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LITHOLOGIC INTERPRETATION OF THE DE BRAGA #2 AND RICHARD WEISHAUPT #1 GEOTHERMAL WELLS, STILLWATER PROJECT, CHURCHILL COUNTY, NEVADA

by

Bruce S. Sibbett
and
Robert E. Blackett

February, 1982

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EARTH SCIENCE LABORATORY
University of Utah Research Institute
Salt Lake City, Utah

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DISCLAIMER

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ILLUSTRATION

INTRODUCTION

The De Braga #2 and Richard Weishaupt #1 geothermal test wells were drilled by Union Oil Company, Geothermal Division, between 1979 and 1981 as part of the U. S. Department of Energy, Division of Geothermal Energy Industry Coupled Program.

They are in the Stillwater area, located on the southeast side of the Carson Desert in Churchill County, Nevada (Figure 1). Hot water was first discovered in the area in 1919 (Garside and Schilling, 1979). There are no known surface manifestations of geothermal activity in the immediate vicinity, however, basaltic cinder cones at Soda Lake, a few miles to the west, are the result of phreatic explosions during the Quaternary (Sibbett, 1979).

GEOLOGY

Regional Setting

The Carson Desert is a large sediment-filled graben in the western Basin and Range physiographic province. During the Quaternary, the basin was filled with lacustrine, alluvial and fluvial deposits. The present surface consists of Lake Lahontan and recent sediments (Morrison, 1964). The Stillwater Range, on the east side of the basin, is composed of Quaternary and Tertiary volcanic rocks and Mesozoic sedimentary and igneous rocks (Page, 1965). A north-northeast-trending normal fault or faults form the boundary between the range and the basin. The block faulting, which has been active since late Tertiary time, is still active as evidenced by earthquakes in 1954 (Morrison, 1964). Ground breakage and minor offset occurred in the Stillwater area along a N 12° E trend during the 1954 earthquakes.

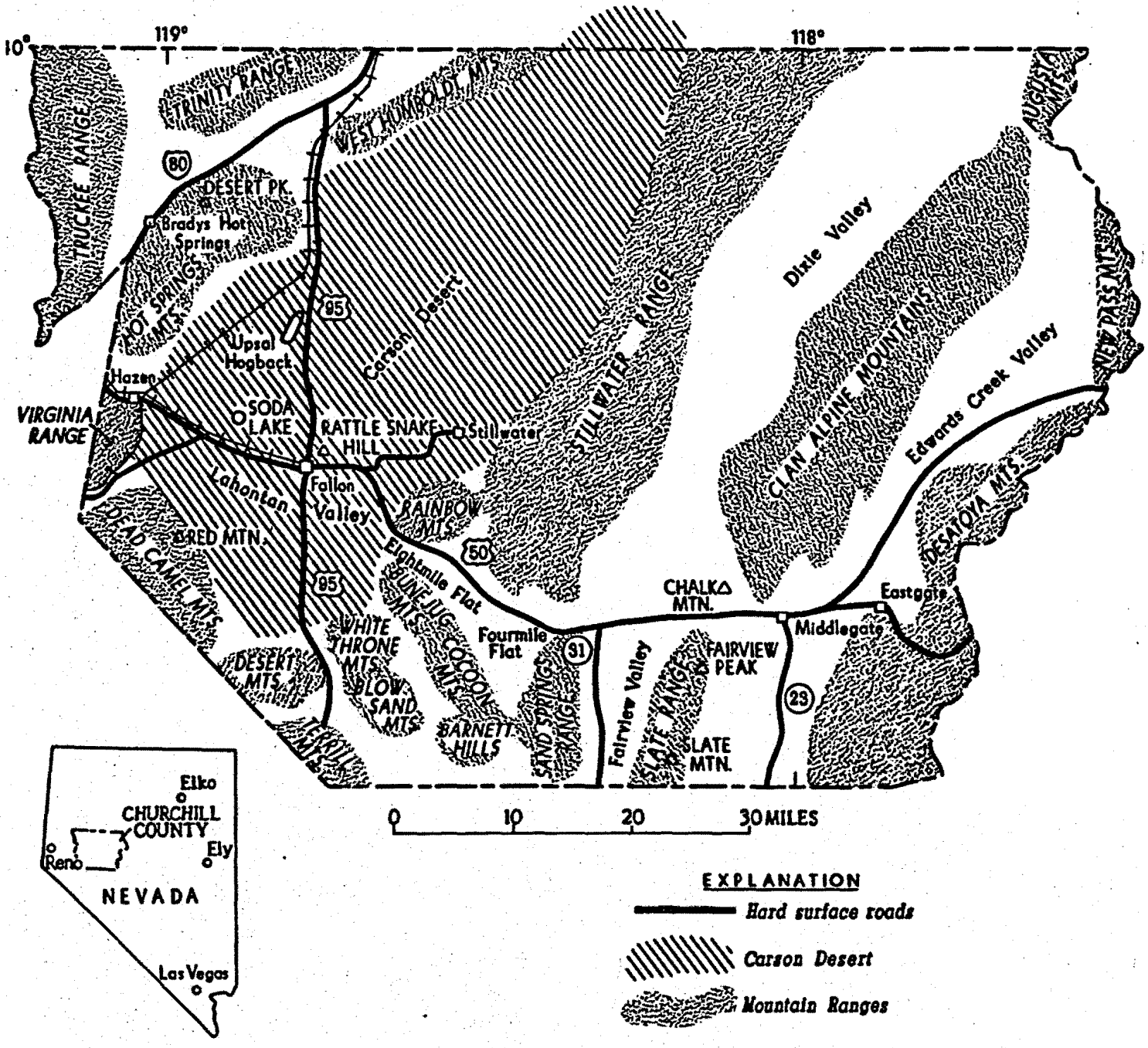


FIGURE 1

INDEX MAP OF CHURCHILL COUNTY, NEVADA

Geothermal System

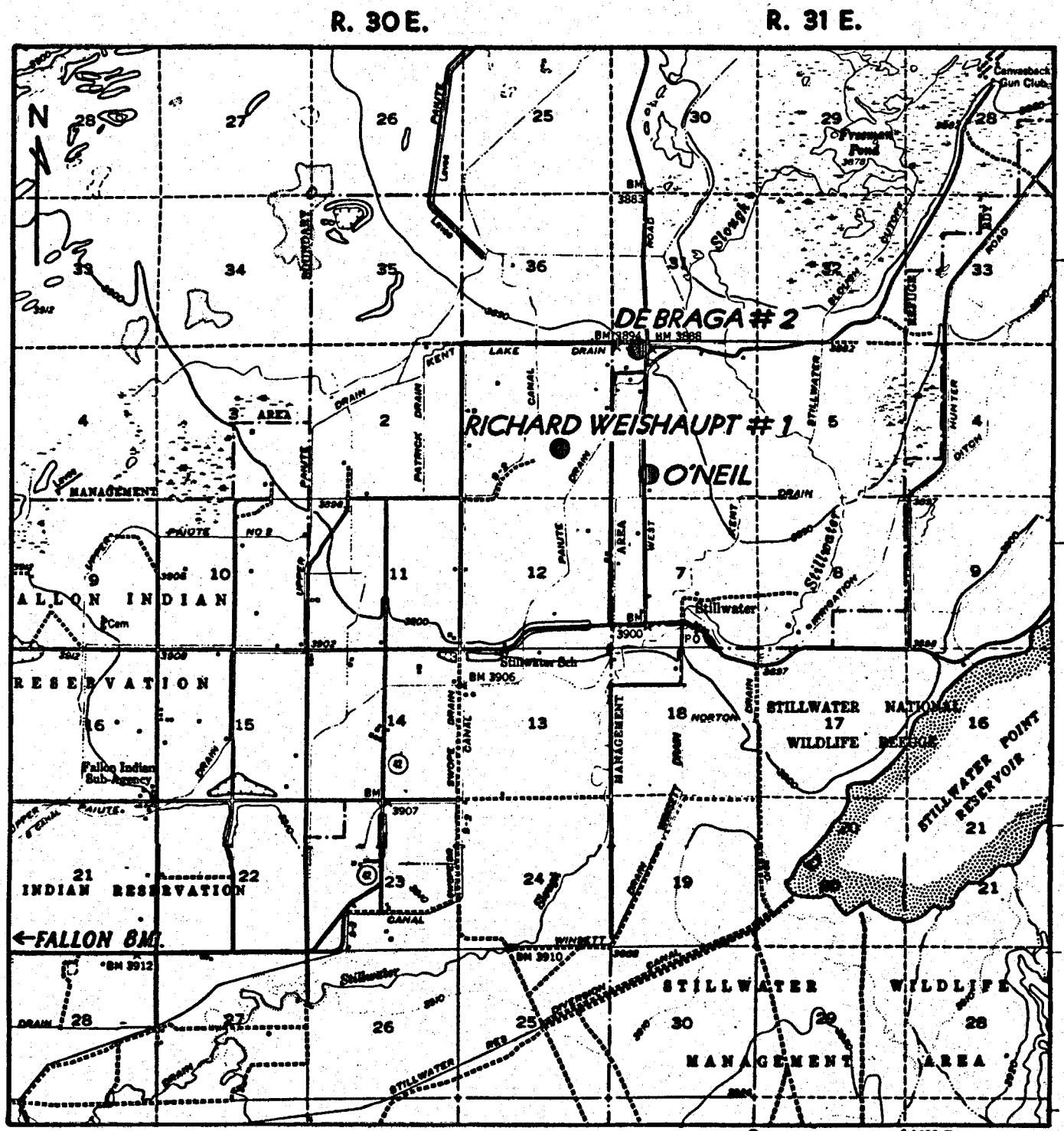
Geothermal occurrences have been known throughout the southern Carson Desert since the early 1900s. In recent years, several geothermal wells have been drilled in the Stillwater area (Figure 2). In 1964, O'Neill Geothermal, Inc. drilled the Reynolds No. 1 well to a depth of 1,291 m (4,237 feet) with a maximum recorded temperature of 136°C (277°F) (Garside and Schilling, 1979, p. 17). Union Oil Company drilled three wells to about 1220 m (4,000 feet) during 1976 and 1977.

