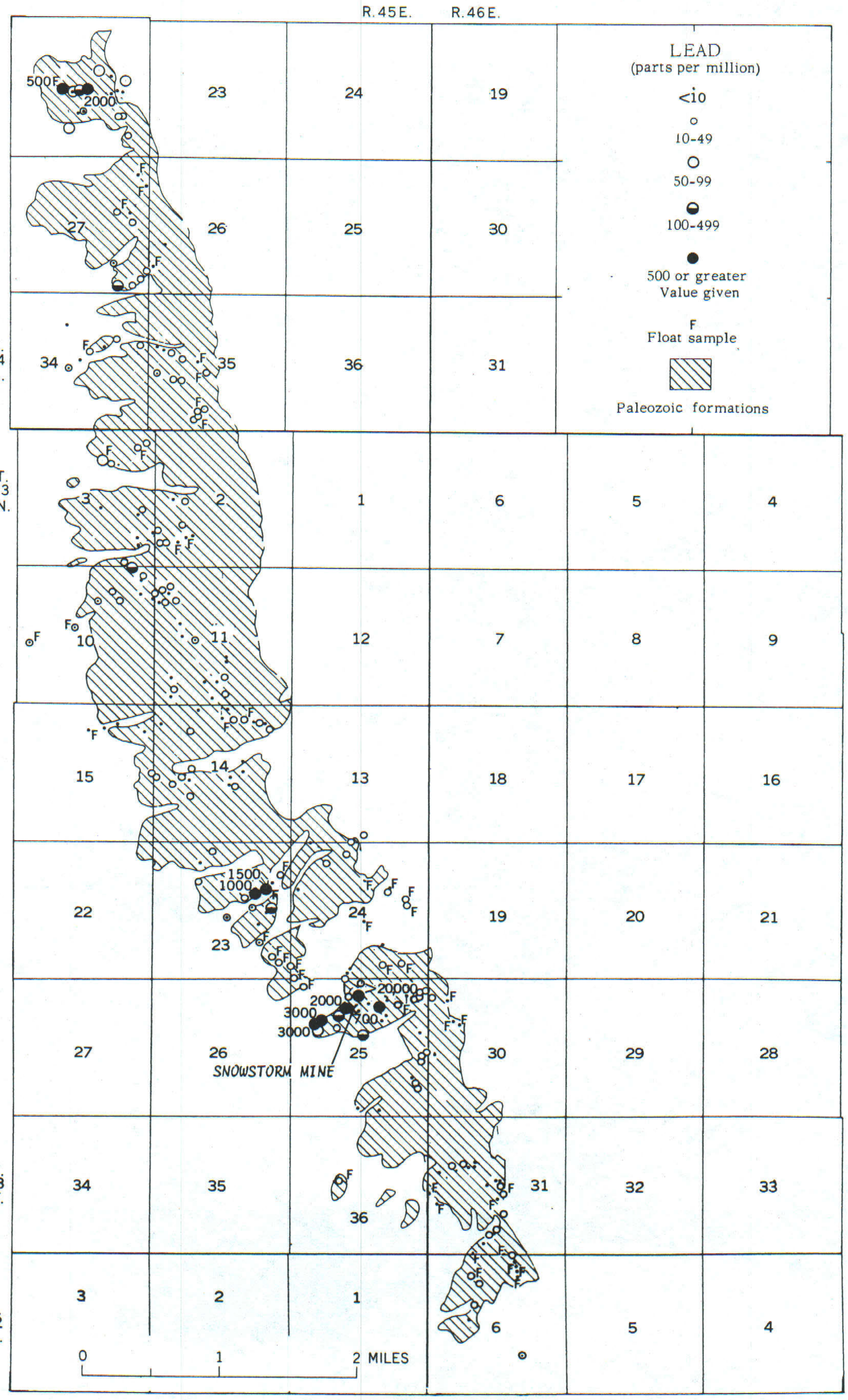



FIGURE 7.—Lead distribution, highest concentration at each locality.

