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LITHOLOGY AND WELL-LOG STUDY OF CAMPBELL "E-2", GEOTHERMAL TEST WELL, HUMBOLDT HOUSE GEOTHERMAL PROSPECT, PERSHING COUNTY, NEVADA

MASTER

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August, 1981

Work performed under Contract No. DE-AC07-80ID12079

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

Prepared for
U.S. Department of Energy
Division of Geothermal Energy

DISCLAIMER

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INTRODUCTION

In 1979 Phillips Petroleum Company completed the Campbell E-2 geothermal test well to a depth of 8060 feet (2456.7m) in Section 15, T31N, R33E, to evaluate the geothermal potential of the Humboldt House thermal area on the northwest side of the Humboldt Range, Pershing County, Nevada. The cuttings and well logs were made available for study by the Earth Science Laboratory, University of Utah Research Institute through the DOE/DGE Industry Coupled Program. The well location is shown on Figure 1.

The thermal area is located on the west side of the Humboldt Range (Figure 1), in the Basin and Range physiographic province. The valley fill consists of Quaternary to Tertiary alluvium (Johnson, 1977), lake sediments and volcanic rocks. East of the range front fault, Triassic slates of the Grass Valley Formation and Natchez Pass Formation are thrust over the Triassic Prida Formation and older rocks (Figure 2). The geology of the range was mapped by Silberling and Wallace (1967).

No active hot springs are known in the area, but siliceous and calcareous sinter deposits are exposed in the valley about three miles northwest of the Campbell E-2 well (Garside and Schilling, 1979, p. 61). A 600-foot-thick interval of siliceous sinter was encountered below 700 feet of alluvium in the Campbell E-1 hole (Earth Science Lab., 1979).

LITHOLOGIC LOG

The cuttings of Campbell E-2 were examined in detail with a binocular microscope supplemented by twelve thin sections of selected intervals. The detailed lithologic log is presented in the appendix and a generalized log is

