A-1

FINAL REPORT

Mercury and Sulfur Reconnaissance Program

August 1980 to January 1981

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February 9, 1981

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SUMMARY

1. Seven geothermal prospects were identified during a regional reconnaissance of eighty-seven known mercury and sulfur deposits in California, Nevada, and Oregon from August to October, 1980 (Figure 1).

2. A follow-up assessment program of the seven prospects including geologic mapping, mercury soil surveying and shallow gradient drilling was completed during November, December and January, 1980 - 1981.

3. Results of the assessment program for each prospect are listed below:

PROSPECT	MINERALIZATION & ALTERATION	MAXIMUM BOTTOM-HOLE TEMPERATURE	MAXIMUM HEAT FLOW
Alum	Intense fumarolic alteration, S deposition, minor opalite.	64.5°C at 100m	24.5 H.F.U.
Fishlake	Intense fumarolic alteration, S deposition, abundant opalite.	75.3°C at 35m	Undetermined
Gilbert	Intense argillic alteration, quartz veining.	18.9°C at 30m	3.9 H.F.U.
Pershing	Minor argillic alteration, cinnibar pore filling.	15.9°C at 55m	4.7 H.F.U.
Rast	Argillic alteration, minor opalite.	18.1°C at 74m	6.9 H.F.U.
Silver Cloud	Massive opalite with cinnibar, intense argillic alteration.	20.4°C at 95m	3.4 H.F.U.
Horsehead	Massive opalite with cinnibar, intense argillic alteration.	3.4° C at 55m	3.1 H.F.U.

4. Recommendations for further assessment:

   a. The Alum and Fishlake Prospects warrant further detailed assessment which should include drilling ten to fifteen shallow gradient holes to determine the extent of the heat flow anomaly; drilling of one 500m gradient hole to determine gradient behavior and aquifer characteristics at depth; application of surface geophysical methods to define subsurface structure and thermal activity.

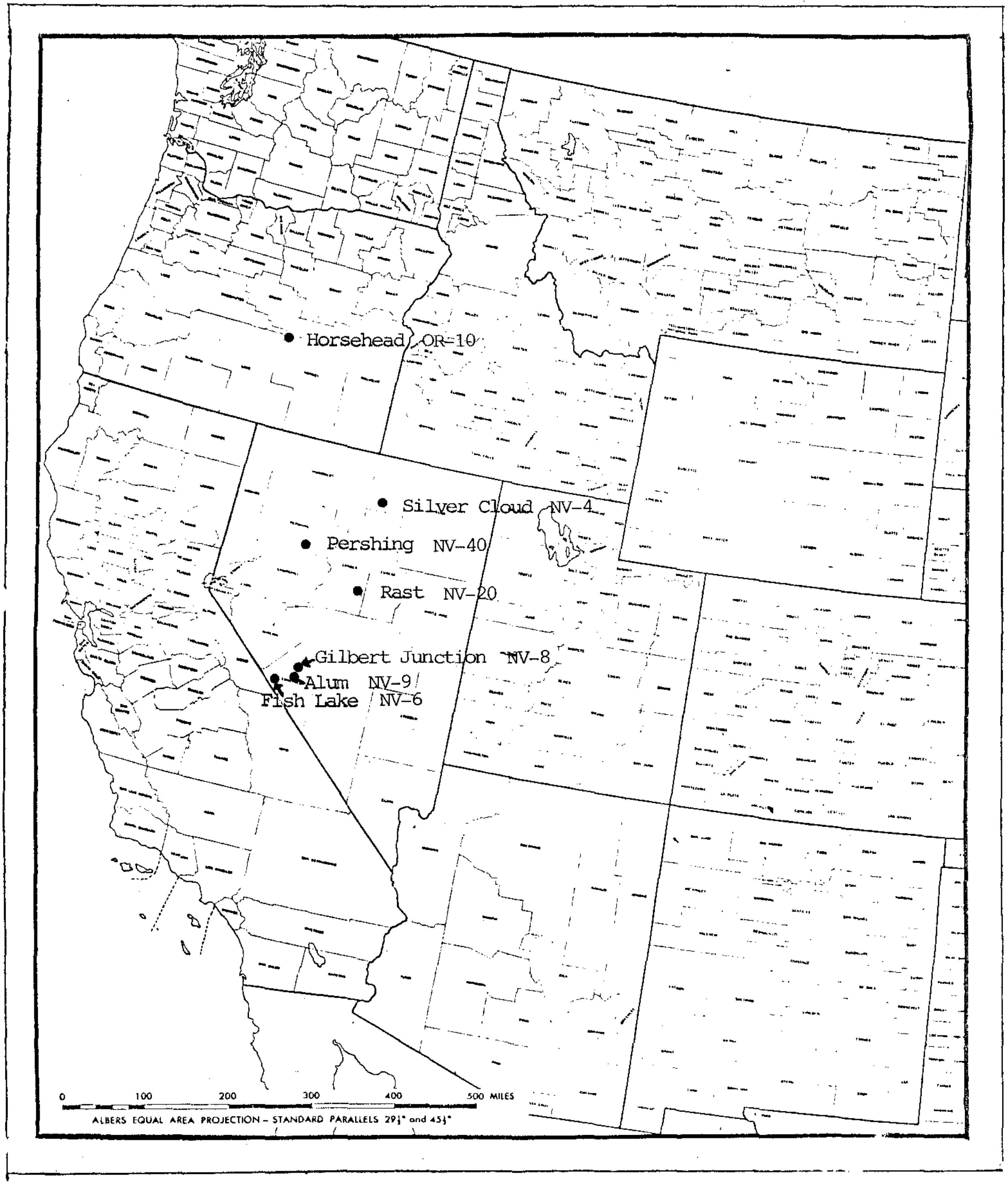
   b. The Gilbert Junction Prospect should have a gradient hole drilled to a depth of 150 meters, to evaluate the thermal effect of the shallow aquifer.

c. The Rast Prospect should have an additional gradient hole drilled to a depth of 150m to verify high heat flows observed in shallow holes.

d. The Horsehead, Pershing and Silver Cloud Prospects do not warrant further assessment work at this time.

5. All seven of the prospects examined in the assessment program exhibit anomalously high heat flow. Two of the seven prospects display very high temperatures at shallow depths. This high rate of success indicates that the O'Brien Resources' exploration method as detailed in earlier reports (Dellechaie et al, October 31, 1980) provides a rapid and cost effective technique of generating prospects of high geothermal potential. This method is readily applicable to a large portion of the Western United States and should be implemented as rapidly as possible prior to the recognition and exploitation of the technique by competitors.

Figure 1. Prospect Locations



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INTRODUCTION

O'Brien Resources Corporation undertook a geothermal reconnaissance program during August, September and October, 1980 (Dellechaie, F., Maurath, G. and Teplow, W., Interim Results of Mercury and Sulfur Reconnaissance, October 31, 1980). The program was based on the geothermal evaluation of known mercury and sulfur deposits in California, Nevada and Oregon. As a result of the program, seven of the eighty-three prospects examined were selected for additional geothermal assessment. The assessment program was completed in January, 1981. The prospects selected were (Figure 1):

Alum, Esmeralda County, Nevada
Fish Lake Valley, Esmeralda County, Nevada
Gilbert, Esmeralda County, Nevada
Horsehead, Harney County, Oregon
Pershing, Pershing County, Nevada
Rast, Lander County, Nevada
Silver Cloud, Elko County, Nevada

The assessment program for each of the seven prospects consisted of geologic mapping, mercury soil surveying and drilling of one to four shallow gradient holes. This report presents results of the assessment program and offers recommendations concerning the geothermal potential of each prospect.

Methodology

Geologic Mapping

Geologic mapping of each prospect was undertaken to clarify the relative chronology of faulting, deformation and mineralization, and to understand the structural control of hydrothermal activity. Mapping was done at a scale of 1:24,000 on a USGS 7½' topographic base. One to two days of field work were alloted for each prospect. Emphasis was placed on mapping faults, deformation, type and extent of mineralization and alteration.

Mercury Soil Surveys

The mercury soil survey was conducted to define the intensity and extent of current thermal activity around each prospect. Samples were taken along three to five lines intersecting orthogonally at the center of prospect or production pits. The lines were 2000-4000 feet long with sample spacing of 75 to 450 feet. In larger mercury deposits, such as the Silver Cloud Mine, sampling lines of five to seven miles with sample spacing of 0.2 miles were run to provide definition of regional anomalies. Samples were taken in undisturbed soil from a depth of seven inches. Dry samples were sieved with an eighty mesh (0.177mm) sieve at the time of collection and the minus eighty mesh fraction was retained in an airtight bottle for analysis. Wet samples were air-dried until sievable. The sieved samples were analyzed for their mercury content using a Jerome Model 301 gold film mercury dectctor. The detector is accurate to within 5 percent for mercury concentrations less than 500ppb and $\pm$ 10 percent for higher concentrations.

Thermal Gradient Measurements

In order to establish the magnitude and extent of thermal anomalies, one to four 30-150 meter thermal gradient holes were drilled and logged at each prospect. Three-quarter inch PVC pipe was placed in each drill hole and back filled. The PVC pipe was then filled with water and allowed to equilibrate for twenty-four hours before the gradient was measured. An additional gradient measurement was made seven to ten days later to minimize temperature perturbations caused by drilling. The thermal gradient of existing mineral holes and wells in the vicinity of the prospect were also measured to aid in clarifying the local heat flow pattern.

The drilling costs for the eleven gradient holes drilled during the program are summarized below:

Total Footage - 2190'

	Cost	Cost/Ft.
Mobilization	$ 5,457.00	$2.49
Footage	10,402.50	4.75
Equipment rental & mileage	1,504.24	.69
Supplies (PVC, soap, casing, etc.)	745.57	.34
Geologist (fuel, room & board)	1,315.12	.60
	$19,424.43	$8.87

Thermal gradient measurements derived from the drilling program are summarized in Figure 2.

FIGURE 2. RESULTS OF JANUARY, 1981 DRILLING PROGRAM

PROSPECT	STATE	HOLE #	DEPTH (m)	GRADIENT ($^{o}C/km$)	CONDUCTIVITY (TCU)	HEAT FLOW (HFU)	REMARKS
Horsehead	Oregon	1	55	44.5	7	3.1	
Silver Cloud	Nev.	1	100	189	1.5	2.8	
		1	100	137	2.5	3.4	Conductivity change
Pershing	Nev.	4	55	69	6	4.7	Includes 14% topo. correction
Rast	Nev.	3	74	129	4.5	5.8	
				71	7.5	5.3	Conductivity change
Rast	Nev.	5	48	76.4	9	6.9	
Gilbert Jct.	Nev.	1	30	77.5	5	3.9	Conductivity change
Alum	Nev.	1	48	250	5	12.5	
				212	6	12.7	
Alum	Nev.	2	50	258	5	12.9	
Alum	Nev.	3	100	490	5	24.5	
				383	6.1	23.4	
Alum	Nev.	4	49	467	4.5	21.0	Conductivity change
				205	6.1	12.5	Conductivity change
Fish Lake	Nev.	3	No heat flow data available due to PVC pipe melt-down.				
			BHT: 75.25°C @ 35.5 M after 1 hour of re-equilibration.				
			Surface steam temperature = 80°C with slight positive pressure				
			BHT: 59.27°C @ 12 M after 6 days of re-equilibration.				

ALUM PROSPECT

Geology

Introduction

The Alum Prospect is located at the Alum Sulfur Mine, Section 29, T1N, R39E Esmeralda County, Nevada. The prospect may be reached from Blair Junction on Highway 50 by traveling south on Highway 47 for a distance of 8.7 miles. At this point an unmaintained dirt road leads northeast and then east for two miles to the prospect site (Figure 3).

The prospect lies at an elevation of 4900 to 5300 feet at the western extremity of the Weepah Hills and the southwestern terminus of the Big Smoky Valley. The western half of the prospect consists of elongated ridges of Quaternary alluvium which have been partially dissected and removed, exposing Tertiary lake beds beneath. Isolated and prominently uplifted blocks of the Tertiary Esmeralda Formation form the western boundary of the prospect. Eastward from the sulfur mine site, the Weepah Hills rise slowly in highly dissected west-trending ridges to an elevation of 7700 feet, ten miles to the east. The Alum prospect lies at the drainage divide between the Big Smoky Valley to the north and the Clayton Valley to the south. The valleys, both of which are closed basins, contain large supplies of brackish water at shallow depths.

The climate is extremely arid and supports only sparse and patchy growths of sage and grass which are confined to stream bottoms of the lower western area. No permanent human habitation or other cultural activities exist in the vicinity of the prospect at this time. A main trunk line of the Nevada power grid passes within five miles of the prospect site.

A general geologic description of the Alum district and Weepah Hills is found in Albers and Stewart (1972). Detailed stratigraphy of the Tertiary sedimentary-pyroclastic section is given by Robinson and others (1968).

Regional Geology

The Alum Prospect lies at the center of a triangular basin bounded by three mountain ranges: the Monte Cristo Range to the north, the Silver Peak Range to the southwest, and the Weepah Hills and Lone Mountain to the east. The three ranges contain rocks ranging in age from Precambrian to Quaternary.

The Precambrian-Paleozoic rocks consist of fine-grained clastic and carbonate facies. They exhibit extensive low angle thrust faulting of large horizontal displacement. The pre-Mesozoic section is intruded by monzonite of Mesozoic age. The Lone Mountain Batholith is the largest exposure of the intrusives, while much smaller stocks occur in the Monte Cristo and Silver Peak Ranges. The intruded sedimentary rocks are deformed in conformance with the dome-shaped intrusive bodies. Tactites and hornfels are common at the monzonite-sedimentary contacts.

Large volumes of Tertiary intermediate and silicic pyroclastic and flow units overlie much of the Paleozoic and Mesozoic rocks of the Monte Cristo and Silver Peak Ranges but are absent in the Weepah Hills-Lone Mountain region.

Fluviatile and lacustrine deposition in basins roughly paralleling present topography took place during the Upper Miocene and Lower Pliocene. Silicic and intermediate pyroclastic and flow units are interbedded with these sediments. The youngest volcanic events in the region are represented by very late Pleistocene and Recent basalt flows and cinder cones which occur five miles south of the map area.

Basin and Range faulting with up to 10,000 feet of vertical displacement began in the early Tertiary and continues to the present. Fault scarps in Quaternary alluvial fans along the northern boundary of the Weepah Hills and Lone Mountain indicate currently active faulting. This faulting is the primary factor in the formation of major topographic features in the region (Albers and Stewart, 1972).

Rock Units

The Alum Prospect lies entirely within the Esmeralda Formation which is exposed throughout the western half of the Weepah Hills and southern Great Smoky Valley (Figure 4). The unit is locally covered by Quaternary alluvium. The Esmeralda Formation consists of lacustrine and fluviatile deposits of sandstone, shale and siltstones interfingered with conglomerates and pyroclastic units. A tuff unit in the upper part of the formation has a K-Ar date of 6.9my. More than nine thousand feet of strata are exposed in the map area, though some of the apparent thickness may be due to faulting. The top and bottom of the formation are not exposed in the map area. A generalized stratigraphic column of the Alum area by Robinson and others (1968) appears in Figure 5.

The section of the Esmeralda Formation in the vicinity of the Alum Sulfur Mine strikes east-west and dips steeply (30^{o}-60^{o}) to the south. Three distinct lithologies characterize this 5000 foot thick section. The predominate lithology is an alternating sequence of well-bedded siltstone, shale and sandstone. This sequence is interbedded with a pyroclastic unit and, in turn, is unconformably overlain by conglomerates.

The well-bedded clastic sequence is dominated by well-indurated tan to buff siliceous siltstone with minor sandy horizons. This siliceous unit alternates with argillaceous, poorly indurated green-brown siltstone which weathers to rounded, soil-covered slopes. The siliceous and argillaceous beds form alternating sequences thirty to fifty meters thick. Thinner beds of fine to medium-grained sandstone, ranging from 0.2-1.0 meters thick, occur within the siltstone sequence. These sandstone beds contain siliceous cement, are very hard, and form prominent ridges in the map area. One to five meter thick beds of light brown highly fissile shale are common throughout the sequence. Occasional chert beds two to five centimeters thick occur in the siltstone dominated parts of the section.

The upper part of the fine-grained clastic section contains a lithic and crystal tuff which varies in thickness from three to ten meters. The tuff contains pumice and silicic volcanic rock fragments in addition to abundant euhedral quartz and feldspar crystals indicating a rhyolitic or dacitic composition. This unit is very well indurated and forms resistant cappings on the most prominent ridges and nobs along the southern boundary of the map area.

A conglomerate and coarse sandstone unit ten to thirty meters thick overlies the fine-grained clastic sequence. The contact is an angular unconformity with the underlying truncated siltstones dipping 20°-30° more steeply than the overlying conglomerates and sandstone. The lower part of the coarse-grained clastic unit consists of a poorly sorted pebbly arkosic sandstone. The sandstone exhibits current crossbedding and cut and fill structures. The sandstone grades into a poorly bedded conglomerate containing sand lenses. The siliceous siltstone clasts may be derived from the underlying fine-grained clastic sequence.

Structure

The map area may be divided into two distinct structural zones along a north-trending line passing through the Alum Sulfur Mine site (Figure 6). West of the dividing line the structure consists of moderately dipping beds striking northeast, while east of the line the beds dip steeply and strike east-west. The transition zone between the two regions is approximately 200-300 meters wide in the east-west direction and 1200 meters long in the north-south direction. It is characterized by small scale (five to ten meter) foldind, high angle faulting and fracturing and a prominent topographic discontinuity. The sulfur mine workings and associated alteration zone is entirely located within this structurally disturbed zone. Beds of the Esmeralda Formation outside the zone do not show any deformation or faulting aside from the regional tilting of 20^{o}-30^{o} to the southeast. The deformation zone may be explained as a partially ruptured plunging fold with dimensions of approximately two kilometers on each limb (Figure 6). Exposures of the fault zone in the mine pits indicate a nearly vertical orientation. Flexure of the bedding in the vicinity of the fault indicate right lateral strike slip movement with a cumulative offset of tens of meters. The topographic step within the fault zone in the otherwise uniform western slope of the Weebah Hills indicates a dip slip component of fault movement with the uplifted block to the east. Small sliver faults stepped down to the west support this model.

Alteration and Mineralization

Alteration in the map area is confined to the zone of strongest deformation where fault brecciation and intense fracturing are present. The alteration consists of argillization resulting in a friable, highly bleached, very low density rock. Accicular clumps of sulfur crystal fill cracks and joints, while coarsely crystalline sulfur fills vugs and larger cracks. White opalite is a minor constituent of the altered zone. The sulfur mineralization is confined to the intensely argillized zones within three to ten meters of brecciated faults. Alunite is abundant in the fractures, appearing as dense, translucent replacement veins up to 10cm thick. Examination of cuttings from drill hole number two (Figure 4) show a disseminated pyrite horizon at a depth of 160 to 175 feet. The pyrite appears as 1 to 2mm stringers in the siltstone and as individual 2 to 3mm euhedral crystals. Scarcity of siliceous deposits, such as sinter or opalite, indicate that near surface alteration is primarily fumarolic with little or no hydrothermal activity involved. The occurrence of alunite and elemental sulfur at the surface indicates that the fumarolic activity has ceased only very recently. The fumarolic activity may be related to the Late Pleistocene to Recent basaltic flows and eruptive centers within five miles of the mine site. Gaseous emanation from the basalt source at depth may have penetrated the thick sedimentary blanket of the Esmeralda Formation by way of the localized faulting within the map area. This model would account for both the apparent recent age and distribution of the fumarolic alteration.

Mercury Soil Survey

The mercury soil survey consisted of three sample lines with a very high sample density (Figures 8 and 9). The correlation between mercury anomalies and fault traces (Figure 2) indicates that mercury deposition is controlled by ascension of mercury rich thermal vapors along these faults.

The mercury soil survey does not indicate any abnormal regional heat flow. The mercury anomaly identified at the north end of line C-C' is probably due to analytical error.

Heat Flow

Extremely high heat flows, greater than twenty HFU's, were observed in two of the four gradient holes drilled in January, 1981. The remaining two gradient holes had heat flows in excess of twelve HFU's (Figures 10 to 14). Gradients from 205° C/km to 490° C/km were measured, mostly in siltstone. A maximum bottom hole temperature of 64.5° C at 100 meters was measured in drill hole number three.

Summary

The high density mercury soil survey is useful in delineating faults associated with ascension of hydrothermal fluids and/or vapors. No correlation between conductive heat flow and mercury soil deposits are apparent for this prospect, indicating that the anomaly may be strictly of convective origin.

The observed heat flow indicates that although the anomaly may be of convective origin, it is much more widespread than the mercury survey would indicate. The high bottom hole temperatures associated with uniform gradients and intense fumoralic alteration indicate that this prospect is a prime target for further assessment.

Figure 3. Alum-Location Map

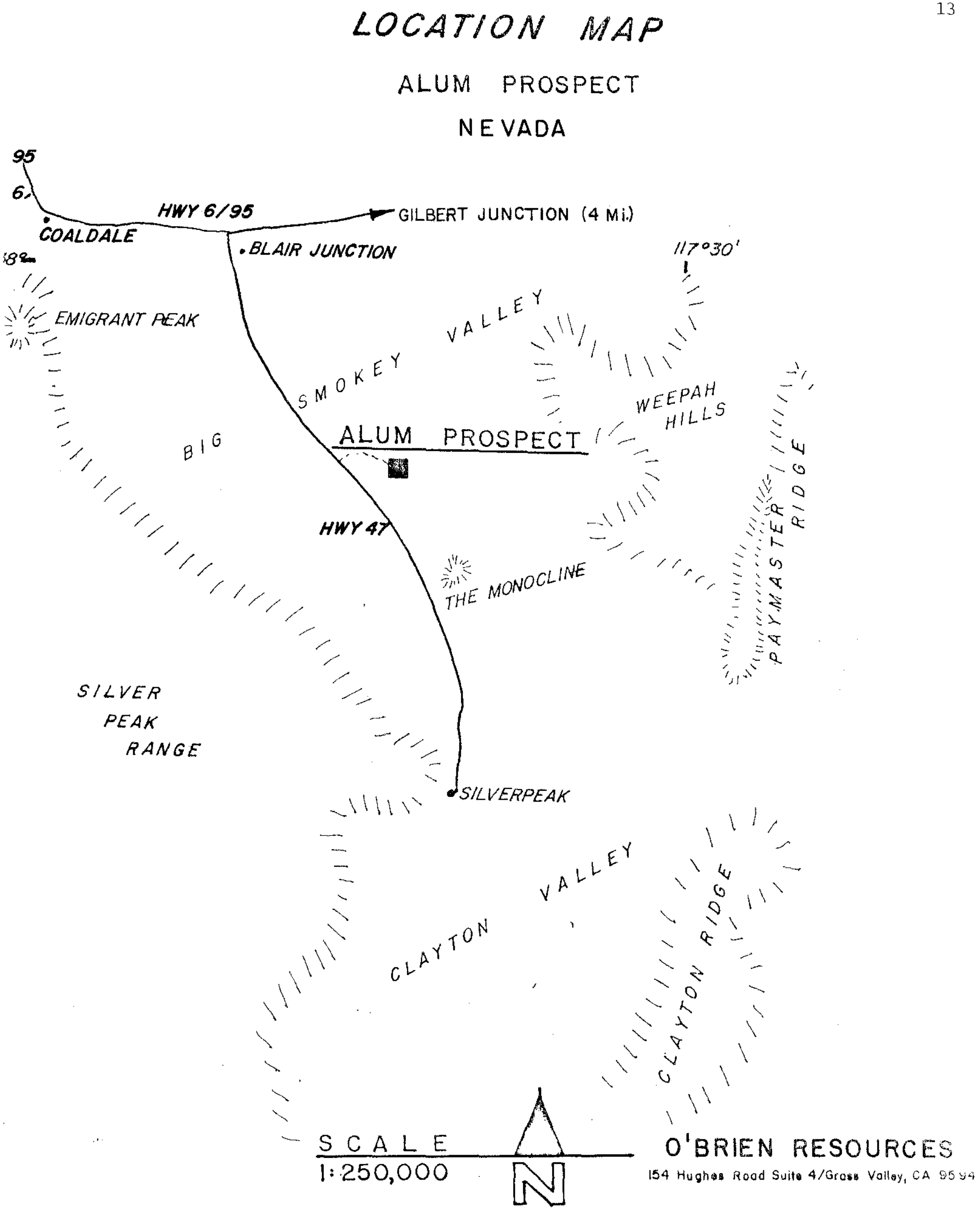


Figure 4. Alum-Geologic Map

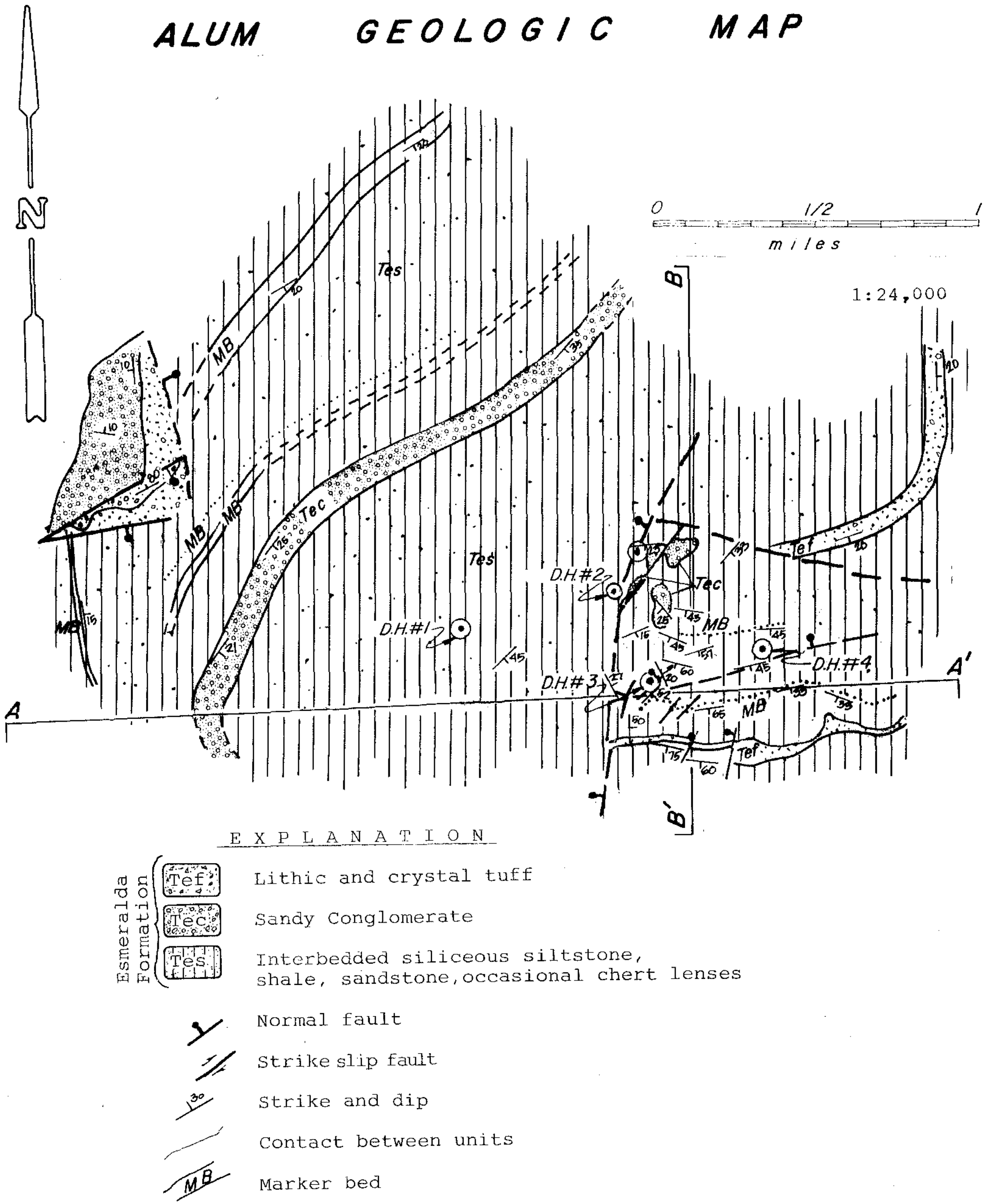
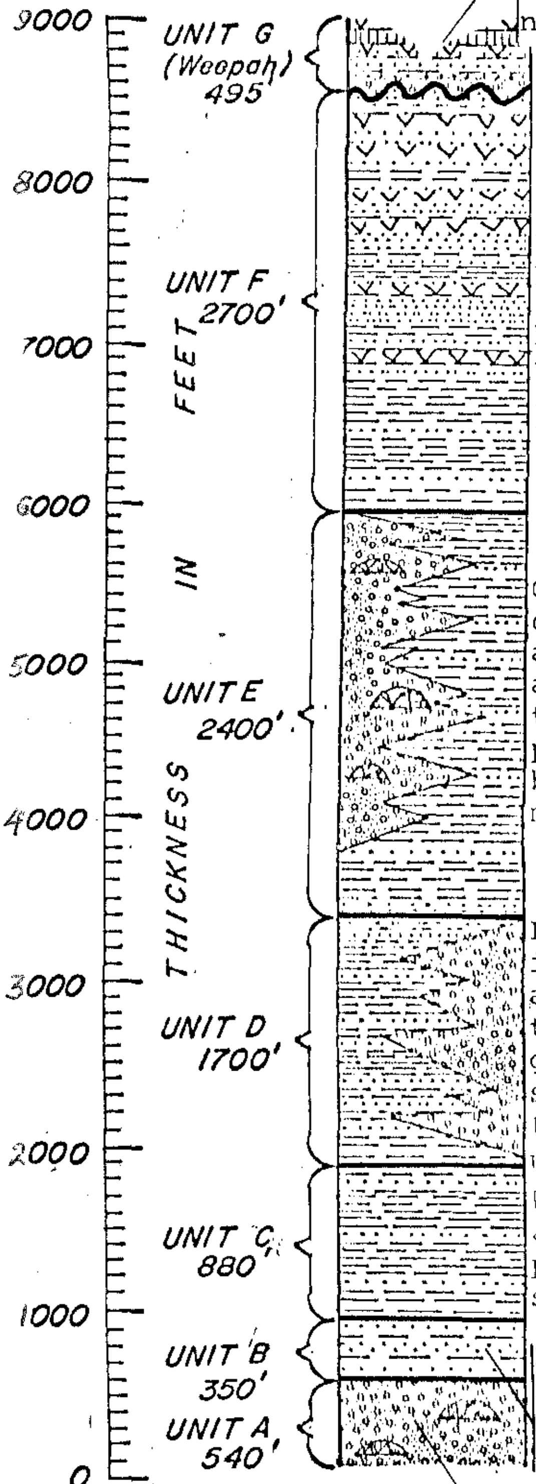


Figure 5 .Stratigraphic Column, Alum District from Robinson P.T., etal (1968)



Gray generally poorly bedded friable, poorly sorted sandstones, siltstones, and conglomerates, white thick-bedded friable vitric tuffs and lapilli tuffs, grayish-black basalt flow; basal yellowish-brown, crudely bedded tuff breccia. Unit characterized by pumicious nature of rocks.

Interbedded generally friable, pale-orange to light gray, laminated to thin-bedded siltstones, pale-orange to light-gray, papery shales yellowish-tray to light-olive-gray, thin to thick-bedded, poorly sorted claystones, light-gray to grayish-orange, thin to very thick bedded, fine to medium-grained, moderately sorted sandstones and very light gray to medium-light gray vitric tuffs. Siltstones and shales predominate in the lower part of the unit, sandstones and vitric tuffs predominate in the upper part of the unit.

