

Geologic Report

Excelsior Property, Mineral County, Nevada

Introduction

The purpose of this study is to examine the geology of the Excelsior Property, Mineral County, Nevada, in order to better define and evaluate its geothermal characteristics.

The property consists of thirty-two sections of T5,6N;R30,31E and occupies the central portion of Whiskey Flat, approximately 12 miles south of Hawthorne, Nevada. Whiskey Flat is a NNE trending valley bounded on the west by the Wassuk Range and on the east by the Excelsior Mountains and Garfield Hills. The property is accessed by Highway 31 from Hawthorne and several dirt roads running both east-west and north-south from Highway 31.

The property has a maximum relief of 1200 feet, but primarily consists of gently sloping alluvial fans with slopes averaging 200 feet per mile. The property drains to the north into the Walker Lake Basin. Vegetation consists of a uniform covering of sage brush 1-3 feet high intermingled with sparse grasses. Juniper and Pinyon Pine forests cover the surrounding mountains.

The previous geologic work used as background for this study is Geology and Mineral Deposits of Mineral County, Nevada, Bulletin No. 58 of the Nevada Bureau of Mines and Geology by Donald C. Ross. Symbols and rock names for this study are taken from Bulletin No. 58, but rock descriptions are derived from field observations by the author.

This study is based on five days of geologic mapping by the author, June 3-7, 1980. Descriptions of lithologies are based on hand lense examination in the field. The base map used was a 2½X enlargement of the U.S.G.S. Powell Mtn. 15' quadrangle.

Geologic FormationsExcelsior Formation

The Triassic Excelsior Formation (Ross, p. 19) outcrops in the northwestern part of the map area along the eastern edge of the Wassuk Front. At this location it appears as a roof pendant, surrounded and intruded by Cretaceous quartz monzonite. The widespread metamorphism observed in the rock is probably due to its contact with the monzonite.

The Excelsior Formation consists of four rock types in the area of study: meta-basalt, andesite breccia, tuffs, and meta-limestones.

The meta-basalt is dark gray with a sugary fracture on fresh surfaces. It is primarily microcrystalline with occasional plagioclase laths of 1-2mm visible with a hand lense. The outcrops are shattered with sharp, angular fragments of 1-10cm. The unit exhibits minor epidote veining.

The meta-limestone is light gray to buff in color with a sugary microcrystalline texture. It contains abundant calcite veins and occasional epidote veins. Remnants of depositional laminations are visible in some outcrops. In part the unit shows a brecciated texture which has been obscured by the metamorphism.

The andesite breccia contains a light pink to gray aphanitic groundmass which produces a dull hackly fracture. It contains plagioclase phenocrysts 1-5mm in length which are entirely altered to clay. The breccia clasts have the same texture as the groundmass and are distinguished by their light green color in contrast to the pink background. In places the unit is entirely altered to clay, forming very incompetent, friable outcrops.

The tuff unit is white or stained orange and yellow by limonite veining. The white tuff is highly friable, whereas the stained tuffs are moderately well indurated and break into small angular fragments.

Cretaceous Granitic Rocks

This unit forms the major part of both the Wassuk and the Excelsior Ranges to the west and east of the map area. At the southern end of both ranges the unit is overlain by Tertiary and Quaternary volcanics.

The unit is a quartz biotite monzonite which displays a hypidiorphic medium to coarse grained texture. A porphyritic texture is also common with pink orthoclase phenocrysts 5-10mm in size. Near the range front faulting of the Wassuk Mountains the monzonite is highly fractured and incompetent, with occasional slickensides and mylonites in fractured zones. Large bodies of hydrothermal alteration appearing light orange-brown are distributed along the Wassuk Front. These zones with vertical and horizontal dimensions of tens to hundreds of meters are characterized by biotite alteration to limonite and plagioclase alteration to clay. They are surrounded by light gray unaltered monzonite.

Esmeralda Formation

The Esmeralda Formation is a continental clastic deposit of Miocene-Pliocene age (Ross, p. 46) consisting of conglomerate and talus-like accumulations of very poorly sorted angular clasts. The clasts represent a wide variety of lithologies including large blocks of quartzite (1-3m'), silicious meta-limestone and smaller angular fragments of felsic to mafic volcanic rocks. The unit is poorly indurated and forms rounded, debris-covered ridges. Copper and silver carbonate mineralization is reported in the outcrop found in Section 12, T6N, R30E at the northern end of the Property.

Tertiary Intermediate Volcanics

This volcanic flow unit borders the Property on its southern end, overlying the Cretaceous monzonite of the Excelsior Range. It consists of dark gray, non-vesicular microcrystalline andesite containing occasional

quartz phenocrysts to 2mm. The unit breaks into large blocks 1-2 meters in size and weathers dark reddish-brown with some desert varnish.