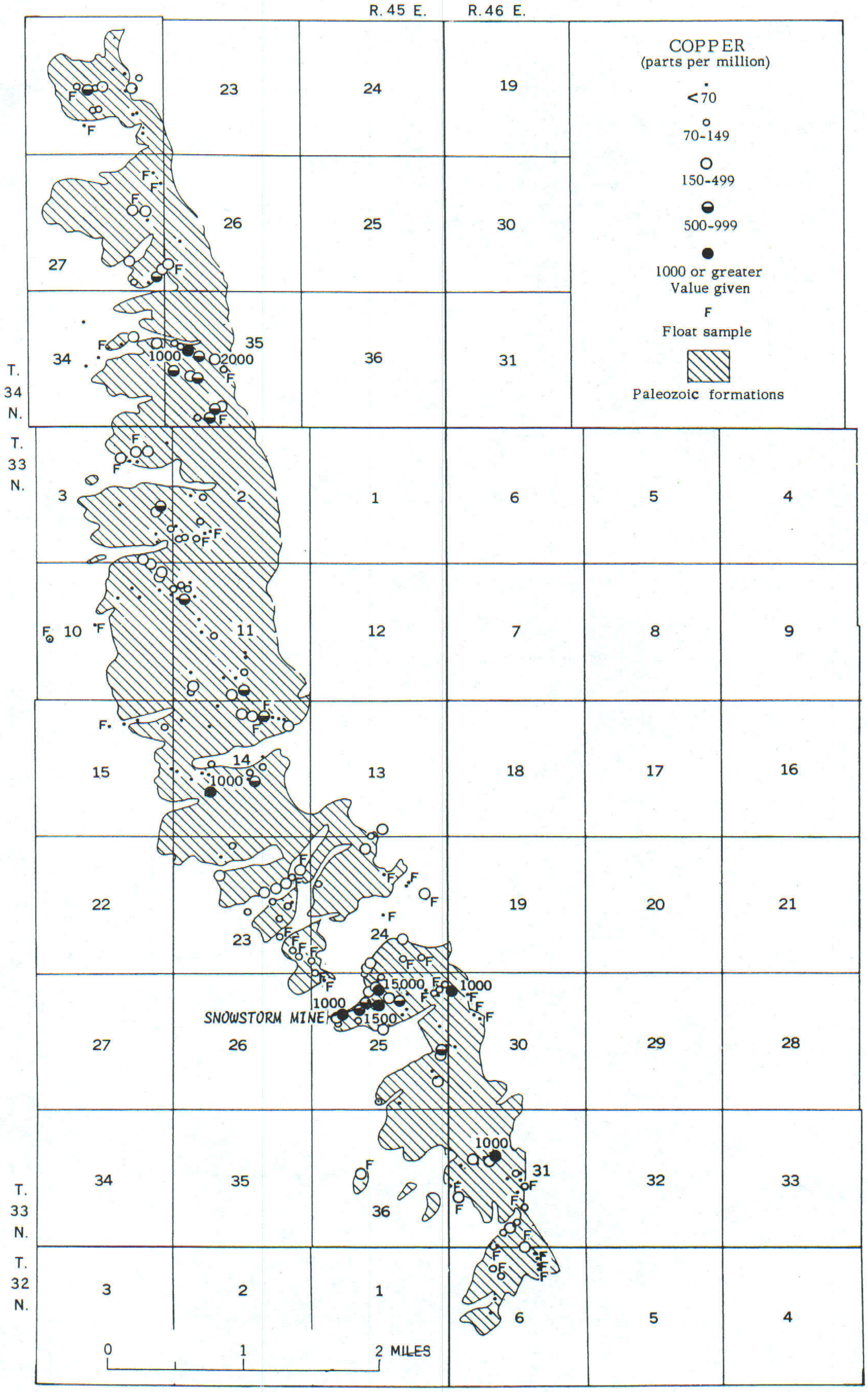



FIGURE 8.—Copper distribution, highest concentration at each locality.