Grayish-orange to grayish-yellow, thin-bedded siltstones, white to olive-gray, thin-bedded, poorly sorted, medium-grained sandstones and yellowish-gray to pale-yellowish-orange, poorly sorted shales and claystones which intertongue with gray to grayish-orange, thick to very thick bedded, lenticular, poorly sorted precambrian and paleozoic-pebble conglomerates with intercoated lenses of grayish-blue Paleozoic-limestone breccia and interbeds of poorly sorted medium to coarse-grained sandstone.

Light-gray to grayish-orange, thin-to very thick bedded, well-indurated, moderately to poorly sorted, volcanic-pebble conglomerates and light-gray to grayish-orange, thin-to thick-bedded, fine to coarse-grained volcanic sandstones which grade laterally into grayish-orange to grayish-yellow, laminated to thin-bedded, poorly sorted, fine-to medium-grained sandstones. Thin interbeds of white to pale-green tuff and reworked tuff occur in the lower part of the unit

White to very pale orange, laminated to very thin bedded tuffaceous and siliceous siltstones and grayish-orange to very pale orange papery shales: thin interbeds of pale-orange to yellowish-brown sandstone.

Pale-yellowish-orange to grayish-yellow, thin-to thick-bedded, moderately indurated, moderately to poorly sorted, fine to coarse-grained, feldspathic lithic sandstones and grayish-orange to yellowish-brown, laminated to thin-bedded siltstones.

Light-brown to greenish-gray thin-to very thick-bedded, well-indurated, poorly sorted pebble conglomerate composed of Paleozoic clasts. Large intercalated lenses of grayish-blue Paleozoic-limestone breccia and thin interbeds of sandstone, siltstone and limestone.

Figure 6. Alum-Idealized Structural Map

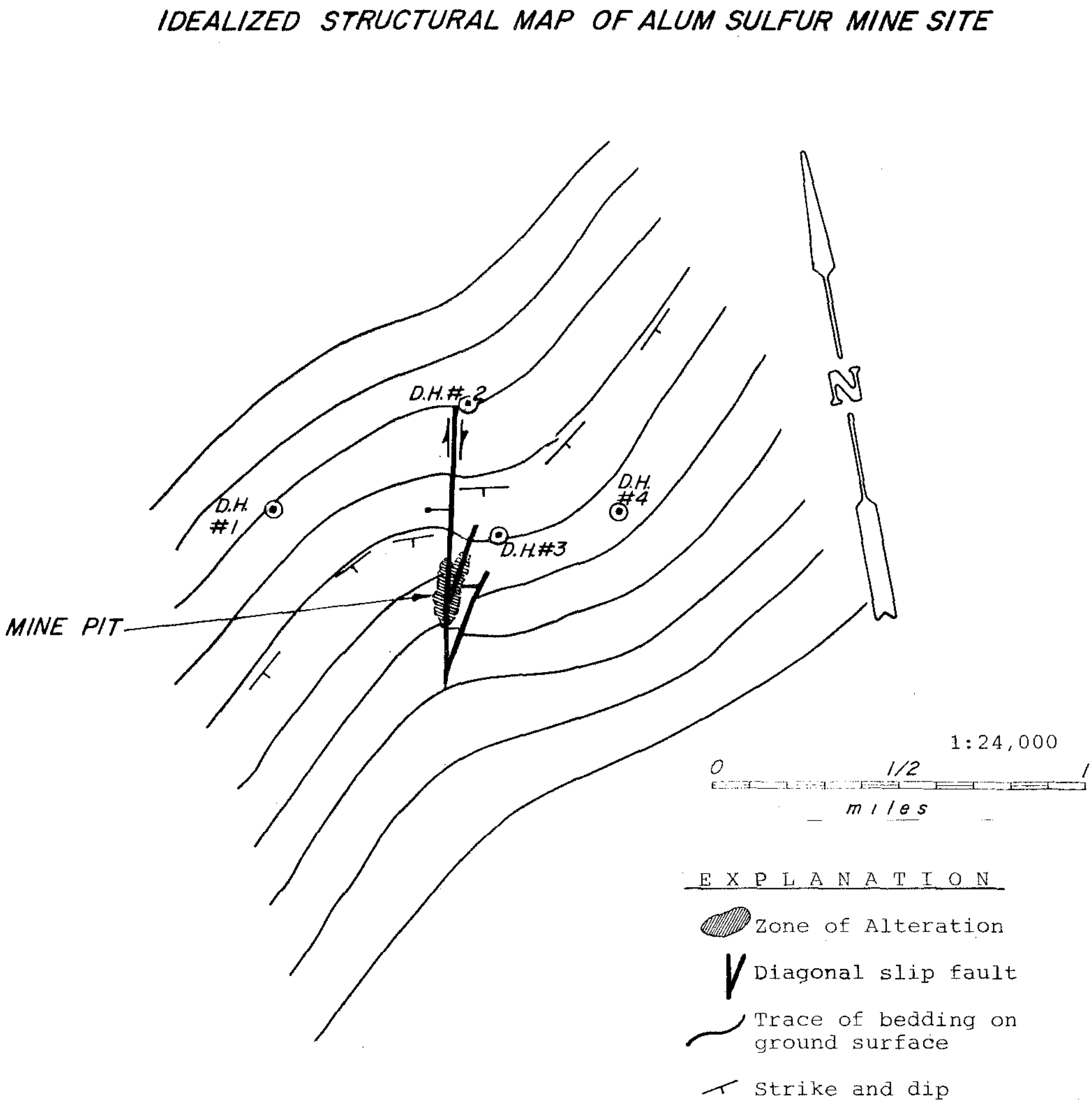


Figure 7. Alum-Cross Sections A-A', B-B'

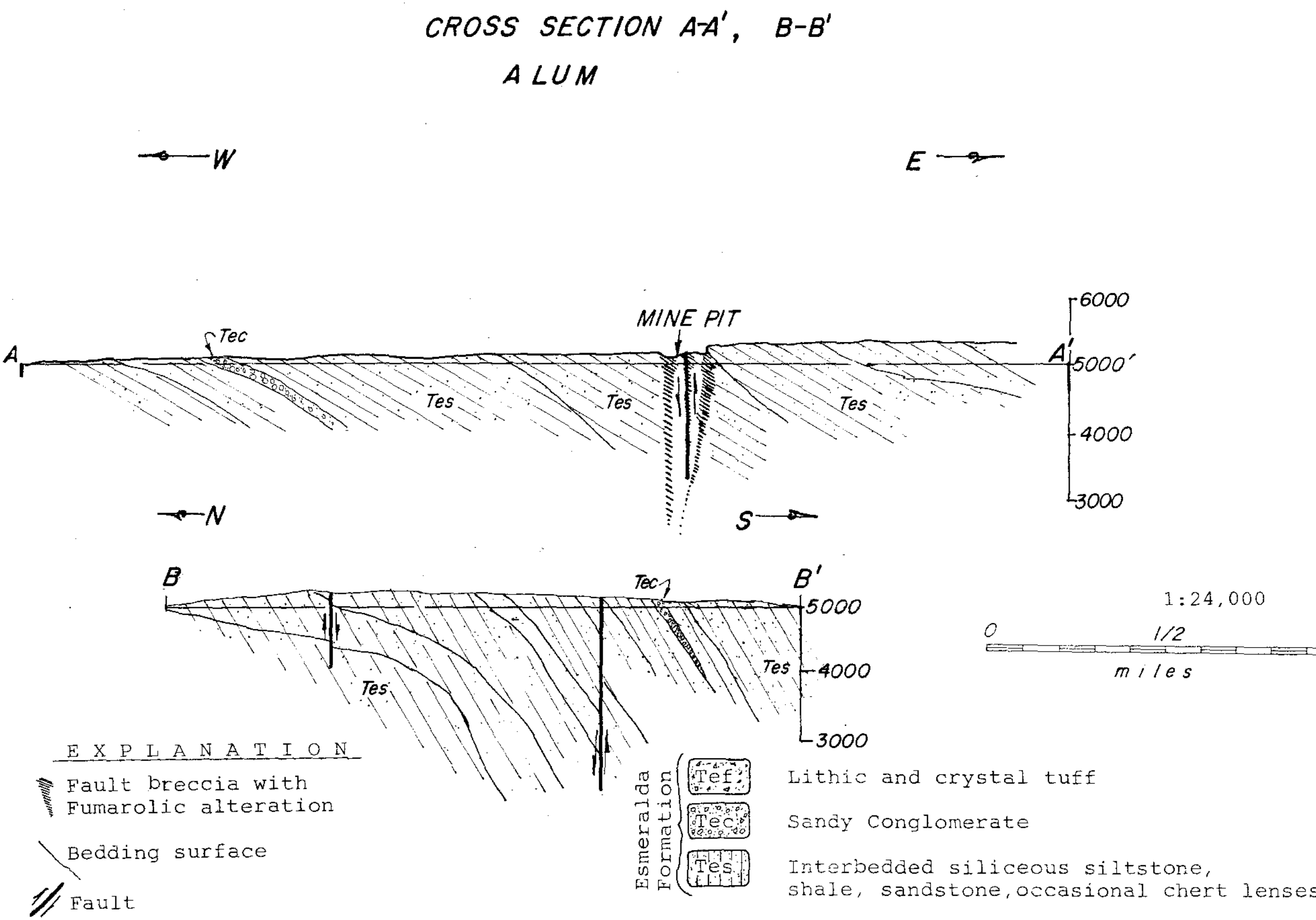


Figure 8. Alum-Mercury Concentration Map

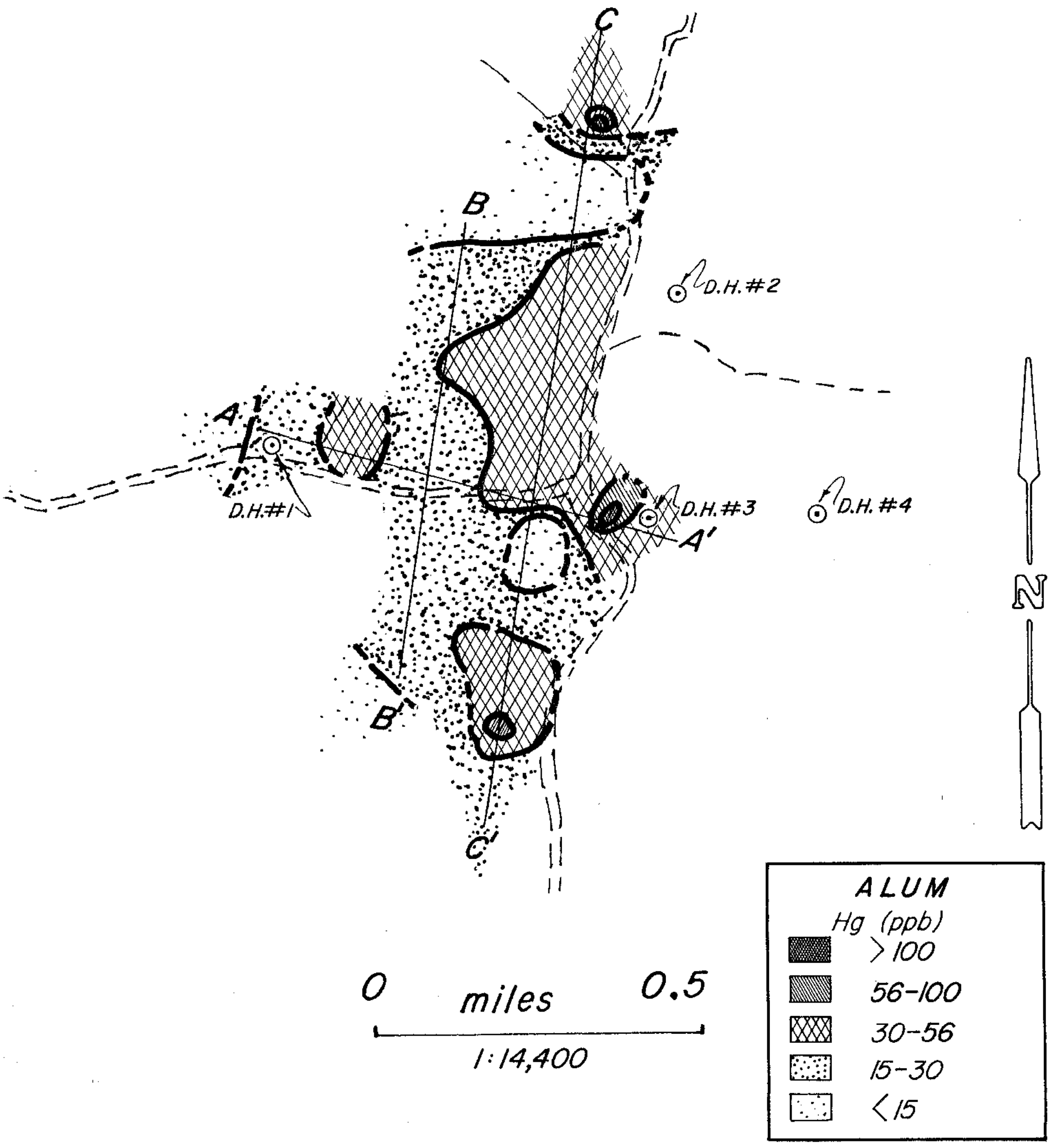


Figure 9. Alum-Mercury Profiles A-A', B-B', C-C'

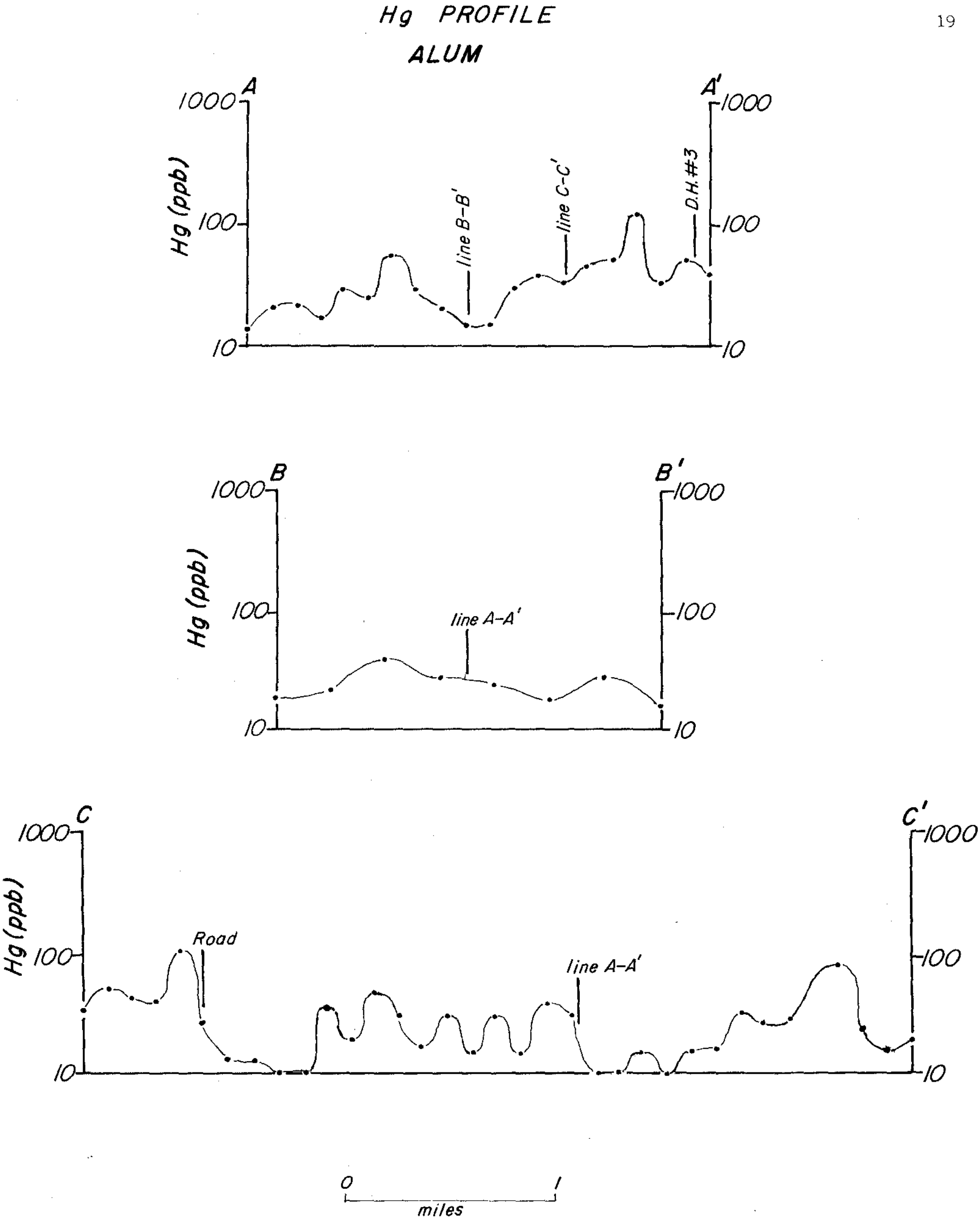
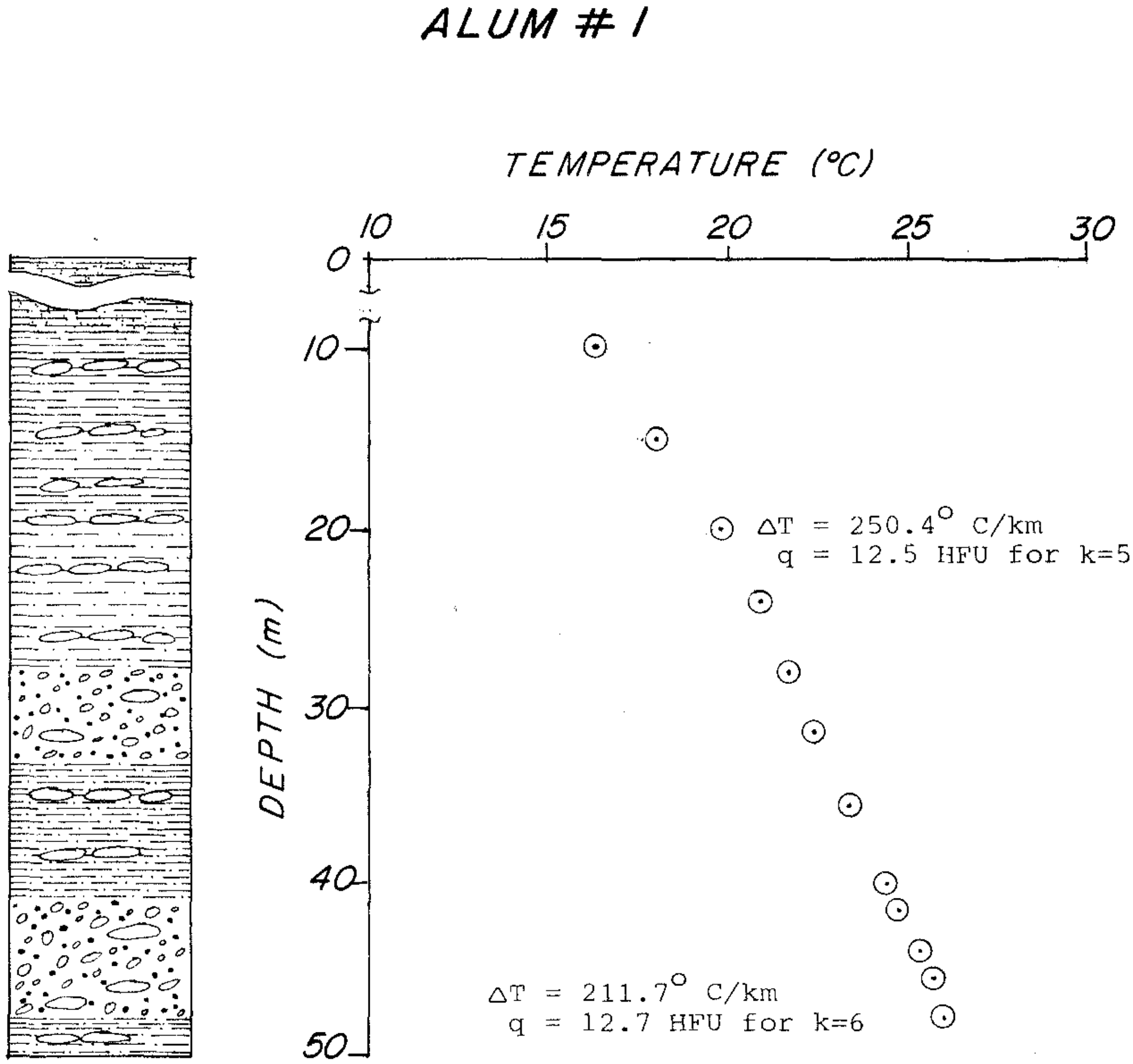
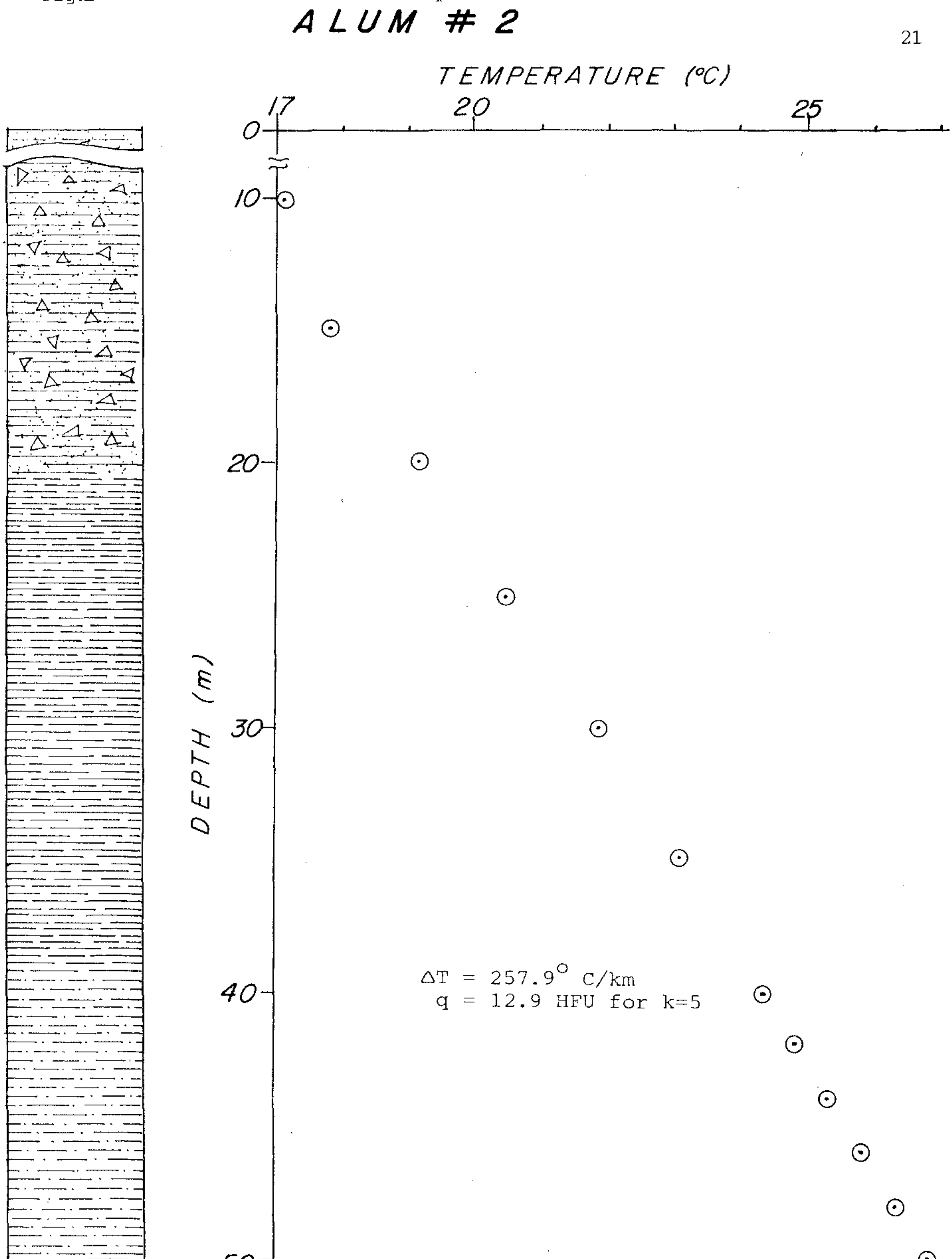


Figure 10. Alum-Drill Hole No. 1, Temperature and Lithology Log



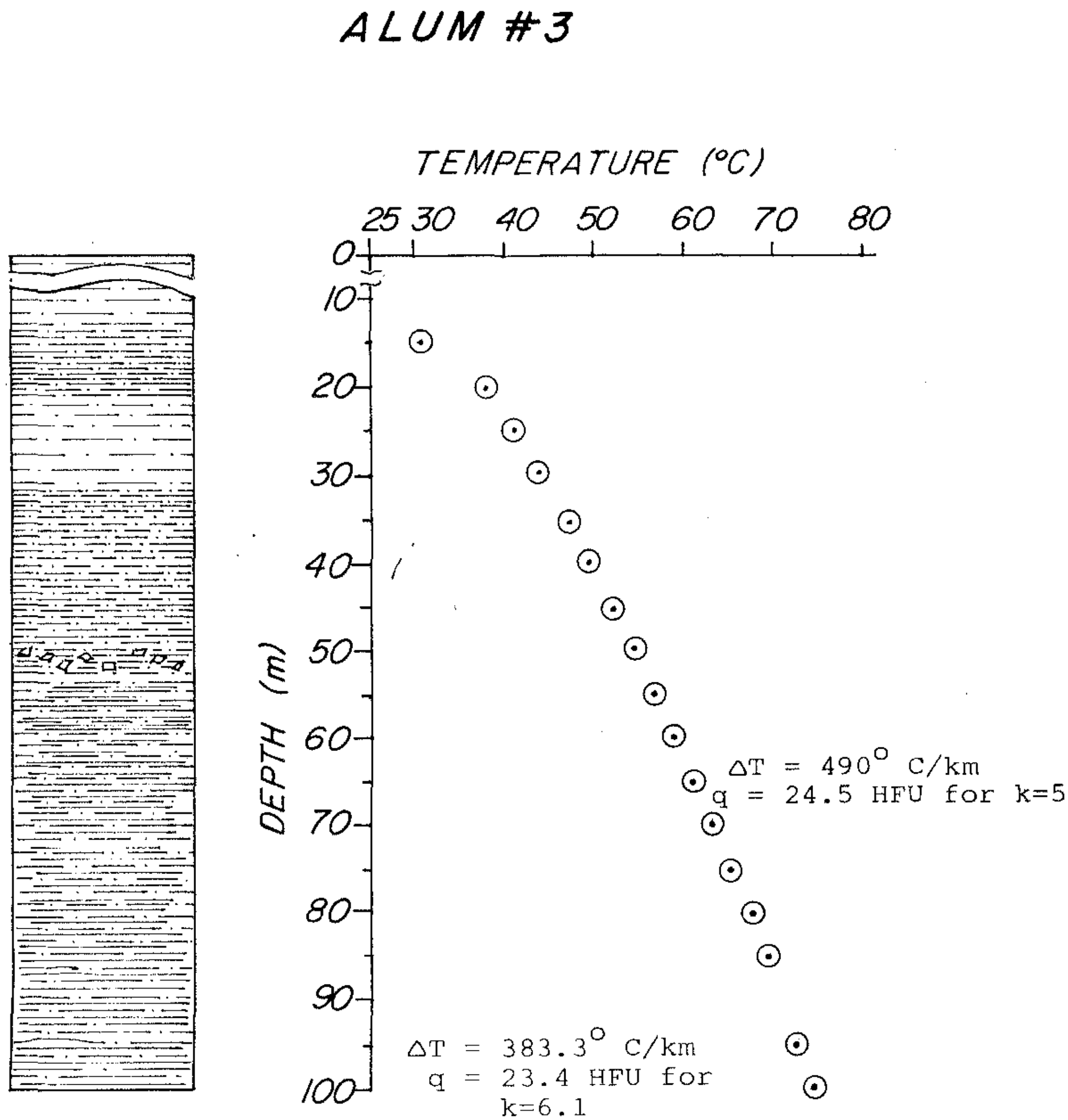
0-9	buff sandy claystone
9-18	greenish buff claystone with cherty layers 2-5mm thick
18-27	greenish buff poorly sorted sandy siltstone with cherty layers subrounded redish gray chert clasts
33.5-41	buff siltstone with cherty layers
41-47	coarse grained, subrounded, pebbly lithic quartz sandstone
47-49	buff siltstone with cherty layers

Figure 11. Alum-Drill Hole No. 2, Temperature and Lithology Log



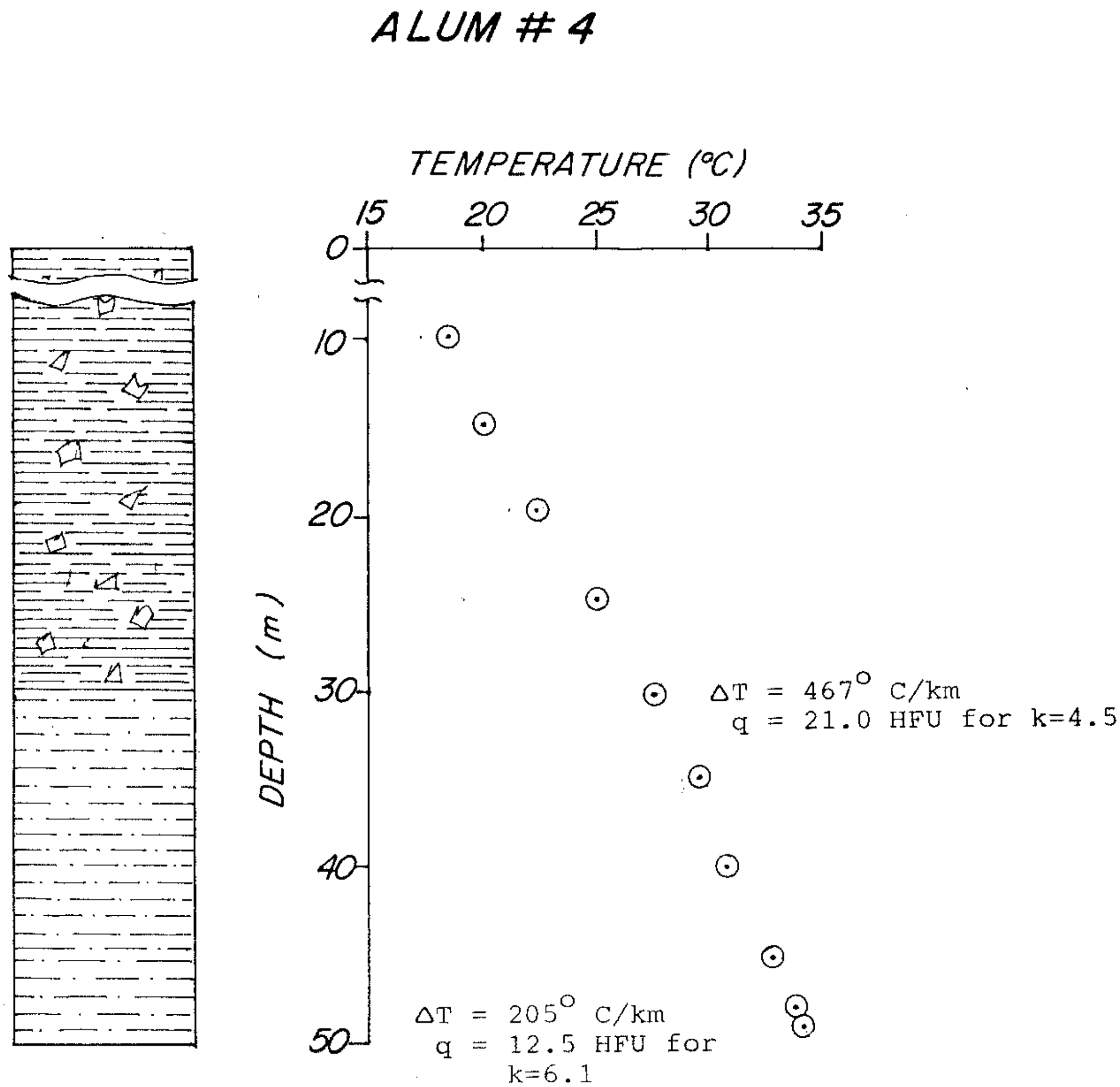
0-21 tuffaceous, medium grained, subrounded sandstone with high clay content
21-39.5 light green-gray claystone
39.5-49 gray sandy siltstone