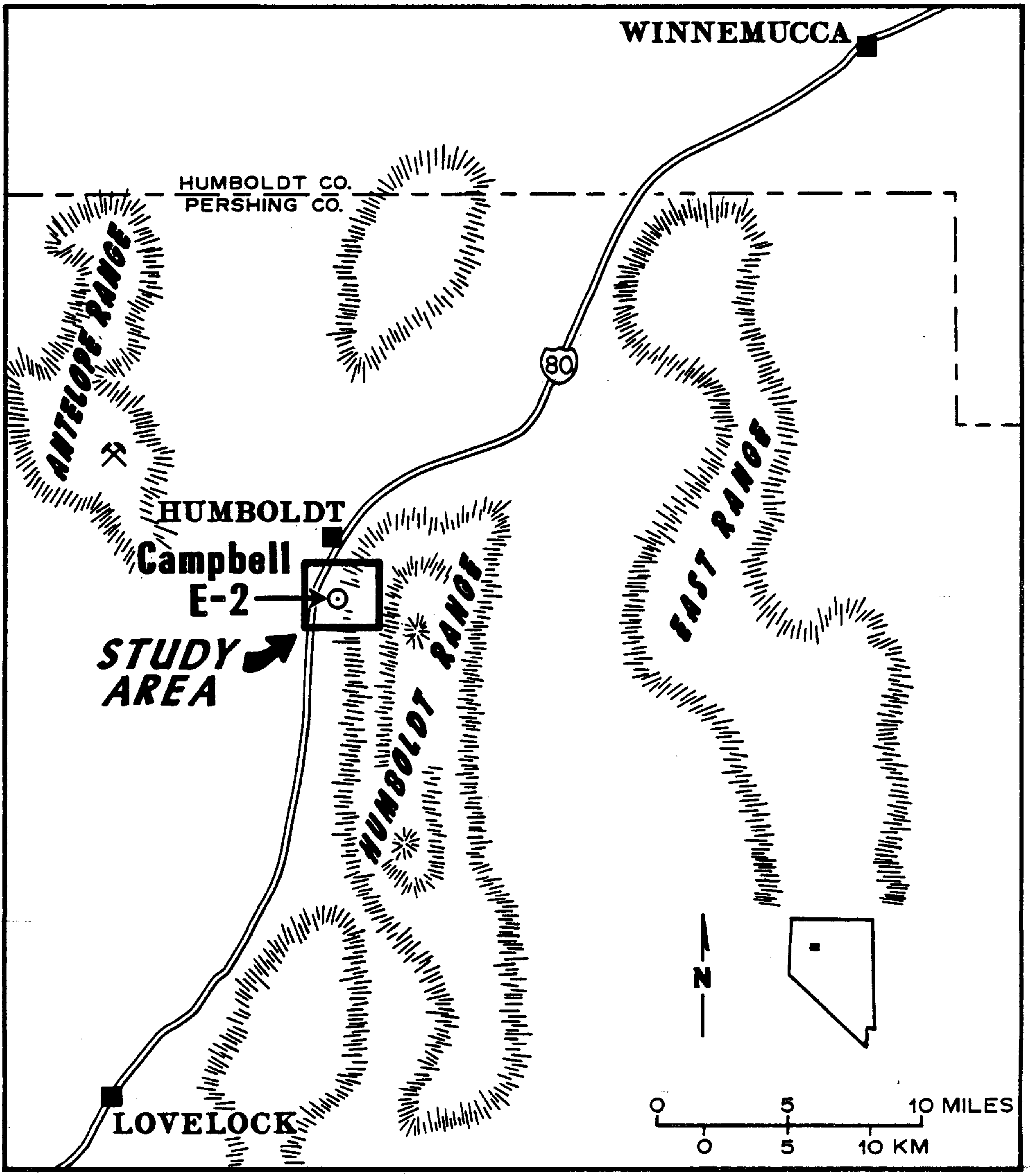


Figure 1. Location map of the Humboldt House geothermal area.