SUBSURFACE STUDIES

The detailed lithologic logs of the De Braga #2 and Richard Weishaupt #1 wells are included in the Appendix to this report. Generalized descriptions of rock types penetrated in the subsurface and tentative stratigraphic correlations for the De Braga #2 and Richard Weishaupt #1 wells are shown on Plate 1, and their locations are shown on Figure 2.

Depths and thicknesses of stratigraphic units reported here refer to probe depths and do not represent actual bed depths and thicknesses due to hole drift and deviation. The Richard Weishaupt #1 well was intentionally deviated below 905 m (2970 ft) to intersect a target located approximately 730 m (2400 ft) due west and 2900 m (9500 ft) vertically downward from the drillsite.

Overall, both wells appear to penetrate nearly identical stratigraphic units. The wells are collared in alluvium and penetrate over 1128 m (3700 ft) in De Braga #2 and over 1158 m (3800 ft) in Richard Weishaupt #1 of unconsolidated and semi-consolidated recent lacustrine sediments and Pleistocene tuffaceous sediments of Lake Lahonton and pre-Lake Lahonton age



BASE TAKEN FROM USGS 15' QUADRANGLES MAPS; STILLWATER, NEV., 1950 AND CARSON LAKE 1951.

FIGURE 2

LOCATION OF GEOTHERMAL WELLS IN THE STILLWATER AREA

(Union Oil Company, 1979 and 1981a). Fossil shell fragments are localized in certain stratigraphic horizons while ostracods appear throughout the sedimentary section. Fragments of coal and lignite may represent either bedded units in the sediments or additions of "lost circulation" material. The sediments are either unconsolidated or poorly cemented with calcite and contain locally strong pyrite.

Underlying the upper unconsolidated sediments and contained within the lacustrine section is a basic to intermediate hypabyssal intrusion. The intrusion is considered to be a sill based upon the depth of intersection (at 732 m and 823 m in De Braga and Weishaupt respectively), thickness (122 to 229 m), apparent lateral extent, and the occurrence of pyrite and argillic alteration slightly above and below the unit that would indicate baking and hydrothermal activity.

The interval between the base of the intrusion and the top of the Bunejug Formation, 853 to 1128 m (2800 to 3700 ft) in De Braga #2 and 1052 to 1158 m (3450 to 3800 ft) in Weishaupt #1, appears to be interlayered tuffaceous claystone and basic igneous rock. Geophysical logs suggest several interlayered units of contrasting character. An intrusive or extrusive nature of the igneous rock was not determinable from cutting samples for this interval.

Below a depth of approximately 1128 m (3700 ft) in both the De Braga #2 and Richard Weishaupt #1 wells is a thick sequence of basalt and basaltic andesite flows and minor intercalated mudstone that is interpreted as the Bunejug Formation. The upper part of this unit is characterized by amygdular basaltic to andesitic lava flows having plagioclase and pyroxene phenocrysts in an aphanitic matrix and vesicles filled with calcite, secondary clay

minerals, zeolite, and celadonite. Hematite is pervasive in the basalt flows.

Felsic tuffs and tuffaceous sedimentary rocks were encountered below 2443 m (8015 ft) and are assigned to the Truckee Formation (Morrison, 1964). These rocks interfinger with the basalt flows of the Bunejug Formation for a vertical distance of approximately 244 m (800 feet).

Various geophysical and mechanical logs were run in both wells (Union Oil Company, 1979 and 1981a). Logs of the De Braga #2 well were digitized for use with the computer software system WELLOG (Atwood et al., 1980). Plate 2 shows a log composite obtained using the WELLOG program having temperature, caliper, resistivity, neutron porosity, density porosity, spontaneous potential and gamma ray logs. Rock types are broadly divisible into four categories, each exhibiting different geophysical responses. Pleistocene unconsolidated and semi-consolidated sediments present to depths of approximately 1158 m (3800 ft) in each hole have high natural gamma radioactivity, low density, low resistivity, and high porosity. Basaltic intrusive rocks occurring at shallow depths (1038 m) in both wells are characterized by low natural gamma radioactivity, high density, high resistivity, and low porosity. Basalt and basaltic andesite flows of the Bunejug Formation have low natural gamma radioactivity and moderate to low resistivity while displaying a somewhat erratic nature on the porosity and density logs. Felsic volcanic rocks encountered below 2443 m (8015 ft) in the Weishaupt well have distinctly higher natural gamma, lower resistivity, and higher porosity than overlying formations.

Temperature profiles of both wells show relatively high near-surface gradients of about 300°C/km in unconsolidated valley sediments to an approximate depth of 396 m (1300 ft). Temperature reversals occur between 427

and 457 m (1400 and 1500 ft) and negative gradients to nearly isothermal conditions exist to approximately 1219 m (4000 ft). The lower portions of both wells below 1219 m have positive gradients of 7.2° - 29°C/km. The maximum recorded temperatures in the De Braga and Weishaupt wells were 169°C and 178°C respectively (Union Oil Company, 1981b, p. 17).

CONCLUSIONS

Lithologies penetrated throughout the upper 732 to 838 m (2400 to 2750 ft) within the Stillwater prospect area are terrigenous sediments of Pleistocene to Recent age. A sill of dacite to andesite composition with a thickness variable between 122 to 208 m (400 to 680 ft) is present below the terrigenous sediments. Between the base of the sill and the top of the Bunejug Formation are intercalated volcanic and sedimentary rocks. All formations overlying the Bunejug Formation are probably of Pleistocene age.

The basalt and basaltic-andesite flows and ash below a depth of approximately 1128 m (3700 ft) are herein assigned to the Bunejug Formation (Morrison, 1964) of Pliocene and possibly early Pleistocene age. The Bunejug Formation is a thick sequence of basalt to andesite flows and hyaloclastite exposed in the mountains surrounding the south half of the Carson Desert and mapped by Axelrod (1956), Morrison (1964), and Page (1965). There is extensive exposure of Plio-Pleistocene basalt and basaltic andesite in the Stillwater Range to the east and south of the Stillwater prospect area (Page, 1965). Page (1965) reports a 488 m (1600 ft) thickness of these rocks overlying folded Pliocene sedimentary strata.

The De Braga #2 well bottomed in Bunejug volcanics at a depth of 2109 m (6920 ft). The Richard Weishaupt #1 well penetrated the entire Bunejug

sequence and entered felsic volcanics and tuffaceous sediments, which possibly represent part of the Truckee Formation, at a depth of approximately 2412 m (7915 ft).

The sedimentary and volcanic stratigraphy penetrated by the De Braga and Richard Weishaupt wells is similar to that penetrated by wells drilled in the Soda Lake area (Horton, 1978 and Sibbett, 1979) located roughly (20 miles) westward. The top of the Bunejug Formation lies at a depth of 1400 m (4595 ft) below the Soda Lake area, at approximately the same structural elevation as in the Stillwater area.

Basalt and andesite encountered in the Carson Sink #1 well near Soda Lake and interpreted as the Bunejug Formation is at least 914 m (3000 ft) thick and is underlain by dacite porphyry, which could be Truckee Formation (Horton, 1978). Nearly 1220 m (4000 ft) of basalt and basaltic andesite were encountered in the Richard Weishaupt #1 well and this unit has been interpreted as Bunejug Formation.