Quaternary-Tertiary Basic Volcanics - Tuffaceous Member

This unit outcrops along the eastern edge of the Wassuk Front and overlies the Cretaceous monzonite. The unit consists primarily of white to buff friable tuff which is in part water lain with cross-bedding and conglomerate lenses near its base. A medium gray, sandy tuff bed 1-10 meters thick appears near the center of the unit.

Basalt Member

The basaltic flow member overlays the tuff member on the western edge of Whiskey Flat, but on the eastern side appears to directly overlie the Cretaceous monzonite. This absence of the tuff unit in the Excelsior Mountains indicates that it pinches out under the alluvium of Whiskey Flat.

The basaltic flow unit is dark gray and contains plagioclase laths of 1-3mm in an aphanitic groundmass. Occasional olivine crystals up to 2mm in diameter are visible with a hand lense. The basalt texture varies from highly vesicular to non-vesicular though most outcrops show at least some vesicularity. The flows weather primarily to cobble-size angular scree that form smooth slopes along major fault scarps. Occasional beds, usually less vesicular, break into large coherent 1-2m' blocks, which weather to a dark reddish-brown color with a wind polished, desert varnish surface.

Quaternary Alluvium

The alluvium of Whiskey may be divided into three sub-units according to grain size distribution. The oldest unit is found at the mouth of Powell Canyon and consists almost entirely of boulder and cobble size clasts with very minor amounts of fine particles. The sub-unit is uplifted and dissected and has a surface slope of 5°.

The bulk of the alluvium of Whiskey Flat is made up of coalescing fanglomerates radiating from major canyons along the Wassuk and Excelsior Ranges. These fanglomerates are poorly sorted and contain from 40% to 80% sand and silt size particles. They form smooth slopes varying from 5° near the range fronts to 1° near the valley floor. In the northern end of the Property near Whiskey spring, recent faulting and uplift have resulted in dissection to a depth of 10-20m' on the otherwise smooth fans. Shallow dissection on the order of 2-3m' also occurs to the north of Whiskey Flat Windmill in the southern end of the Property. Lineaments in this same region which cross-cut the drainage are clearly visible when viewed from the east at an elevation of 1000 feet above the valley floor. They may represent fault scarps of recent faulting. Fault scarps due to earthquakes as recently as 1934 have been reported in this region (Ross, p.57). The scarps are difficult to discern in on-site inspection, but appear to be a shallow step in the alluvial fan slope approximately 1-1.5m' high and 15-20m' across. Other lineaments represented by brown streaks across the bluish-green sage cover on the fans to the north of Powell Canyon are also clearly seen from the ridges of the Excelsior Range. Close inspection shows that these brown lineaments are areas of dead and defoliated sage which may indicate a disruption of drainage and root systems due to recent faulting. These lineaments show no topographic expression.

The third and youngest alluvial sub-unit consists of flat-lying sand and silt and occupies the lowest part of the Whiskey Flat basin. It contains very few clasts of pebble size or larger and may be in part lacustrine or playa deposits.

Structure and Geothermal Activity

The structure of Whiskey Flat is dominated by the Wassuk Range Front fault system running roughly north-south along its western margin. Along the northern half of the Property the zone is characterized by a single, steep, east-dipping, normal fault with a vertical displacement of several thousand

feet. The southern half of the Property is bounded on the west by series of normal step faults, each with a displacement of several hundred feet. These step faults produce a benched topography along the range front and a series of offsets of the Quaternary volcanic/monzonite contact. Apparent fault scarps in the alluvium to the west of these benches indicate that the step fault system continues underneath the alluvium and probably dies out near the center of Whiskey Flat.


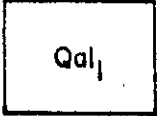


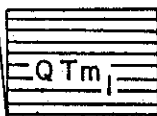

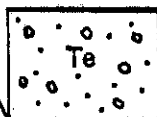
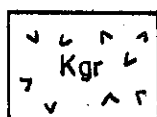
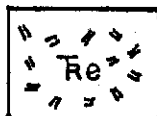
The Excelsior Range on the eastern boundary of Whiskey Flat has a moderate westward slope and shows no offsets of the Tertiary volcanic/monzonite contact. This indicates that the range is tilted toward the west with little or no faulting east of the center of Whiskey Flat.