Figure 12. Alum-Drill Hole No.3, Temperature and Lithology Log



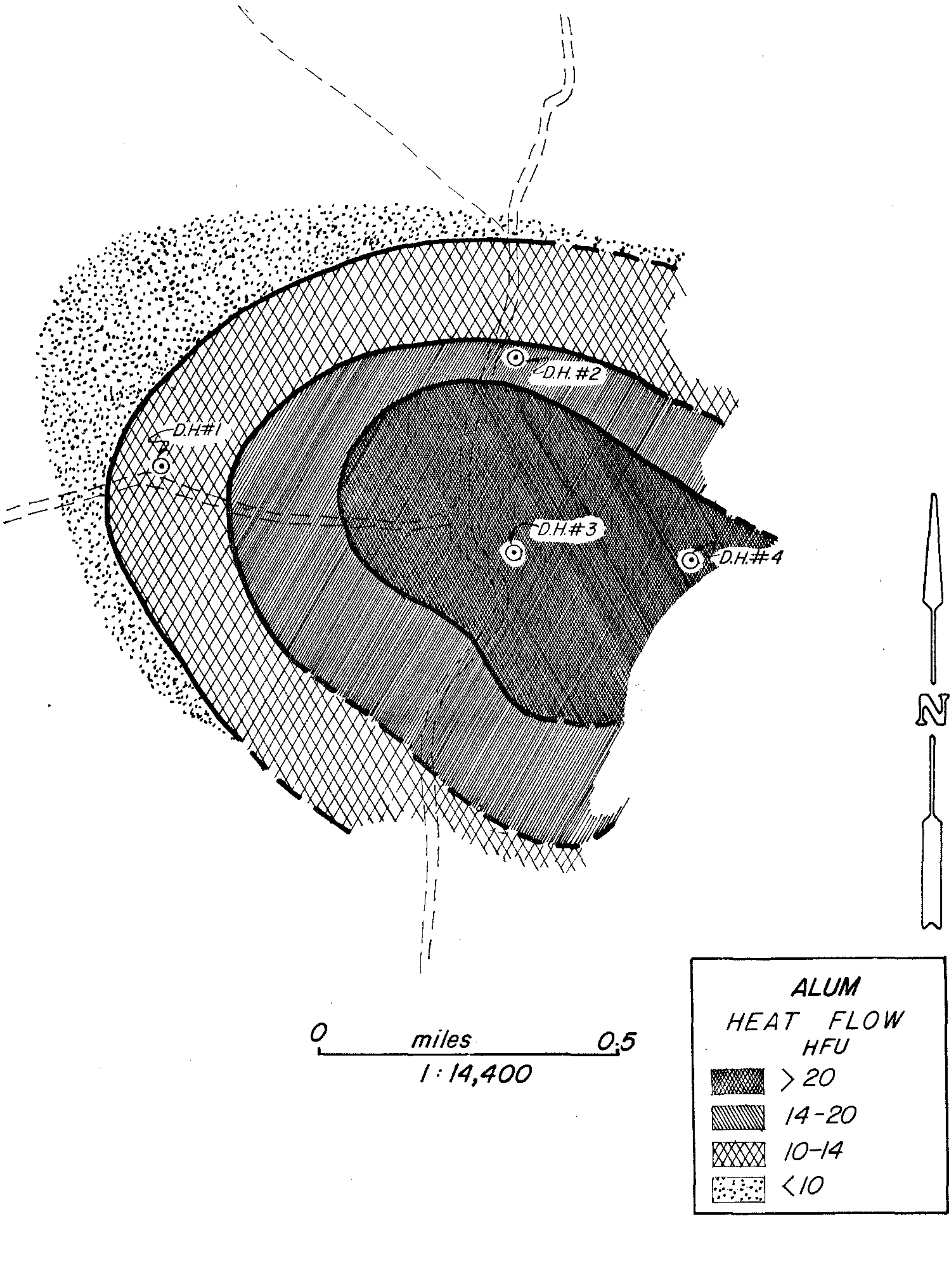
0-12	white-very light buff siltstone
12-21	very light gray siliceous siltstone
21-32	light gray siliceous siltstone with iron staining
32-49	medium gray non-siliceous siltstone
49-53	medium gray non-siliceous siltstone with pyrite crystals
53-100	medium gray siliceous siltstone

Figure 13. Alum-Drill Hole No.4, Temperature and Lithology Log



0-27 very light gray argillite with 2-5mm quartz fragments
27-50 medium green gray siltstone (argillic ?) interbedded with dark green-gray medium grained graywacke with green glauconite (?) cement

Figure 14. Alum-Heat Flow Coutour Map



FISH LAKE VALLEY PROSPECT

Geology

Introduction

The Fish Lake Valley Prospect is located in TIS, R35E Esmeralda County, Nevada. The prospect is reached by traveling 16.3 miles south on State Highway 3A from U.S. 6/95. At this intersection a graded county road leads three miles east to a point one mile south of the prospect. An unmaintained dirt road connects the county road to the prospect site (Figure 15).

The Fish Lake Valley Prospect is a mercury prospect consisting of a seven meter deep vertical timbered shaft and two bulldozed pits three meters deep and 100 meters long. The prospect is located on the southern edge of the Volcanic Hills at the northern end of Fish Lake Valley. The prospect is located between two major northwest trending uplifted blocks of the Basin and Range Province: the Silver Peak Range to the east and the White Mountains to the west. The climate is arid but the Fish Lake Valley receives abundant ground and surface water run off from heavy precipitation in the White Mountain Range. A shallow groundwater table results in heavy sage vegetation over two meters high. Numerous farms in the region exploit the groundwater for growing alfalfa. Aside from the scattered farms, the only community in the area is Dyer, which is located 15 miles southwest of the prospect.

A general geologic description of the Volcanic Hills and surrounding ranges is given by J.P. Albers and J.H. Stewart (1972).

Regional Geology

The Silver Peak Range which forms the eastern boundary of Fish Lake Valley contains rocks ranging in age from Precambrian to Quaternary. The northern half of the range consists of Upper-Precambrian and Lower Paleozoic fine-grained marine clastic and carbonate units. Many of the contacts within pre-Tertiary sediments are overlain by Pliocane silicic and intermediate flow rocks which have K-Ar dates of 5.9 m.y. (J.P. Albers and J.H. Stewart, 1972-page 47). This part of the range exhibits Late Pliocene-Pleistocene, closely spaced normal faulting which trends north and northeast and cuts Late Pliocene Volcanics. In addition, the Early Pliocene volcanics are tilted 5^{o}-15^{o} to the east and north. Overlying Late Pliocene volcanics are not tilted. Recent fault scarps cutting Quarternary alluvium are found along the northwest pediment of the range indicating that range front faulting is still active. The southern half of the range has been extensively intruded by a quartz-monzonite pluton of Late Mesozoic age.

The western boundary of Fish Lake Valley is formed by the quartz monzonite White Mountain Batholith of Lake Cenozoic Age. The batholith contains several roof pendants of Paleozoic marine sediments. Large displacement range front faulting with displacement of over 10,000 feet forms the eastern border of the range and accounts for the 14,000 foot elevations of the range crest. Scarps in Quaternary alluvium indicate ongoing movement along the fault.

The north end of Fish Lake Valley is defined by moderate topography consisting of Late Tertiary and Quaternary silicic pyroclastics and basalt flows. These units, in which the prospect is located, contain closely spaced high angle normal faulting which trends north and northeast. The units show regional tilting of 5°-15° to the east and north.

Rock Units

Two silicic pyroclastic units of Early Pliocene age outcrop in the map area (Figure 16). The lower unit, whose base is not locally exposed, has a thickness of 170 meters. The mercury prospect pits are completely contained within this unit. South of the prospect the unit is buried under Quaternary alluvium of Fish Lake Valley. The lower unit is overlain by a silicic welded tuff which reaches a thickness of 30-40 meters in the northern part of the map area. These units are exposed extensively in the Silver Peak Range to the south with a distribution of more than 150 square miles.

The lower pyroclastic unit (Tf) is a poorly sorted air-fall lithic tuff. Color varies from white to light tan with darker tan on weathered surfaces. The rock is poorly indurated, friable and forms elongated rounded ridges. Pumice fragments make up about 60 percent of the rock while angular quartzite clasts from 1-50 mm make up the rest of the coarse material. A fine grained glass shard matrix with occasional quartz crystals to 2 mm makes up the remaining 20 percent of the rock.

The overlying welded tuff (Tw) contains abundant plagioclase and biotite phenocrysts to 1 mm. The rock consists of approximately 50 percent glass which displays flow banding and is slightly vesicular. Fresh surfaces are medium gray to brown while weathered surfaces are dark red-brown. The unit forms prominent outcrops with scree and boulder aprons.

Structure

Structure in the map area is dominated by high angle normal faulting of small displacement (Figure 17). The faults trend north-northeast and are separated by 1-1.5km. The resulting faulted blocks dip approximately 10° to the south-east. Fault zones are characterized by drag folding, slickensides and chalcedony filled breccia. Major gullies and canyons are developed along the fault traces. Offset of the Tw-Tf contact indicates a maximum vertical movement of 120 meters. Faults of less displacement trending west and northwest connect between the more prominent northeast trending faults.

Alteration and Mineralization

Two types of mineralization are found in the map area. The more widespread type which is found throughout the southern third of the area consists of chalcedony and quartz veining. The less common type which is confined to the prospect pits consists of argillic alteration accompanied by opalite and native sulfur deposition.

The chalcedony - quartz veins vary in thickness from 0.5 to 10 cm and occupy fractures and fault planes. Two stages of deposition are indicated by amorphous, banded chalcedony overlain by euhedral, accicular quartz. The free growing quartz crystals indicate open fissure filling rather than replacement of wall rock. Veining is more intense in and near major faults and becomes sparse between faults.

In the prospect pits argillic alteration with opalite deposition dominates. The tuff is uniformly bleached and is more friable over the 300 X 300 meter area of the prospect pits as compared to the surrounding rock. Vertical east-west fractures in the pits are opalized to a width of 30 - 40 cm. Quartzite clasts in the tuff near the opalized fractures exhibit silicic halos of 3 to 10 mm thick. The clasts apparently form a nucleus for silica deposition. Minor amounts of native sulfur appear in rocks removed from the vertical shaft at a depth of less than ten meters. Native sulfur was not found in place in the pit walls or floor.

The quartz veining was apparently produced by widespread low to moderate temperature hydrothermal flow which was controlled by faults and fractures. Alteration in the prospect pits is primarily gaseous with mobilizations and redeposition of wall rock silica accompanied by leaching of calc-alkalai elements. The fumarolic nature of the alteration is further indicated by the presence of native sulfur. The presence of sulfur in the near surface environment may indicate recent fumarolic activity.

Mercury Soil Survey

Four high density sampline lines were run. The results (Figure 18) display a very high correlation with the argillized zone and associated fault centered on drill hole number three. The difference between the background and anomalous values is approximately three orders of magnitude over very short distances, indicating that mercury soil deposition is fault controlled (Figures 19 and 20).

Heat Flow

No heat flow data is available for this prospect. Steam was encountered at a depth of thirty meters while drilling. The PVC pipe used for temperature measurements melted when inserted into the drill hole and subsequent measurements could only be made to a depth of 12 meters. One initial BHT measurement of 75°C at 30 meters, one hour after completion, was obtained. Six days after completion, a BHT of 59°C at 12 meters was observed. Steam discharging from the drill hole had a temperature of 80°C with slight positive pressure.

Summary

The occurence of intense argillic alteration, opalite deposition, near surface mercury and elemental sulfur mineralization and very high temperature accompanied by steam at shallow depths indicates the presence of an active hydrothermal system. Further gradient hole drilling and geophysical surveys should be performed to evaluate this very promising prospect.

Figure 15. Fish Lake Location Map

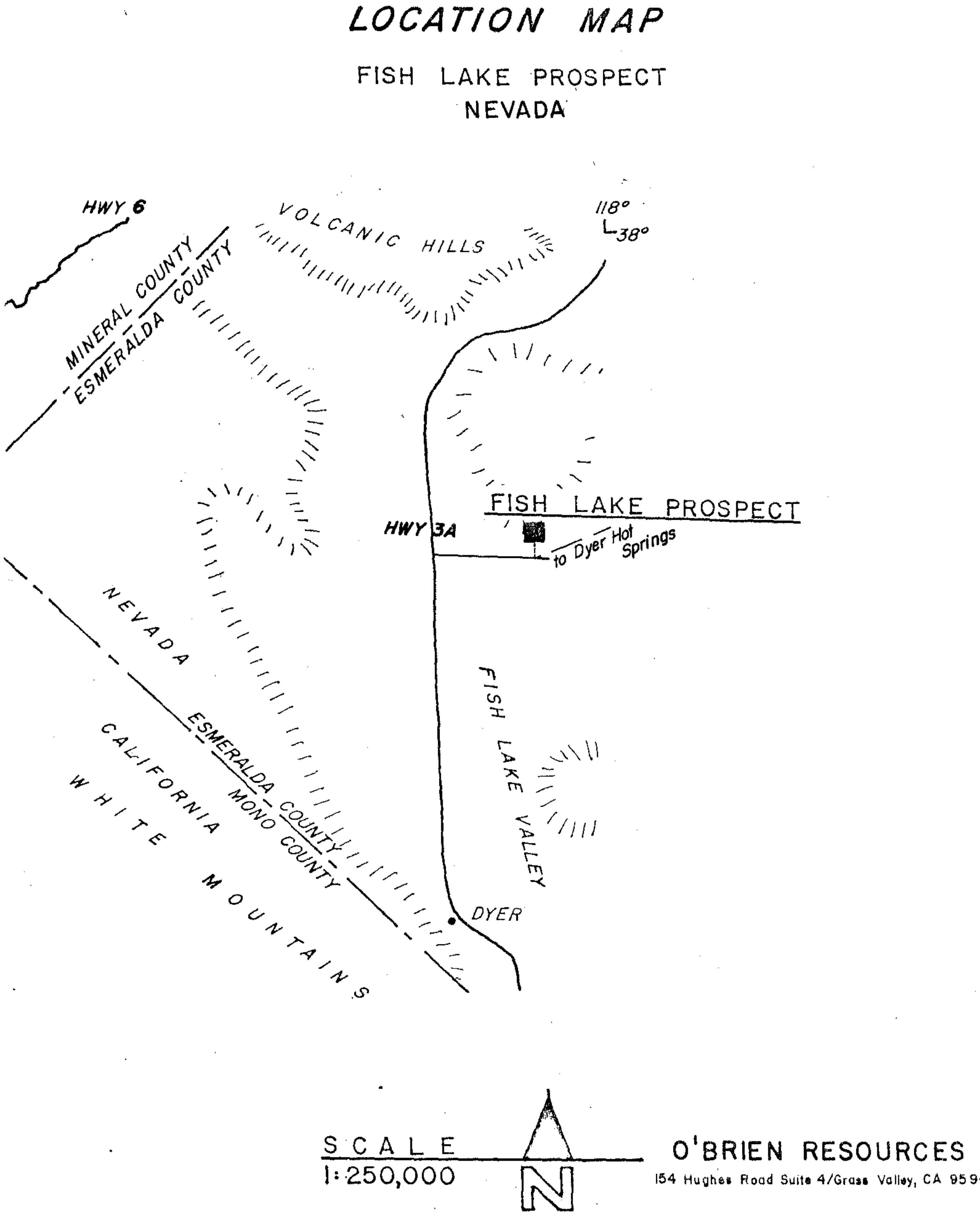
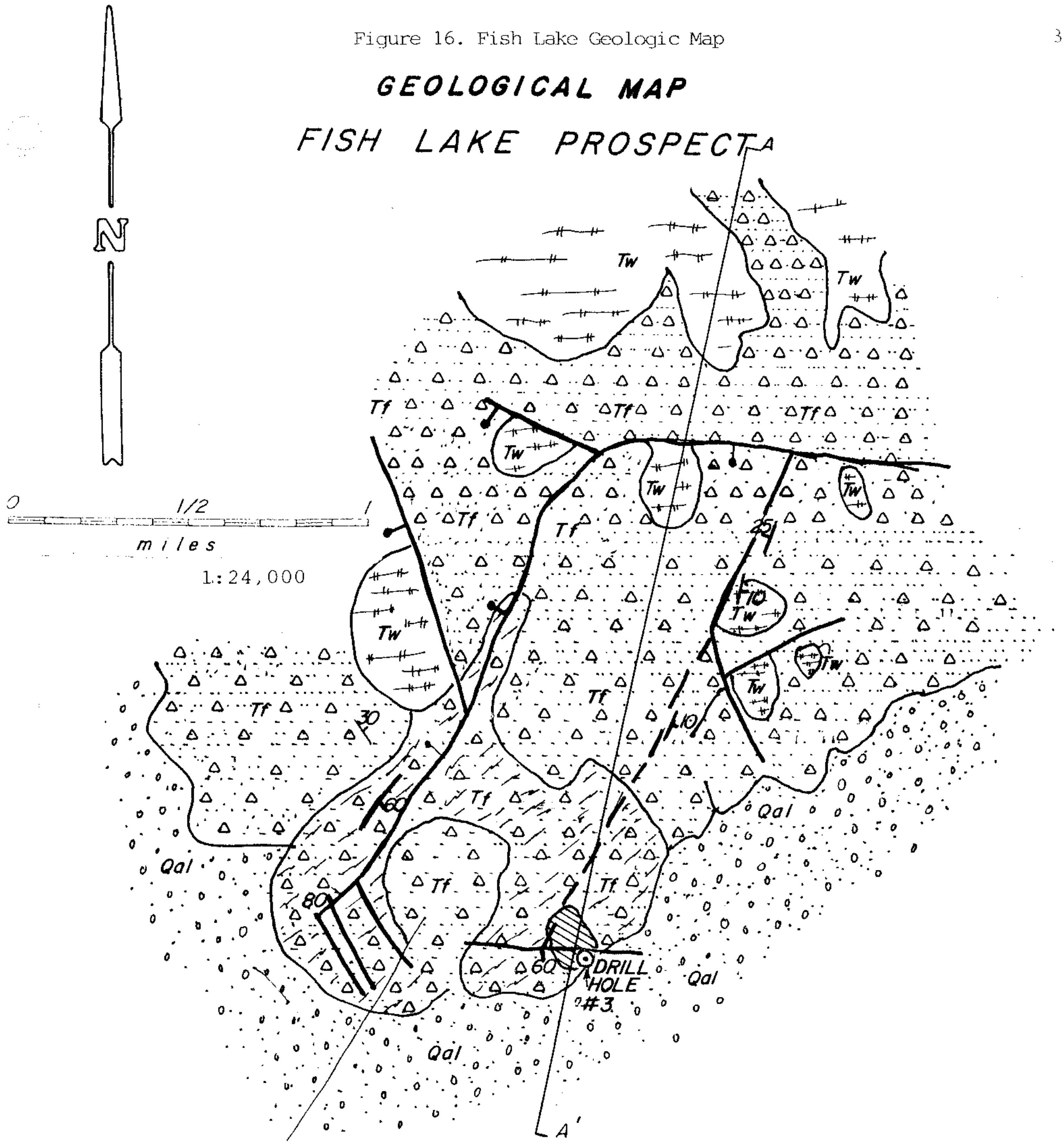


Figure 16. Fish Lake Geologic Map



E X P L A N A T I O N

Qal — Quaternary Alluvium

Tw — Welded ash flow

Tf — Airfall tuff

Zone of argillic alteration

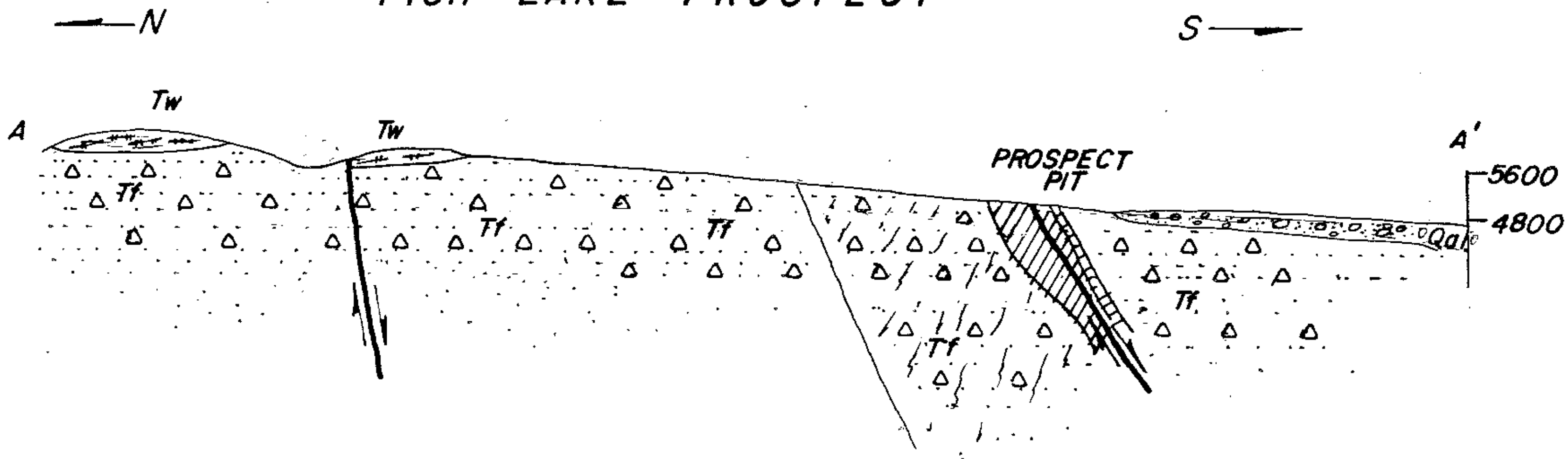
Zone of quartz-chalcedony veining

Normal fault showing dip, ball side down

50 — Strike and dip

Figure 17. Fish Lak Cross Section A-A'

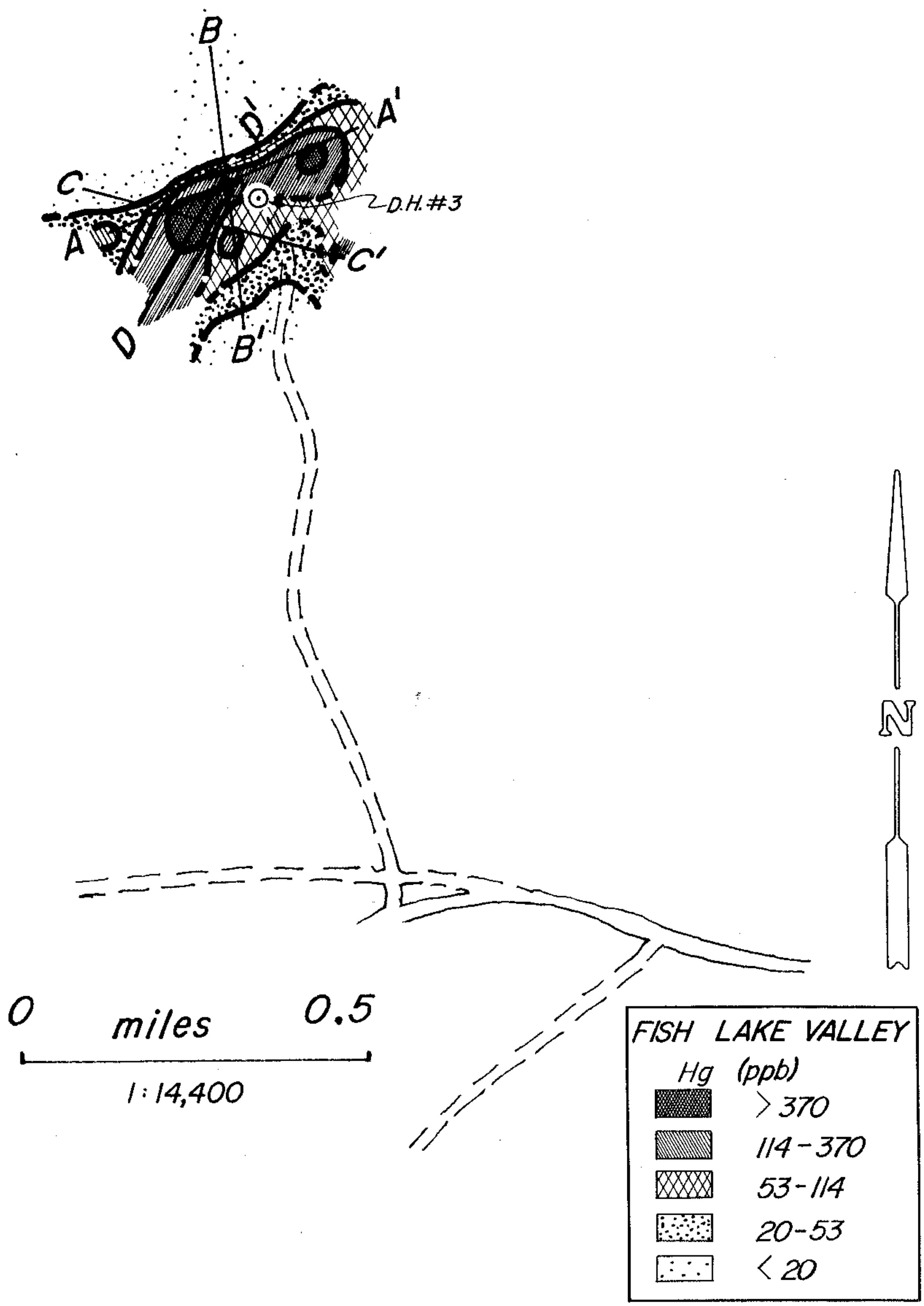
CROSS SECTION AA'
FISH LAKE PROSPECT



E X P L A N A T I O N

- Qal — Quatenary Alluvium
- Tw — Welded tuff
- Tf — Lithic airfall tuff
- Normal fault
- Quartz chalcedony veining
- Argillic alteration

Figure 18. Fish Lake Mercury Concentration Map



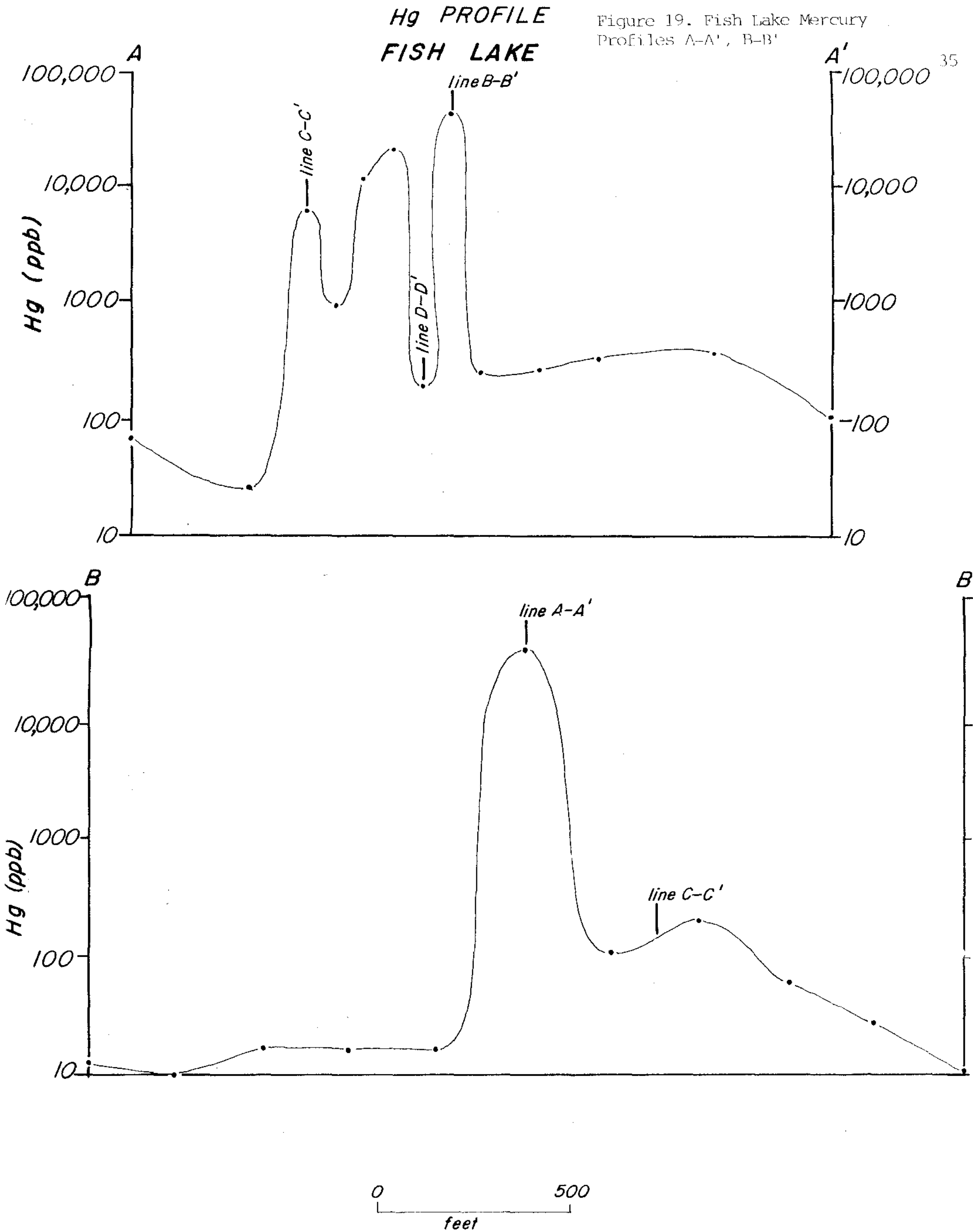
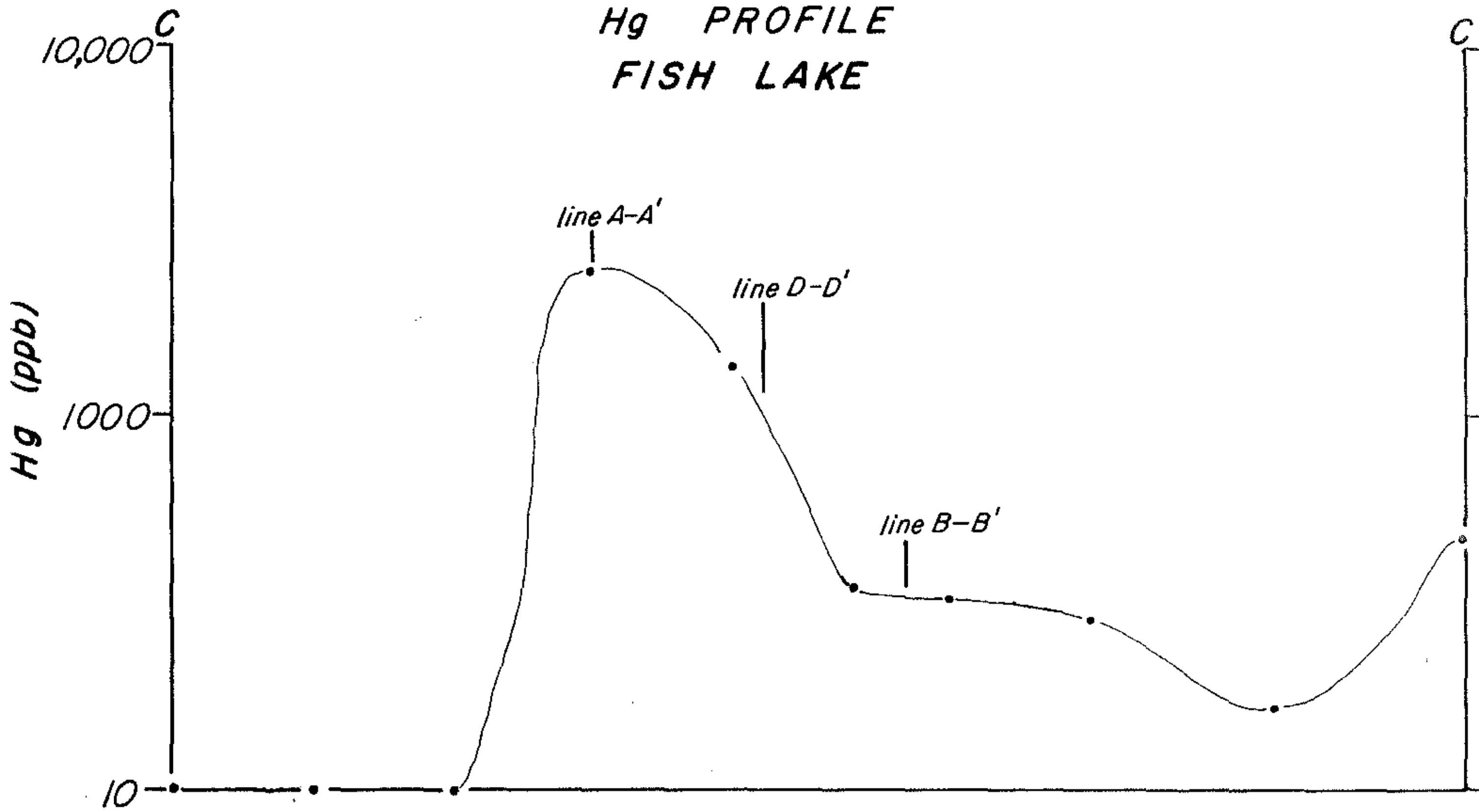
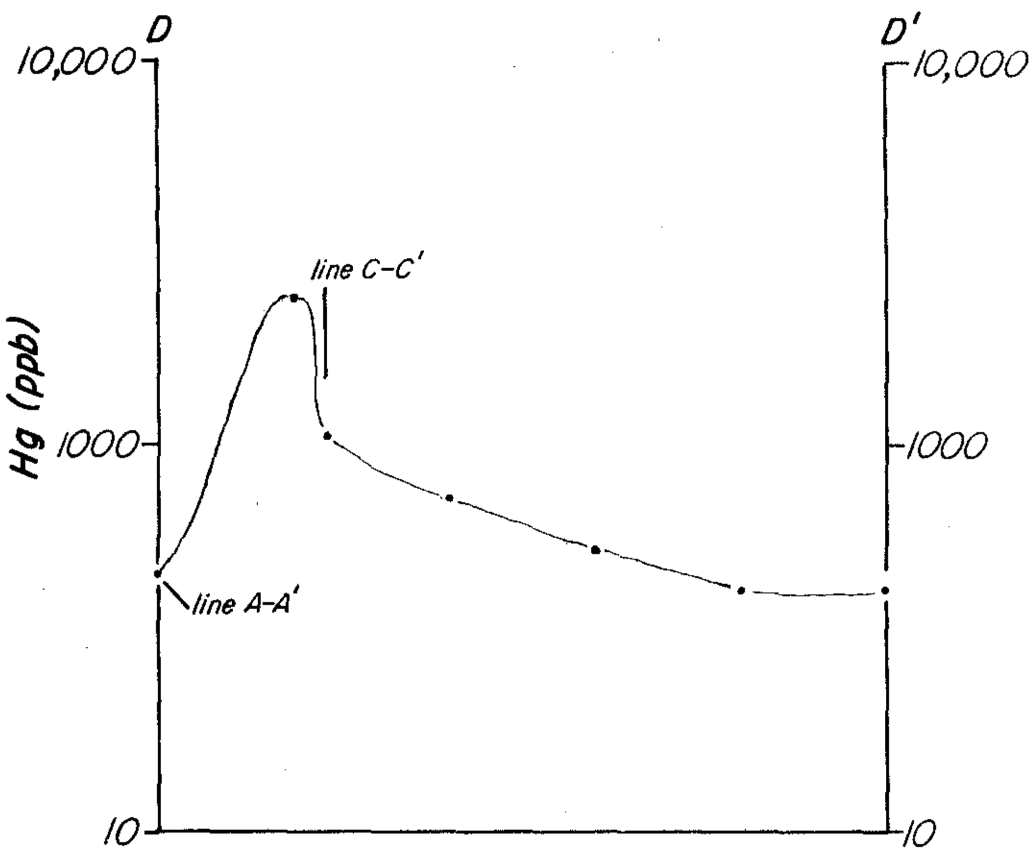