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APPENDIX

LITHOLOGIC LOG

De Braga - 2

GRAPHIC LOGS

DESCRIPTIONS

20' Sample interval
Ground elevation: 3890'

DEPTH	ALTERATION (Tr: TRACE, 1. WEAK, 2. MOD., 3. STRONG) Limon.	Chlor.	Pyrite					2ndary Calcite		GRAPHIC GEOLOGY	Unit interval VEINLETS	DESCRIPTIONS
100											100-120	Gravel, granules of vol. rx ~½ of f.: ½ lithic arkose, ½ clay + cal matrix
140											120-200	Mudstone, greenish gray, w/ calcite plus f. to V.C. lithic sand.
160												140-160 1mm ostracodal shells.
200												160-180, teeth, white tuff? frag. w/ marc.
20											200-240	Silt and calcareous-silty mudstone
40												with a few sand grays., greenish gry
60											240-280	Sand, V.f. with ~½ larger to granules.
80											280-360	Silt, calcareous, w/ sand & clay.
300										No Sample		Few wh. tuff clast (poss. cement)
			Tr.									
											360-1200	Mudstone, lt olive gray (5Y6/1) w/ sand + silt high calcite content. sand is f. to med., arkosic, & few lithic grains Sand is moderate to poorly round.
400												
500			Tr.									480-500 sand zone, clay matrix
												540-680 Sandy mudstone, f.-med. sand grains are arkosic, with a few lithic grains, Volcanic rocks
600												
			Tr.									Mudstone continued, with med. to f. sand, some felsic lithic grains, Med. to poor round.
700												
20												720 · tooth.
40												
60												
80												
800												Mudstone continued, few sand grains, Calcareous Light olive gray (5Y6/1) Trace clear xline calc.
900												
1000												Tr. alt. bio. grains
40										No Sample		
60												
1100												Trace clear xline calc.

DRILL HOLE DeBraga - 2 Union Oil Co.
LOCATION NW¼ Sec. 6, T.19 N., R.31E. Churchill Co. Nev.

LOGGED BY Sibbett

GRAPHIC LOGS

ALTERATION (1. WEAK 2. MOD. 3. STRONG) — 1ST | 2ND | Prnt | 3RD | 4TH | 5TH | 6TH

Secondary Calcite | Secondary Quartz | GRAPHIC GEOLOGY

DEPTH

Tr. TRACE 1. WEAK 2. MOD. 3. STRONG

VEINLETS

DESCRIPTIONS

T.S. in depth column. – Thin section made.
20' sample interval

DEPTH	VEINLETS	DESCRIPTIONS
1100	360-1200	Mudstone (cont. from 360') li. olive gray, with silt to med. sand. Sand is arkosic, few vol. lithic. Mudstone has a high calcite content.
40		
60		
80		
1200		
T.S.		A frag. of wh. tuff and bio. xls. cemented at 1205'
	1200-1240	Cement chips-V. li. gray, peppered with blk. & wh. specks, Calc., tuff or cement?
	1240-1320	Mixed Mudstone, sand & tuff? chips Tuff. ~2/3, Sand-Silt.-~1/2, Mudst. 1/4
1300	Tr., qtz, py	1300-1320 angular chips li. gray qtz with V.f. py.? enclosed. (cemented-1307-1355)
	na Sample	
	1340-1360	Sandy mudstone & tuff like chips
T.S.	1360-1420	Sand, m.-c, argil., euh. qtz, tuff chips
1400	1, qtz, py	lignite frag, qtz vug, Ostracode
20		Calcite cemented sand grains
40	1420-1630	Mudstone, med. to li. gray, calcareous ~1/4 lithic sand, tuff component
60		1470-1490 lignite frag., few round. frg
80		Calcite cemented sand
1500		1490-1530 calcareous mudstone, or marl
20		few sand. grains, Ostracodes in thin section
T.S.		lignite,
		1590-1630 ~1/4 sand grains, lignite
		lignite specks in a wht. silt. mudst.
1600		lignite
	1630-1710	Sand, C. to med., lithic, mod. round. and ~1/2 sample mudstone, abun. lignite
		1650- xl. dear calc., 1670-90 cal. cem.
1700		1670-90 poss. fault gouge.
	1, py, qtz	S. S.
	1710-1800	Sand, C. to m. rounded, lithic.
	1, py	euh, qtz & py., Calc. cement.
	1, py	py. cem., lignite grains in mudstone
	1, py.	
1800	1800-1870	Mudstone, li. gray, with lignite specks
20		Minor C. sand, micro. fossils
40		1840- abundant lignite
60		Ostracode,
80	1870-1890	Sand, C. to med., argil.
1900	1890-1930	Mudstone, li. gray, w/ C. Sand mixed
	1930-2100	Mudstone, brnish gray, w/wh. specks, ~95% li. gray Mud. & 15% med sand. Fossiliferous. -Ostracodes., yell. waxy min
		Zones of li. gray mudstone included
2000		White and black specks in brnish gray mudst. probably alt. feldspar and lignite or biotite specks.
		abundant lignite, orange-wax drill add
2100		

DRILL HOLE DeBraga - 2' Union Oil Co.

LOCATION

LOGGED BY Sibbett

GRAPHIC LOGS

DEPTH	ALTERATION (1. WEAK 2. MOD. 3. STRONG)		Pyrite				Gypsum	Secondary Calcite		GRAPHIC GEOLOGY	Tr. TRACE 1. WEAK 2. MOD. 3. STRONG VEINLETS	DESCRIPTIONS — 20' sample interval
	1	2	3	4	5	6	7					
2100												White micaceous min., foliated rx.
20												
40											2100-2340	Mudstone, and ~⅓ f. sand
60			Tr.									minor lignite, few C. rd. sand.
80												2160-2200 abund. lignite (¼ of sample)
2200												plus waxy-orange material.
												2200-2340 pure li. gray mudstone
												Tr. lignite, ostracodes
			Tr.									few qtz grains
			Tr.									ostracodes
2300												
											2340-2360	Mudstone, med. dk. gray, minor li. gray
											2360-2380	Mudstone, med. li. gray, calcareous
2400												few chips lighter & dker.
20											2380-2420	⅔ dk. gray, amph., hard pass. vol.
40												⅓ pass. mudst. li. gray. ~2400-?? mudst.
60											2420-2460	Diorite? phaneritic, pyroxene plag. minor mudst.
80											2460-2700	~½ mudst. li. gr. & ½ igneous rx. grn.
2500												amphanitic, as above. Slicken & gauge
												igneous rx. is olive black, felsic
												to porphyritic or ~~amphanitic~~
							Tr.					2560- gypsum or zeolite, abundant pseudo-gouge 2401-2700
							Tr.					most gauge is white with grn. & blk
							Tr.					specks smeared out to pred. foliation.
2600												Continued ~½ olive black felsite
			Tr.									& ~½ mudstone, li. gray
												Few slicken side surf. on chips.
												gauge? material could be drill
												produced in part?
2700												Hem. stain from bit frag. - Brass frags
20											lost	
40											2720-2940	Mudstone, li. gray to med. li. gray chips.
60												Trace lignite, few chips w/ bedding.
80												a f. lithic Ss. chips, few vol clast. of
2800												olive blk as above (2420-)
												lignite specks in li. gray mudst. chip
												high calc. content., few gauge chips
												▲ seem silicified?
			Tr.									py. in gauge
2900												Cont. li.-med gray mudst. & li. grn
			Tr.									mudst., few olive blk. igneous chip.
T.S.											Fossil	2920-40. igneous chips increase to ⅓ sample
			Tr.								2940-2960	Gabbro 80%, olive blk w/ clear xls
											2960-3080	~½ Gabbro: & ½ mudstone, li. gray, grn.
3000											Tr. chl.	mudstone chips are mottled with white
20												spots & black specks, pass. alt. tuff.
40			Tr.									igneous rx has grn cast to feldsp.
60			Tr.									some qtz present in igneous rx.
80												
3100			Tr.								3080-3700	Mudstone, li. to m. li. gray, pass. fossil.
												few olive blk. igneous rx. chips.
												high calc. in mudst. fines.
												ostracodes at 3100'

DRILL HOLE DeBraga 2 Union Oil Co.