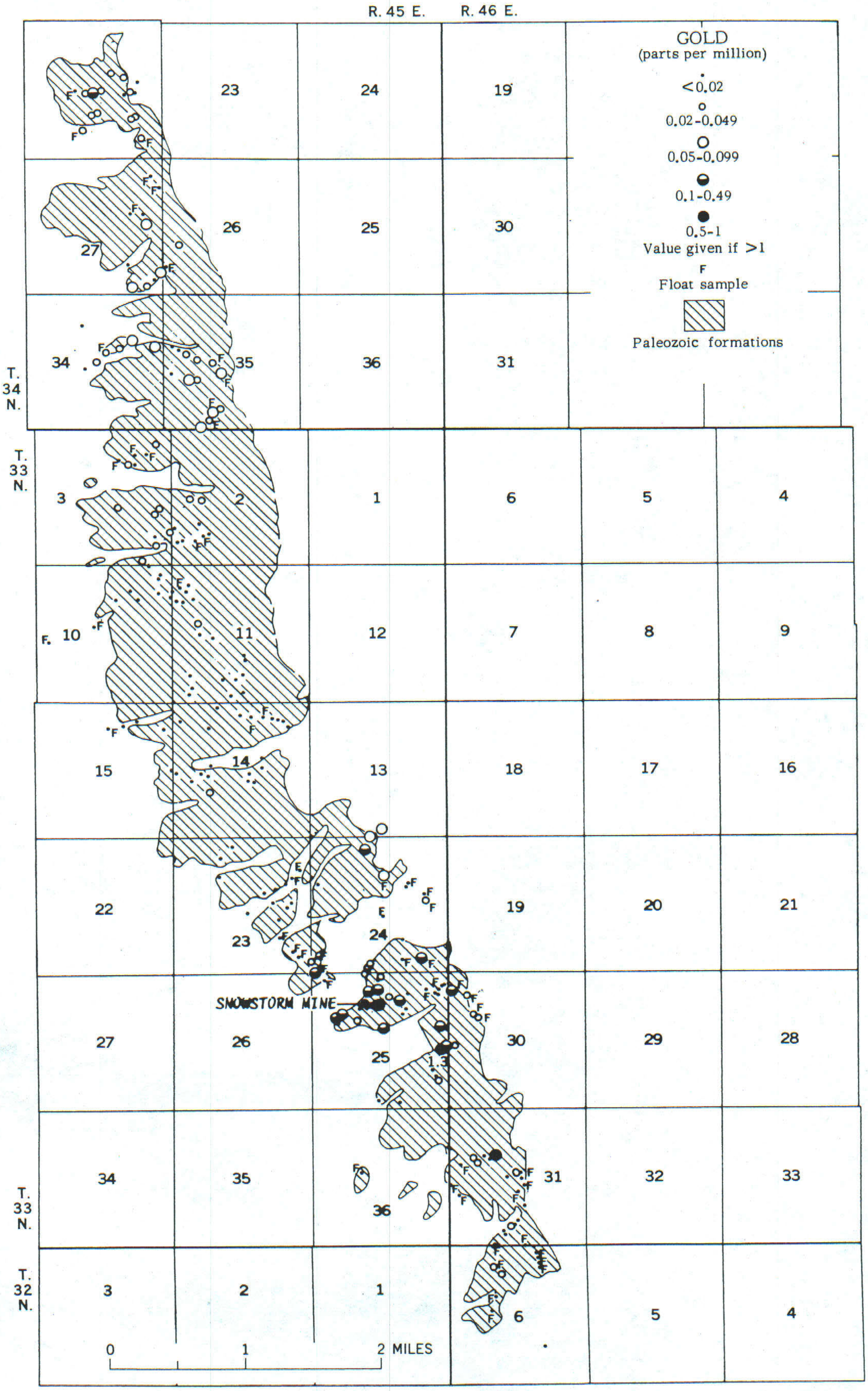



FIGURE 9.—Gold distribution, highest concentration at each locality.

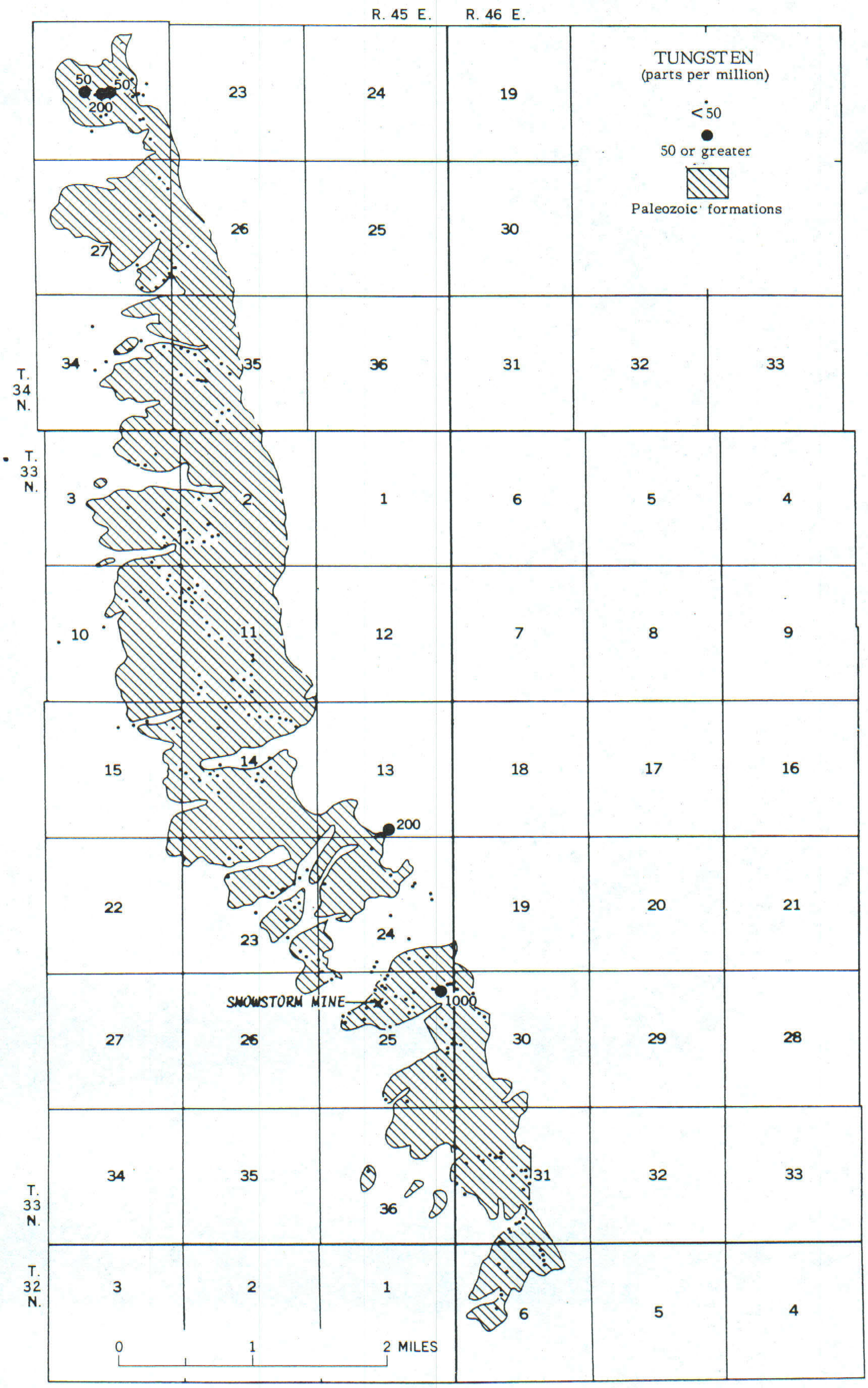



FIGURE 10.—Tungsten distribution, highest concentration at each locality.

It is not known whether or not the Paleozoic rocks in the Sheep Creek Range originally contained a metal content comparable to that of the earth's crust, but it appears that most of the elements listed have subsequently been locally enriched by very large factors.