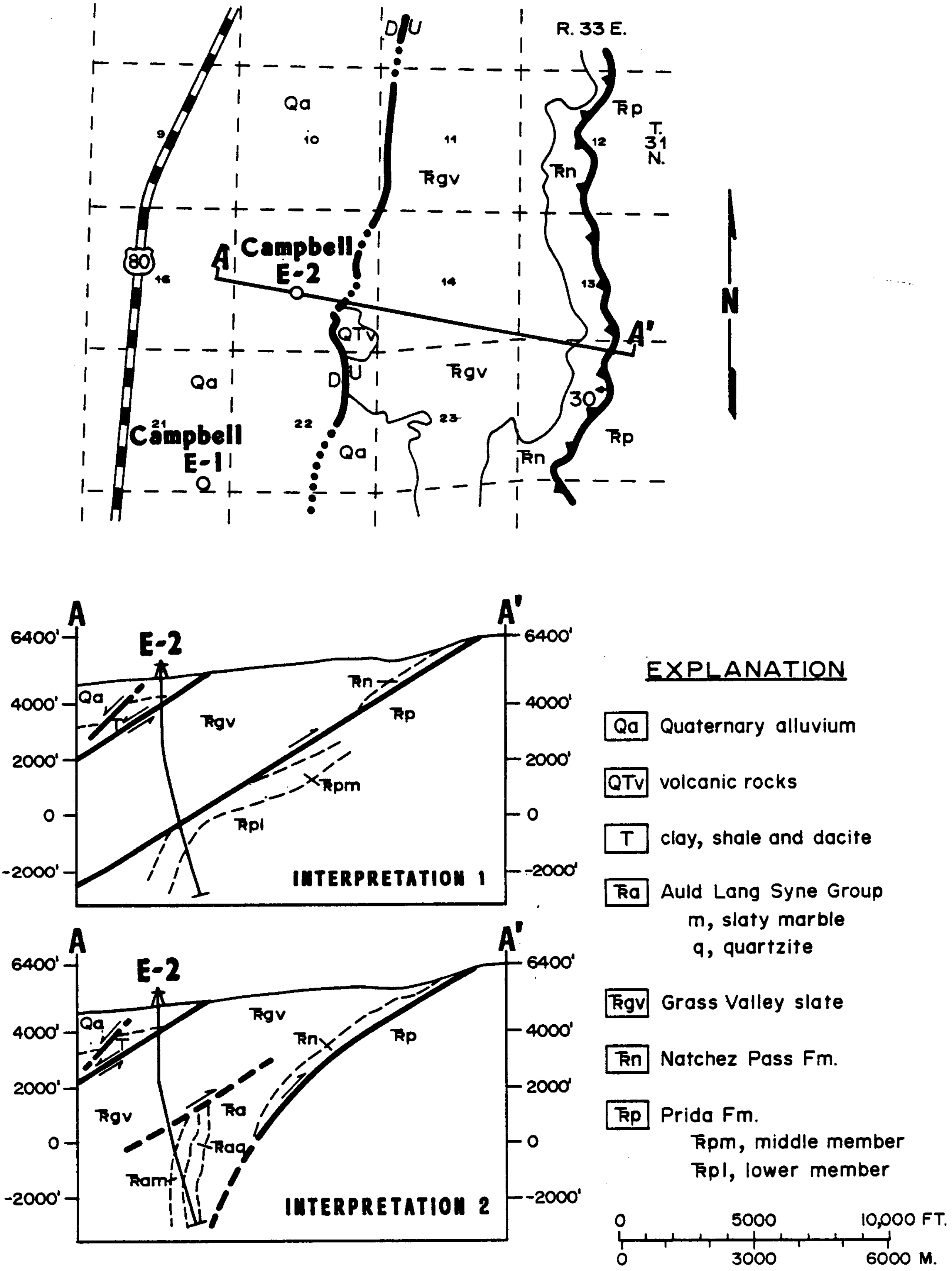


Figure 2. Geology of the Campbell E-2 well site and cross sections. Surface geology from Silberling and Wallace (1967). Interpretation 1 and 2 based on lithologic log and surface geology.

shown with the well logs on Figure 3 (in pocket).

The drill hole penetrated 740 feet (225 m) of gravel and conglomerate (Figure 3). The next 150 feet (45 m) of interbedded mudstone and dacite are probably Tertiary age, followed by about 5,000 feet (1524 m) of gray slate (Figure 3). This formation is probably the Triassic Grass Valley Formation which is exposed east of the well (Figure 2). The range front fault was probably penetrated at the top of the slate at 890 feet, (271.3 m) and below this depth the drill hole is in the Humboldt House horst. This geometry requires the range front fault to dip approximately 33 degrees from its surface trace at an elevation 100 feet (30.5 m) higher than the drill site and 1,500 feet (457.2 m) to the southeast. No evidence of faulting or of alteration which might occur along a major fault was found within the upper 2,000 feet (609.6 m) of the slate.

Within the depth interval of 5,260 to 5,800 feet (1603.2-1767.8 m) the calcite content of the slate increases; below this zone a graphite-rich marble is interbedded with slate. These carbonate rocks and the thick quartzite below cannot be correlated with the lithologies of the Grass Valley Formation (Silberling and Wallace, 1967; Burke and Silberling, 1973) or of the Natchez Pass Formation (Silberling and Wallace, 1969) which underlies the Grass Valley Formation. Two interpretations of the lithologies encountered in the hole are possible. The first interpretation suggest that the slaty marble may be correlative with the middle member of the Prida Formation and the quartzite correlative with the lower member of the Prida Formation (Silberling and Wallace, 1969). Cross section AA' (interpretation 1, Figure 2), illustrates this possibility. Interpretation 1 implies that the Humboldt City thrust was crossed at 5,260 feet (1603.2 m) and the Natchez Pass and upper Prida Formations are missing due to thrust faulting. The thrust dips 30° in outcrop (Silberling and Wallace, 1967). An average dip of 32° would put the fault at 5,260 feet (1603.2 m) under Campbell E-2. A fault zone at this depth is consistent with data from geophysical logging which indicates significant changes in rock properties over a zone from 5,240 to 5,260 feet (1597.2-1603.2 m) (Figure 3, in pocket).