LOCATION

LOGGED BY Sibbett

GRAPHIC LOGS

DEPTH

ALTERATION — Tr. TRACE, L. WEAK, M. MOD., S. STRONG

Pyrite | Zeolite | Secondary calcite | Secondary quartz ~10% | GRAPHIC GEOLOGY | VEINLETS

DESCRIPTIONS

10-20' sample intervals.
T.S. - Thin section from interval indicated

DEPTH	VEINLETS	DESCRIPTIONS
3100	3080-3780	Mudstone (cont.) li. to m. li. gray. & white
40		contains minor calcite
60		½ gabbro? - grn. igneous clast.
80		poss. stilbite filled amygdule
3200		intermixed gabbro-andesite chips
Tr.	Tr. qtz	are probably from sed. clast. in
Tr.	Tr. qtz	the mudstone.
3300		Probable alluvial fan deposit
Tr.	Tr. qtz	with mudst. matrix - or cong. - mudst.
T.S.	Tr. qtz	calcite amygdule, pyrite cubes.
3400	Tr. calc.	
20		Mudstone componet may be from
Tr.		caving and washouts above 2400'
40		
60		
80		
3500		
T.S.		
3600	2-3 qtz, py	silicified zone, Mudst. minor ign.
		no cuttings
3700	3700-5730	Basalt or Basaltic-Andesite & mudst.
20		Brownish-black & dusky brn., grn. tints
T.S. 40	1, qtz, py	with amygdules of calcite, stilbite,
60		variable amounts of mudstone chips.
80		Basalt flows (or rubble) interbedded with
3800		mudstone, or mudstone contamination.
T.S.		Basaltic-andesite, plag. glates, pyroxene.
		Multi-colored chips. ~½ v. dk. red,
		~½ dk grnish gray, & li. olive gray Mudst
3900		
Tr.		hem. impregnated basalt chips, saponite or celadonite
T.S.	1, qtz, cal, py	palagonite, amygdules of stilbite
	1, qtz	
Tr.	1 qtz	3980-4020 felsic rock, poss. tuff?, silicif.
4000		
		4040- Mixed lithologies, basalt &
		mudst.
		Poss. rubble with mudst. matrix?
		or mudstone washing from above
		2400 or 3700' and contaminating
4100		samples.

DRILL HOLE DeBraga 2 Union Oil Co.

LOCATION

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GRAPHIC LOGS

ALTERATION — 1. WEAK 2. MOD. 3. STRONG

DEPTH | Pyrite | Zeolite | Secondary Quartz | GRAPHIC GEOLOGIC LOGS

Tr. TRACE 1. WEAK 2. MOD. 3. STRONG

VEINLETS

DESCRIPTIONS

T.S. In depth Column Marks thinsection intervals

DEPTH	VEINLETS	DESCRIPTIONS
4100	3700-5730	Continued - basalt and mudstone.
		Basalt & palagonite & Celadonite (green) few mudst chips. amygdules of stilbite.
4200 T.S. 20		plag. phyre, palagonite, amygdules few mudstone clast.
40		
60		
T.S. 80 4300 T.S.		4280-4300 - strong hem. coloring of basalt Calc. amygdules, pass basaltic ash.
		Basalt with tachylite, palagonite, amygd. few mudstone chips.
		stilbite chips. & pass other zeolites
4460		
T.S.		basalt, palagonite, stilbite amygdules
4500		
20		
40	Tr. qtz	euhedral quartz crystal
60		celadonite
80		
4600		
4700		celadonite
		4730-4780 10% orange wax min, pass. fossil or drilling additive
		4740-60 - few large muscovite sheets, additive
4800		
20		
40		
60		
80		celadonite (bright grn) stilbite.
T.S. 4900 T.S.		minor calcite, palagonite
		hem. impregnated chips, few mudstone.
		4930-4980 abundant stilbite amygdules and abundant celadonite-
5000		
		lost
T.S. T.S.		Basalt with palagonite, mudstone,
T.S. 5100	Tr. chl.	Basalt with minor palagonite

DRILL HOLE DeBraga 2, Union Oil Co.

LOCATION

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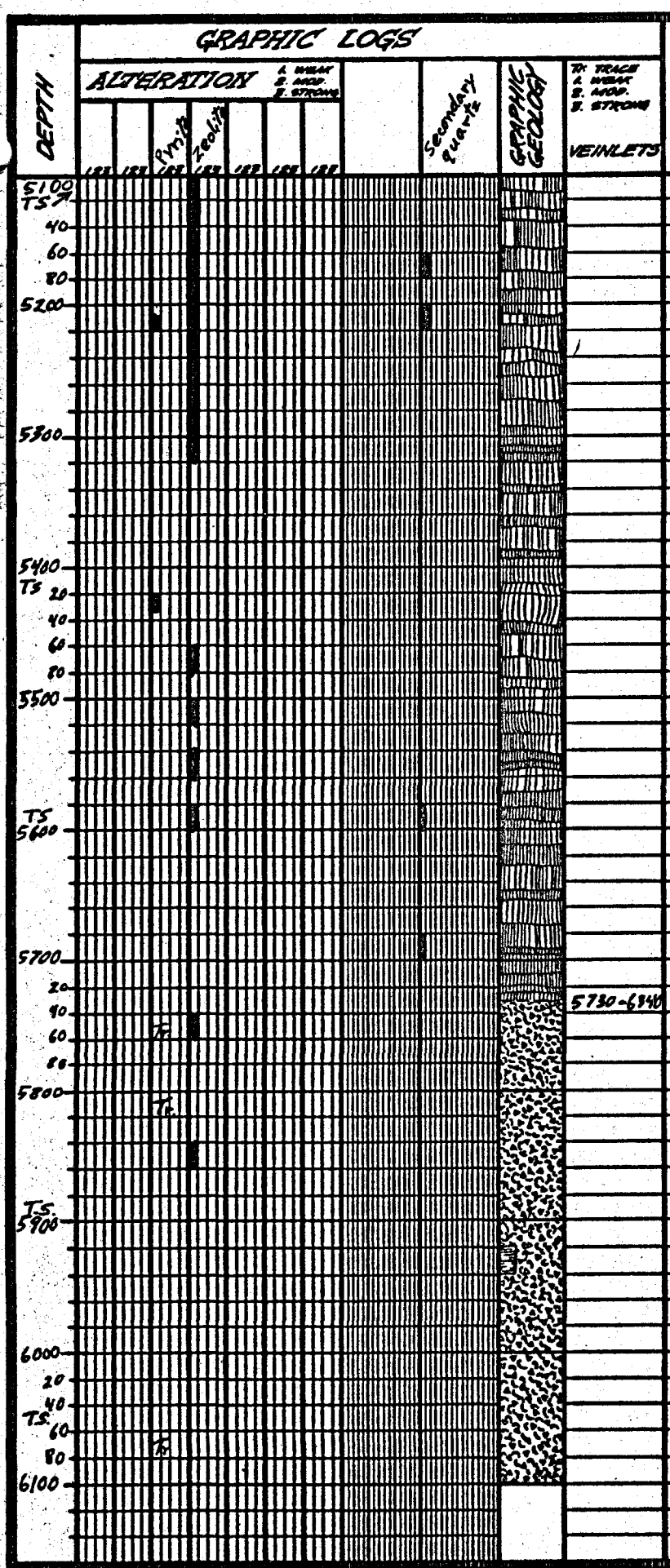


DESCRIPTIONS

T.S. in depth column indicates thin section for the interval.

Basalt and Mudstone Cont. from 3700'
calcite shells in mudstone chips.
celadonite, stilbite, calcite
hem. impregnated chips.
pieces of large zeolite amygdules

few mudstone chips included
5260-80 & ll. gray igneous chips-
poss dacite flow.

Mostly olive gray, & dk grn. gray
and greish blk.

Trace carbon with a zeolite?

Basalt with palagonite & celadonite

5560-5730 increasing ash intermixed
with flow chips.

Small amygdules, poss. basaltic ash.

Most of the diversity in chip color
is due varying degree of alteration
and type of alteration, ie. chlorite
and palagonite formation or hem.
impregnation.

5730-6340 Basaltic ash with minor flows.
Caving has added to the lithology
and color mix in individual samples.
5770-80 poss flow with ash & cinders.
5810-5830 poss. flow with in the ash

Basalt with palagonite, stilbite amygd.
some calcite. May be ash or breccia

heterogeneous basalt, prob. cinders,
ash and minor flows.
zeolite amygdule
Basaltic ash or andesitic ash.

hem. impregnated, basaltic ash,
zeolite and celadonite amygdules.

DRILL HOLE De Braga 2, Union Oil Co.
LOCATION Stillwater, Nev.