The metals were probably introduced into the heavily fractured rocks by upward or laterally migrating solutions. The anomalies may represent a dispersion halo above or around concealed mineral deposits, possibly located along or below the thrust plane or associated with a buried intrusive mass, or they may constitute the whole mineral deposit. Inasmuch as broken and crushed rock along the Roberts Mountains thrust plane is known to be a favorable host for ore deposits elsewhere, the possibility that mineral deposits exist along the thrust below the anomalies is at least reasonable. The geophysical investigations indicate that the possibility of the existence of an unexposed intrusive mass in the southern part of the area is also reasonable.

A geochemical association of arsenic, mercury, antimony, and tungsten with gold has been recognized in many of the ores of north-central Nevada (Erickson and others, 1966). Examples of ore deposits with this kind of association are the Getchell, Bootstrap, Carlin, and Gold Acres mines and the newly discovered gold deposit in the Cortez area. The similar geochemical association of metals on the west side of the Sheep Creek Range may be similarly significant.

## GEOPHYSICAL INVESTIGATIONS

Aeromagnetic surveys of large areas in western and north-central Nevada have been flown as part of the U.S. Geological Survey's program of geologic investigations. Of timely interest is an aeromagnetic map made from a 1967 survey of the Battle Mountain quadrangle (U.S. Geological Survey, 1968); part of this map is shown in figure 11. A local magnetic high near the Rennox railroad siding is superimposed on a northeastward-increasing regional magnetic gradient. The prominent, high-amplitude magnetic anomaly shown in the northeast part of the map is related, in part, to basaltic rocks of Tertiary age that form the cap rock of the Sheep Creek Range. This anomaly is an extension of the linear northwest-striking regional magnetic anomaly reported previously by Mabey (1966).

The local magnetic anomaly centered near Rennox is over alluvium along the western front of the Sheep Creek Range. In amplitude and shape, the anomaly resembles the magnetic anomaly in the Cortez area 40 miles to the southeast (Mabey, 1965).

Subsequent geophysical investigations—a low-level aeromagnetic survey, a gravity survey, and electrical resistivity soundings—were made in and around the Rennox area to provide some insight into the probable source of the magnetic anomaly.