The lithologies of both the slaty marble and the quartzite appear very uniform in the cuttings, whereas the middle and lower members of the Prida Formation in outcrop have diverse lithologies characterized by carbonate, argillite, siltstone, and metavolcanic rock (Silberling and Wallace, 1969). The sandstones in the lower member are characterized as calcareous (Silberling and Wallace, 1969), but the quartzite in Campbell E-2, which may be the metamorphosed equivalent of the Prida Formation sandstones, is noncalcareous. Assuming the hole intersects the formations at a small angle to the bedding plane, there is no problem with the thick intercepts because the hole would be cut nearly parallel to bedding, but the middle member would have to be crossed to reach the quartzite. The lack of evidence of interbedded lithologies in the cuttings is a problem for the Prida Formation interpretation.

An alternate interpretation suggests that the slaty marble and quartzite may be part of the Auld Lang Syne Group (Figure 2, AA' interpretation 2). The Auld Lang Syne Group, as exposed in the Antelope mining district west of the valley, contains both quartzite and limestone beds (Johnson, 1977, p. 46). The general description of the slates in the Antelope district is consistent with the slate in Campbell E-2. The Grass Valley is the lower formation in the Auld Lang Syne Group. Quartzite and carbonate units occur in the upper formations of the group. Interpretation 2 suggests that the Grass Valley Formation is thrust over upper Auld Lang Syne rocks in the Campbell E-2 hole.

The calcareous slate and slaty marble between a depth of 5260 and 6080 feet (1603-1853 m) contains a significant amount of graphite as indicated by binocular microscope and thin section study of the cuttings. X-ray defraction of insoluable residue of cuttings from 5340 feet (1627.6 m) and 5910 feet (1801.4 m) confirmed the present of graphite. Graphite is an electrical conductor and the high graphite content in these rocks corresponds to a highly conductive zone on the resistivity log (Figure 3).

Relatively resistive zones in the lower part of the conductive interval correlate with clean marble, while the highly conductive zones correlate with carbon and graphite-rich rocks. The calcareous slate probably has low permeability, and the neutron porosity log shows no significant change across the contact at 5,240 ft (Figure 3). As noted below, the neutron "porosity" is almost entirely water in hydrated minerals. Permeability, therefore, doesn't seem to be a major factor in the conductive zone. The graphite zone may be responsible for low resistivity anomalies indicated by surface methods. Other anomalously conductive zones are known in carbonaceous limestones and shales and their metamorphic equivalents in Nevada (Howard Ross, personal communication).

Surface electrical methods may not be able to distinguish between thick conductive zones due to carbonaceous material and those due to thermal fluids. Caution should be used in interpreting electrical exploration surveys where these type of rocks may be present.

WELL LOGS

A fairly complete set of well logs was obtained in the Campbell E-2 well from near surface to 5530 ft (1685.5m). Below this depth, only resistivity and temperature logs were obtained; a summary of well logs obtained in Campbell E-2 is given in Table 1. Most of the well log data were digitized and are plotted in Figure 3 (in pocket). The log composite (Figure 3) includes the drilling rate from the mud log and lithologic log abridged from the data given in the Appendix. The bit size and casing record for the well are also shown on the log composite beside the caliper log. The log quality appears quite good except that the induction log becomes saturated in the resistive quartzite and the single arm caliper obtained with the nuclear tools does not accurately depict the borehole diameter and exhibits some drift with depth. The caliper log obtained with sonic log in the upper part of the well also appears inaccurate.