LOGGED BY Sibbett

GRAPHIC LOGS

ALTERATION — 1. WEAK, 2. MOD., 3. STRONG

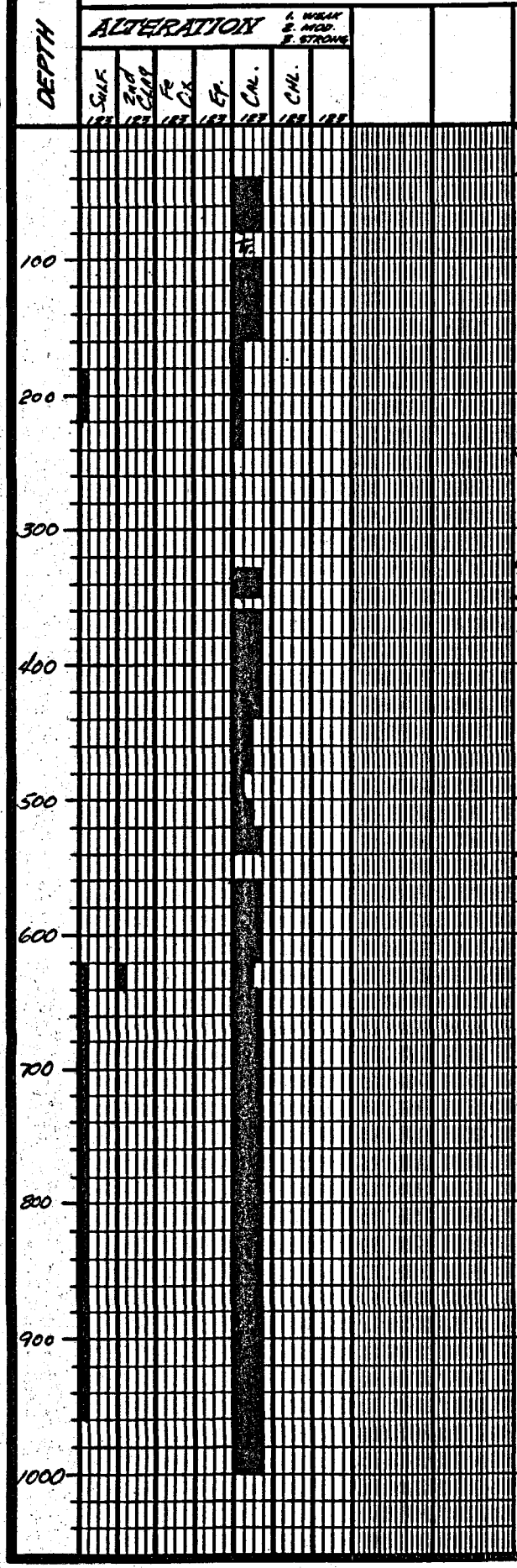
DEPTH	123	123	Pyrite 123	Zeolite 123	123	123	123	Secondary Quartz	GRAPHIC GEOLOGY	Tr. TRACE, 1. WEAK, 2. MOD., 3. STRONG — VEINLETS	DESCRIPTIONS — T.S. in Depth column indicates thin section
6100											Basaltic or andesitic ash & cinders with minor flows and mudst chips zeolites and calcite amygdules. celadonite, palagenite.
40											
60											
80											
6200											6140-6370 cutting ground V. fine. could be due to fine ash or drilling operation.
				Tr							
6300											
				Tr							6340-6480 Basalt flow, Greenish black with olive black & dark gray chips. few plag phens., zeolite amygdules and few hem. impregnated chips.
6400											
T.S. 20				Tr							Stilbite, few chips med. gray & brn. blk.
40											
60											
80											6480-6680 Basaltic to andesitic ash and cinders. med. to dark gray, grn. hats.
6500											
				Tr							Chip with mudst — ash contact.
TS											Basaltic ash, palagonite, stilbite amygdules
6600											few flow chips & mudstone chips.
											6680-6780 Basalt flows, olive-black,
6700											
TS 20											V. fine grain, ap phens., fresh, mudstone and ash chips.
40											
60											
80											6780-6830 Basaltic ash with mudstone med. gray to dk. grnish gray
6800											
											6830-6850 Basalt flows, Olive black.
				Tr							6850-6920 Basaltic ash & lapilli grays & grn. hats.
6900											
T.D.											1 - qtz

DRILL HOLE DeBraga 2, Union Oil Co.

LOCATION Stillwater

LOGGED BY Sibbett

GRAPHIC LOGS



DEPTH INT.	DESCRIPTIONS
40-1700	Sand, Silt and Clay; coarse grained conglomeratic Sand, to very silt & Clay, largely unconsolidated to semi-consolidated, abundant local ostracodes, some Carbonized plant fragments, predominantly calcareous arkose, locally quartzose. Sediments are mediums to light gray and tan. microfossils and pellets probably represent lacustrine facies within a dominantly alluvial and fluvial regime. Carbonate Cementing is possibly primary and may not reflect hydrothermal activity.
	abundant ostracodes with shell and bone fragments
	pyrite nibs embedded in clay matrix

DRILL HOLE Richard Weishaupt #1

LOCATION SE, Sec. 1, T. 19 N., R. 30 E. Churchill Co., Nev.

LOGGED BY Blackett

LITHOLOGIC LOG

Richard Weishaupt - 1

GRAPHIC LOGS

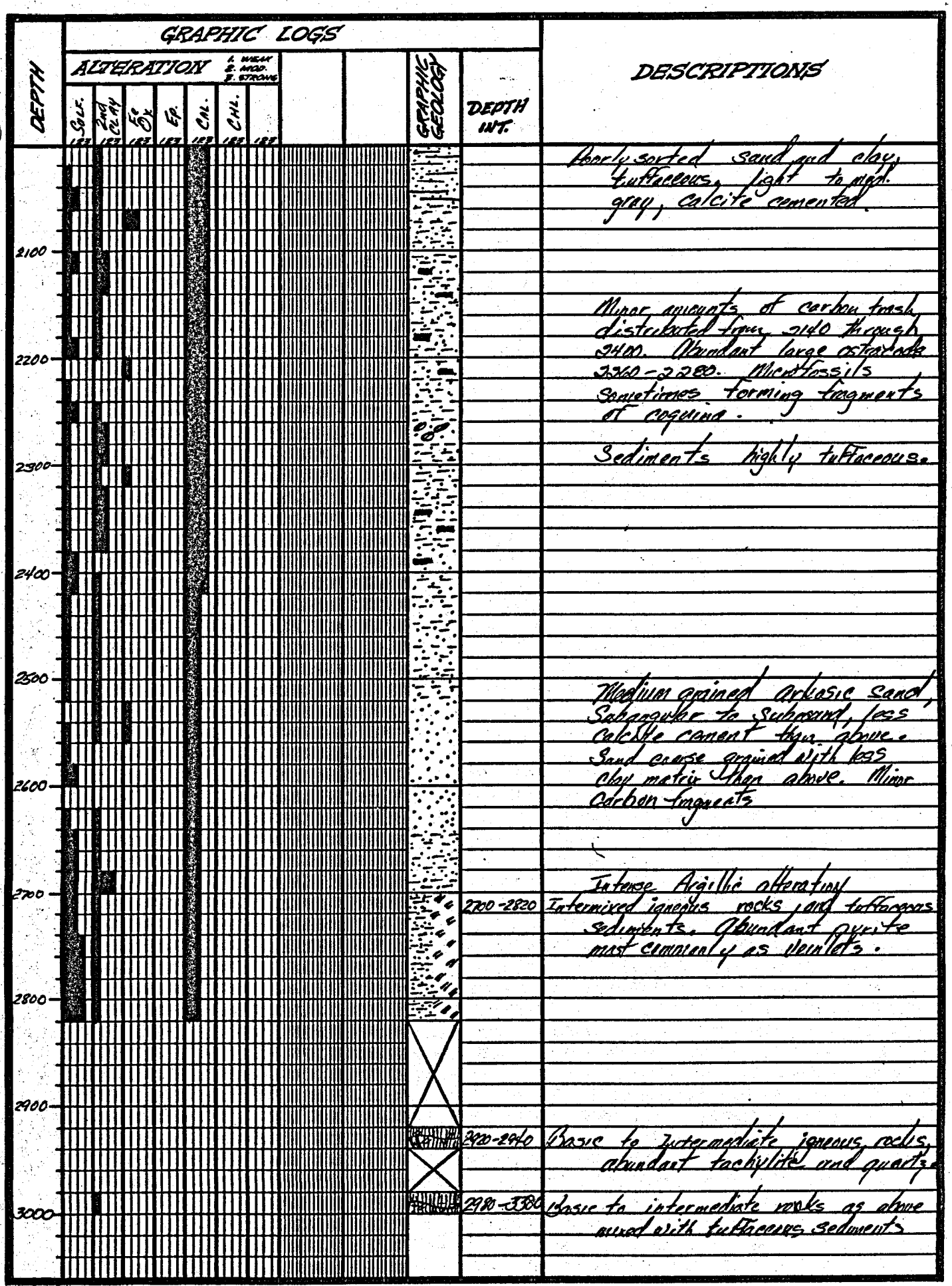
ALTERATION 1. WEAK 2. MOD. 3. STRONG

DEPTH	Sulf.	Sed Clay	Fe Ox	Ep.	Cal.	Chl.		GRAPHIC GEOLOGY	DEPTH INT.	DESCRIPTIONS
	123	123	123	123	123	123	123			
1100									1080-1220	Abundant microfossils, moderate pyrite and other sulfides occuring in carbonized plant fragments.
1200										
1300										
1400									1400-1660	Sand, light grey, well sorted, sub-angular to subround, arkosic becoming quartzose near 1620.
1500										
1600									1660-1760	10% ± bright coal (vitrain) chips present, possibly a drilling additive. Bivalves also present.
1700									1760-1900	Sediments becoming more hetero-lithologic. larger chips of shale and claystone, and volcanic rock fragments.
1800										
1900									1900-1960	Ostracods and gastropods. silt and poorly sorted sand, subangular, medium to light grey, tuffaceous.
2000									1960-2100	Mixed lithologies continue

DRILL HOLE Richard Welshaupt #1

LOCATION SE, Sec. 1, T. 19N., R. 30E., Churchill Co., Nev.