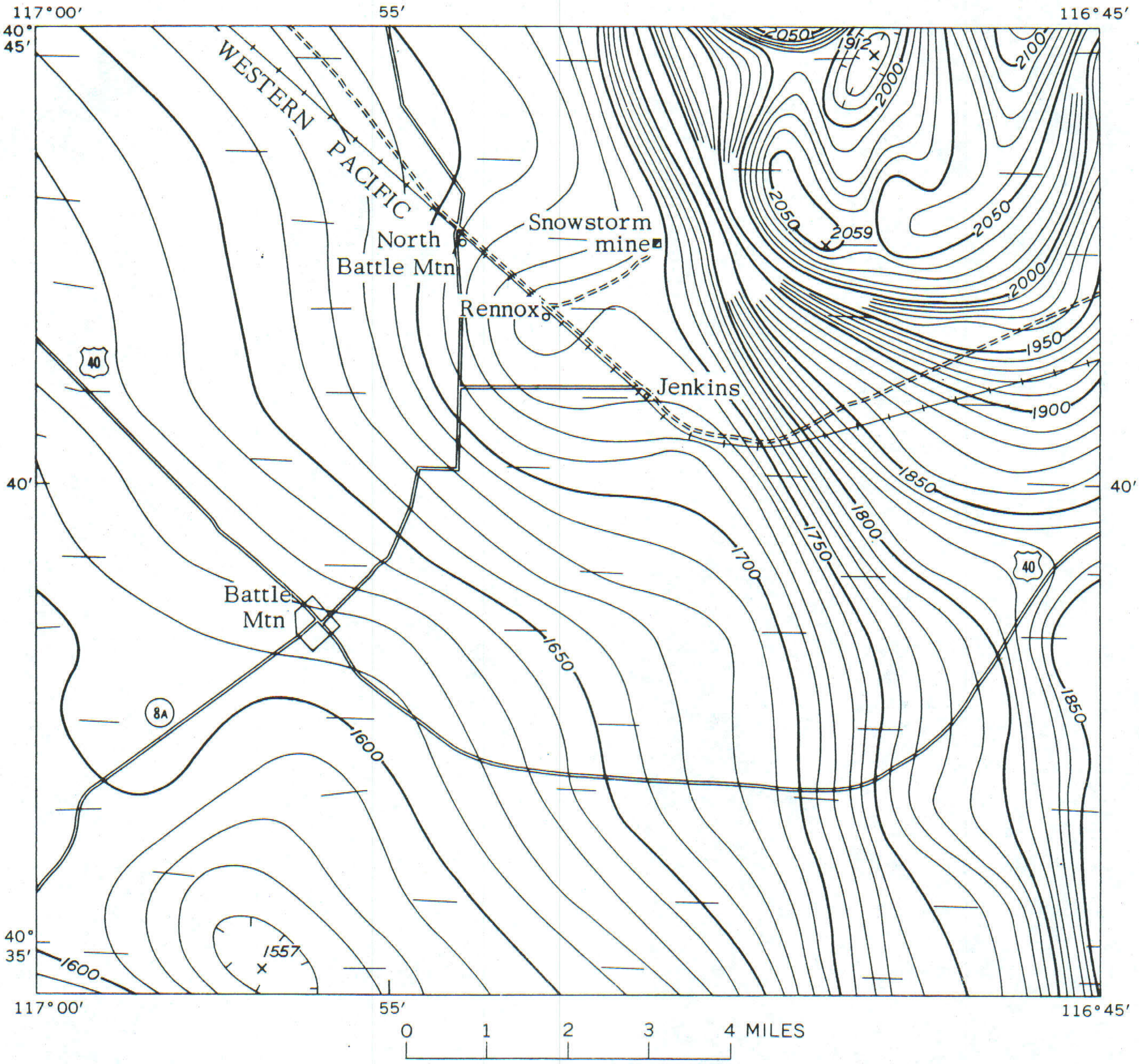
### MAGNETIC DATA

Two prominent magnetic features exist in the area of the low-level aeromagnetic survey (fig. 12). The feature at the southeast end is attributed to exposed basalt; basalt extends some distance southward beneath alluvial cover.

The magnetic anomaly near Rennox, only partially surveyed, shows pronounced lineations on the north and east sides of the feature; the lineation along the east side coincides with the projection of the inferred fault on the photogeologic map. The steepest magnetic gradient on the north side of the anomaly indicates a source less than a hundred feet below the surface. Magnetic material also exists at shallow depths immediately to the south of the Snowstorm mine and east of the inferred fault.

The Rennox anomaly does not fit a simple model of a normally magnetized, steep-sided body because no low (relative to background) is developed on the north and northeast sides. A model based in part on the gravity and electrical data (fig. 13) is a two-dimensional tabular body 1,500 feet thick and 3,750 feet long, having a minimum depth from the surface in the vicinity of the fault of 750 feet and inclining to the southwest toward Rennox to a maximum depth of 1,500 feet.

The smaller amplitude anomaly east of the fault could not be attributed solely to a thin veneer of basalt boulders and fragments on the Paleozoic chert-quartzite sequence. The magnetic material probably is an intrusive mass in the Paleozoic bedrock.




EXPLANATION

—2000—

Magnetic contours
Showing total intensity magnetic field of the earth in gammas relative to arbitrary datum; ×, location of recorded maximum or minimum intensity within a closure. Contour interval 10 and 50 gammas.

Flight path
Showing location and spacing of data

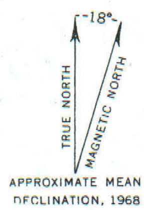



**FIGURE 11.**—Aeromagnetic map of part of the Battle Mountain quadrangle, Nevada, obtained from a flight elevation of 9,000 feet above sea level. Aeromagnetic survey flown by R. W. Krizman; compilation supervised by C. L. Long.