The only geothermal activity in the Whiskey Flat region is evidenced by the $240^{\circ}\text{C}/\text{km}$ temperature gradient and high bottom hole temperature (42°C) found in the Whiskey Flat BLM Windmill, Section 19 of T5N,R31E near the southern end of the Property. Three irrigation wells with depths of approximately 120m' produce water at $12\text{--}13^{\circ}\text{C}$. The ground water level at these wells is approximately 20m' below the surface. The ground water depth decreases to the north where it surfaces at Whiskey Springs. This may be due to a damming effect produced by faulted Tertiary volcanics at the northern terminus of Whiskey Flat. This cool aquifer may mask geothermal activity below the 120m' level in the northern end of the Property. The thermal anomaly of the Whiskey Flat Windmill may be explained by upward circulation of thermal waters along the stepped Wassuk Range Front fault system, which apparently extends eastward under the alluvium to the vicinity of the windmill.

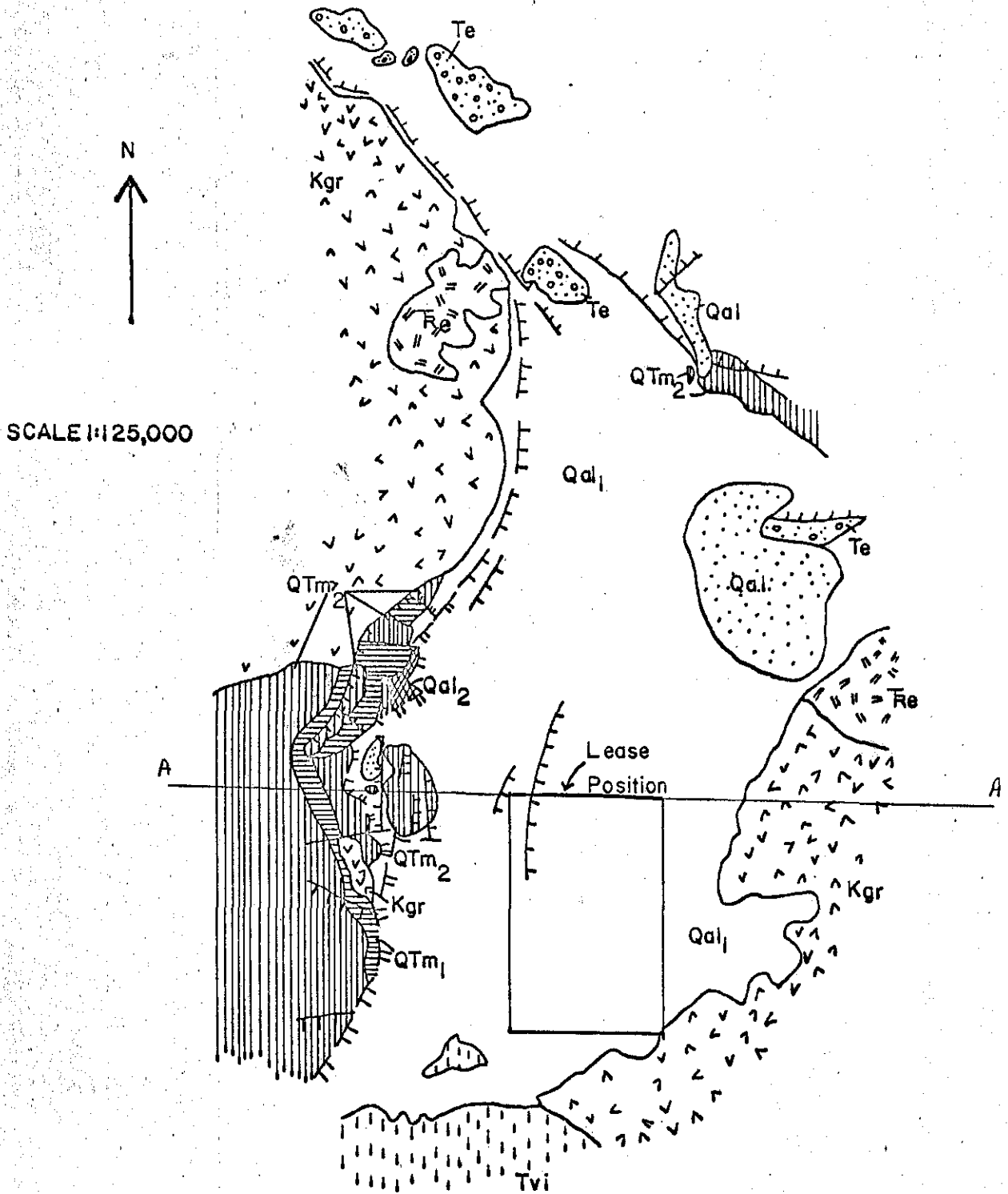
References

Ross, Donald C., Geology and Mineral Deposits of Mineral County, Nevada, Bulletin 58, Nevada Bureau of Mines and Geology, Mackay School of Mines, 1978.