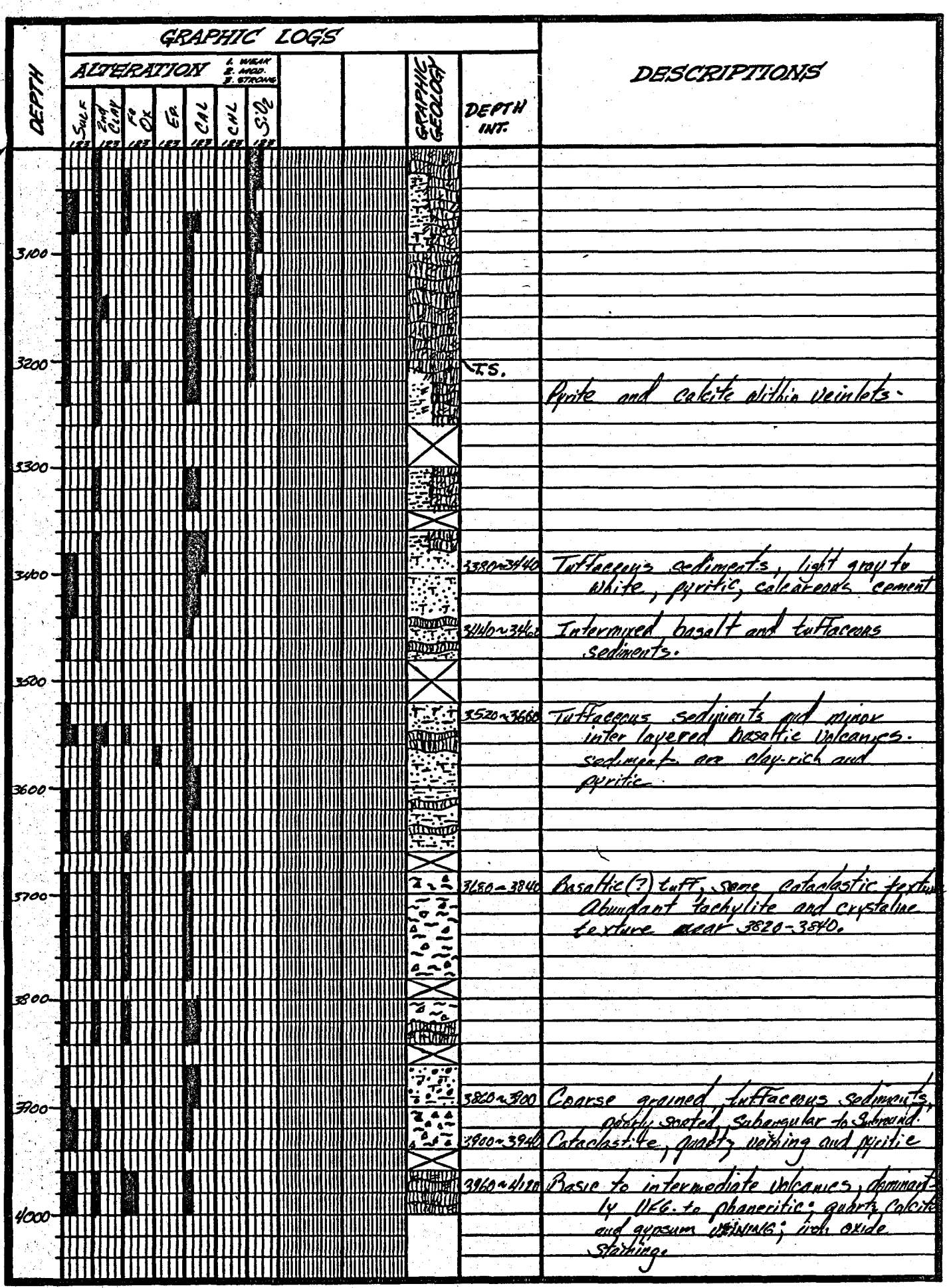
LOGGED BY Blackett



DRILL HOLE Richard Weishaupt #1

LOCATION SE, Sec. 1, T. 19N., R. 30E., Churchill Co., Nev.

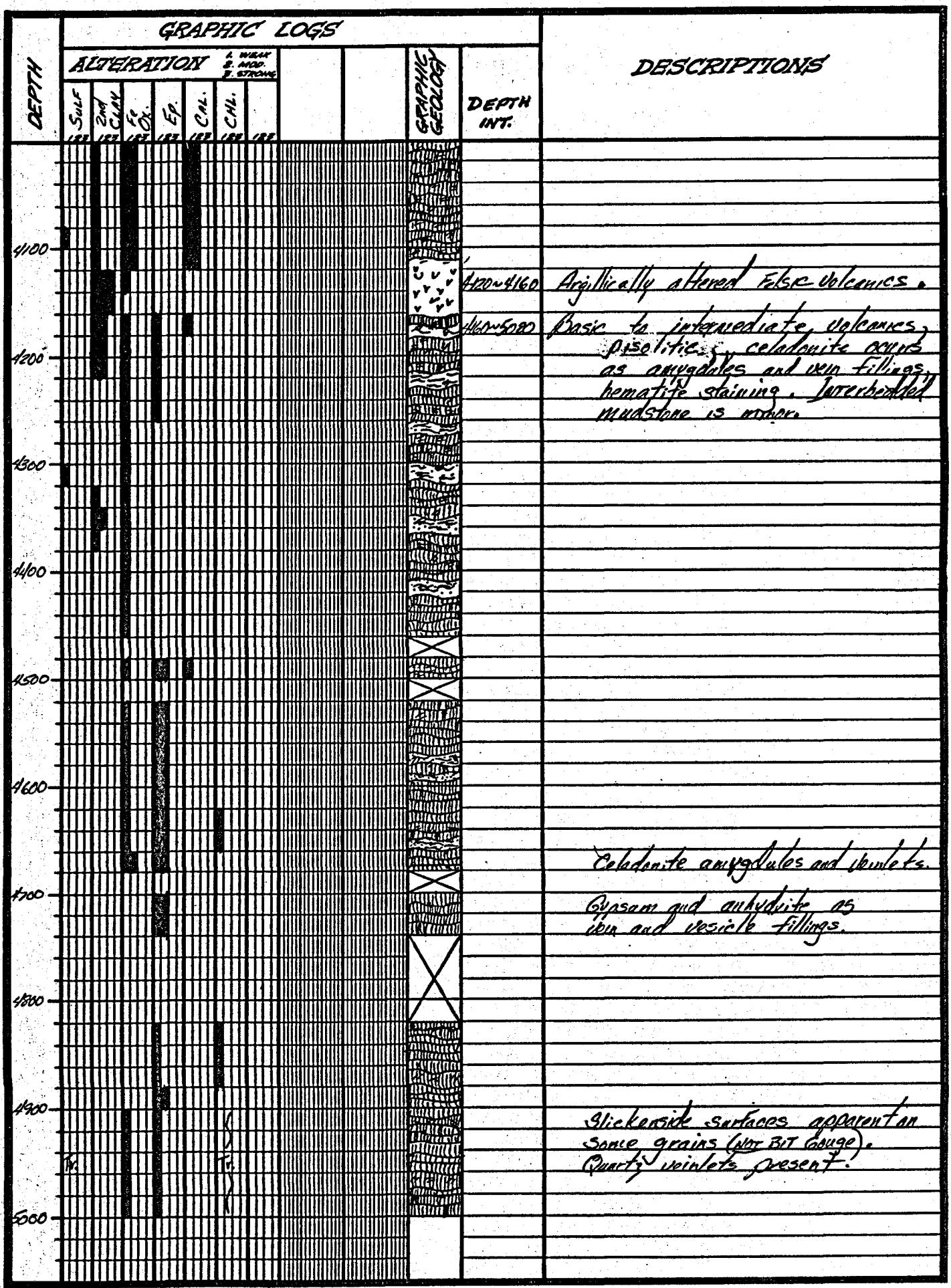
LOGGED BY Blackett



DRILL HOLE Richard Weismaupt #1

LOCATION SE, Sec. 1, T. 19N., R. 30E., Churchill Co., Nev.