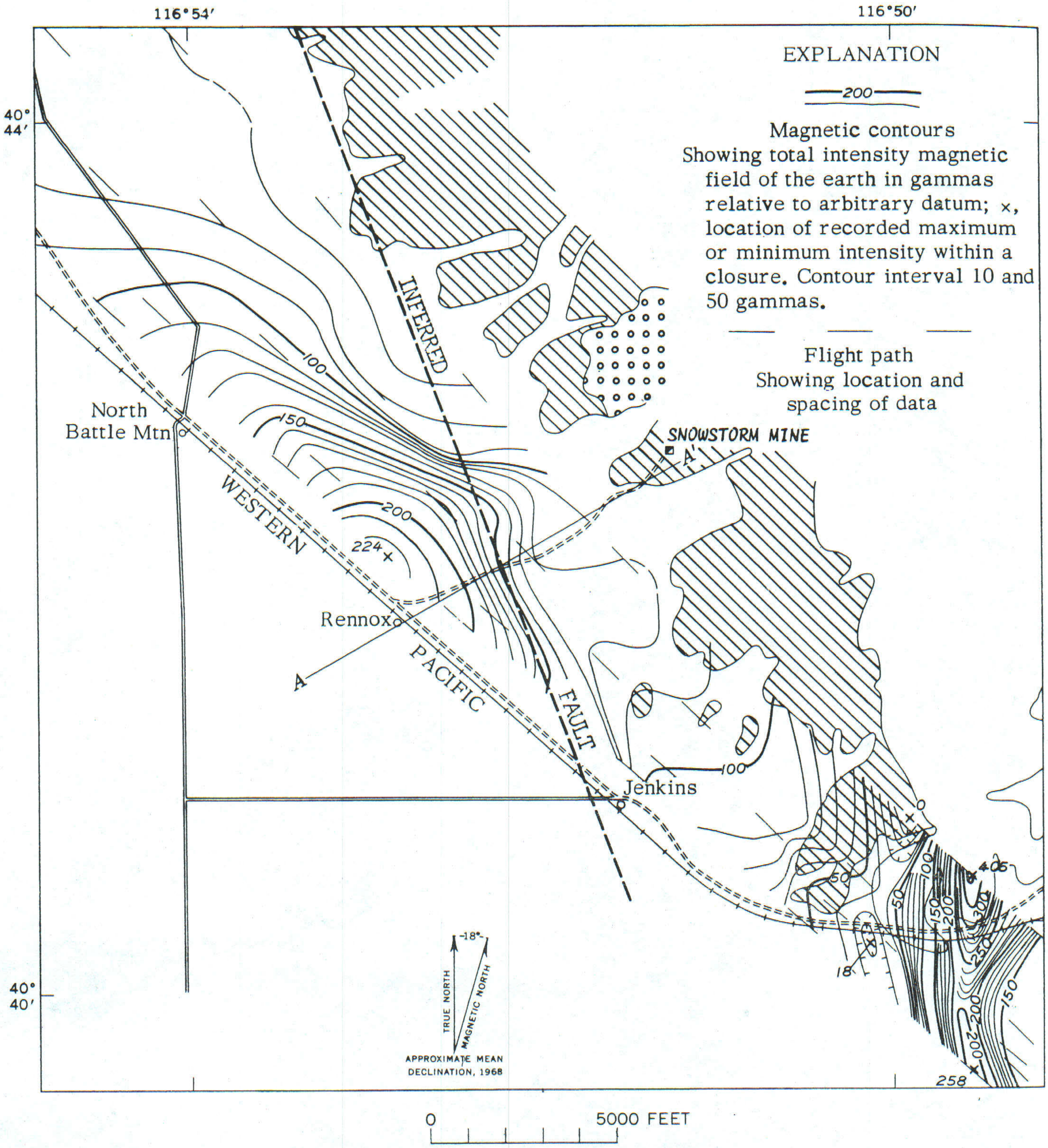



FIGURE 12.—Aeromagnetic and generalized geologic map of the Rennox area, Nevada. Aeromagnetics from flight elevation of 400 feet above ground. $A$–$A'$, location and extent of profile discussed in text. Geologic symbols explained in figure 2.

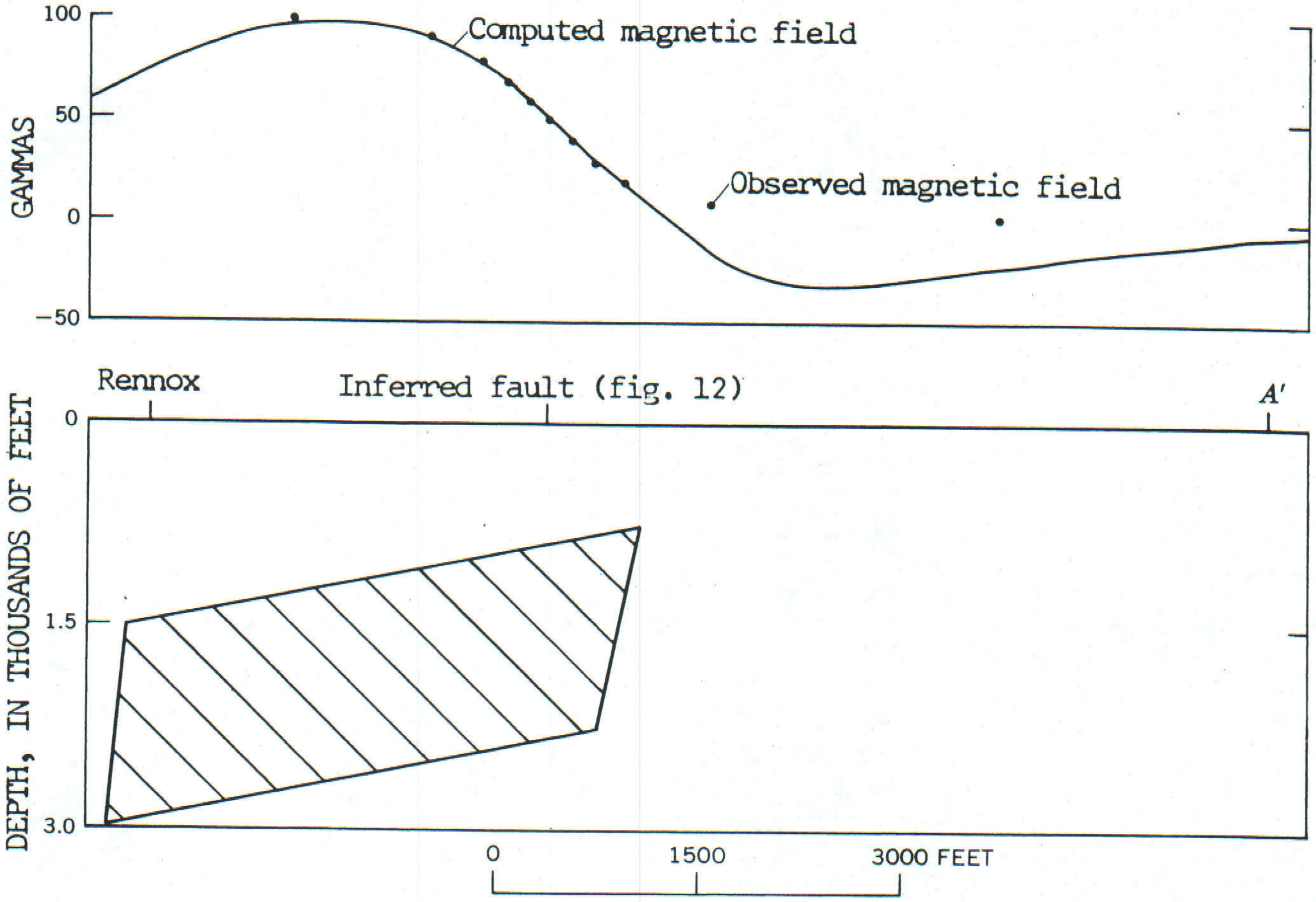



FIGURE 13.—Comparison of magnetic data taken from aeromagnetic map along line segment from Rennox to *A′* (fig. 12) with model curve for the two-dimensional body shown. Line of observation is 400 feet above ground. Magnetic susceptibility, $1.5\times10^{-3}$ cgs (centimeter-gram-second system) units; total field, $5.45\times10^{-4}$ gammas; inclination, 66°. Strike of model is 37° west of magnetic north.