Legend for geologic map of the Excelsior property
and surrounding area, Mineral County, Nevada

Quaternary		Flat lying silt and sand covering lowest elevations of Whiskey Flat. Light buff color; poorly consolidated.
		Fanglomerate forming coalescing alluvial fans from base of Wassuk and Excelsior Ranges to the center of Whiskey Flat.
		Very coarse fanglomerate, uplifted and dissected at the mouth of Powell Canyon.
		Dark gray aphanitic basalt, in part vesicular. Coarse volcanic breccia at base of unit.
		White to buff poorly consolidated tuff, in part water lain with conglomerate lenses near base of unit.
Tertiary		Fine grained medium gray andesite.
		<u>Esmeralda Formation</u> Talus and fanglomerate; clasts poorly sorted and angular. Contains felsic to basic volcanic, meta-limestone, quartzite and granitic clasts.
Cretaceous		Hypidiomorphic medium to coarse grained quartz biotite menzonite, in part porphyritic with pink orthoclase phenocrysts.
Triassic		<u>Excelsior Formation</u> Meta-basalts, meta-limestones, tuffs.

Geologic Map of the Excelsior Property
and Surrounding Area, Mineral County, Nevada



EXCELSIOR PROJECT
MINERAL COUNTY, NEVADA

LOCATION AND ACCESS: The project site is located in west-central Nevada, approximately 15 miles south of Hawthorne. The site is reached from Hawthorne by State Highway 31.

LEASE POSITION: T5N, R31E, Sections 17, 18, 19, 20,
29 and 30

GEOHERMAL AND GEOLOGIC DESCRIPTION: Heat flows of up to 6.7 HFU, with thermal gradients of up to 224°C/km, have been measured on the site. This very high heat flow, along with the proximity of the project site to the very large displacement Wassuk Range Front Fault, indicate an active, fault-controlled hydrothermal system at shallow depth.

ENERGY MARKETING POTENTIAL: The project site is within 100 miles of Nevada's major metropolitan center of Reno-Sparks. The site is in close proximity to the U. S. Ordnance manufacturing facility at Hawthorne.

APPENDIX H. EXCELSIOR

PROJECT: Excelsior, Nevada. *Walker Lake*

LOCATION: The property is located south of Hawthorne in south central Nevada near the Nevada-California border. It is centered on $118^{\circ} 32'$ WLong., $38^{\circ} 17'$ NLat. (T5N, R31E) in the Basin and Range Province.