LOGGED BY Blackett



DRILL HOLE Richard Wenshaupt #1

LOCATION SE, Sec., 1, T.19N., R.30E., Churchill Co., Nev

LOGGED BY Blacket

GRAPHIC LOGS

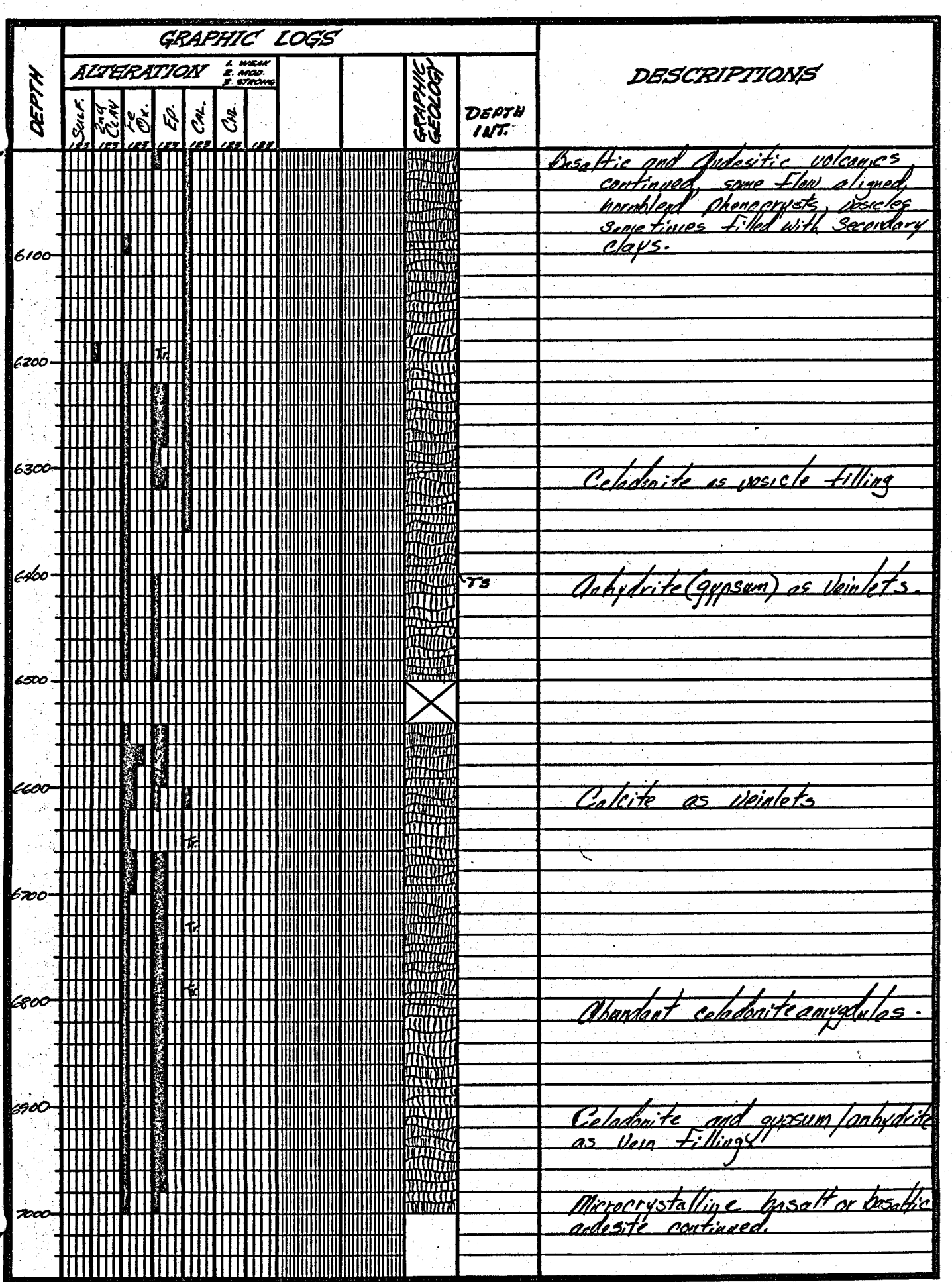
ALTERATION (1. WEAK 2. MOD. 3. STRONG)

DEPTH	Silic.	2nd Clay	Fe Ox.	Ep.	Cal.	Chl.		GRAPHIC GEOLOGY	DEPTH INT.	DESCRIPTIONS
5100										
5200	Tr.								5180–5240	Andesitic (?) volcanics; some pisolitic texture and minor tuffaceous sediments, some vesicles filled with secondary clays including celadonite. Tuffaceous seds near 5260 possibly derived from higher in section.
5300	Tr. Tr.								5360–5440	Andesitic to Dacitic volcanics; highly oxidized, feldspars completely altered to clays, celadonite and gypsum along veinlets.
5400										
5500										
5600									5640–5720	Felsic volcanics; light gray to pink with gypsum occuring along veinlets.
5700									5720–7400	Basalt; very fine grained to aphanitic, some clastic textures, dominantly aphanitic, celadonite and clay filling vesicles, hematite staining and Palagonite. Lost circulation material (Walnut Hulls) 5720–5760
5800					Tr. Tr.					
5900	Tr. Tr.				Tr.					more celadonite Walnut Hulls.
6000										

DRILL HOLE Richard Weishaupt #1

LOCATION SE, Sec. 1, T. 19N., R. 30E., Churchill Co., Nev.

LOGGED BY Blacketti



DRILL HOLE Richard Weishaupt #1

LOCATION SE, Sec., 1, T.19N., R.30E., Churchill Co., Nev.

LOGGED BY Blackett

GRAPHIC LOGS

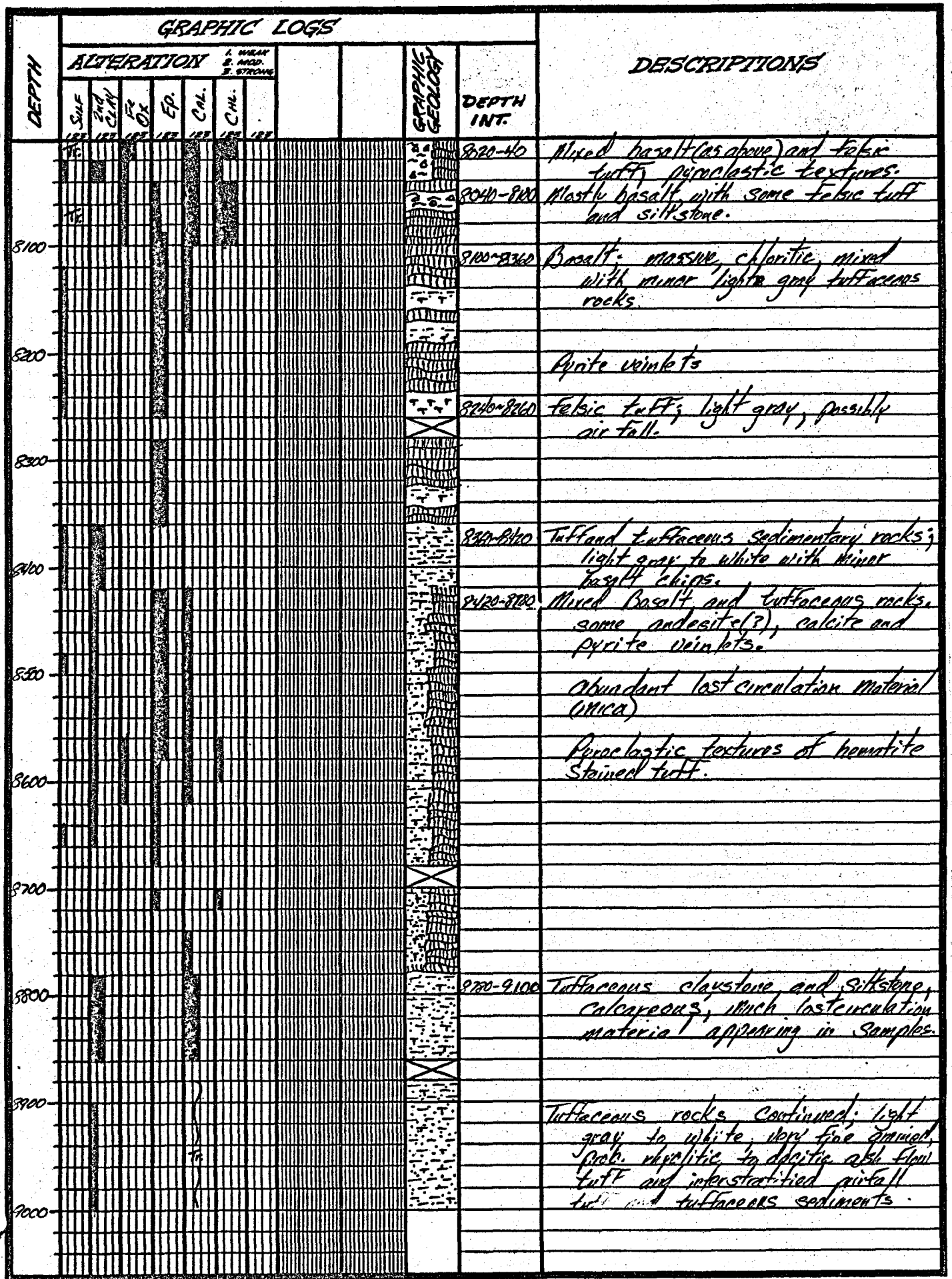
ALTERATION 1. WEAK 2. MOD. 3. STRONG

DEPTH	Sulf.	2nd Clay	Fe Ox.	Ep.	Cal.	Chl.			GRAPHIC GEOLOGY	DEPTH INT.	DESCRIPTIONS
	123	123	123	123	123	123	123				
7100											
7200											
7300											
7400										7400-7520	Felsic Tuff: very fine grained, prob. andesitic to dacitic volcanics, pyroclastic textures and quartz veining. Calcite as cement.
7500										7520-7900	Basaltic to andesitic volcanics, mixed with felsic volcanics from above. Some calcite veinlets. Intervening entirely matic volcanics beneath.
7600											
7700					TE.						
7800											
7900	TE.									7900-7940	Basalt and tuffaceous sediments mixed.
	TE.									7940-8020	Basalt: chloritic, dark brown, massive, calcite as veinlets.
8000	TE.										