### GRAVITY DATA

A two-dimensional model which fits the observed gravity data taken along profile *A–A′* indicates the probable existence of two faults that displace the bedrock surface beneath the surficial cover (fig. 14). The smaller of the two faults is about 750 feet northeast of the fault inferred on the photogeologic map. Bedrock on the northeast side of the smaller fault probably lies less than 100 feet below the surface, and bedrock on the downdropped side is about 750 feet below the surface. The larger fault near Rennox is probably a major Basin and Range fault with an approximate displacement of about 7,000 feet. It may be an extension of the fault along the west front of the Shoshone Range south of the Argenta Siding reported by Mabey (1964) and corroborated by Erwin (1967).

### RESISTIVITY DATA

The interpretation of six Schlumberger resistivity soundings made between Rennox and the Snowstorm mine supports some parts of the gravity and magnetic models presented. Soundings 1 and 2 (fig. 15) indicate that a low-resistivity section (perhaps water-saturated alluvium) extends to a depth of at least 800 feet.

Soundings 3 through 6 indicate that the pediment cover is only 15 to 35 feet thick on the northeast side of the fault. A second zone, about 500 feet thick, has a resistivity of about 50 ohm-meters at sounding 3, which gradually increases to about 140 ohm-meters at sounding 6. The values in this zone would normally be

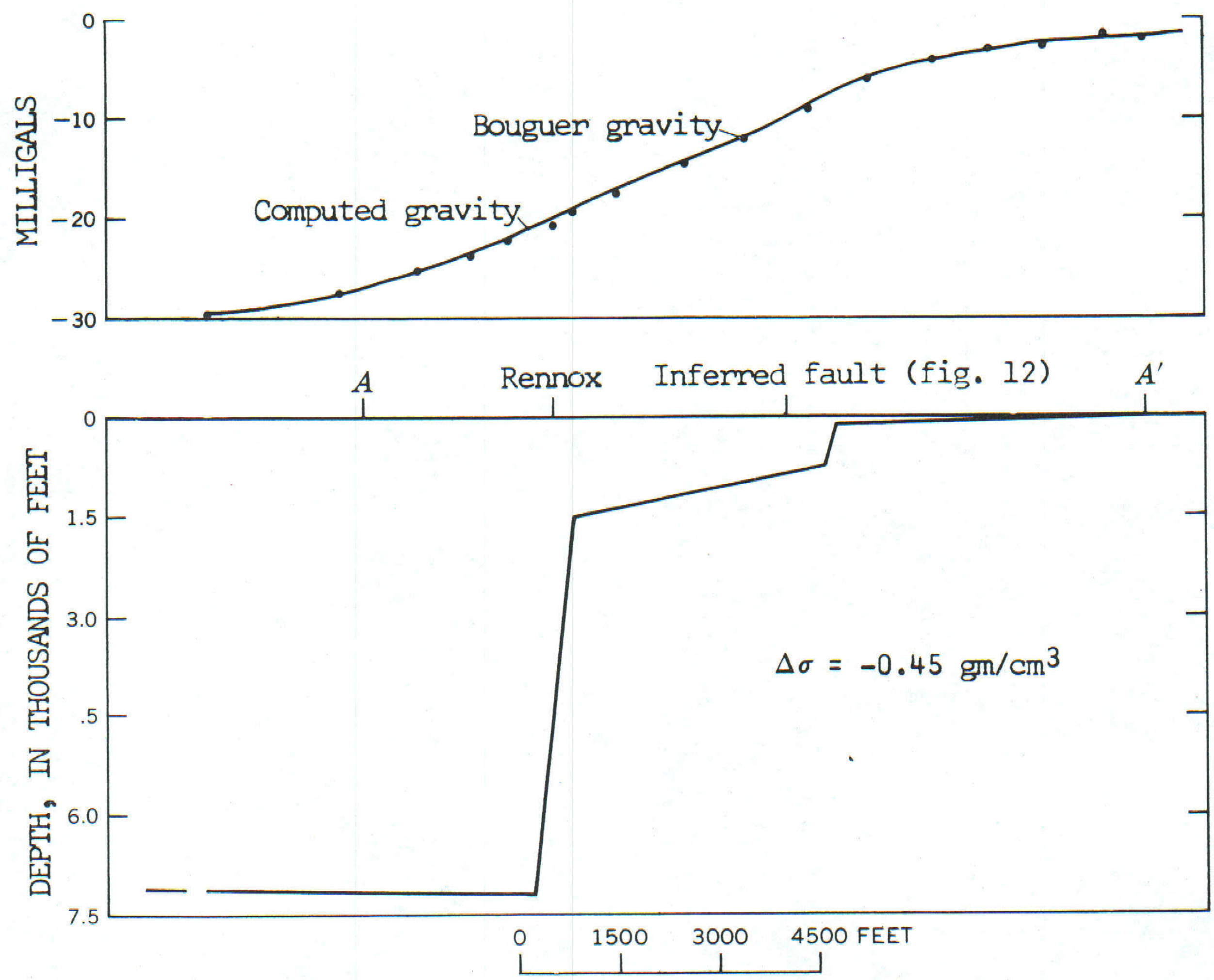



FIGURE 14.—Comparison of the simple Bouguer gravity values projected along $A$–$A'$ (fig. 12) with model curve for the two-dimensional structure shown. Density contrast between the two bodies is —0.45 gm/cm³ (gram per cubic centimenter).

too low for competent chert and quartzite, which have rather low intergranular porosity. However, because the chert and quartzite in the area are highly brecciated and fractured, values such as these are not unlikely.