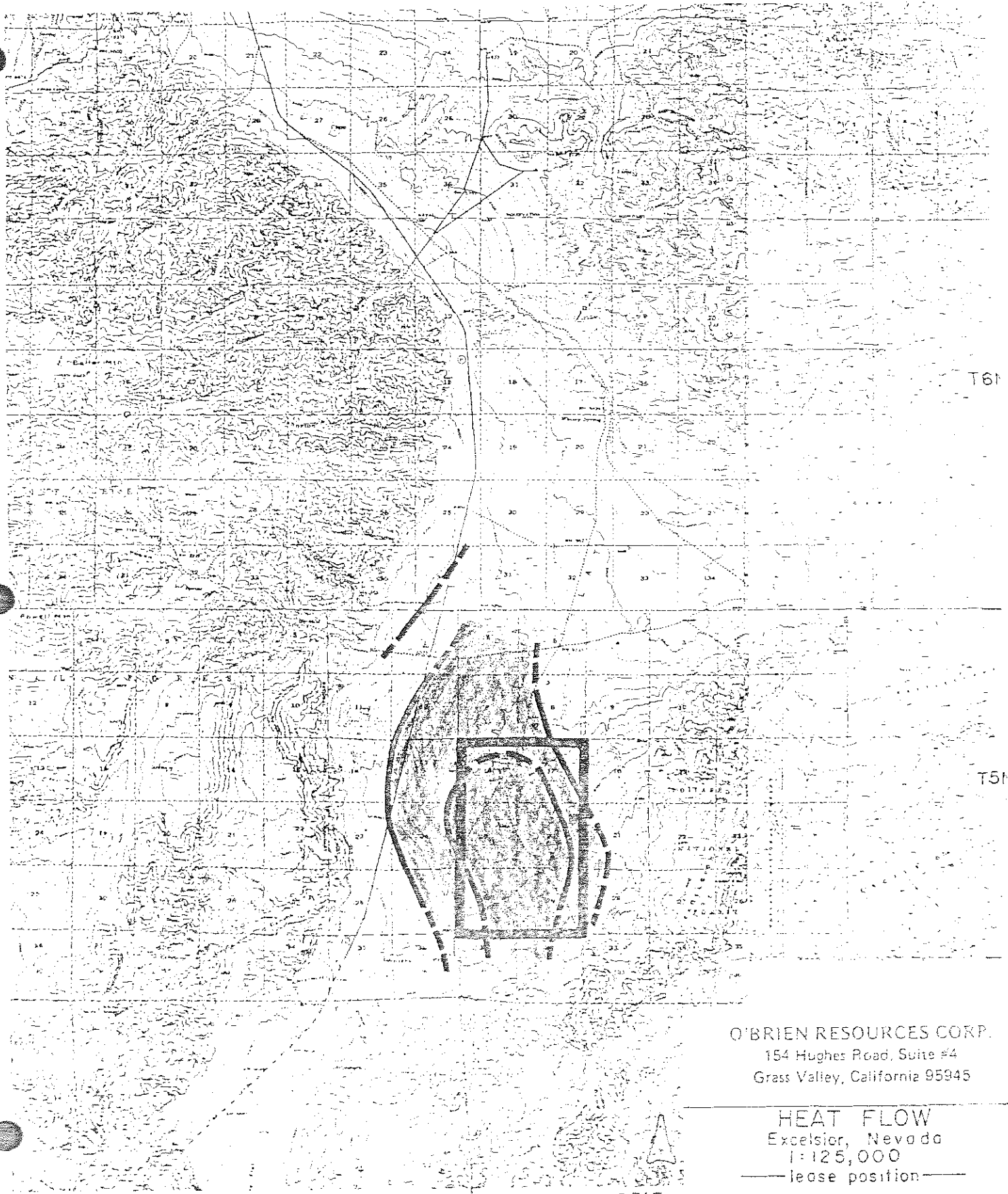
LEASE POSITION: T5N, R31E Sections 17, 18, 19, 20, 29 and 30

AVAILABLE DATA: Figure H-1: The lease position is based on two heat flow values of 5.9 and 6.7 HFUs.

GENERALIZED GEOLOGY: Figures H-2 and H-3: The area is dominated by the Wassuk Range west of the lease position. Quaternary-Tertiary basalts predominate in this portion of the range. The location of the anomaly paralleling the Wassuk fault system suggests that upward migration of hydrothermal fluids along fault zones under artesian pressure is the source of the anomaly. Lateral convective mixing of these fluids with the shallow phreatic ground water regime and conduction are responsible for the lateral definition of the anomaly. The longitudinal extent of the anomaly is partially governed by these effects. However, displacement of rock units, particularly aquifers, has disrupted the ground water flow regime, resulting in a pinching out of the anomaly to the north and south.





ASSESSMENT WORK COMPLETED: In June 1980 seven 50m thermal gradient holes were drilled and logged. These holes were relogged in August. Figure H-1 depicts this current data. A water sample has been taken from Whiskey Spring to the north but remains to be analyzed. Detailed geologic mapping of the lease position and the surrounding area was completed by Bill Teplov in June 1980 (Figures H-2 and H-3).

PROPOSED ASSESSMENT WORK: A mercury survey should be conducted as the final step for preliminary assessment. Large scale aerial photography should be obtained.



O'BRIEN RESOURCES CORP.
 154 Hughes Road, Suite #4
 Grass Valley, California 95945