DRILL HOLE Richard Weishaupt #1

LOCATION SE, Sec. 1, T. 19N, R. 30E., Churchill Co, Nev.

LOGGED BY Blacketi



DRILL HOLE Richard Weishaupt #1

LOCATION SE, Sec. 1, T. 19N., R. 30E., Churchill Co., Nev.

LOGGED BY Blackett

GRAPHIC LOGS

ALTERATION 1. WEAK 2. MOD 3. STRONG

DEPTH	SILF	2:1 CLAY	Fe OX.	ED.	CAL.	CHL.		GRAPHIC GEOLOGY	DEPTH INT.	DESCRIPTIONS
	123	123	123	123	123	123	123		9020-40	Slickensides; possible fault. No fragmental textures apparent.
9100					TR				9080-9120	Tuffaceous rocks; with basalt chips composing ~30% of the sample.
			TR						9120-	Tuffaceous rock continued.
9200									T.S.	
9320										Few fragmental textures
										Occasional blebs of Magnetite
9460										Most of unit largely very fine grained to aphanitic, some fragmental textures and hornblend and biotite microphenocrysts locally present.
9500										
9600										Abundant lost circulation material (mica, walnut hulls, etc.).
9700										
9800										
9950										Calcite occuring as vainlets
										Felsic tuffaceous rocks, mixed with basaltic rocks and black shale (?) fragments.
10000									TD: 10,019'	

DRILL HOLE Richard Weishaudt #1

LOCATION SE. Sec. 1, T. 19N., R. 30E., Churchill Co., Nev.

LOGGED BY Blacketi

4500'
N 7°E

Richard Weishaupt #1
Union Oil Company

De Braga #2
Union Oil Company

DEPTH IN FEET

0
400
800
1000
1600
2000
2400
2800
3200
3600
4000
4400
4800
5200
5600
6000
6400
6800
7200
7600
8000
8400
8800
9200
9600
10,000

DEPTH IN METERS

200
400
600
800
1000
1200
1400
1600
1800
2000

Pre-Lake Lahontan and Lake Lahonton Sediments: Dominantly clay with interstratified tuffaceous silt and sand. Coarser-grained fractions are quartzose. Calcite cement is common. Secondary minerals are pyrite and clays.

Basic to Intermediate Composition Sill: Fine grained, 1-2mm phenocrysts, hypidiomorphic granular textures. Geophysical logs indicate low porosity, high density and low gamma ray count.

Directional drilling begins at this point (2964ft.)

Interstratified Felsic Volcanics and Tuffaceous Sediments.

Bunejug Formation.
Basalt or basaltic andesite flows with minor interbedded mudstone. Basalt contains plagioclase and pyroxene, abundant zeolite amygdules. Tachylite altering to palagonite and celadonite. Basalt is multicolored: olive gray, dark brown, red and green tint. Hematite staining is pervasive.

?
?
?

Truckee Formation
Interstratified felsic tuffs and tuffaceous sedimentary rocks. Basalt of the Bunejug Formation interfingering within the upper 800ft

Probe Depth: 10,014'
True Vertical Depth: 9569'
2306'West and 357'South of Surface Location

EXPLANATION

- basaltic intrusive
- recent lacustrine and fluvial sand, silt, and clay
- basalt and andesite flows
- basaltic cinders
- felsic volcanics and tuffaceous sediments.

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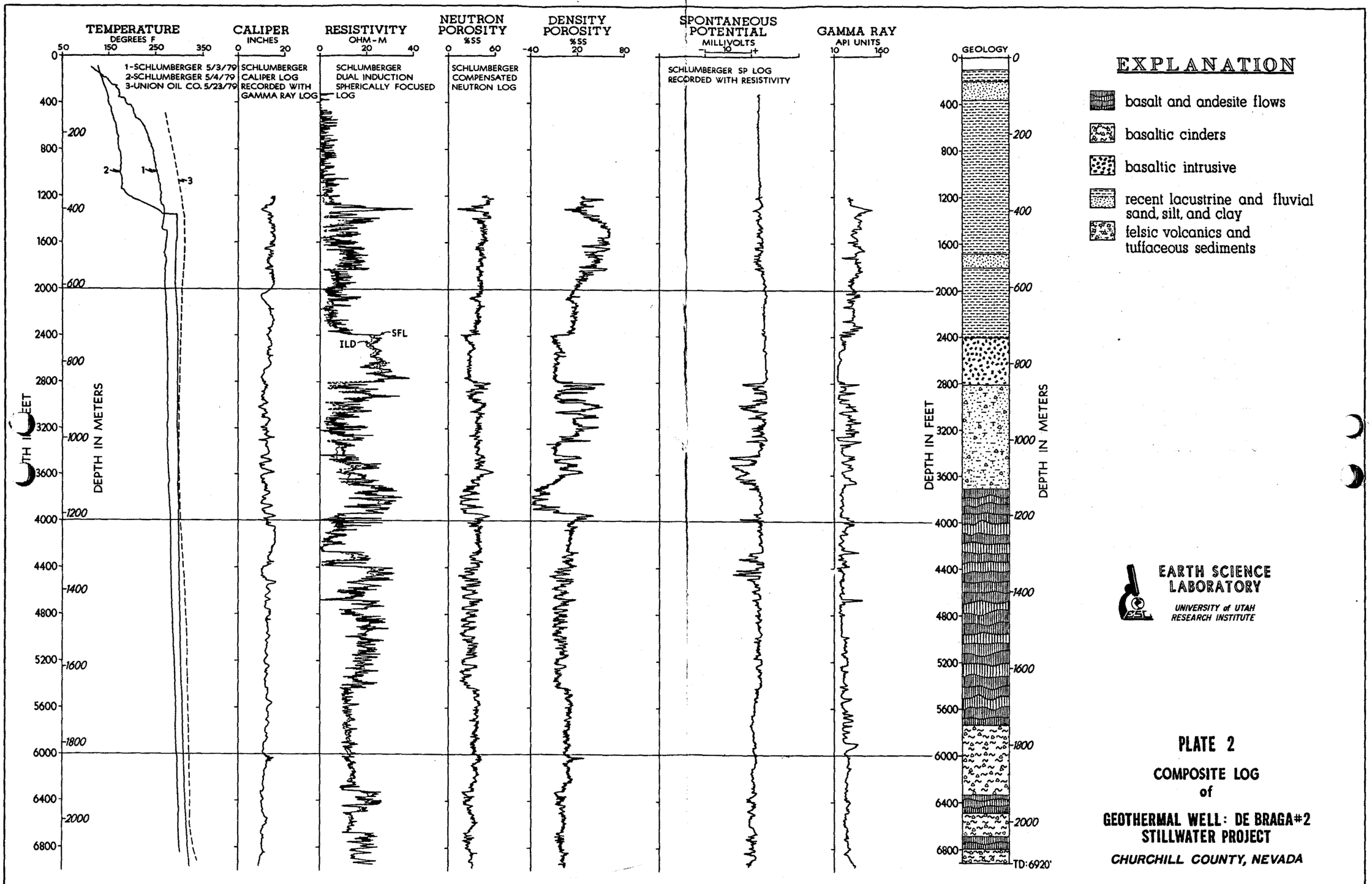
0 400 300Feet
0 200 400Meters

PLATE 1
CORRELATION OF BEDDED UNITS IN THE STILLWATER AREA
CHURCHILL COUNTY, NEVADA



EXPLANATION

- basalt and andesite flows
- basaltic cinders
- basaltic intrusive
- recent lacustrine and fluvial sand, silt, and clay
- felsic volcanics and tuffaceous sediments

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PLATE 2

COMPOSITE LOG
of
GEOTHERMAL WELL: DE BRAGA#2
STILLWATER PROJECT
CHURCHILL COUNTY, NEVADA