Figure 19. Fish Lake Mercury Profiles A-A', B-B'

Figure 20. Fish Lake-Mercury Profiles C-C', D-D'





GILBERT JUNCTION PROSPECT

Geology

Introduction

The Gilbert Junction Prospect is located in north central Esmeralda County, Nevada in the southeastern corner of T3N, R38E (Figure 21). The prospect is 16.5 miles east of Coaldale Junction and 22.5 miles west of Tonopah. A 3/4 mile unmaintained dirt road leads to the prospect from Highway 95/6. The road intersection with the highway is located approximately 200 yards southwest of Black Rock, a prominent Paleozoic outcrop which is indicated on the Devils Gate 7½ Quadrangle.

The prospect is located on the southeastern edge of the Monte Cristo Range which forms the southwestern boundary of the Big Smoky Valley. The Monte Cristo Range is an arcuate pile of Tertiary volcanics which is convex to the south. The extremely steep and complex topography varies in elevation from 5000 feet at the prospect site to a maximum of 7995 feet five miles to the north. The short south slope drains through a large number of parallel washes to the closed basin occupying the southern end of the Big Smoky Valley. Groundwater depth is 30 meters at the prospect site and decreases to ground level at the salt marsh 1.5 miles to the southeast. Extreme aridity of the climate is indicated by very sparse sagebrush vegetation which is completely absent on steeper slopes. The nearest permanent habitation is Coaldale Junction to the west and Tonopah to the east. A main trunk line of the Nevada power grid passes within six miles of the prospect.

The prospect workings which are located near the center of the map area consist of several recently dug trenches one to three meters deep, extending over an area of 150 X 150 meters. A large number of 30 meter mineral exploration holes are found within a 1/2 mile radius of the site. An older ten meter deep vertical timbered shaft is located in the center of the trenched area.

The Monte Cristo Range including the prospect area was mapped by Ferguson and others (1953). In addition the generalized geology was described by J.P. Albers and J.H. Stewart(1972).

Regional Geology

The Monte Cristo Range is comprised of Late Teriary (Pliocene) silicic, intermediate flow units and welded tuffs which overlie a Paleozoic-Triassic fine-grained marine basement. The basement rocks exhibit extensive deformation including folding, tilting and very large displacement thrust faulting. The northern extensions of the range are capped by Quaternary basalts originating from eruptive centers located to the north-west in adjacent Mineral County.

The volcanic series pinches out rapidly to the south as evidenced by an outcrop of Paleozoic rock 1.5 miles to the southwest of the range boundary at Black Rock and the absence of these units in the Lone Mountain Range five miles to the south across the Big Smoky Valley.

Structurally the Monte Cristo Range has remained relatively stable during the Tertiary with only minor normal faulting within the range. Major Late Tertiary vertical movement between the Monte Cristo block and the Lone Mountain - Weepah Hills block to the southwest has taken place along the range front fault on the northwest escarpment of Lone Mountain. Recent movement in this fault system is indicated by fault scarps in the Quaternary alluvium. Total vertical offset may be as much as 10,000 feet.

Rock Units

The dominant rock units in the map area consist of two andesite flows with a total exposed thickness of approximately 120 meters. The units are part of the Gilbert Andesite of Pliocene age which reaches a thickness of about 1000 meters at the crest of the Monte Cristo Range five miles to the north. The andesite outcrops of the map area are buried to the south under the coalescing alluvial fans of the Monte Cristo pediment (Figure 22).

The only pre-Tertiary basement rock exposed in the map area is a small knob of the Ordovician Palmetto Formation which projects above the alluvium 1/2 mile southeast of the prospect pits. The outcrop consists of black, very well indurated silicious siltstone. Graptolite fragments are very abundant throughout the massive unit. Abundant quartz replacement veins

0.5 to 2 cm thick permeate the rock. Breccia zones contain massive quartz filling with partial replacement of siltstone fragments. The contact with the overlying Gilbert Andesite is not exposed.

The lower andesite unit (Tg3) is light pink-gray and contains abundant euhedral hornblende and plagioclase phenocrysts varying in size from 1-5mm. The unit is massive and relatively unjointed. It exhibits brecciation within two to three meters of its upper contact with the overlying andesite unit. A 60 meter thickness of this unit is exposed in the map area but since the bottom is not exposed it may be much thicker.

A dense, fine-grained to aphanitic, medium gray andesite (Tg1) overlies Tg3. The unit contains no identifiable phenocrysts. It exhibits intense jointing which produces 3 to 10 cm angular, equidimensional shards. Forty to 60 meters of this unit is exposed in the map area but no upper contact is observed so the unit may thicken toward the interior of the Monte Cristo Range.

Lenses of white, air-fall, lithic, quartz crystal tuff measuring a few meters thick are found within the Tg1 unit. The tuff is vesicular and partially silicified. Vesicles are filled with drusy quartz.

Structure

The structure of the map area is dominated by a series of parallel, northeast trending normal faults (Figure 23). The faults dip steeply to the southeast. The faults are expressed topographically by isolated knobs 60 to 120 meters high which are separated from each other and from the main Monte Cristo block by linear depressions. Vertical offset of the Tg3–Tg1 contact was used to measure fault displacement.

The isolated block of Ordovician basement rock in the southeast corner of the map area may be explained by the existence of a normal fault of reverse throw buried in the alluvium separating Black Rock from the prospect pits. Such a fault parallel to the faults previously mentioned would create a northeast trending graben structure. The southeast rim of the graben could therefore be uplifted sufficiently to expose the Paleozoic basement. This interpretation is represented in the cross section A–A′ (Figure 23). Alternatively, simple pinching out of the Gilbert Andesite could account for the exposure though some form of uplift is still required to account for the observed elevation of the Paleozoic block.

Alteration and Mineralization

Alteration in the map area is confined to the upper andesite unit Tg1 and is primarily argillic in nature. It does not penetrate the thin alluvial veneer. The argillization is most intense near the vertical shaft where Tg1 has been completely altered to a sectile, nearly pure clay rock with abundant iron oxide staining. Alteration decreases radially from the center of the prospect to a distance of 150 meters where fresh andesite predominates. Except for the massive clay deposit near the center of the prospect, alteration in varying degrees is confined to east–west trending vertical shear zones. The degree of alteration varies from more intense which appears very light gray and friable to less intense which is orange-red and competent. The unaltered andesite is medium gray.

Mineralization consists of limonite staining and fracture filling and calcite and quartz veining. Intensity of limonite deposition parallels the intensity of argillic alteration whereas calcite and quartz veining is more widespread. The calcite which is colorless, transparent and very coarse grained (3 - 5 cm) is found in shear zones of altered and unaltered andesite. The quartz appears in thick veins up to 40 cm thick which dip steeply and trend northwest in the map area. No other megascopic mineralization was noted.

The mineralization may be interpreted as occuring in two separate stages. The coarse grained calcite and quartz deposition represents a moderate temperature hydrothermal stage which left the wall rock relatively unaltered. A later stage of gaseous fumarolic activity would produce the argillization and bleaching of the andesite. Mobilization of iron from the mafic minerals and transport to the fracture zones would account for the observed pattern of iron oxide deposition and staining surrounded by bleached, argillized andesite.

Mercury Soil Survey

The mercury soil survey consisted of three high density lines (Figure 24 and 25). The results are somewhat questionable since the variation between background and anamalous values is only slightly larger than the experimental error.

Heat Flow

Eight mineral holes and one gradient hole (Figure 26), all less than 35 meters, were used to generate a heat flow map (Figure 27). Due to a shallow high transmissivity aquifer, true heat flow values could not be obtained.

Summary

Low mercury values do not preclude the existence of a thermal anomaly. When coupled with the fairly uniform heat flow observed they suggest that any surficial thermal effects are currently controlled by the hydrogeologic regime. A gradient hole which penetrates the entire aquifer is necessary to obtain a reliable heat flow measurement.

Figure 21. Gilbert Junction Location Map

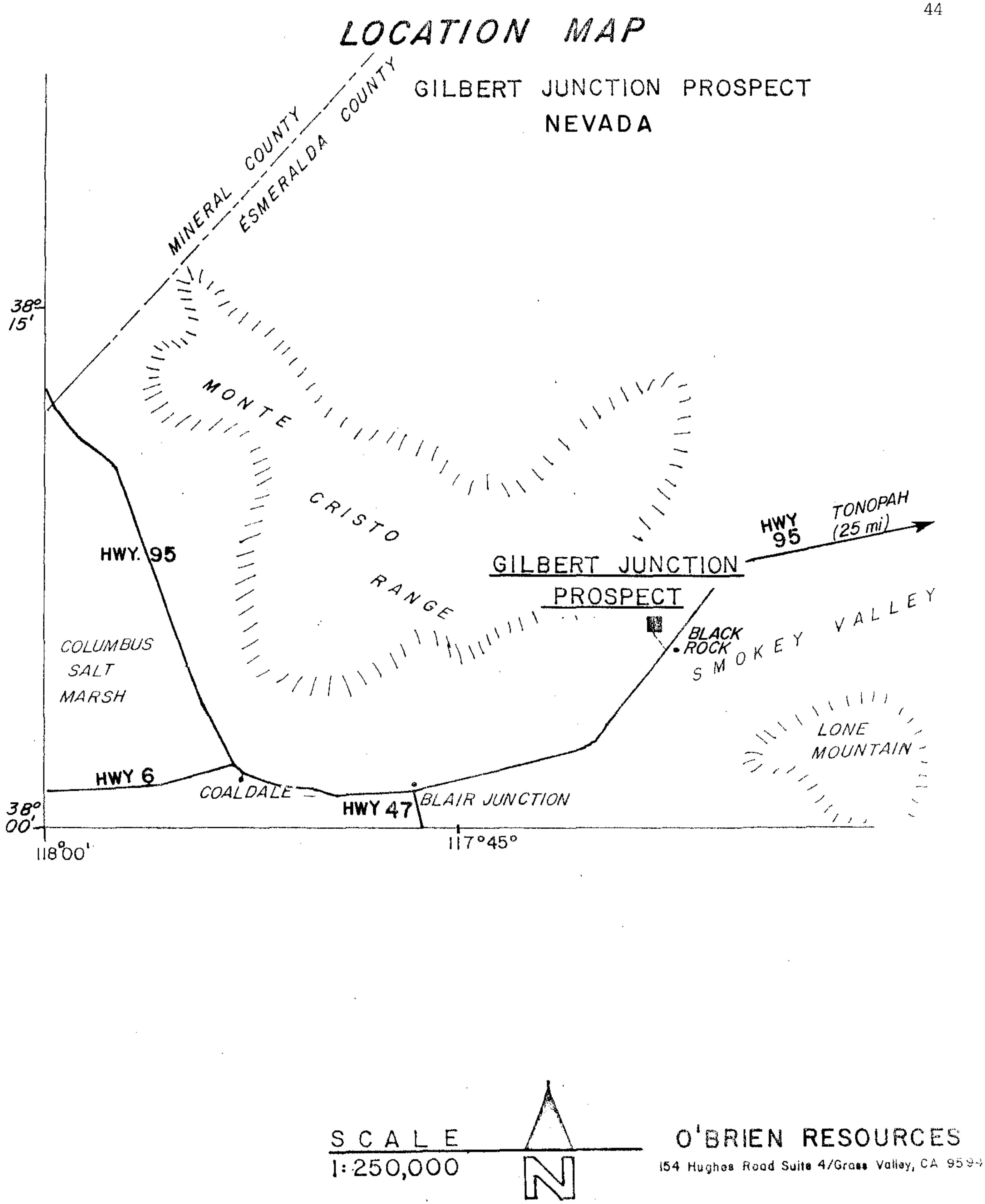
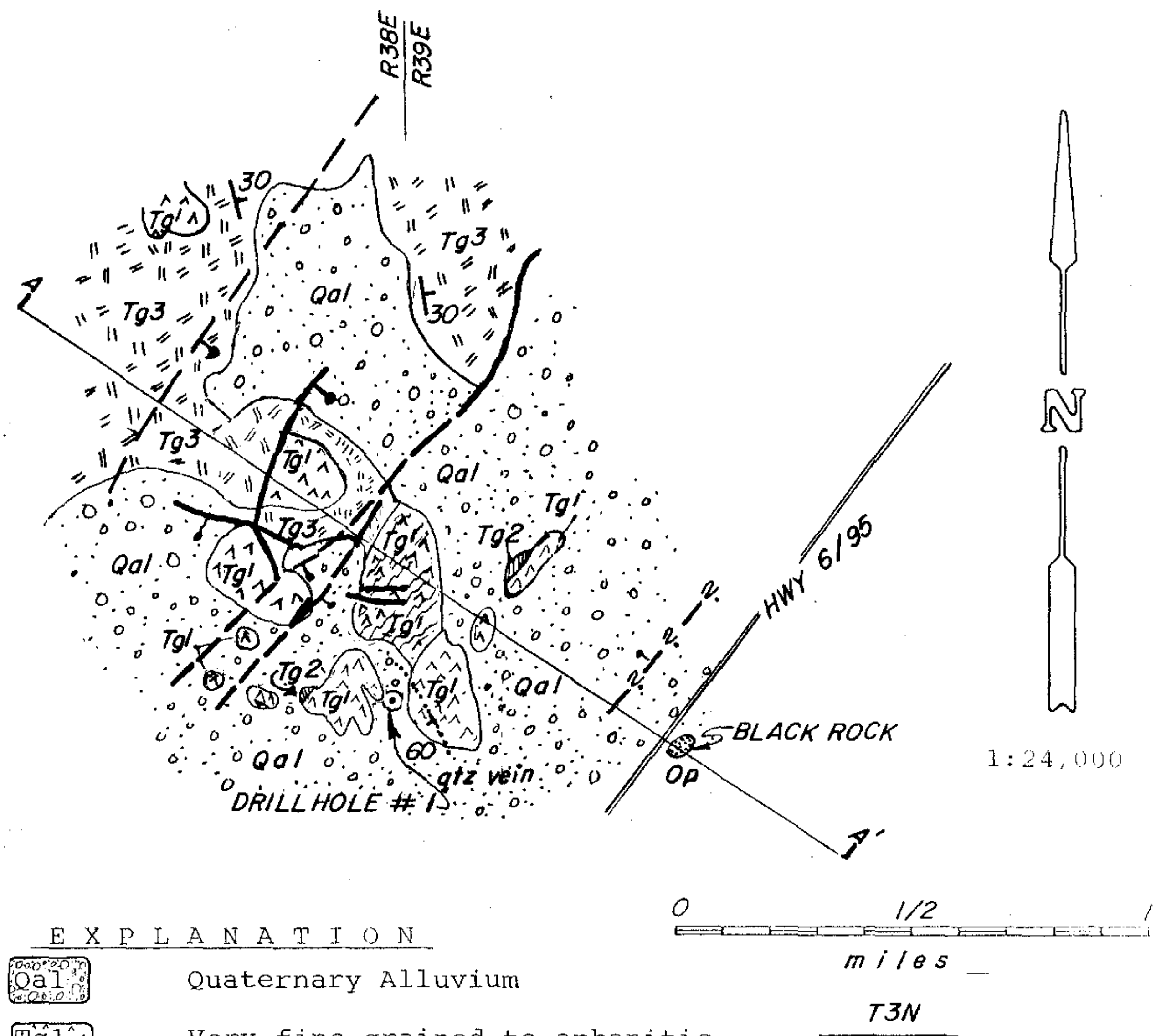


Figure 22. Gilbert Junction Geologic Map

GEOLOGIC MAP
GILBERT JUNCTION PROSPECT



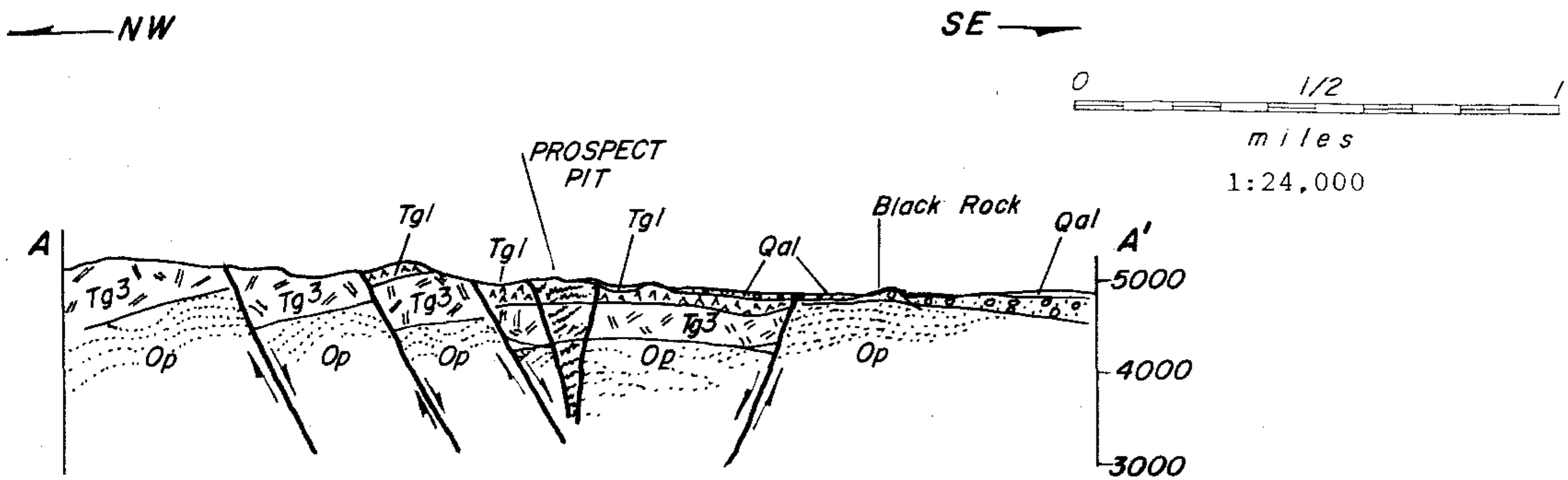
EXPLANATION

Quaternary	Qal	Quaternary Alluvium
Pliocene	Tg1	Very fine grained to aphanitic dark gray andesite
	Tg2	White resicular tuff partially silicified
	Tg3	Fine grained hornblende andesite
Ordovician	Op	Silicic black siltstone
		Quartz vein showing dip
		Argillized shear zone
		Normal fault, ball side down
	60	Strike and dip

Figure 23. Gilbert Junction Cross Section A-A'

CROSS SECTION A–A'

GILBERT JUNCTION PROSPECT



EXPLANATION

Normal fault

Contact

Zone of Argillic Alteration

Ordorician Pliocene Quaterarty

Qal	Quaternary Alluvium
Tg1	Very fine grained to aphanitic dark gray andesite
Tg3	Fine grained hornblende andesite
Op	Silicic Black siltstone of the Palmetto Formation

Figure 24. Gilbert Junction Mercury Concentration Map

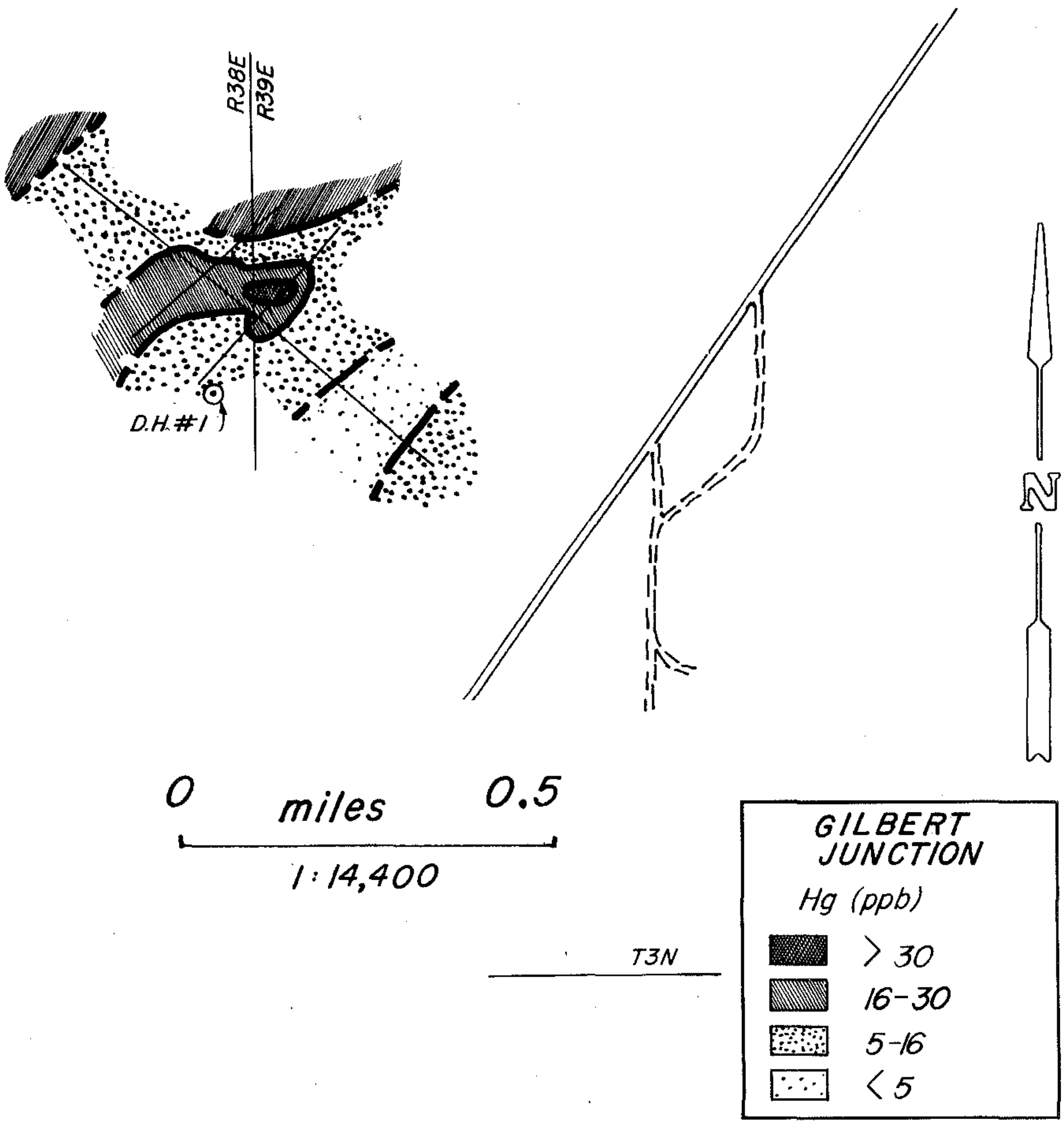


Figure 25. Gilbert Junction Mercury Profiles A-A', B-B', C-C'