HEAT FLOW
 Excelsior, Nevada
 1:125,000

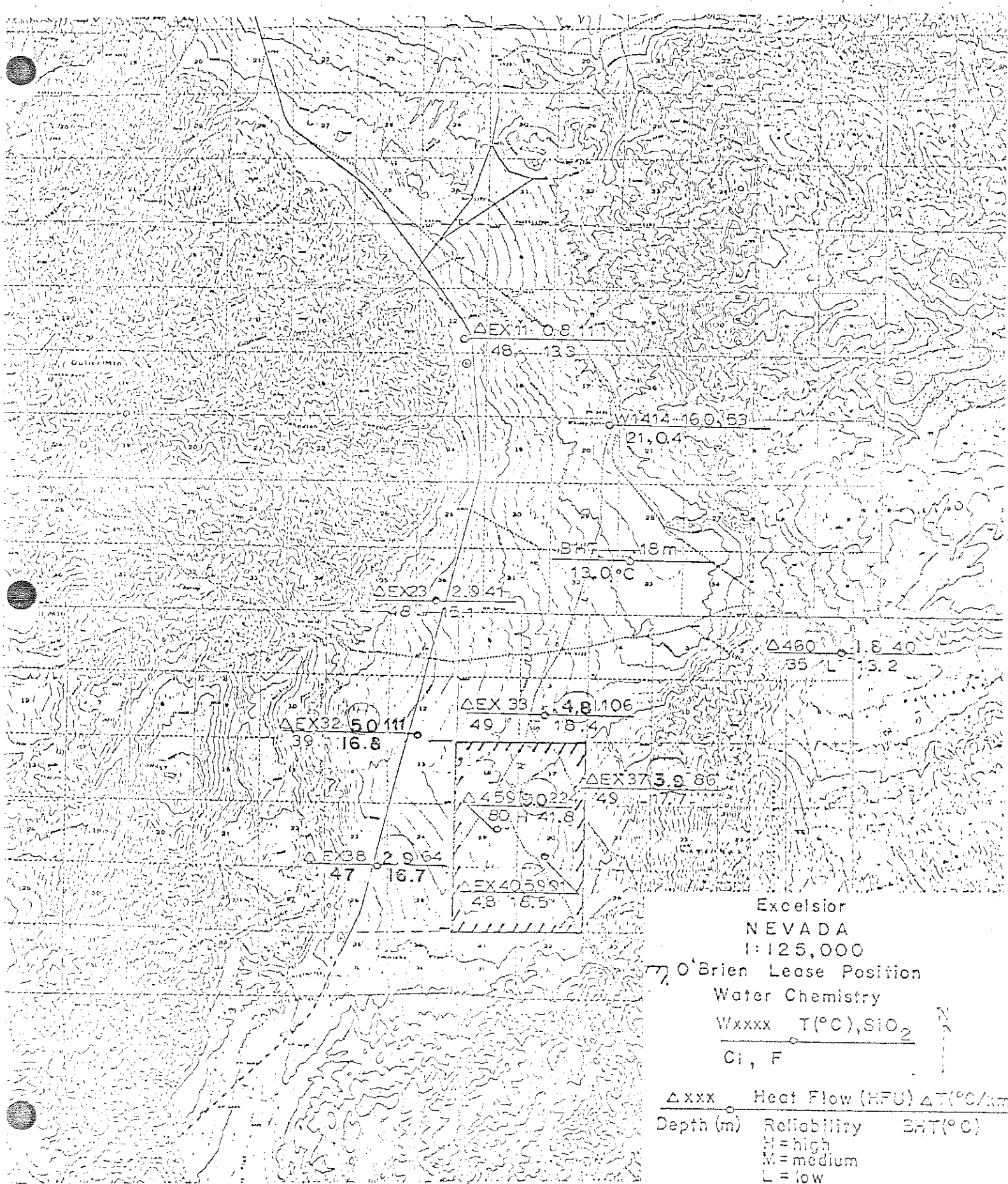
- lease position —
-  > 50 HFU
 -  3.5-5.0 HFU
 -  2.0-3.5 HFU
 -  < 2.0 HFU