Perhaps the most significant result of these four soundings is an anomalously lower resistivity zone below 500 feet, extending to at least 1,000 feet. Resistivity values of about 20–30 ohm-meters in the bedrock would likely require the presence of some clay minerals with high ion-exchange capacity.

## CONCLUSIONS

The source of the magnetic anomaly in the vicinity of Rennox was not resolved by the geophysical studies made in the area. Although the simple straight-sided gravity and magnetic models presented might be suggestive of a block of basalt, the physical counterpart might be quite different. The thickness of the magnetic mass could be greater and its shape more irregular than shown. The high-level aeromagnetic data suggest the magnetic mass extends almost a mile southwest of Rennox at a depth in excess of 6,000 feet. This configuration would suggest an intrusive mass. Further, the broad magnetic anomaly with smaller amplitude east of the fault appears to be caused by an intrusive mass. The anomalously low resistivity zone below 500 feet could result from clay alteration related to an intrusive body.

Because most of the anomalous rocks inferred from the geophysical data are at shallow depths, a drilling program would effectively resolve the uncertainties. A drill hole near the steepest gradient shown on the north side of the magnetic anomaly should intercept the igneous rock within 100 feet from the surface.

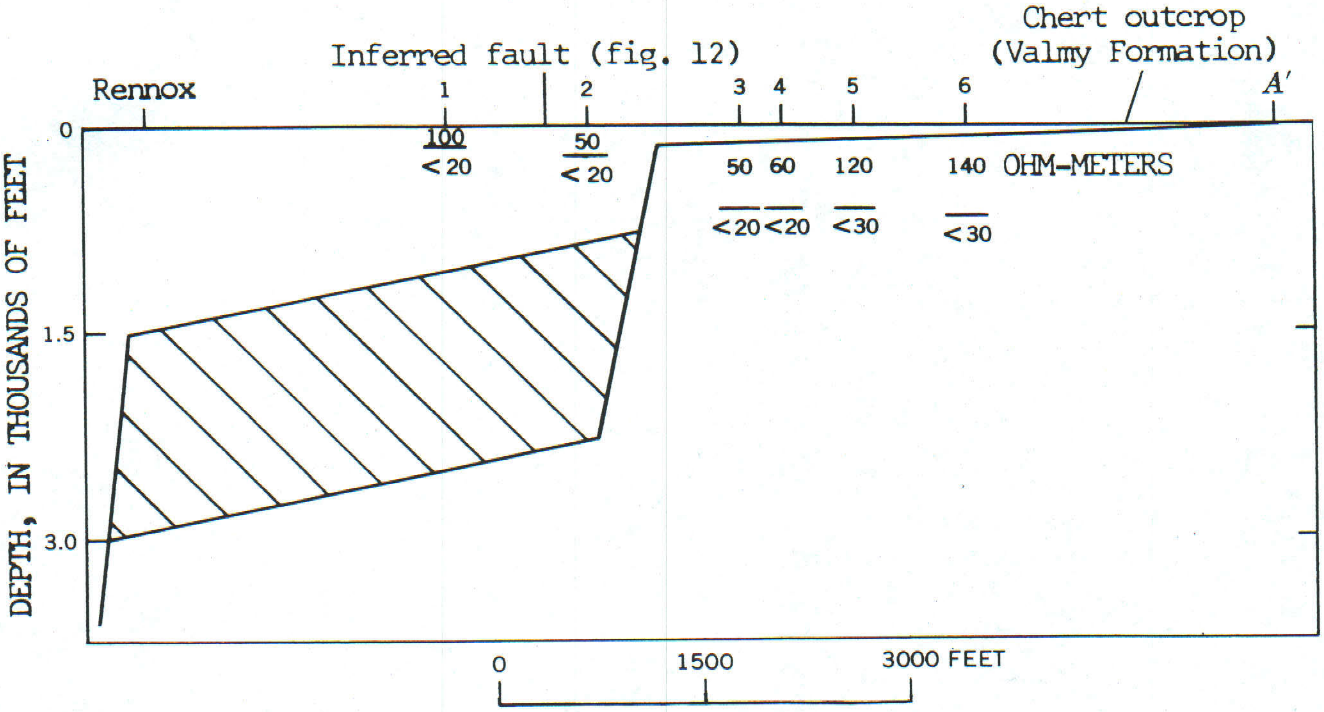



FIGURE 15.—Generalized cross section along line segment from Rennox toward *A′* (fig. 12) showing location of the resistivity soundings, (1–6), expanded in a N. 20° W. direction, with the resistivity values of the various zones defined by the electrical survey and the diagrammatic shape of the bedrock based on the magnetic and gravity models shown in figures 13 and 14.

Similarly, a hole placed on the northeast side of the inferred fault about one-half mile southwest of the Snowstorm mine would determine the composition of the bedrock material. The juxtaposition of the geophysical and geochemical anomalies in the vicinity of the Snowstorm mine further suggests that consideration should be given to an exploration program in that area.

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