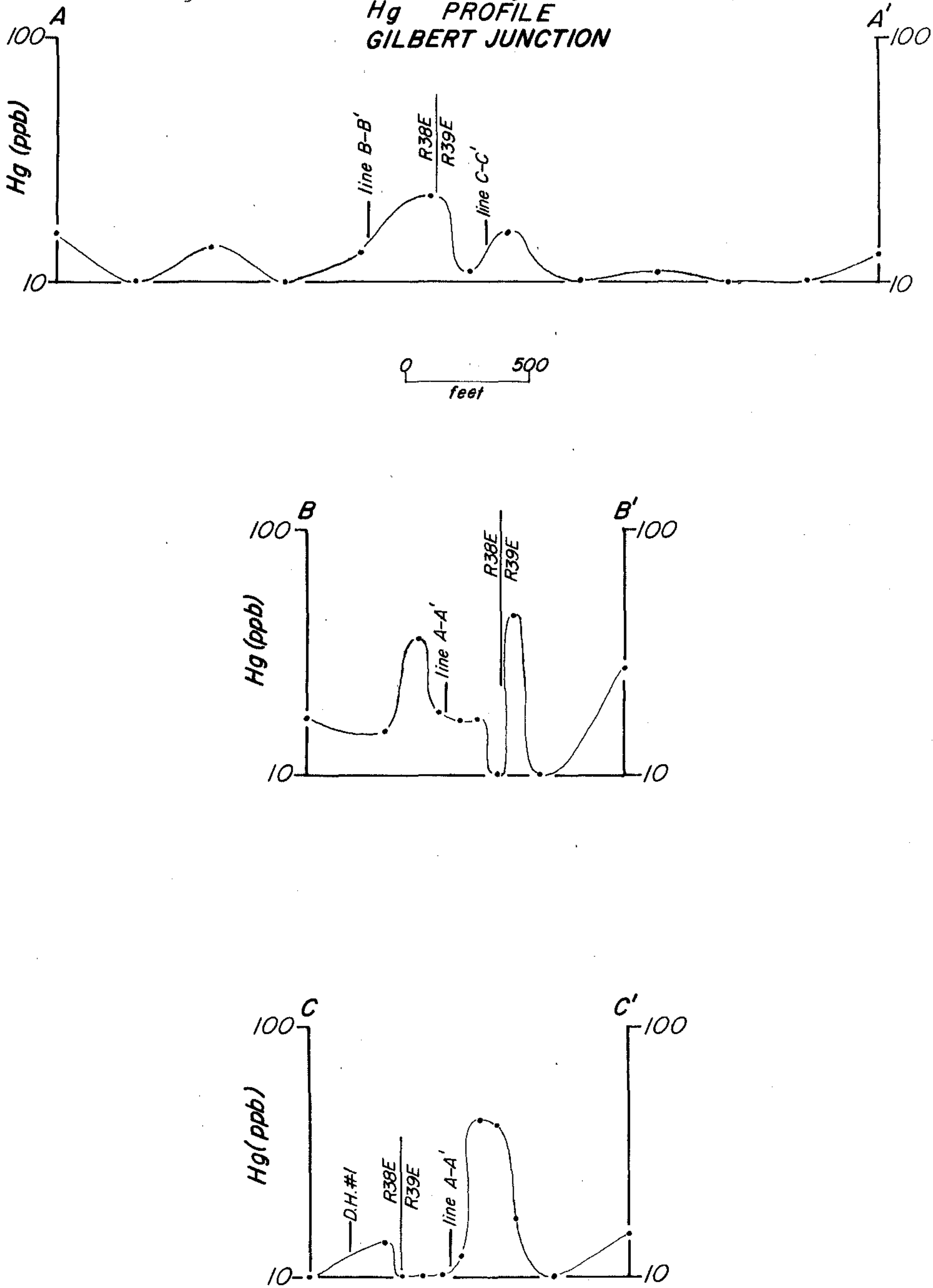


Figure 26. Gilbert Junction Drill Hole No. 1, Temperature and Lithology Log

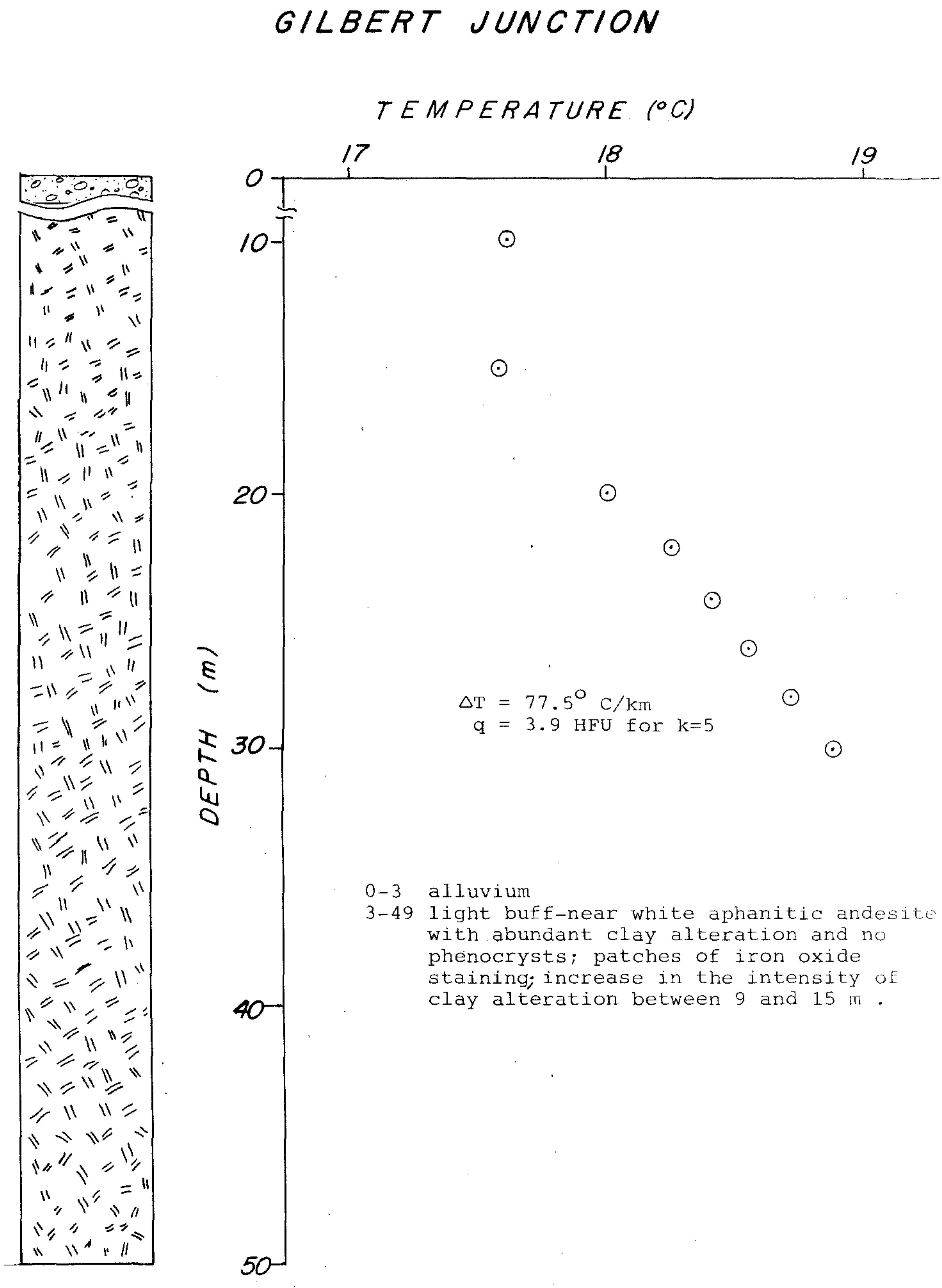
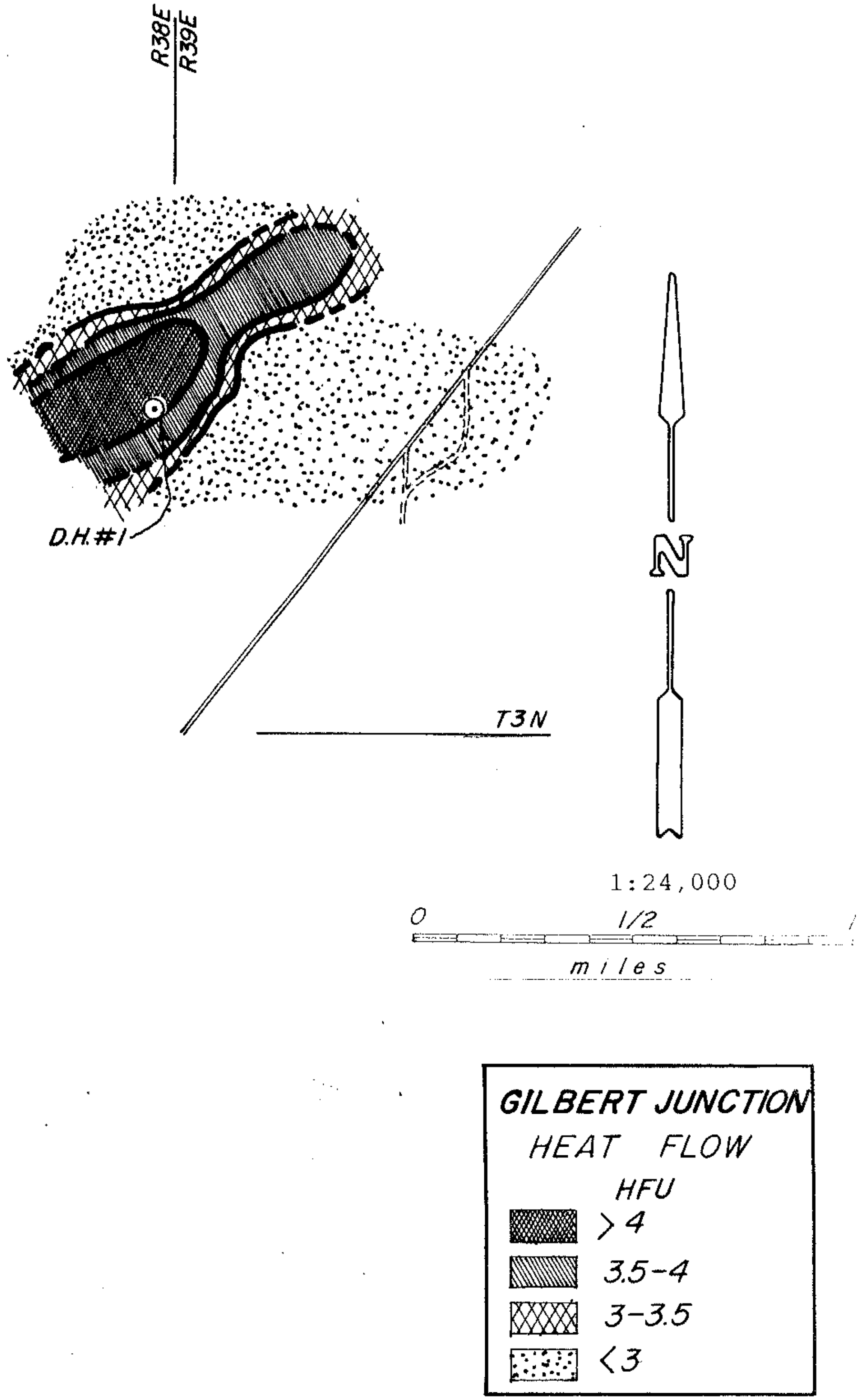


Figure 27. Gilbert Junction Heat Flow Map



PERSHING PROSPECT

Geology

Introduction

The Pershing Prospect is located in T27N, R34E, south-central Pershing County, Nevada. The prospect is reached by the Coal Canyon - Buena Vista Valley Road which turns eastward from I-80, six miles north of Lovelock. Twelve unmaintained dirt roads lead north from the Buena Vista Road to various points in the prospect (Figure 28).

The prospect is located at an elevation of 4600 - 5200 feet at the southern end of the Humbolt Range near the head of the Carson Sink drainage. The area is bounded on the west by the West Humbolt Range which is a moderately elevated spur of the higher, main Humbolt Range.

The arid climate supports sage brush on the lower slopes and very sparse growths of pinyon pine above an elevation of 6000 feet. Ground water in Packard Wash which drains the map area is found at a depth of 30 meters. Two cold springs of small discharge issue from the north end of Packard Wash three miles north of the prospect.

Several mercury mines with a combined production of over 10,000 flasks are located along a four mile northwest trending line which terminates at the southern end of the prospect. Production was discontinued in 1943 (Bailey and Edgar, 1944). The region is now used for cattle and horse grazing.

Geology of the region is discussed by Johnson (1977) and Bailey and Phoenix (1944).

Regional Geology

The Humbolt Range consists of a 14,000 foot thick sedimentary sequence of Triassic carbonate, siliceous and argillaceous rock. The sedimentary units are interbedded with and intruded by Triassic volcanic and granitic rock. Minor flows of Quaternary basalts are distributed along the eastern margin of the range.

Structure in the range is dominated by north trending high angle normal faulting along its eastern and western margins. Parallel faults of the same orientation with lesser displacement are distributed throughout the sedimentary block. Steep scarps on both the eastern and western side of the range indicate a horst structure. The major west-side range front fault is displaced six miles eastward in the southern portion of the range, thereby splitting the southern half of the range into the West Humbolt Range and Buffalo Mountain (Johnson, 1977).

Rock Units

Three Triassic sedimentary units are exposed in the map area (Figure 29).

The lowermost unit is the Natchez Pass Formation which outcrops in the northern end of the map area. It consists of massive dark gray limestone with interbedded pyroclastic rocks. The limestone exhibits abundant white calcite veining. The interbedded pyroclastics consist of vesicular welded tuff with quartz phenocrysts and are probably rhyolitic in composition. The unit has a thickness of 400 meters in the map area.

The Natchez Pass Formation is overlain by the Grass Valley Formation. This unit is primarily mudstone with minor amounts of interbedded sandstone. The mudstone is mildly to moderately metamorphosed to argillite or phyllite in several locales throughout the map area. Where not metamorphosed, the unit is soft and forms rounded hills with a deep soil cover. The unit is approximately 450m thick in the map area.

The uppermost Triassic unit in the map area is the Dun Glen Formation which is a massive to thickly bedded gray limestone with a thickness of 30 to 40 meters. This unit outcrops in the southern half of the map area where it is intensely folded and faulted.

Structure

The map area is divided into two structural regions which are separated by South Relief Canyon (Figure 30). The northern region contains the steeply dipping southern flank of a broad anticline. The anticline plunges to the east and is truncated by the Humbolt Range front fault to the west. This region is relatively coherent with little or no internal faulting. The beds dip to the south 30 to 60 degrees. The apex of the broad arch is occupied by a Triassic leucogranite intrusive.

South of South Relief Canyon the continuation of the south dipping anticlinal flank is obscured by a number of northwest trending folds and normal faults. These structures are truncated to the northwest by the arcuate southern extension of the Humbolt range front fault.

Mineralization and Alteration

Argillic alteration in the map area is confined to a small breccia zone which lies on an offshoot of the Humbolt range front fault. This zone which trends northeast is approximately 50 meters wide and 200 meters across and occurs in the tan mudstone of the Grass Valley Formation. The mudstone is highly crushed and bleached to a white friable clay with patches of orange iron oxide staining. A seep of very low discharge with abundant efflorescent NaCl is located along the strike of the range front fault approximately one kilometer southwest of the argillic alteration. Cinnibar mineralization is confined to the southern part of the map area. The cinnibar occurs in calcite veins and as pore fillings in sedimentary limestone breccia of the Dun Glen Formation. The ore bearing solutions or vapors were probably transported from depth to the porous breccia zones by the system of high angle northwest trending faults that pass through the district. This fault control is evidenced by northwest trending linear distribution of cinnibar deposits in the district.

Mercury Soil Survey

Five moderate density sampling lines were run. The uniformity of background mercury levels can be clearly seen in Figure 31. The two largest anomalies along lines A-A' and C-C' represent single samples which are not associated with thermal anomalies (Figures 32 and 33). The anomaly coinciding with the intersection of lines B-B' and C-C' may indicate the most thermally active area.

Heat Flow

Drill hole number four (Figure 34) has a continuous gradient of 69^{o} C/km which corresponds to a corrected heat flow of 4.7 HFU. Mine tunnels to the east of the prospect are reportedly warm, however, no supporting evidence has been found.

Summary

The moderate heat flow observed in drill hole number four, the diffuse mercury anomalies, the very limited extent and intensity of hydrothermal alteration and the limited availability of unleased land make further assessment work unattractive at this time.

Figure 28. Pershing Location Map

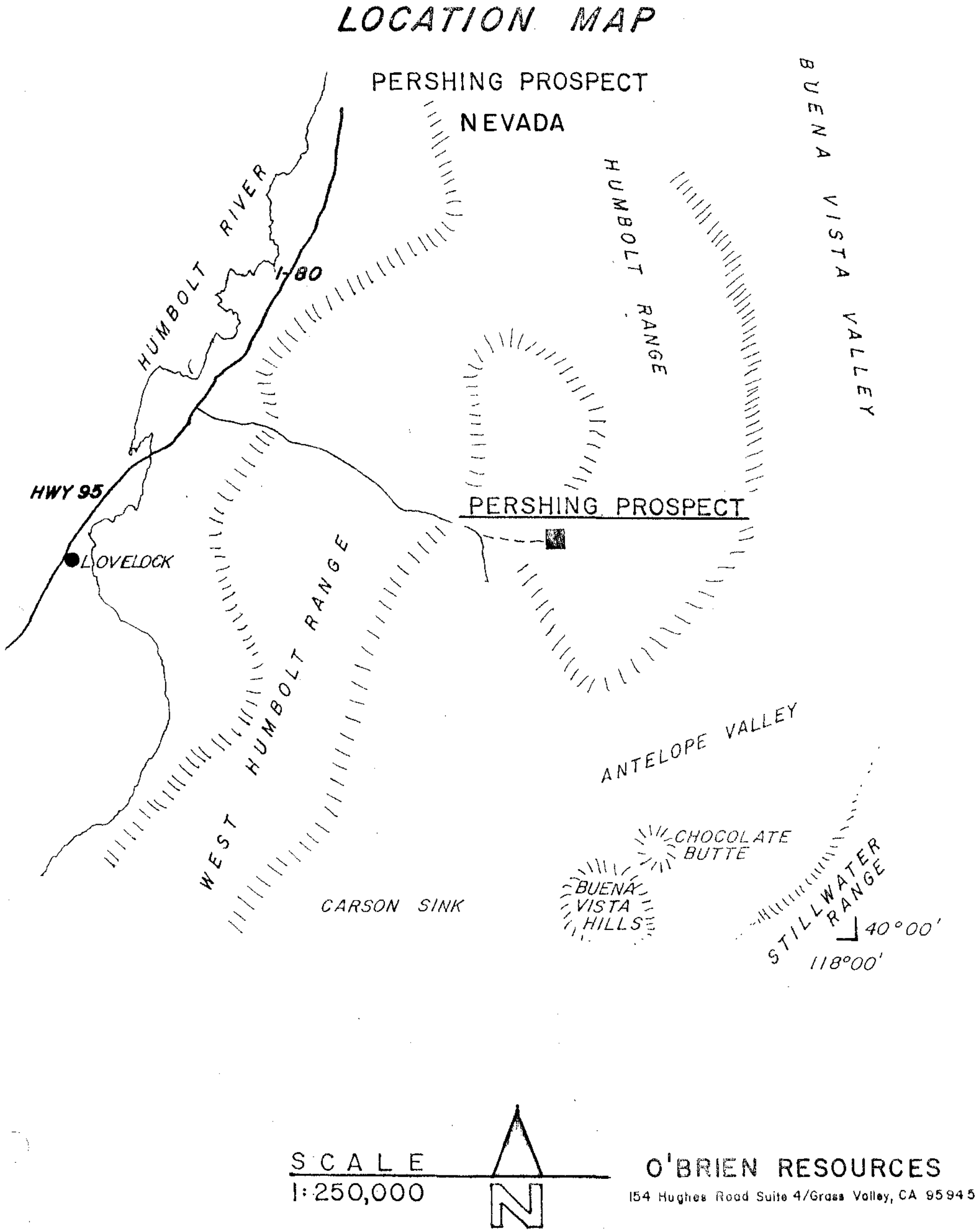


Figure 29. Pershing Geologic Map

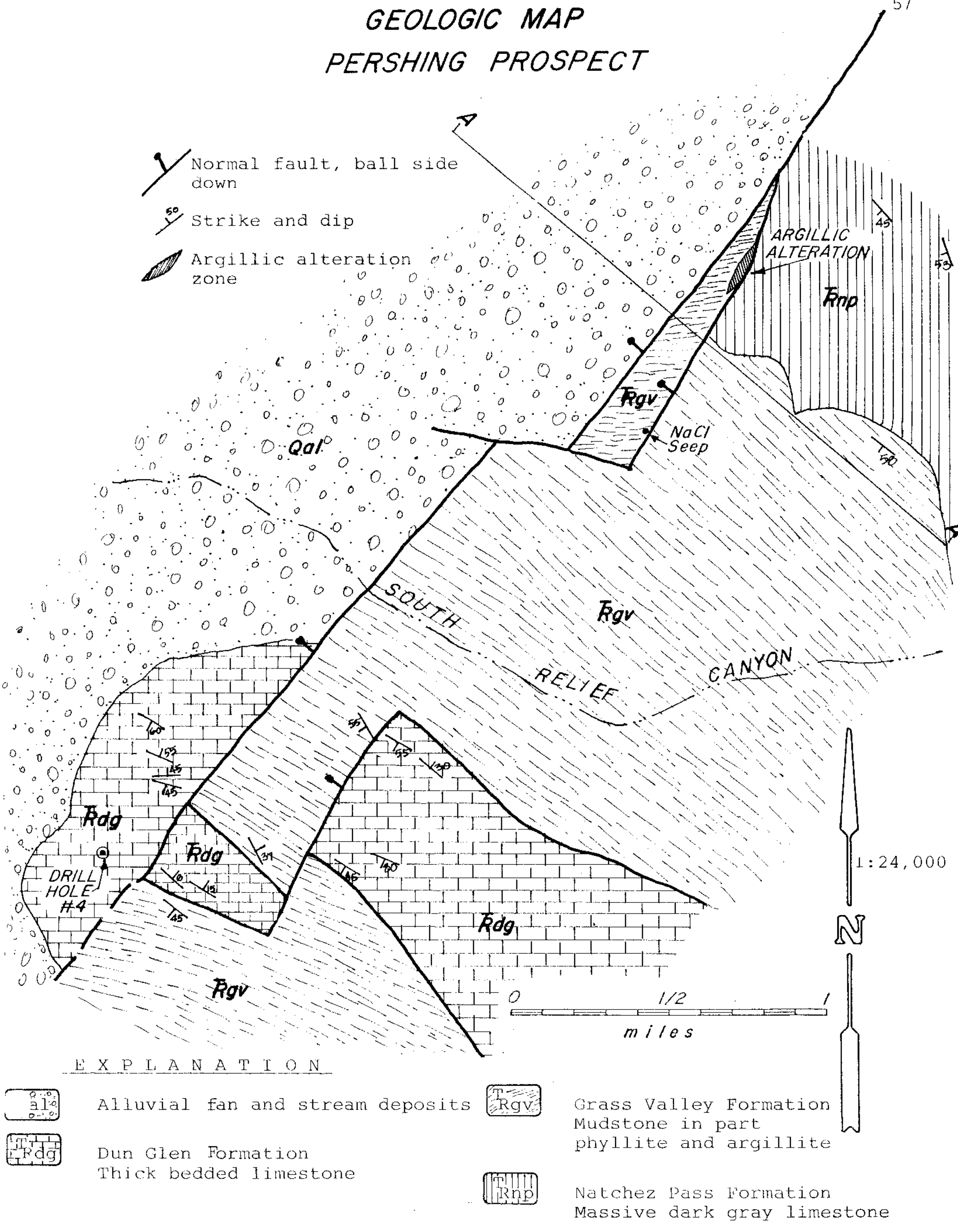
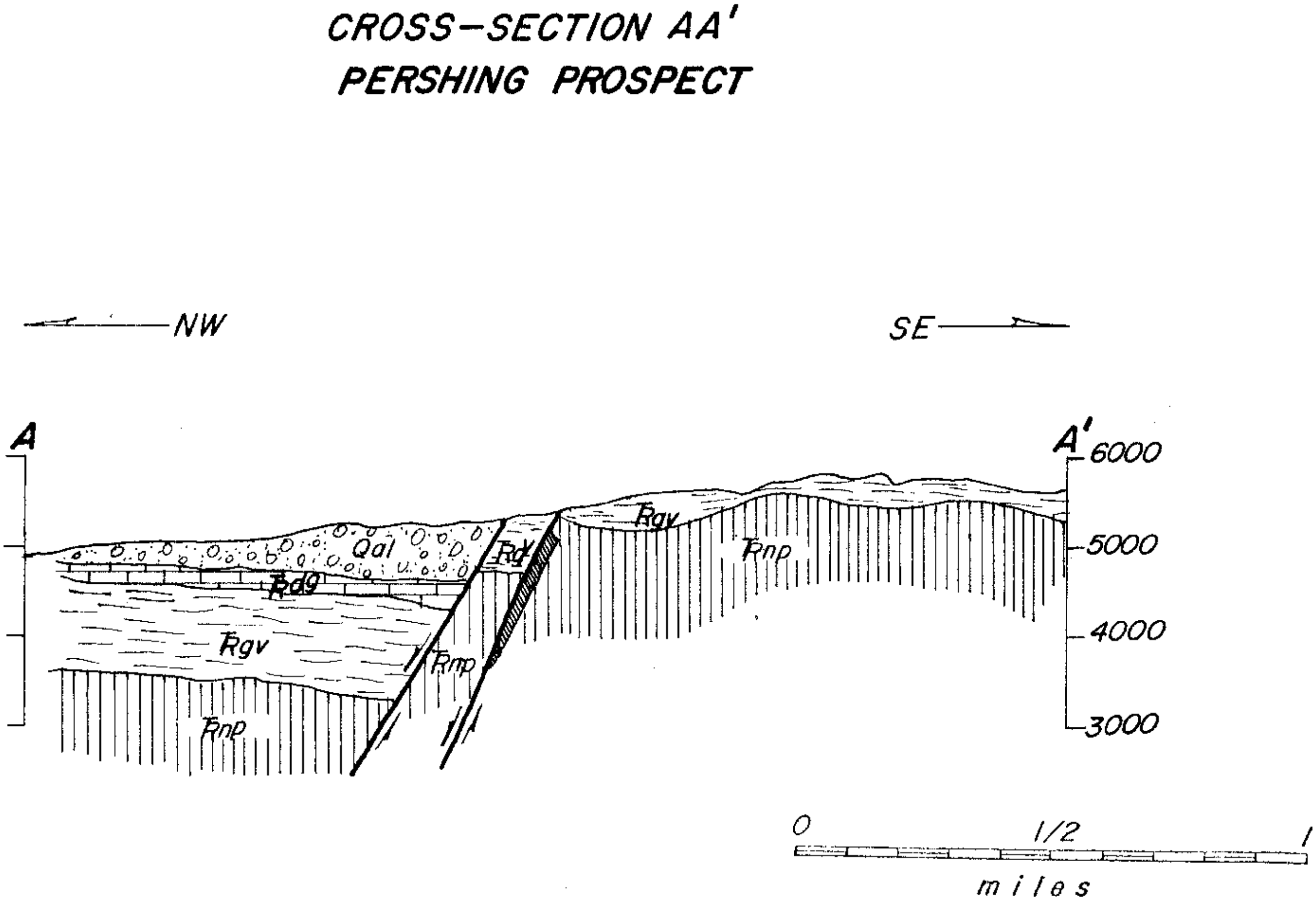


Figure 30. Pershing Cross Section A-A'



E X P L A N A T I O N

Qal	Alluvial fan deposits
TRdg	Dun Glen Formation- thick bedded limestone
TRgv	Grass Valley Formation mudstone in part recrystallized to phyllite and argillite
TRnp	Nachez Pass Formation massive limestone
(fault symbol)	Normal fault

Figure 31. Pershing Mercury Concentration Map

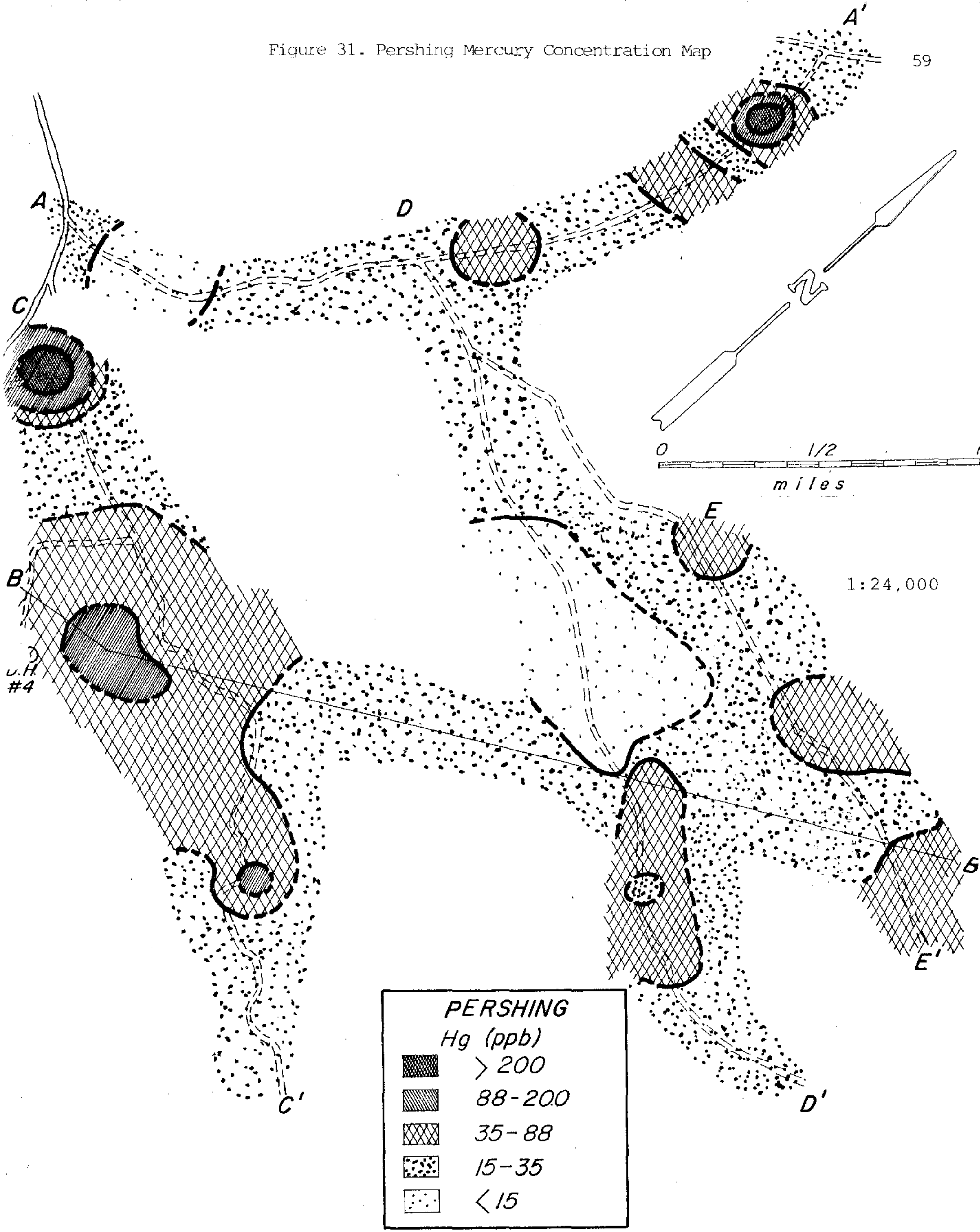


Figure 32. Pershing Mercury Profiles A-A', B-B'

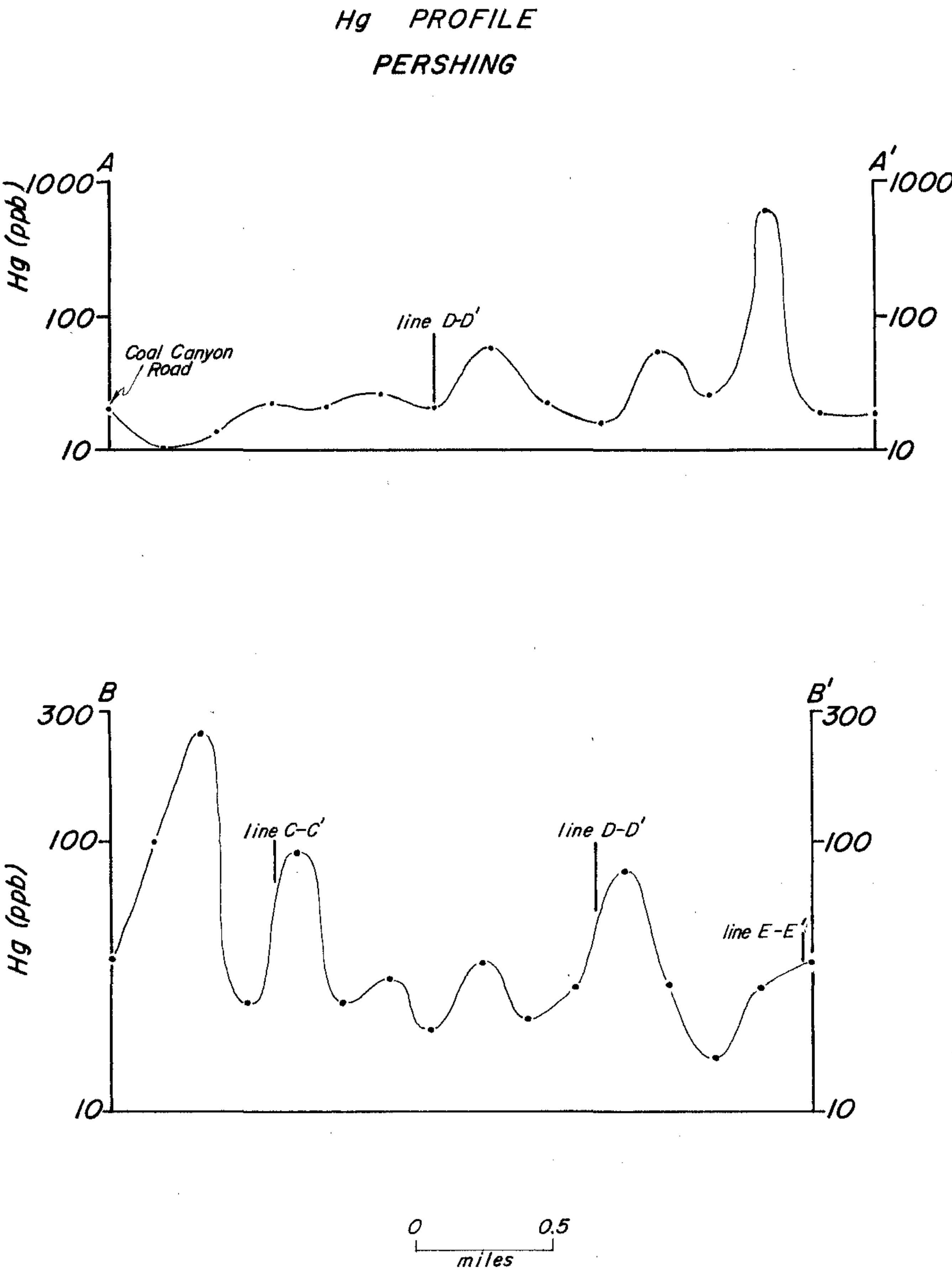


Figure 33. Pershing Mercury Profiles C-C', D-D', E-E'