R30E

R31E

T6M

T5M



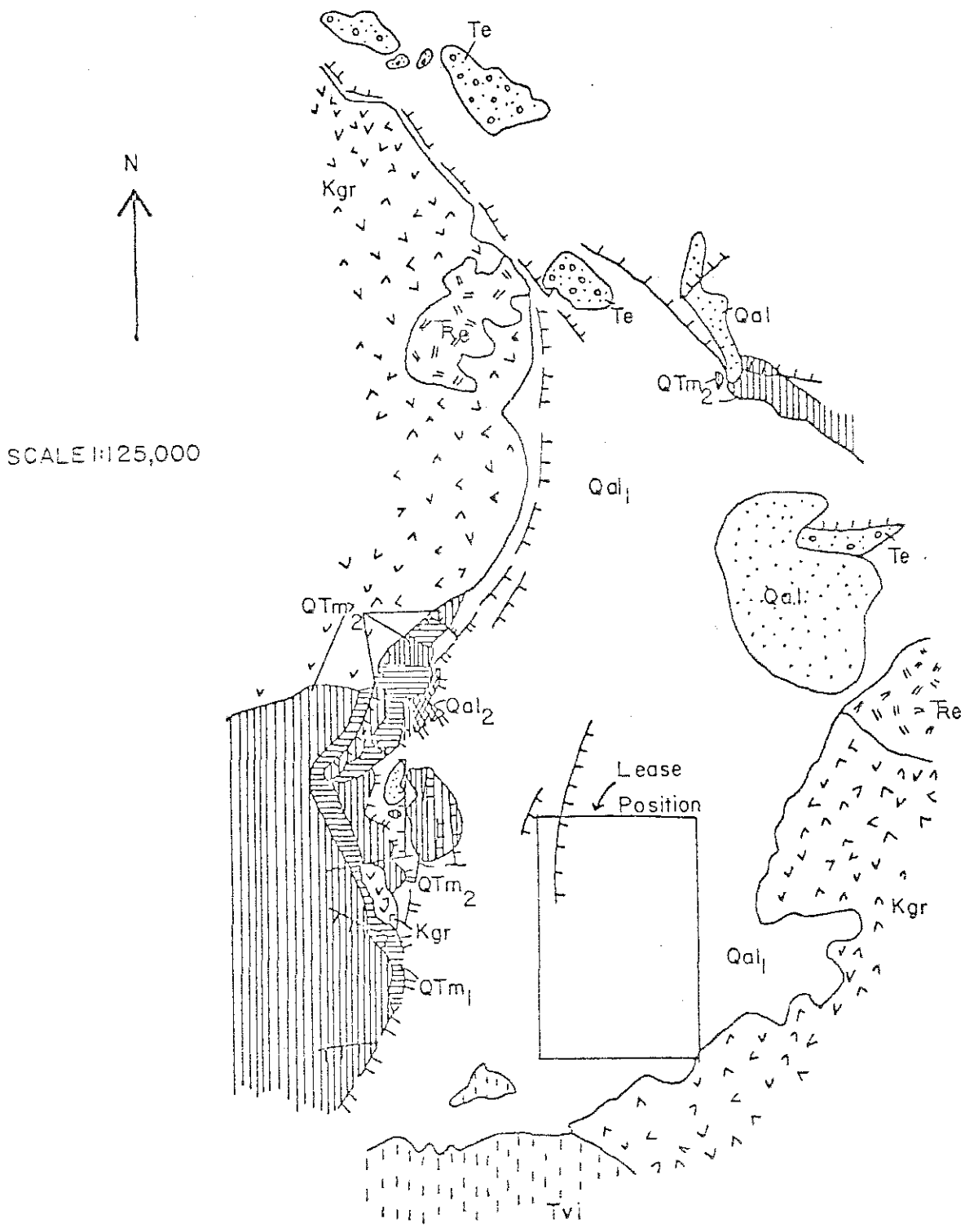
30 E

31 E

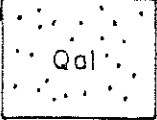
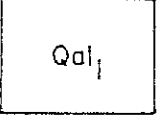
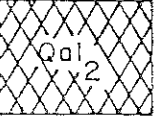
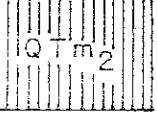


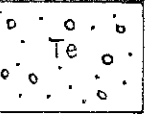
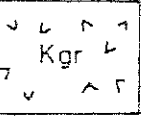

Excelsior
 NEVADA
 1:125,000
 O'Brien Lease Position
 Water Chemistry
 Wxxxx T(°C), SiO₂
 Cl, F
 Δxxx Heat Flow (HFU) ΔT(°C/km)
 Depth (m) Reliability BHT(°C)
 H=high
 M=medium
 L=low

Figure H-2.