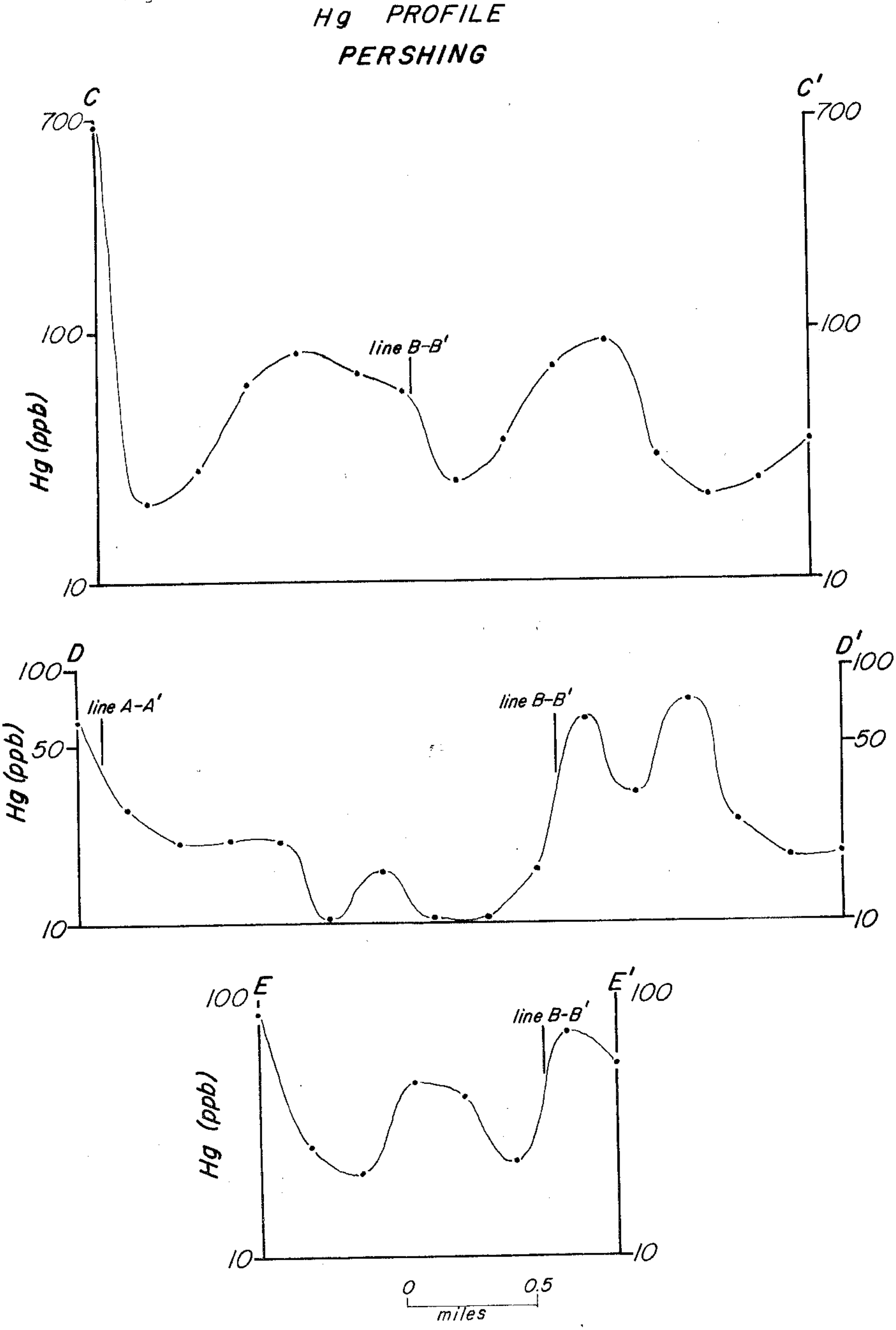
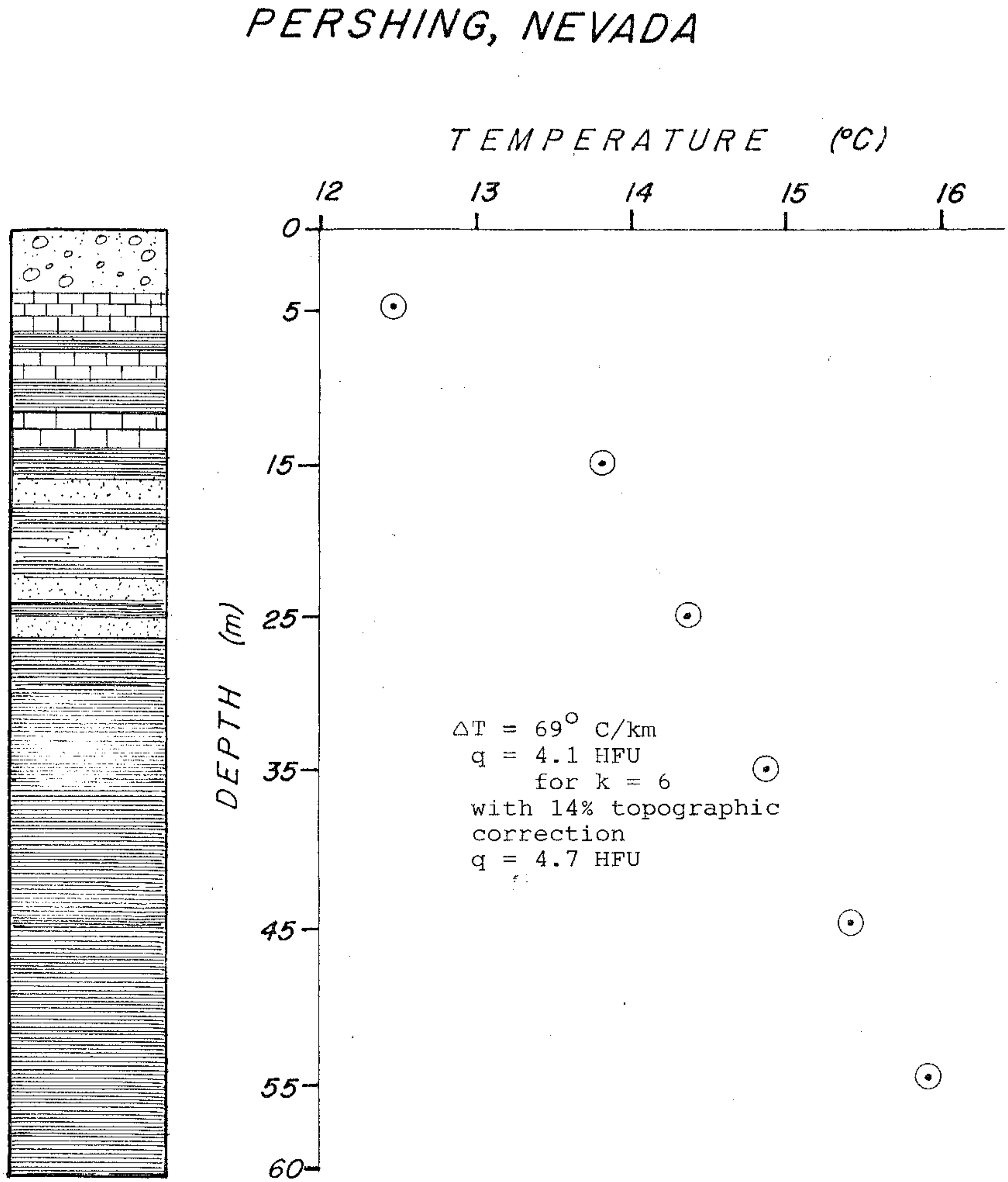


Figure 34. Pershing Drill Hole No. 4, Temperature and Lithology Log



0-4.5	alluvium
4.5-13	dark gray, fine-grained limestone with minor amounts of light brown silty sandstone
13-14	dark gray shale
14-26	dark gray shale with light brown fine-grained sandstone stringers
26-61	dark gray shale

RAST PROSPECT

Geology

Introduction

The Rast Prospect is located in T2N, R45E, central Lander County, Nevada. The prospect is reached by traveling five miles east from Austin on Highway 50 and then turning north on the Grass Valley Road (County Road 21) for 14 miles. At this point the road branches with the left branch leading an additional three miles to the prospect (Figure 35).

The prospect is located at an elevation of 6800 feet at the southern end of Grass Valley. It lies at the eastern base of the Toiyabe Range which reaches a maximum elevation of over 10,000 feet, six miles to the northwest. The area receives moderate precipitation and supports a dense growth of pinyon pine between an elevation of 6600 and 9000 feet. Two perennial streams and several springs drain eastward into Grass Valley from the prospect area. Several ranches in the area exploit the relatively abundant ground and surface water for alfalfa growing and cattle production.

The prospect centers around the Rast Mercury Prospect which consists of a number of shallow pits dug in Paleozoic limestone and quartzite. No quicksilver production was reported from the prospect (Bailey and Phoenix, 1944). Geology of the area is discussed in Stewart and others (1977).

Regional Geology

The north-northwest trending Toiyabe Range, which lies immediately to the west of the Rast Prospect, consists of several thousand feet of Paleozoic siliceous and carbonate sediments.

Two low angle thrust faults of Paleozoic age with several miles of horizontal displacement dominate the internal structure of the Paleozoic block. This sedimentary block is terminated six miles to the south of the prospect by a Triassic quartz monzonite pluton centered near the town of Austin. To the north the Paleozoic section is overlain by thick deposits of intermediate to silicic tuffs with an age of about 34 m.y. (Steward and McKee, 1977). Andesite flows of similar age are the predominant rock type of the Simpson Range which lies six miles to the east of the prospect. The andesites overlie a basement of Paleozoic sediments and extend westward to within two miles of the prospect. No volcanics of younger age are found in the region.

The Toiyabe Range adjacent to the prospect appears to have a broad horst structure with high angle north-trending faults stepping downward along the eastern and western flanks of the range. This range front faulting has been active through the Pleistocene as indicated by scarps in uplifted Quaternary sediments which form the eastern Toiyabe pediment.

Rock Units

Three Paleozoic sedimentary units are exposed in the prospect area

(Figure 36). The oldest unit is the Upper Cambrian Crane Canyon sequence (Stewart, 1977). The lower part of the unit consists of alternating beds of fine grained gray limestone 2 to 3 cm thick and gray chert of similar thickness. The upper part of the unit is characterized by laminated argillaceous limestone which weathers to a dark red-brown. A 300 meter thick section of the unit is exposed in the map area, but because the base is not exposed, the true thickness may be greater.

The overlying Ordovician unit is made up of the Goodwin Limestone, the Ninemile Formation and the Antelope Valley Formation. This unit is characterized by massive to thickly bedded dark gray limestones. The unit contains abundant large gastropods and is heavily veined with white calcite. The unit tends to form prominent cliffs. Ths contacts between this unit and the underlying Crane Canyon sequence are primarily thrust faults. The incomplete section has a thickness of 125 meters.

The uppermost unit of the Paleozoic section in the map area is the Ordovician Valmy Formation. The unit consists of a vitreous reddish-brown conglomeratic quartzite which has been thrust over the Ordovician limestone sequence mentioned above. This very resistant unit forms prominent knobby outcrops in the map area.

Structure

The Paleozoic sediments of the map area strike uniformly east-west and dip 15° to 35° to the south. The section is broken into two main blocks by north-south trending normal faults (Figure 37). The western block forms a prominent 300 meter high peak with a steep eastern escarpment. The eastern block has been down-drapped approximately 200 meters to form the gently sloping pediment. Fault breccia is exposed in the prospect pits and bulldozer scrapes over a distance of 1.5 km along the base of the escarpment.

Mineralization and Alteration

Mineralization is confined to the fault breccia zone at the base of the steep escarpment rising to the west. The mineralization is primarily limonite deposition and staining within the fractures and voids found in the fault zone. The limonite deposits produce a bright red orange soil which contrasts sharply with the surrounding buff soils, which can be traced for approximately 1.5 km in the north-south direction within the map area.

Mercury Soil Survey

Three moderate density sample lines were run, however, due to equipment failure only the results of line A-A' are available (Figures 38 and 39). This limited amount of data is inconclusive.

Heat Flow

Two gradient holes (Figures 40 and 41) display continous gradients with depth. A maximum bottom hole temperature of 18.1^{o}C was observed at a depth of 74 meters in drill hole number three. Drill holes number three and five had heat flows of 5.8 and 6.9 HFU's respectively. These two holes and several older mineral exploration holes were used to generate a heat flow map (Figure 42). The two heat flow highs are probably due to a convective hydrothermal system associated with the range front fault of the Toiyabe Range.

Summary

Moderately high heat flows observed in the shallow gradient holes should be verified with at least one deep (150m) gradient hole before additional assessment work is justified.

Figure 35. Rast Location Map

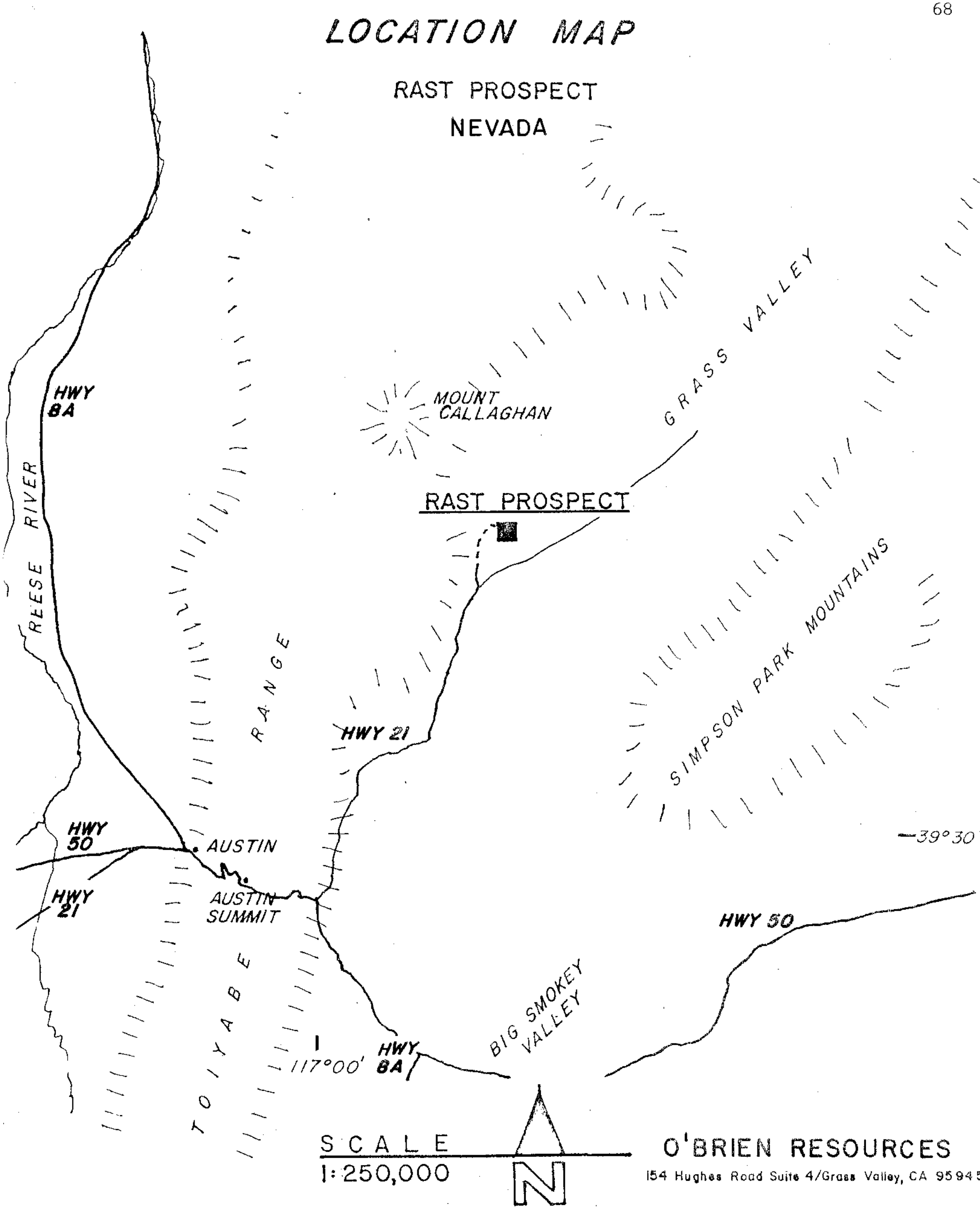
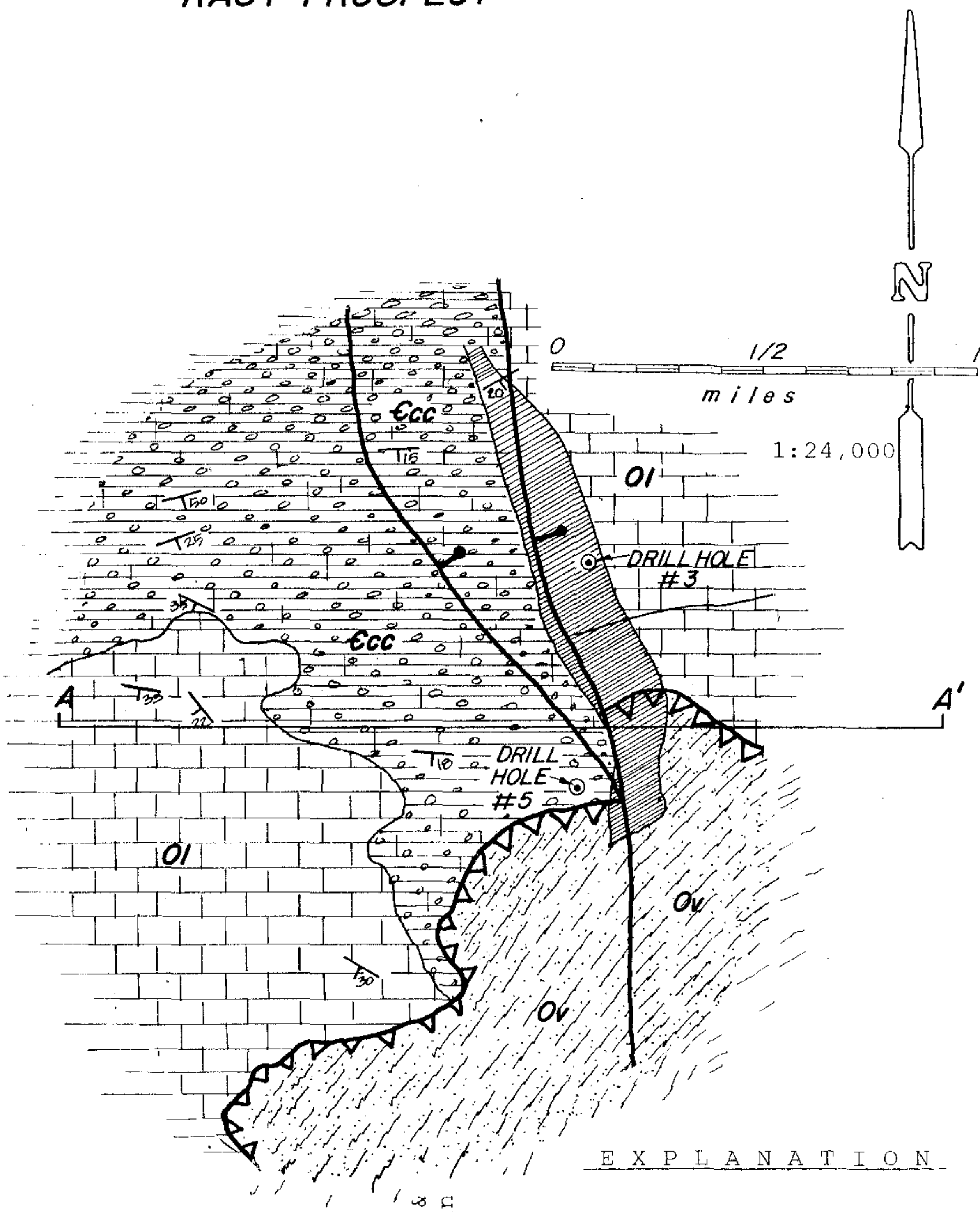


Figure 36. Rast Geologic Map

GEOLOGIC MAP
RAST PROSPECT



E X P L A N A T I O N

Normal fault
ball side down

Thrust fault,
teeth on upper plate

Strike and dip

Zone of argillic alteration
and limonite staining

Cambrian & Ordovician

Ov — Valmy Formation
quartzite and chert

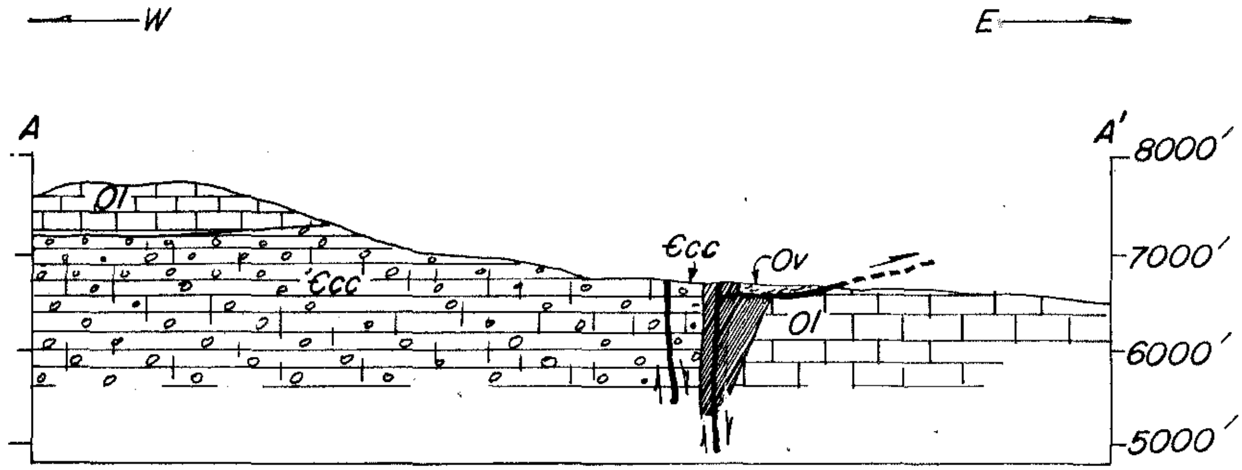
Ol — Antelope Valley Limeston
Massive cliff forming

Middle-Upper Cambrian

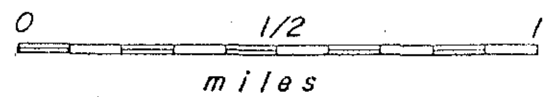
Єcc — Crane Canyon Formation
Laminated limestone and
chert

Figure 37. Rast Cross Section A-A'

CROSS SECTION-AA'
RAST PROSPECT



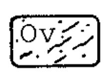
1:24,000



EXPLANATION

 Normal fault

 Zone of argillic alteration and limonite staining



Valmy Formation quartzite and chert

Antelope Valley Limestone Massive cliff forming

Crane Canyon Formation Laminated limestone and chert

Figure 38. Rast Mercury Sample Location Map

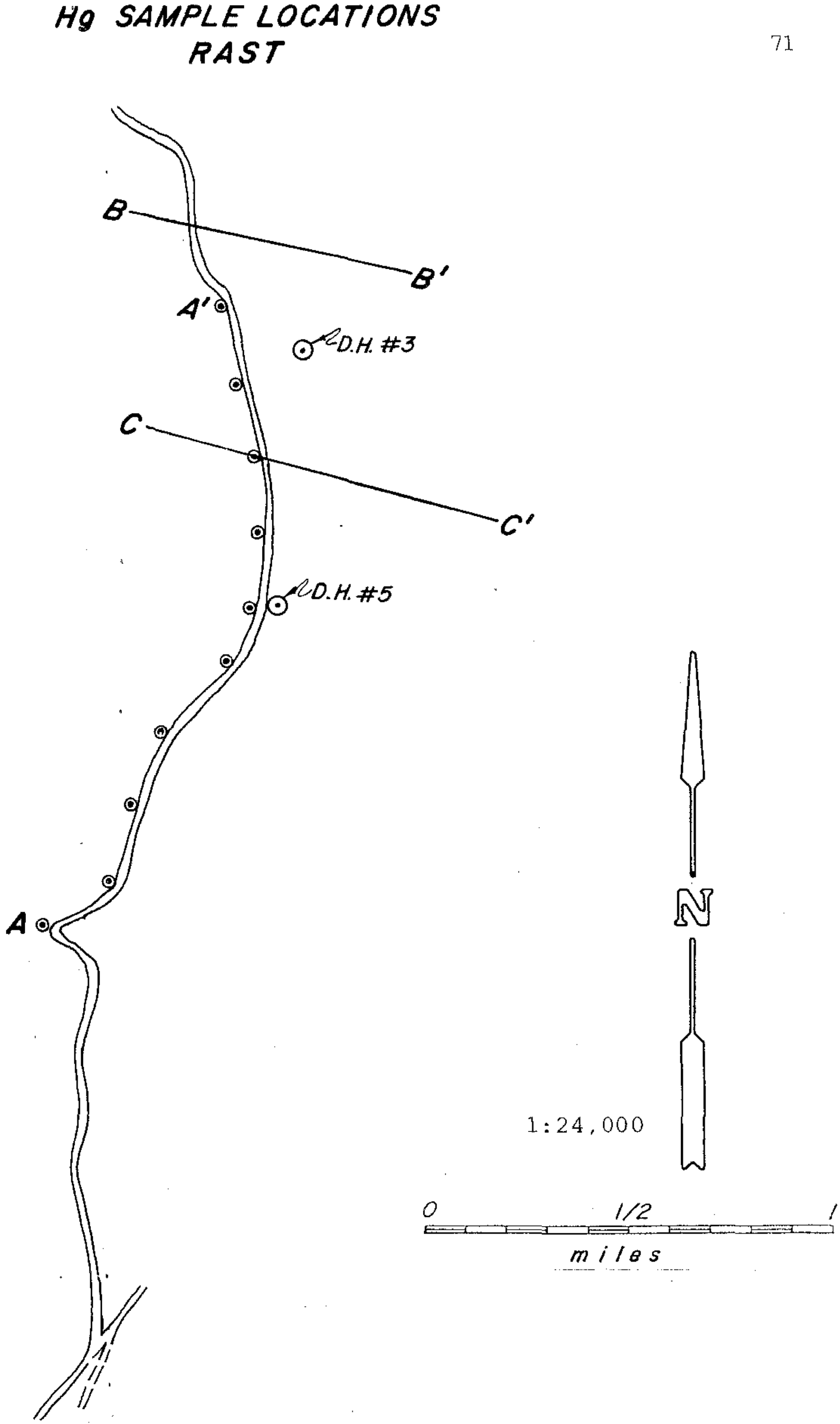


Figure 39. Rast Mercury Profile A-A'

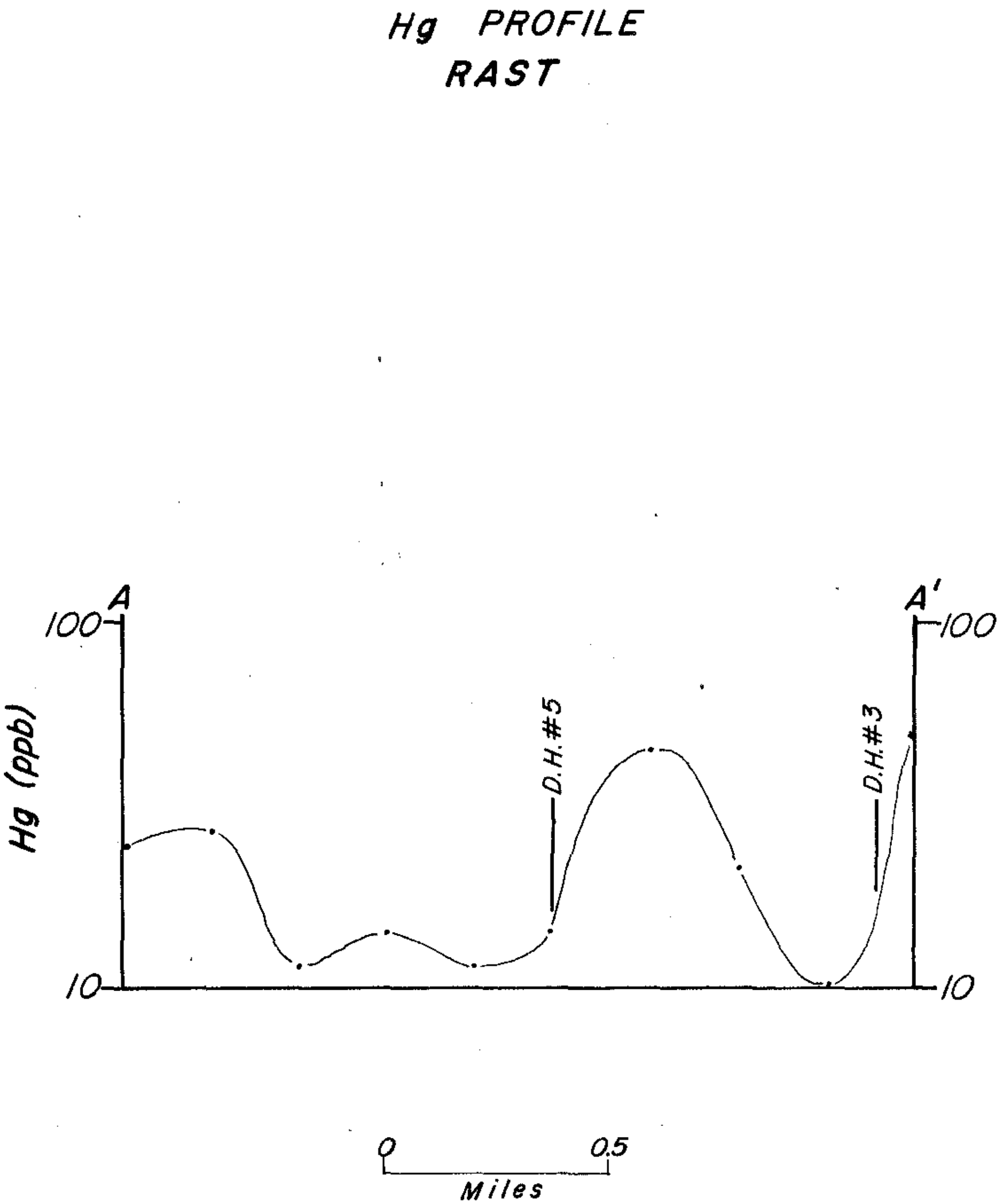
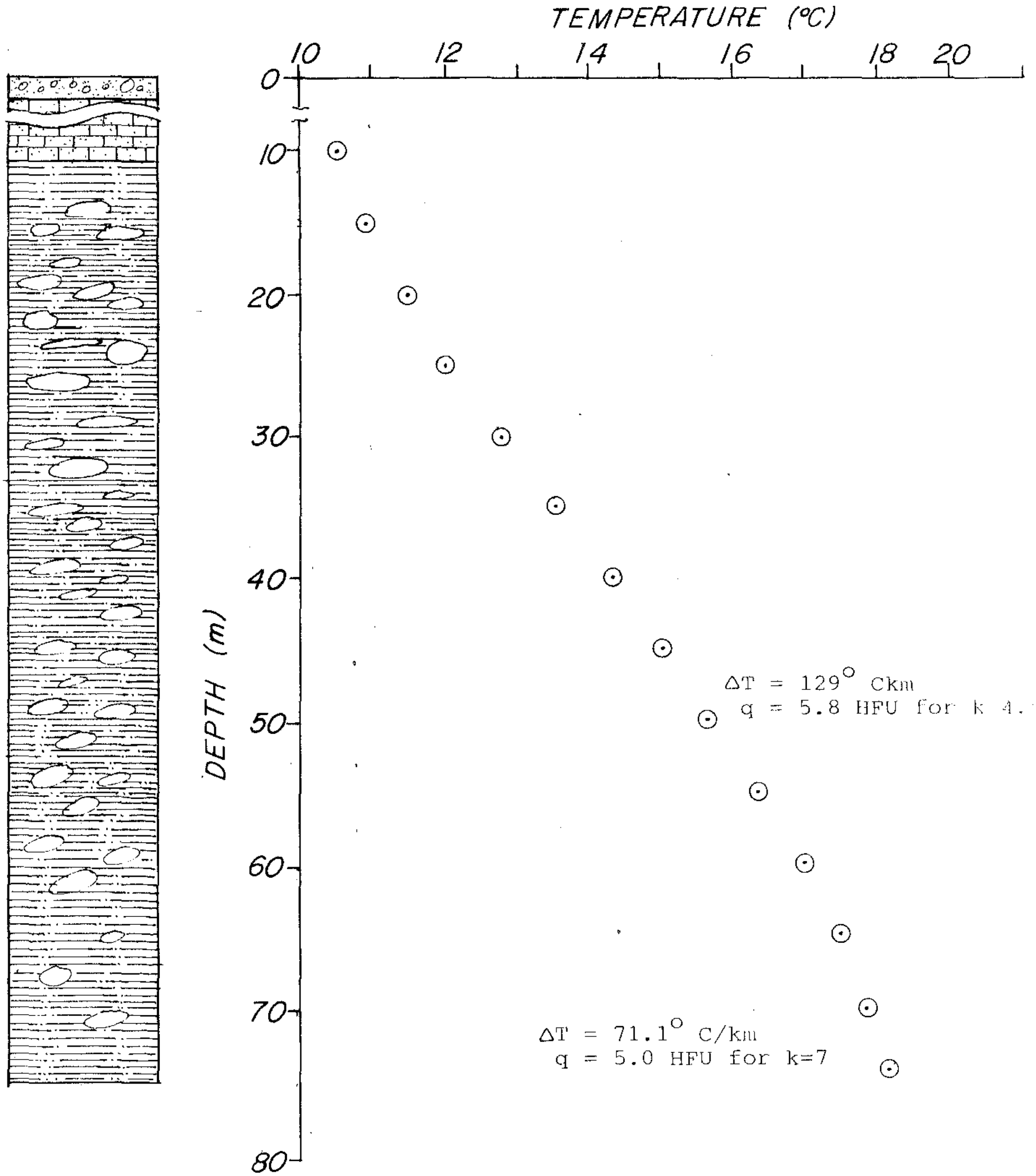


Figure 40. Rast Drill Hole No. 3, Temperature and Lithology Log

RAST # 3

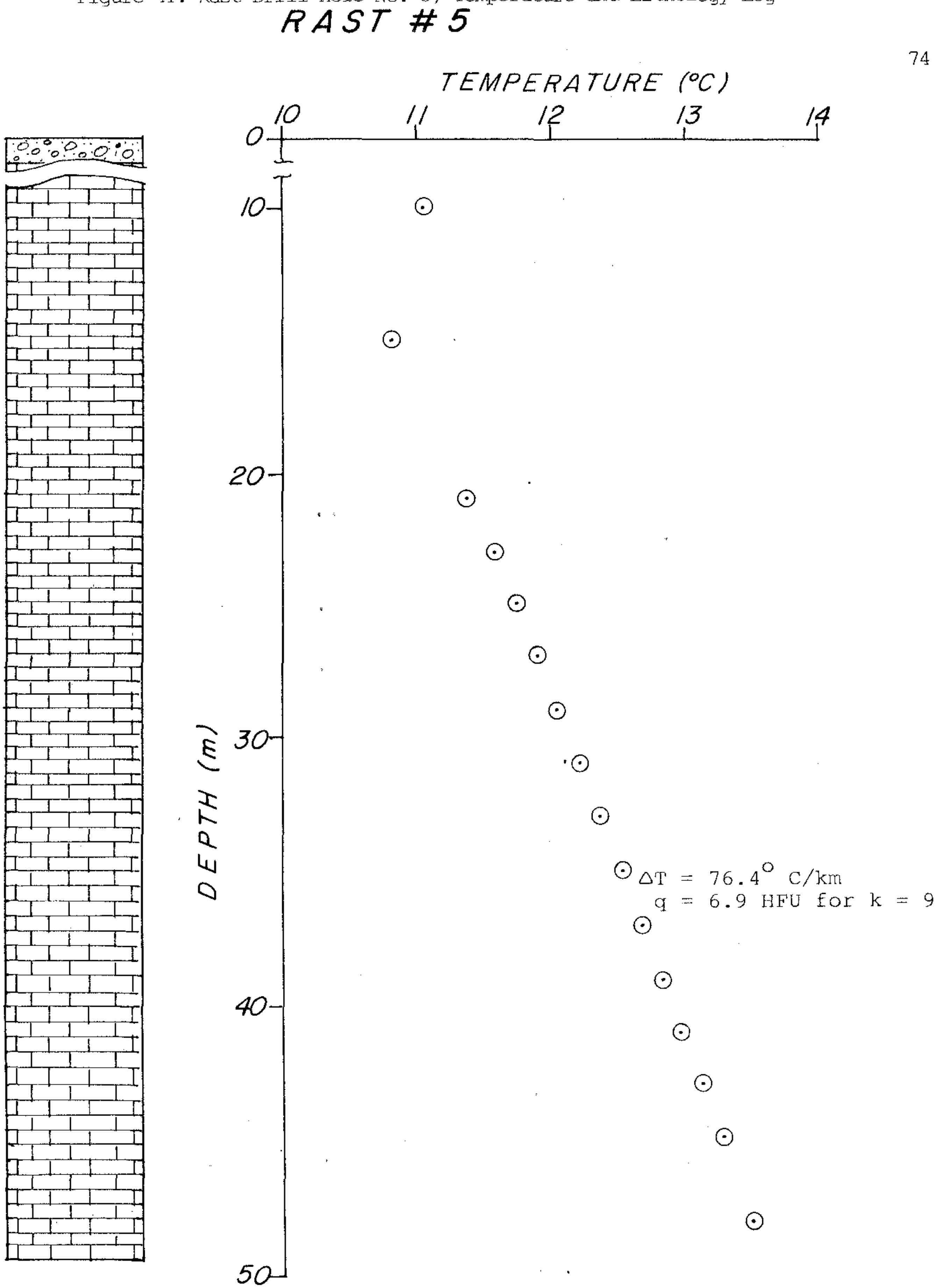


0-3 pebble alluvium

3-11 white-buff friable sandy limestone

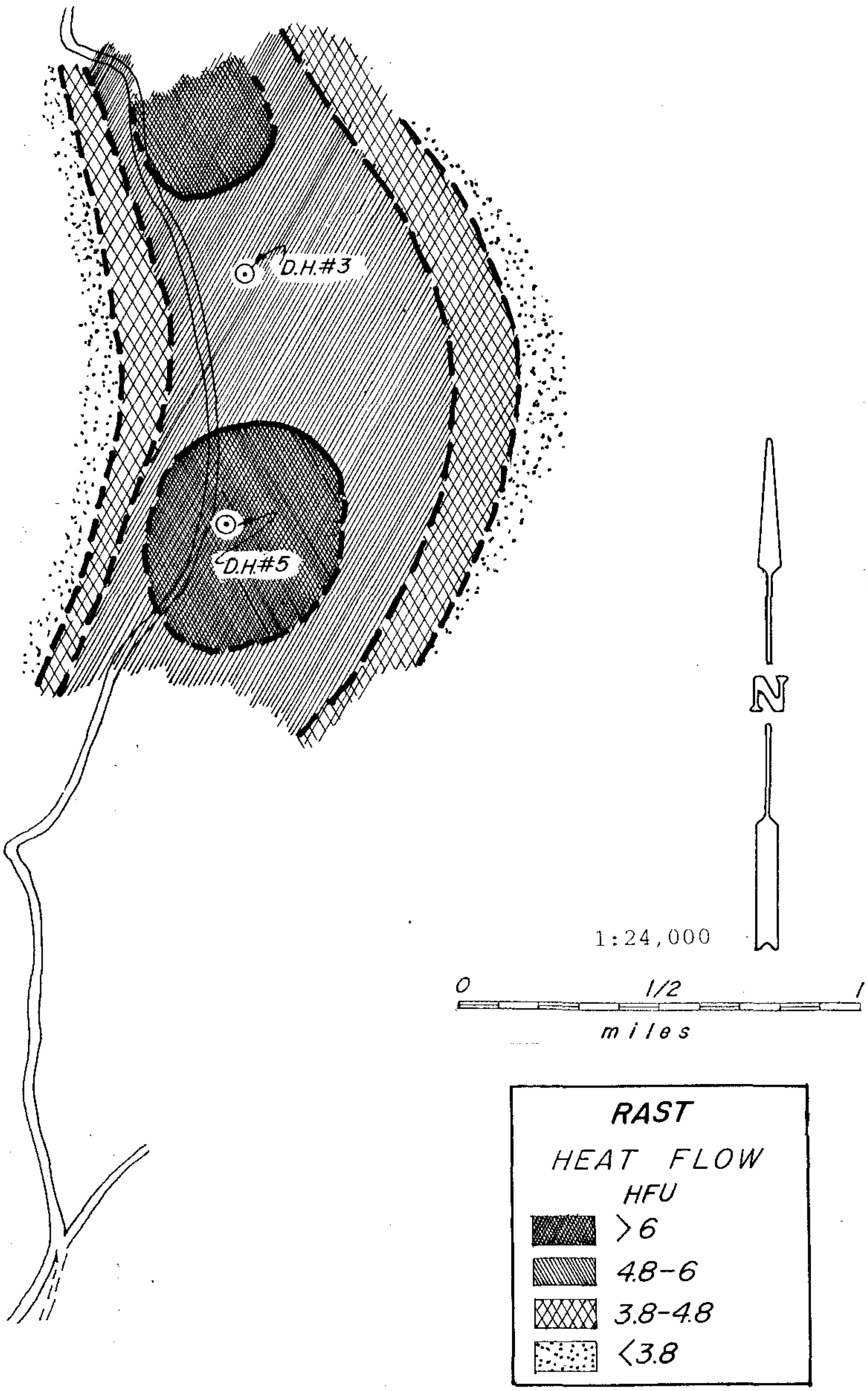
11-73 medium gray chert and hard siliceous siltstone; chert content decreases below 60 m

Figure 41. Rast Drill Hole No. 5, Temperature and Lithology Log



0-3 alluvium
3-49 dark gray, fine grained limestone

Figure 42. Rast Heat Flow Map



The Silver Cloud Prospect

Geology

Introduction

The Silver Cloud Prospect is located in T37N, R47E, southwestern Elko County, Nevada (Figure 43). The prospect is centered around the Silver Cloud Mercury Mine, which produced 866 flasks from a stratiform opalite deposit in tuff. The prospect lies at an elevation of 5400 feet in the volcanic highlands of the Sheep Creek Range. This prospect is reached via graded county roads from Battle Mountain.

The region is composed of elongated, parallel, north-trending ridges of moderate relief. The topography is interrupted by major alluvium-filled northeast-trending valleys which contain perennial streams, including Antelope, Willow and Rock Creek. The region has an arid climate but receives enough precipitation to support a thick growth of sage. While the area has no permanent habitation, it is extensively used for cattle grazing. A general geologic description of the area is found in Granger et al.(1957) and Stewart and Carlson (1976).

Regional Geology

The region consists of flat-lying rhyolitic, andesitic and basaltic flows of Middle to Upper Tertiary age. The uppermost flows are six m.y. old, while the oldest are 43 m.y. Tuffaceous sedimentary units with thicknesses ranging from tens to hundreds of feet are interbedded with the flow rocks. Upper Tertiary andesitic and basaltic flows predominate in the southern half of the Sheep Creek Range, while Middle Tertiary rhyolites dominate the northern half. Antelope Creek forms the boundary between the two rock types.

The volcanic sequence has been moderately uplifted along a northeast-trending system of normal faults forming the southeastern boundary of the Sheep Creek Range. Smaller displacement faulting also trending northeast in the interior of the range accounts for the dominant drainage patterns.

The total thickness of the Tertiary volcanic sequence may be as much as 1500 feet. The sequence overlies a Palezoic basement of siliceous marine sediments which is exposed only along the southeastern margin of the Sheep Creek Range.

Rock Units

Rock units in the map area consist of water-deposited tuffs overlain by air-fall tuff, obsidian and rhyolite flows (Figure 44). The lower tuff unit consists of glass shards and flakes which are poorly cemented and form a very low-density and friable rock. The rock exhibits bedding from 1 to 20cm thick and contains abundant current cross-bedding. The color varies from white to light tan. The bottom of the unit is not exposed in the map area, but drill cuttings indicate a thickness of at least 45 meters.

The water-deposited tuff is overlain by a massive air-fall tuff bed. The unit is poorly consolidated and contains abundant feldspar crystals which have been completely altered to clay. The groundmass is very fine-grained and exhibits a greenish-gray color. The unit has a maximum thickness of 40 meters.

The air-fall tuff is overlain by a perlitic obsidian flow. The obsidian is dark green and transparent in thin flakes and contains abundant sanidine phenocrysts which have been extensively altered to clay. The rock shows flow-banding and is moderately vesicular with opalite-chalcedony filling of vesicles. The unit is approximately 80-100 meters thick.

The uppermost unit in the map area is a light pink rhyolite with abundant 1-3mm sanidine phenocrysts. The rock shows flow-banding and is slightly vesicular. The top of the unit is not exposed in the map area, but minimum thickness is at least 70 meters.

Structure

Structure in the map area is dominated by a broad north-south trending anticline which plunges about 10° to the south and is about 1000 meters wide (Figure 45). The Silver Cloud Mercury Mine is located in the crest of the anticline. The anticline is truncated to the east by a north-northwest trending normal fault with approximately 25m of uplift to the east. This fault belongs to a series of parallel, small displacement faults which dissect the area. This set of faults is truncated in the south by the Antelope Creek fault, which trends northeast and has an uplift of approximately 30 meters to the south.

Mineralization and Alteration

Mineralization in the map area is characterized by massive and bedding-controlled replacement of host rock by chalcedony and opalite. The water-deposited tuff unit in the mine pit shows preferential opalite replacement in beds from 2 to 10cm thick with intervening layers of unaltered tuff from 10-50cm thick. The opalized layers are interconnected by opalized conduits which penetrate the unopalized beds at irregular intervals. The proportion of opalite versus unaltered tuff increases with depth until opalite is the prodominate mineral on the mine pit floor. Also, unopalized tuff layers become more bleached and argillic with depth, indicating an increasing intensity of hydrothermal alteration.

Overlying obsidian flows contain extensive chalcedony veining and vug filling. The flows also contain massive chalcedony replacement bodies measuring 200-300 meters long and several meters thick. These bodies are aligned to the north of the mine pit along the anticlinal axis.

The mineralization appears to be the result of large volume silica-rich hydrothermal fluid migration into the crest of the anticlinal fold. Lack of silica deposition in adjacent north-trending faults indicate that fluid movement ceased before the onset of faulting and is, therefore, probably Late Pliocene or Early Pleistocene in age.

Mercury Soil Survey

Four medium density sampline lines were run across the prospect (Figures 46 and 48). Line A-A' was run to determine background mercury levels. Anomalously high values at the southern end of line A-A' correspond with the Antelope creek flood plain and are most likely due to concentration of mercury by fluvial processes. Other concentrations of mercury correspond with areas of alteration.

Heat Flow

One 100 meter gradient hole was drilled. The results (Figure 49) indicate a mean heat flow of 3.0 HFU. The decrease in thermal gradient with depth from 189^{o}C/km to 72^{o}C/km is due to an increase in opalite content, which increases the mean conductivity of the rock.

Summary

The Late Pliocene age of mineralization and moderate heat flow suggests that the hydrothermal system associated with the prospect is currently inactive. Further assessment work is, therefore, not justifiable at this time.

Figure 43. Silver Cloud Location Map

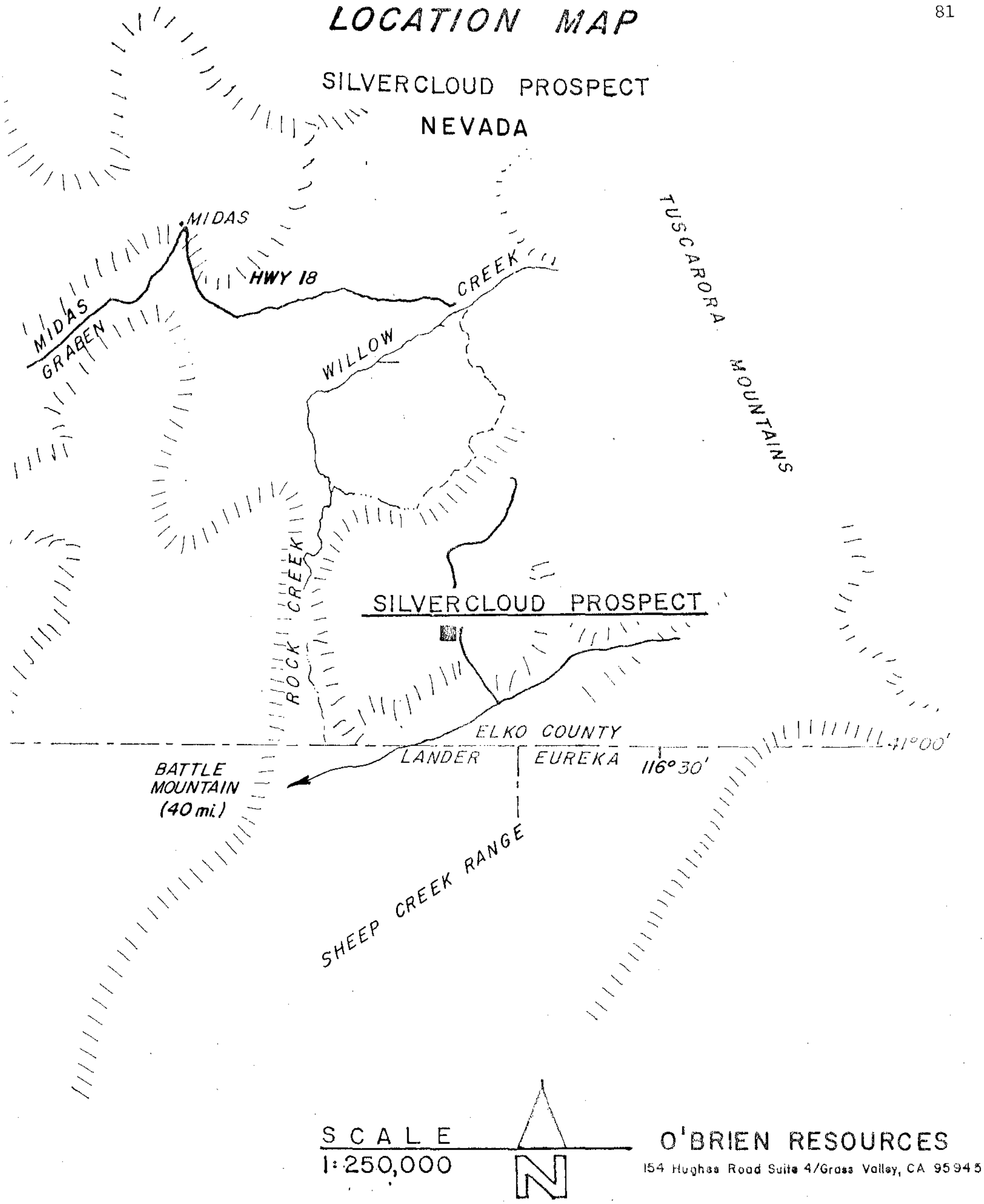
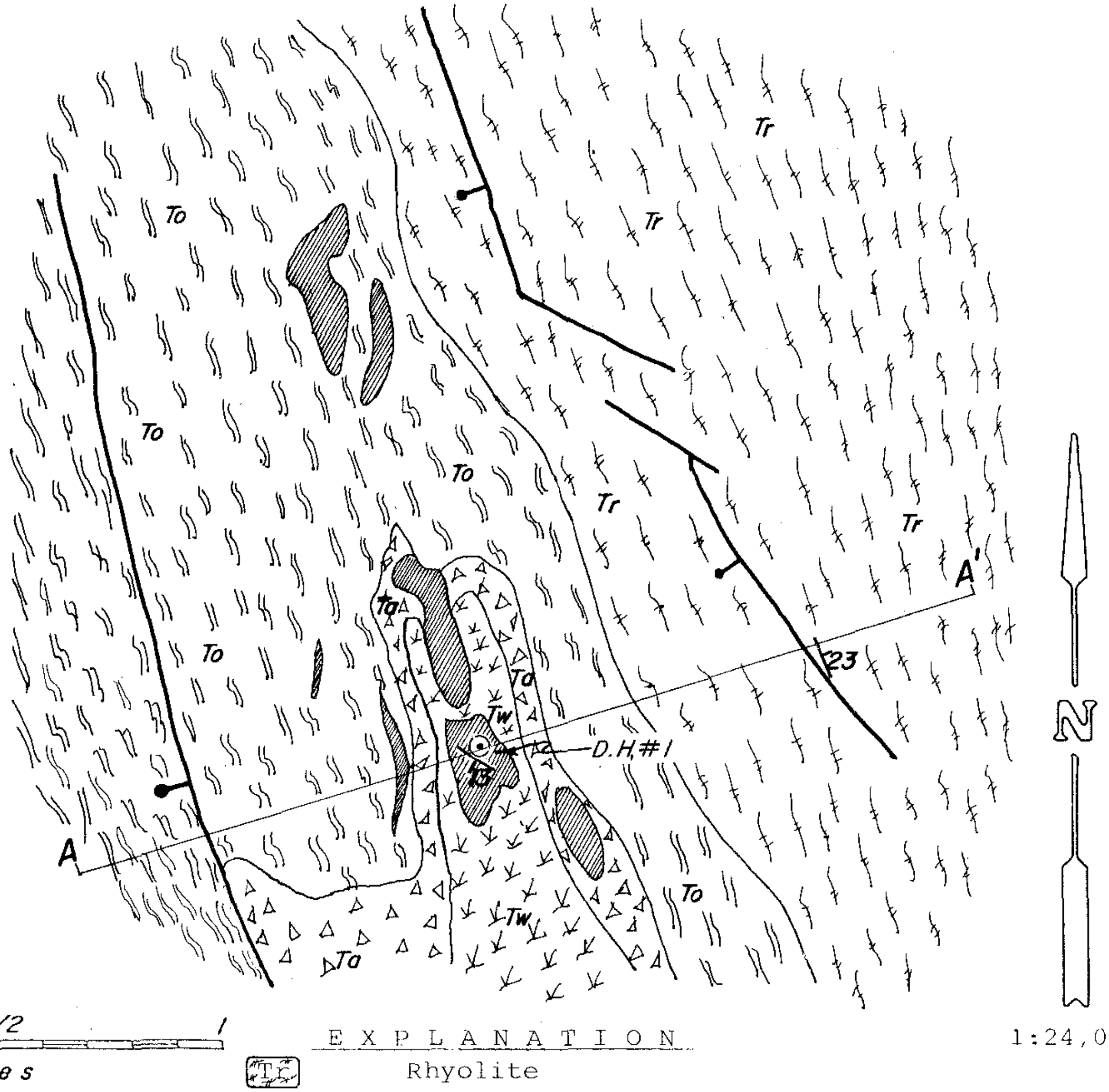


Figure 44. Silver Cloud Geologic Map

GEOLOGIC MAP
SILVER CLOUD PROSPECT

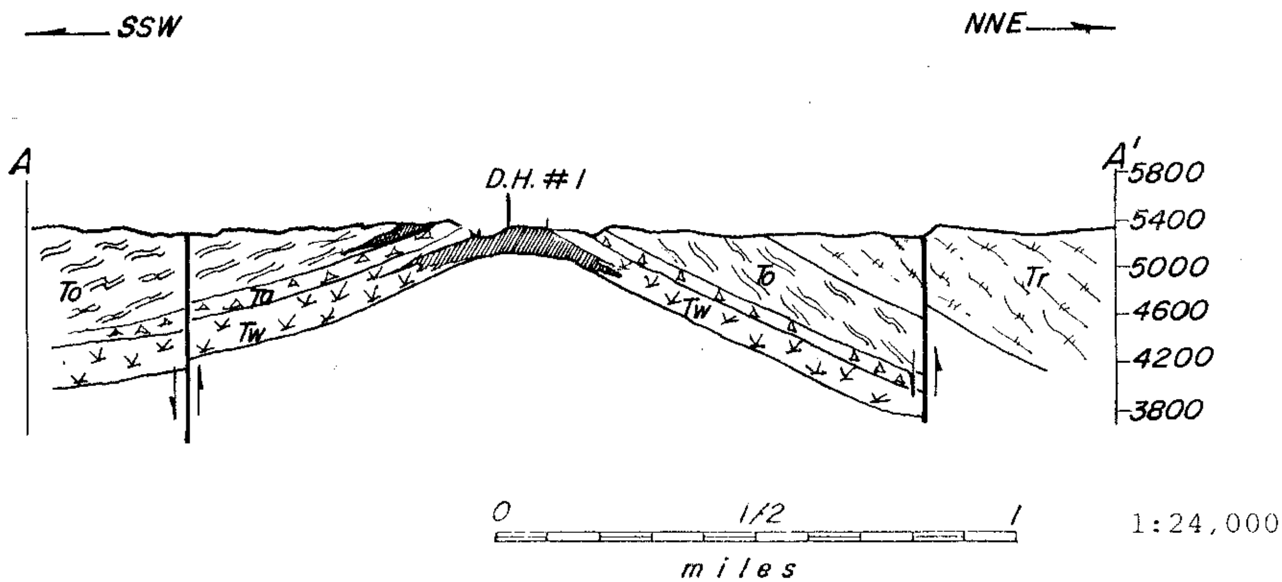


EXPLANATION

Tr	Rhyolite
To	Obsidian
Ta	Massive airfall tuff
Tw	Water deposited tuff
(hatched body)	Opalite and chalcedony replacement bodies
(fault symbol)	Normal fault, ball side down
60	Strike and dip

Figure 45. Silver Cloud Cross Section A-A'

CROSS SECTION AA'
SILVER CLOUD PROSPECT



E X P L A N A T I O N

- Tr — Rhyolite
- To — Obsidian, flow banded
- Ta — Massive airfall tuff
- Tw — Water deposited tuff
- Opalite and chalcedony replacement bodies
- Normal fault
- Contact

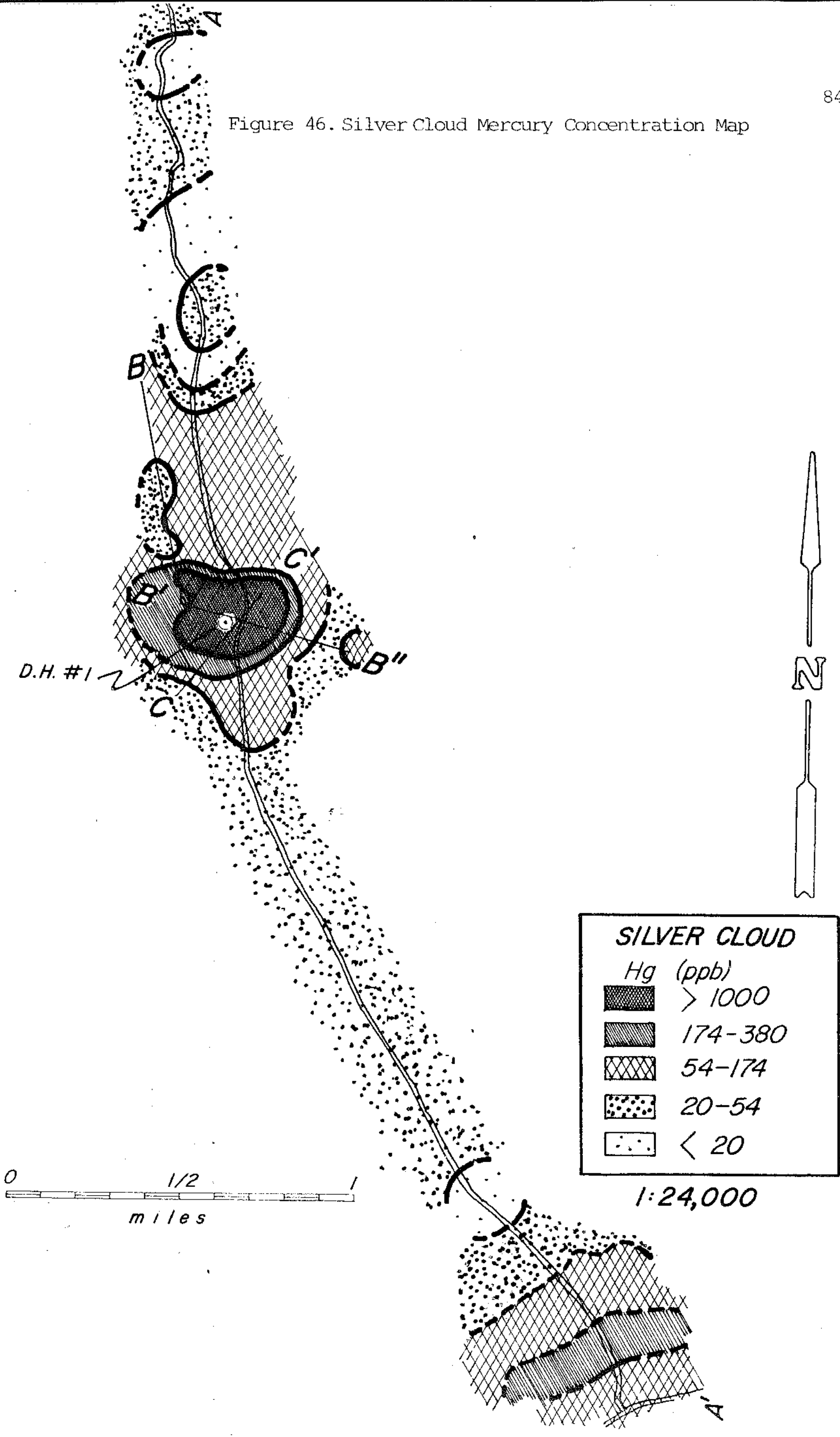
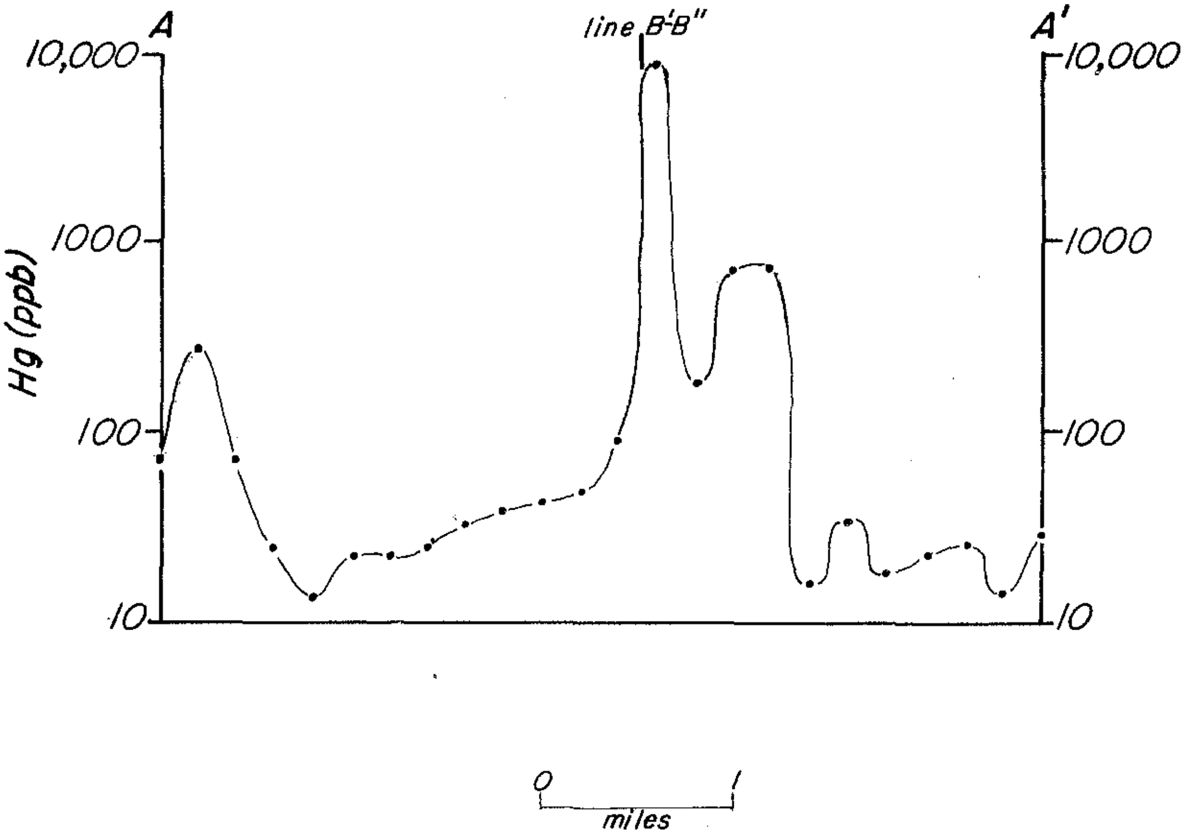