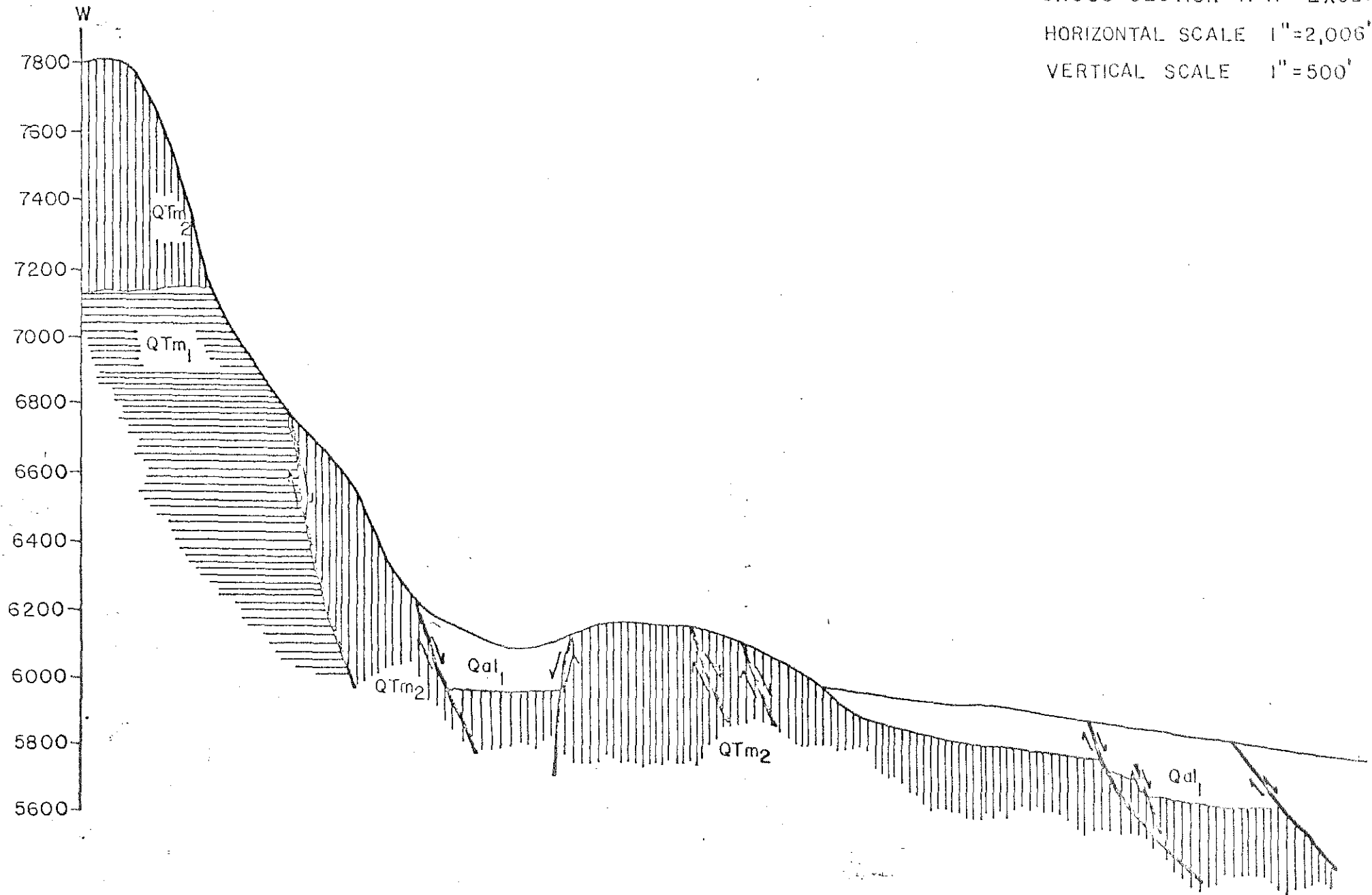
Geologic Map of the Excelsior Property and Surrounding Area, Mineral County, Nevada



Legend for geologic map of the Excelsior property
and surrounding area, Mineral County, Nevada

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		<p>Very coarse fanglomerate, uplifted and dissected at the mouth of Powell Canyon.</p>
		<p>Dark gray aphanitic basalt, in part vesicular. Coarse volcanic breccia at base of unit.</p>
Tertiary		<p>White to buff poorly consolidated tuff, in part water lain with conglomerate lenses near base of unit.</p>
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		<p><u>Esmeralda Formation</u> Talus and fanglomerate; clasts poorly sorted and angular. Contains felsic to basic volcanic, meta-limestone, quartzite and granitic clasts.</p>
Cretaceous		<p>Hypidiomorphic medium to coarse grained quartz biotite monzonite, in part porphyritic with pink orthoclase phenocrysts.</p>
	Triassic	

CROSS SECTION A-A' EXCEL
HORIZONTAL SCALE 1"=2,000'
VERTICAL SCALE 1"=500'



O'BRIEN RESOURCES CORPORATION

154 HUGHES ROAD • SUITE 4
GRASS VALLEY, CALIFORNIA 95945
(916) 272-7203

June 29, 1982

Bureau of Land Management
Nevada State Office
300 Booth Street
P.O. Box 12000
Reno, NV 89509

Attn.: Land Records

Gentlemen:

Please send us copies of the geothermal steam lease plats for the following areas. If the geo-steam plats are not available please send the master title plats.

Mt. Diablo base line

<u>Township</u>	<u>Range</u>	<u>Township</u>	<u>Range</u>
T26N	R34E	T23N	R42E
T26N	R35E	T23N	R43E
T26N	R36E	T23N	R44E
T25N	R34E	T6N	R30E
T25N	R35E	T6N	R31E
T25N	R36E	T5N	R30E
T24N	R34E	T5N	R31E
T24N	R35E	T4N	R30E
T24N	R36E	T4N	R31E
T24N	R42E		
T24N	R43E		
T24N	R44E		

Our account number is 0144. Thank you for your cooperation.

Yours truly,

Garry Maurath
Senior Geologist

GW/ek