Figure 46. Silver Cloud Mercury Concentration Map

Figure 47. Silver Cloud Mercury Profile A-A', B-B'

Hg PROFILE

SILVER CLOUD



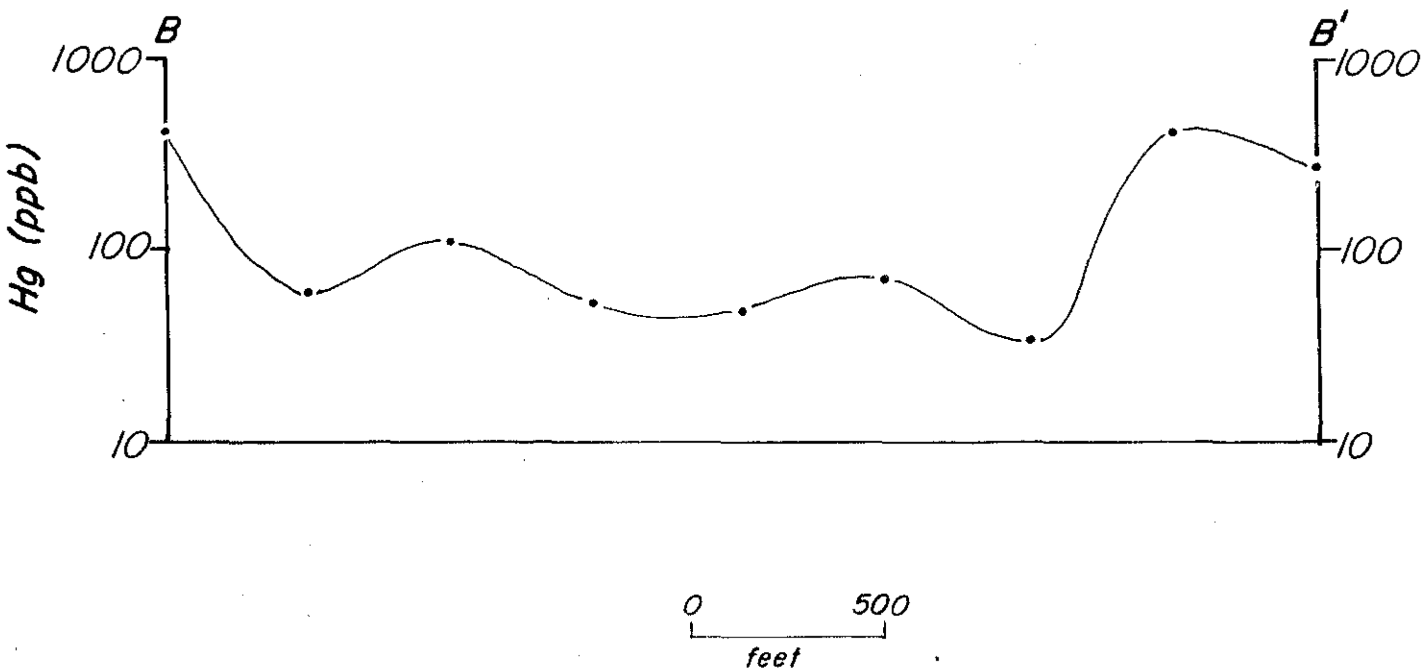


Figure 48. Silver Cloud B'-B", C-C'

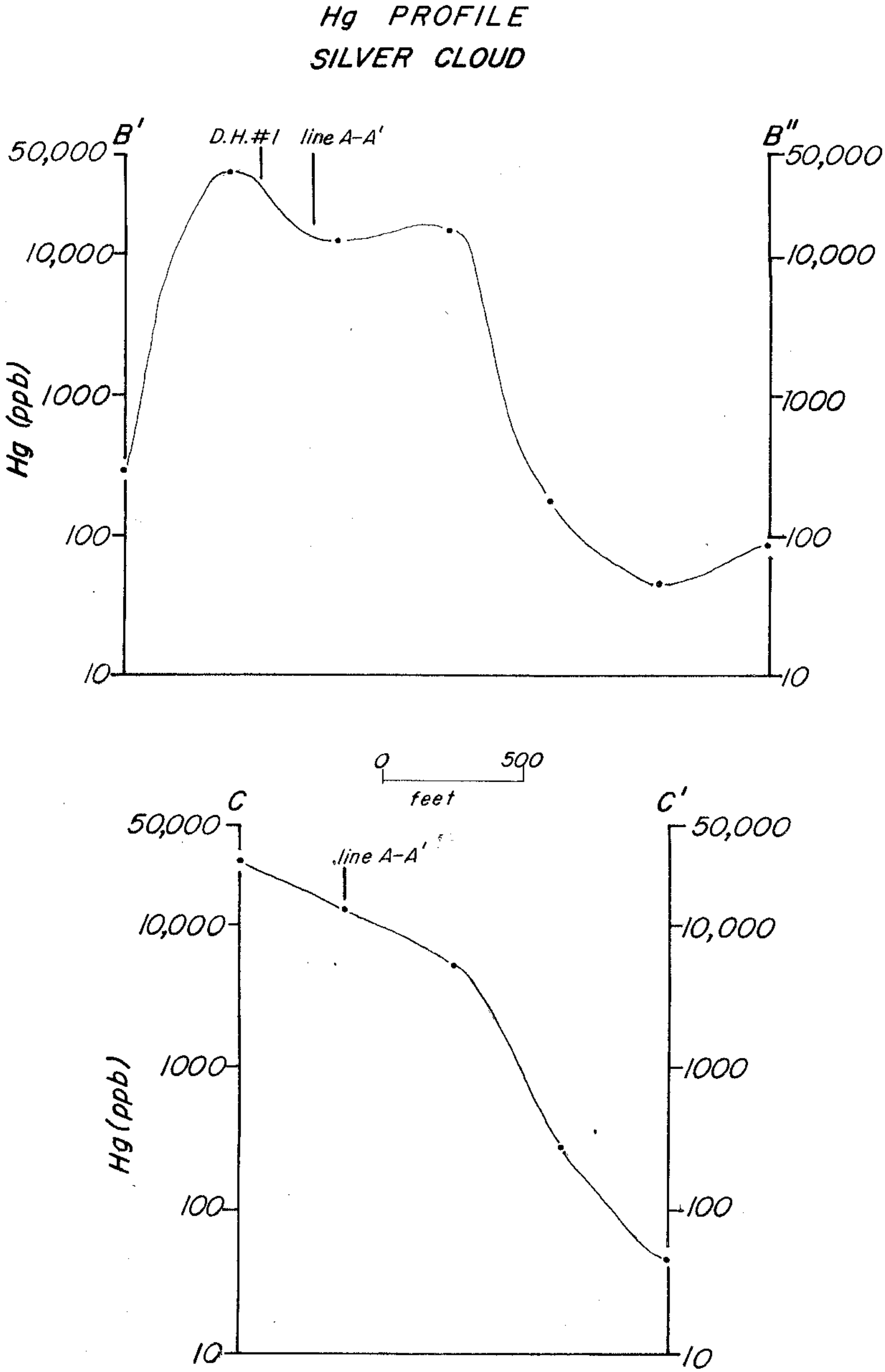
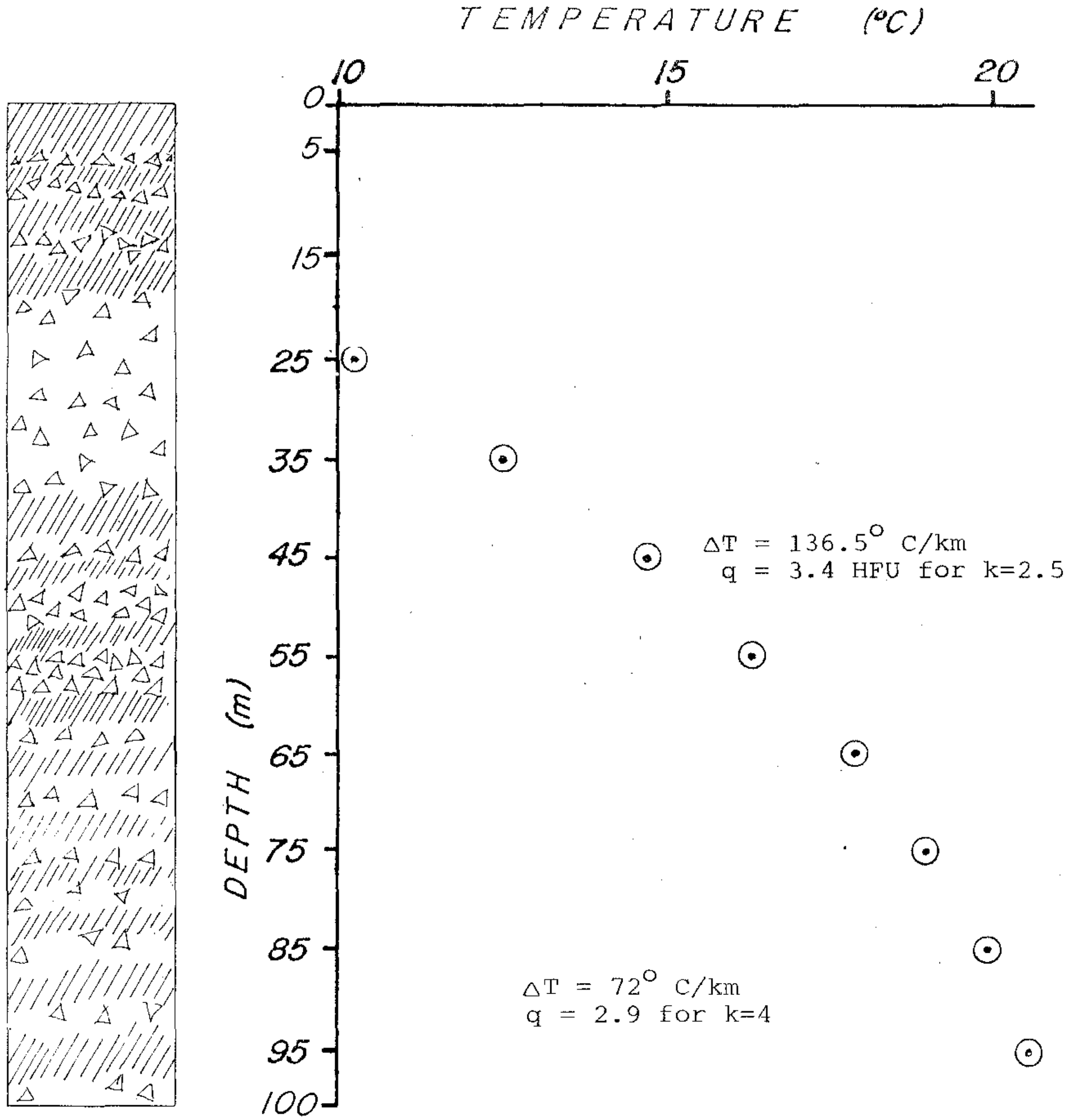


Figure 49. Silver Cloud Drill Hole No. 1, Temperature and Lithology Log

SILVER CLOUD, NEVADA



0-5 massive opalite
5-18 interlayered opalite and unconsolidated tuff
18-40 tuff
40-94 interlayered consolidated tuff and opalite with opalite content increasing with depth
94-98 airfall tuff

HORSEHEAD PROSPECT

Geology

Introduction

The Horsehead Prospect is located in T27S, R25E, western Harney County, Oregon. The prospect is reached from Highway 395, four miles south of Wagontire by traveling east on a graded county road for eight miles and then north on unmaintained dirt roads to the northern terminus of Horsehead Mountain (Figure 50).

The prospect is located in the high volcanic plateau region of Central Oregon at an elevation of 5000 feet. This region consists of low, elongated volcanic ridges separated by narrow, flat-bottomed washes. The flat topographic profile is interrupted by occasional silicic and basaltic eruptive centers which form 500 to 1000 foot high buttes throughout the region. The prospect is centered around a small mercury mine which consists of a bulldozed pit four meters wide and 50 meters long. A small retort is located on the site.

The arid climate supports a dense growth of sage. Pinyon pine and juniper are found only on elevated slopes of volcanic buttes and along stream beds where small amounts of precipitation are sufficiently concentrated. Shallow groundwater is confined to lower valleys and basins and is generally absent from the elevated plateaus. The region is exploited primarily for open cattle grazing. A major power line from Medford to Burns, which passes within six miles of the prospect, is currently being completed. The regional geology of the area is summarized by Walker (1977).

Regional Geology

Rocks in the region may be divided into two basic lithologies: silicic pyroclastic and flow rocks and basaltic flows. The silicic rocks are rhyolitic and rhyodacitic in composition and make up over 90 percent of the rock volume, while the remainder is primarily olivine basalt. The silicic rock appears primarily as large sheets of welded ash flows while rhyolitic flows and flow breccias are confined to elevated eruptive centers and their flanks.

Two major fault systems intersect in the Horsehead area. The northwest trending Brothers Fault Zone, which consists of a ten to thirty mile wide strip of parallel, small displacement normal faults, passes through the prospect and is terminated sixty miles to the southeast by the Alvord Desert Basin and Range structure. The north-northeast trending Albert Rim range front fault terminates in close proximity to the prospect within the Brothers Fault Zone. This fault has over 1000 feet of vertical displacement with the uplifted block to the east. This escarpment extends over sixty miles to the south of the prospect and forms the eastern margin of both the Goose Lake and Lake Albert basins.

Rock Units

Two distinct rock units are prevalent in the map area (Figure 51). The perimeter of the map area is dominated by welded tuff. The tuff consists of over 90 percent glass with occasional 1-2 mm quartz phenocrysts. The unit is slightly vesicular and exhibits flow banding. K-Ar dating give ages ranging from 6 to 9 m.y. (Walter, 1977).

The central part of the map area is occupied by a dissected rhyolite dome. The rhylolite consists of about 70 percent dark gray glass with abundant 1-2 mm euhedral quartz and sanidine phenocrysts. In the center of the dome the rhyolite has flow breccia texture. Similarity in composition between the pyrolastic and flow rock indicate contemporaneous formation.

Structure

The rhyolitic welded tuff flows appear to be nearly flat lying and undeformed (Figure 52). A single northwest trending high angle fault passes along the northeast flank of Horsehead Mountain. The down-dropped northeastern block has been vertically offset approximately 30-40 meters. The rhyolite dome was produced by a conduit which apparently pierced the tuff sheet near the present topographic high. The resultant dome and adjacent flows overlie the surrounding tuff.

Mineralization and Alteration

The only mineralization noted in the map area is a small opalite deposit found on the trace of the northwest trending fault on the northeast flank of Horsehead Mountain. The deposit is a few meters wide and extends approximately 100 meters along the fault. Massive white opalite containing cinnibar stringers and blebs outcrops at the northwestern end of the occurrence. The massive opalite grades into a highly argillized fault breccia in the host tuff. The argillic zone is extensively replaced with irregular patches and stringers of opalite.

Mercury Soil Survey

No mercury soil survey was conducted at the Horsehead Prospect.

Heat Flow

A single 55 meter gradient hole had an observed gradient of 44.5°C/km and a bottom hole temperature of 13°C at 55 meters which gives a heat flow of 3.1 HFU (Figure 43). The sharp increase in gradient at the bottom of the hole is most likely due to analytical error in the 45 meter depth measurement.

Summary

The low heat flow and bottom hole temperature observed at the Horsehead Prospect do not justify further assessment work.

Figure 50. Horsehead Location Map

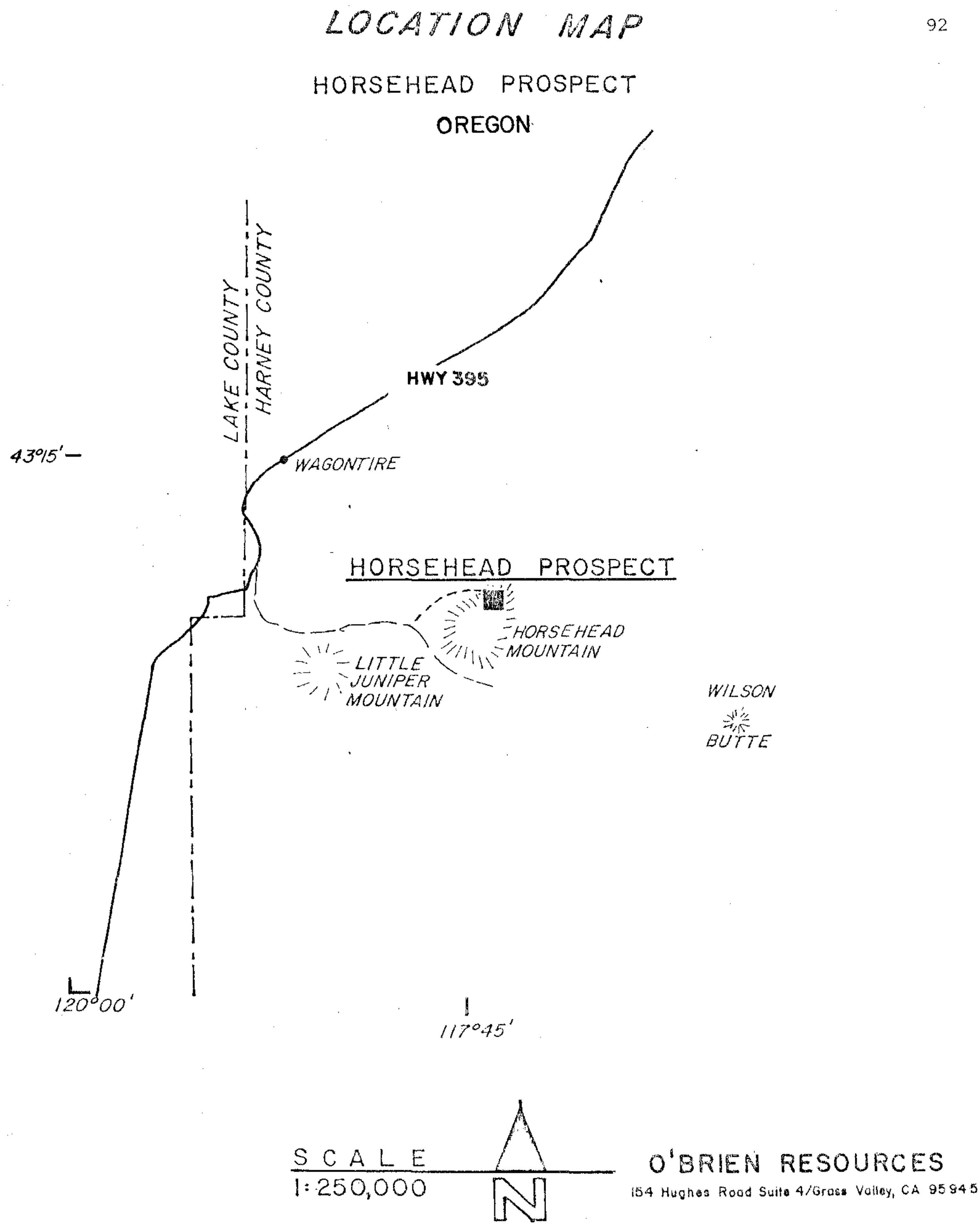


Figure 51. Horsehead Geologic Map

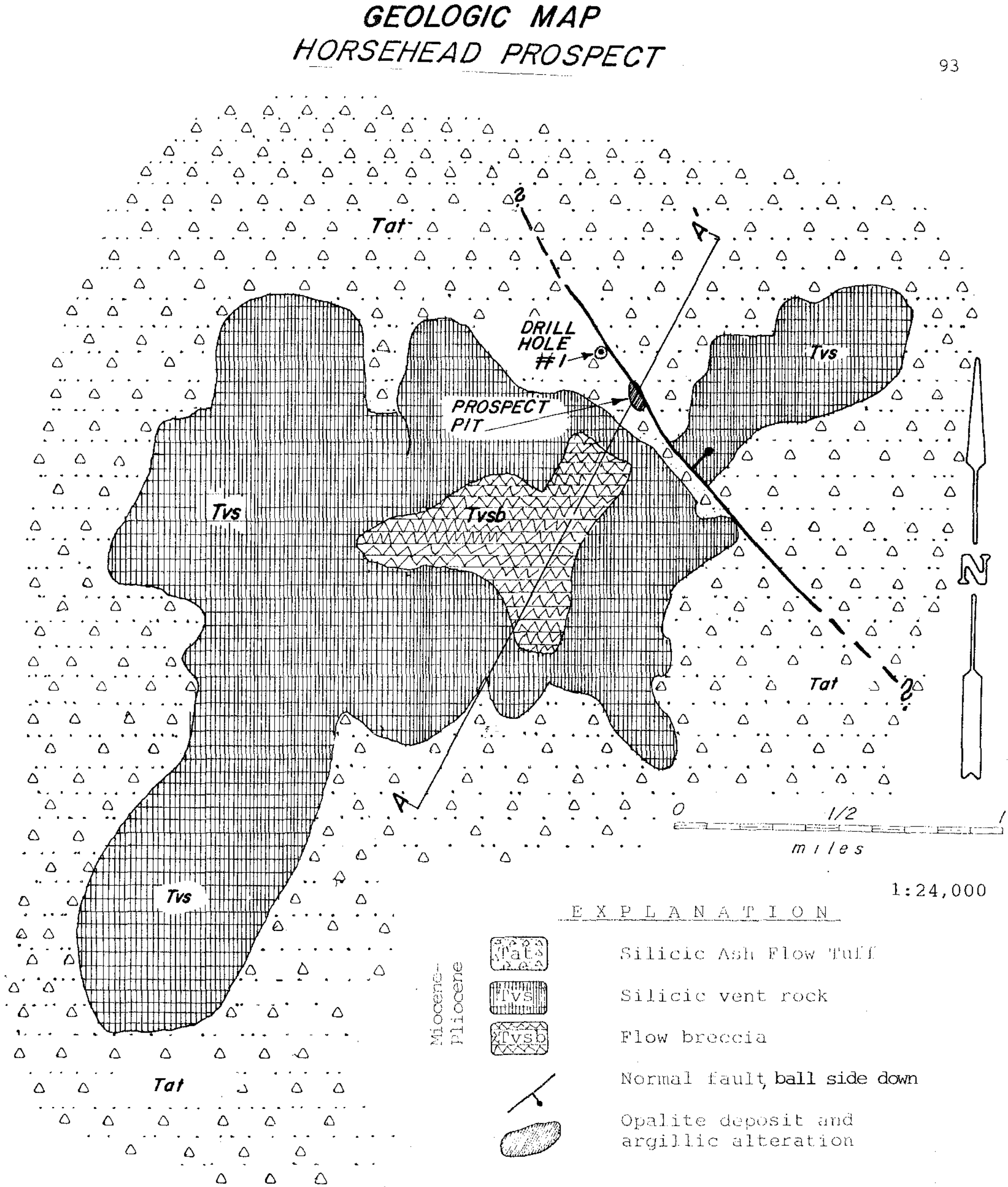


Figure 52. Horsehead Cross Section A-A'

CROSS-SECTION AA'
HORSEHEAD PROSPECT

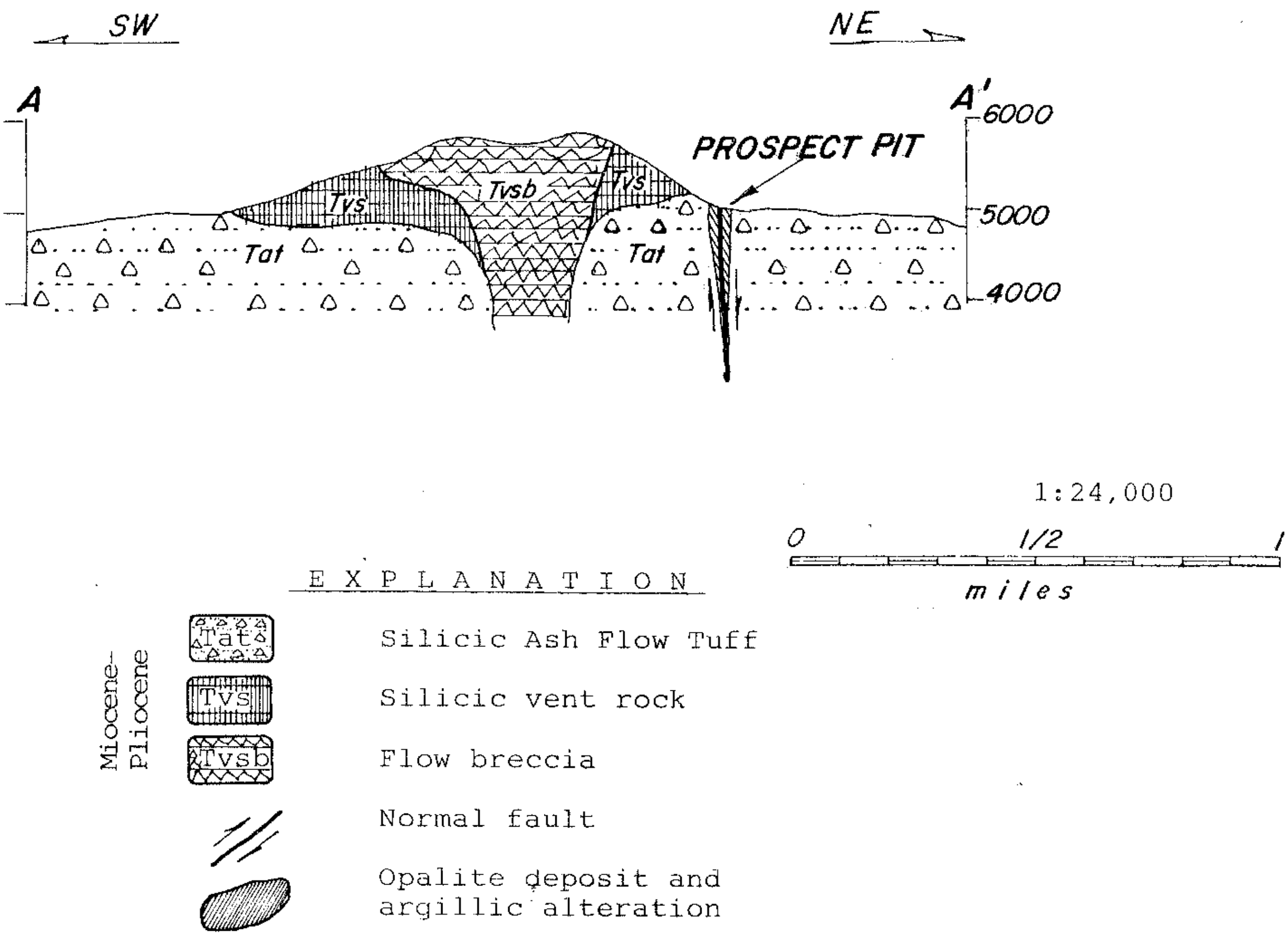
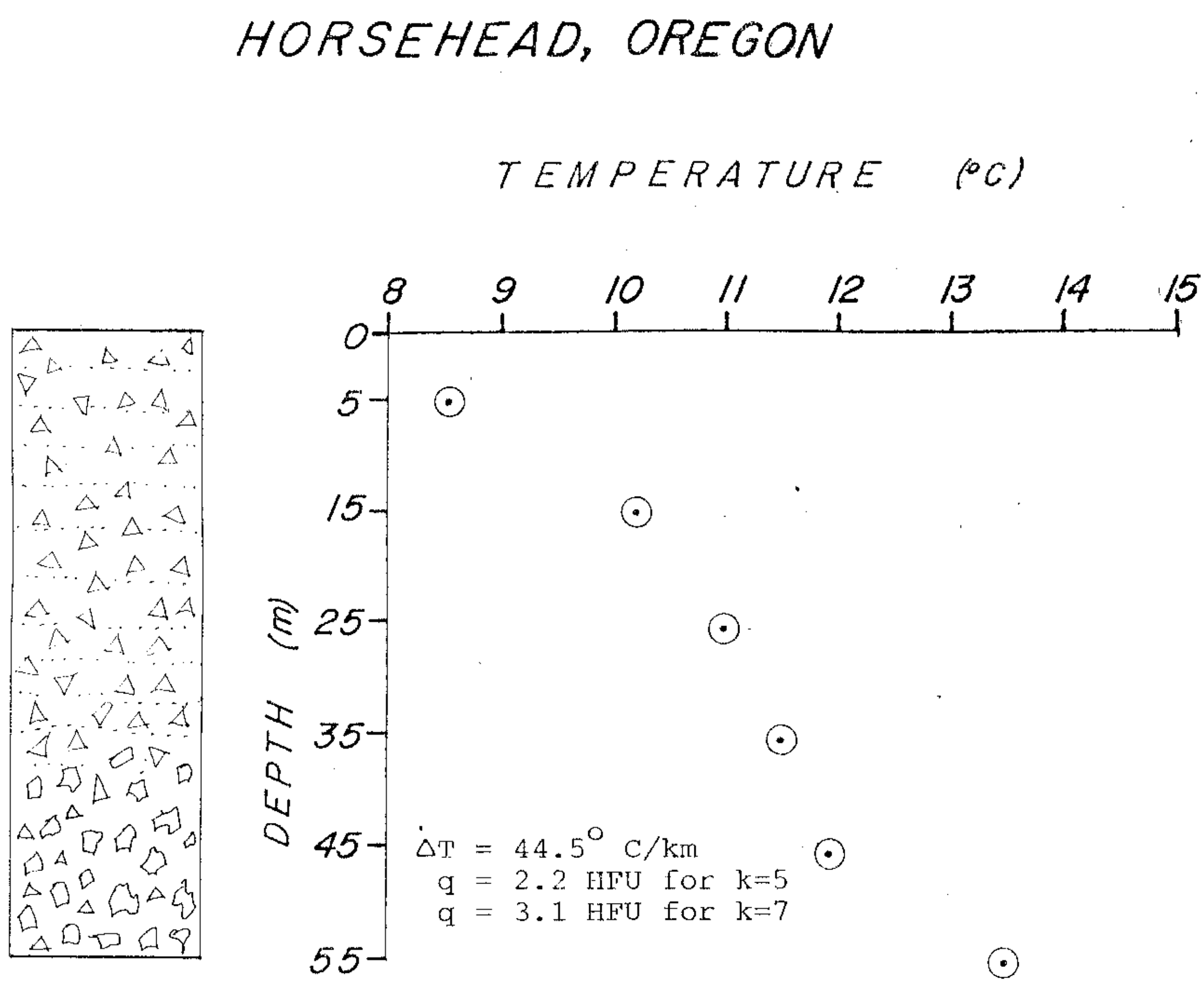


Figure 53. Horsehead Drill Hole No. 1, Temperature and Lithology Log



0-6 dark gray, glassy rhyolitic tuff
6-43 redish, slightly glassy, flow banded rhyolitic tuff
43-55 viscular welded tuff

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