A few distinct correlations between the lithology and well logs are apparent in Figure 3. The Tertiary clay/shale unit (Ts) between 740 and 870 ft (225.6 and 265.2 m) is well marked by lower resistivity, higher SP and interval travel time than surrounding rock units. The dacite in the Ts unit in this interval does not have any distinct geophysical response. The well logs agree with the top pick from drill chips for the Ts unit but suggest that the base of the unit is closer to 920 ft. At this depth a difference in the underlying slate was noted in the chip samples. The upper few meters of the slate may be weathered and fractured to generate a response similar to the Ts units.

TABLE 1 LOGS
CAMPBELL "E" NO. 2

DATE	COMPANY	TYPE OF LOG	INTERVAL LOGGED FT.	REMARKS
1-5 to 3-5-79	Energy well logging service	Energy log with lithology	45-8061 (13.7-2457.0m)	Drill Rate, mud temp., CO_2 H_2S Lithology
1-19-79	Go wireline services	B.H.C. Sonic & GR	165-1919 (50.3-584.9m)	
1-19-79	Go wireline services	Dual induction-laterolog with linear correlation log (SP)	165-1927 (50.3-587.3m)	R_m = 9.7 R_{mf} = 6, @ 58°F, 14.4°C R_{mc} = 10, MRT = 130°F, 54.4°C
2-16-79	Go wireline services	Comp. Density Neutron & Caliper & GR	1559-5530 (a) (475.2-1685.5m)	SS Calib. for Neutron Log.
2-16-79	Go wireline services	Dual induction-laterolog with linear correlation log (SP)	1559-5530 (475.2-1685.5m)	MRT = 236°F, 113.3°C R_m = 7, @ 50°F, 10°C R_{mf} = 5.1, @ 53°F, 11.7°C R_{mc} = 7.2, @ 50°F, 10°C
2-17-79	Go wireline services	B.H.C. Sonic & GR	1414-5514 (a) (431.0-1680.7m)	
3-6-79	Go wireline services	Dual induction-laterolog with linear correlation log (SP)	5303-8060 (1616.4-2457.0m)	R_m = 9.0, @ 150°F, 65.6°C R_{mf} & R_{mc} N/A MRT = 312°F, 155.6°C
3-7-79	Agnew and sweet	Temperature	100-8061 (30.5-2457.0m)	
4-30-79	Agnew and sweet	Temperature	100-8055 (30.5-2455.2m)	

(a) Individual logs were made for 2"=100' and 5"=100' scales.

The Grass Valley slate from 280 to 1600 m exhibits little variation in lithology or geophysical log response. Some highs in the SP log correlate with pyrite in the cuttings.

The top of the calcareous slate is defined by a drop in the neutron porosity, by lower resistivity, higher SP and lower gamma ray (Figure 3). This contact at a depth of 5260 feet (1603 m) is the most distinct geophysical break in the hole. As discussed above, the low resistivity is probably due to the high graphite content and fractures rather than increased porosity because bulk density is unchanged and the neutron porosity is lower. There is only a trace of pyrite in the cutting so the low resistivity is not due to sulfides.

Only the resitivity, SP and temperature logs continue into the slaty marble and thick quartzite at depth. The logs show little difference between the calcareous slate and marble. However, the marble is interbedded with slate. The lower resistivity may be due, in part, to greater fracturing of the calcareous slate and marble and, in part, to the graphite in the slate. The drilling rate was higher throughout most of this interval, again suggesting the presence of more fractures in this interval.

The quartzite below 6230 ft (1898.9 m) has such a high resistivity that the induction logs appear saturated over most of the interval. The few lower resistivity breaks suggest the presence of small fractures at these depths. The latite dike in the quartzite appears to correlate with one of these fractured intervals. The quartzite has a distinct and predictable lower gamma ray response and neutron porosity.

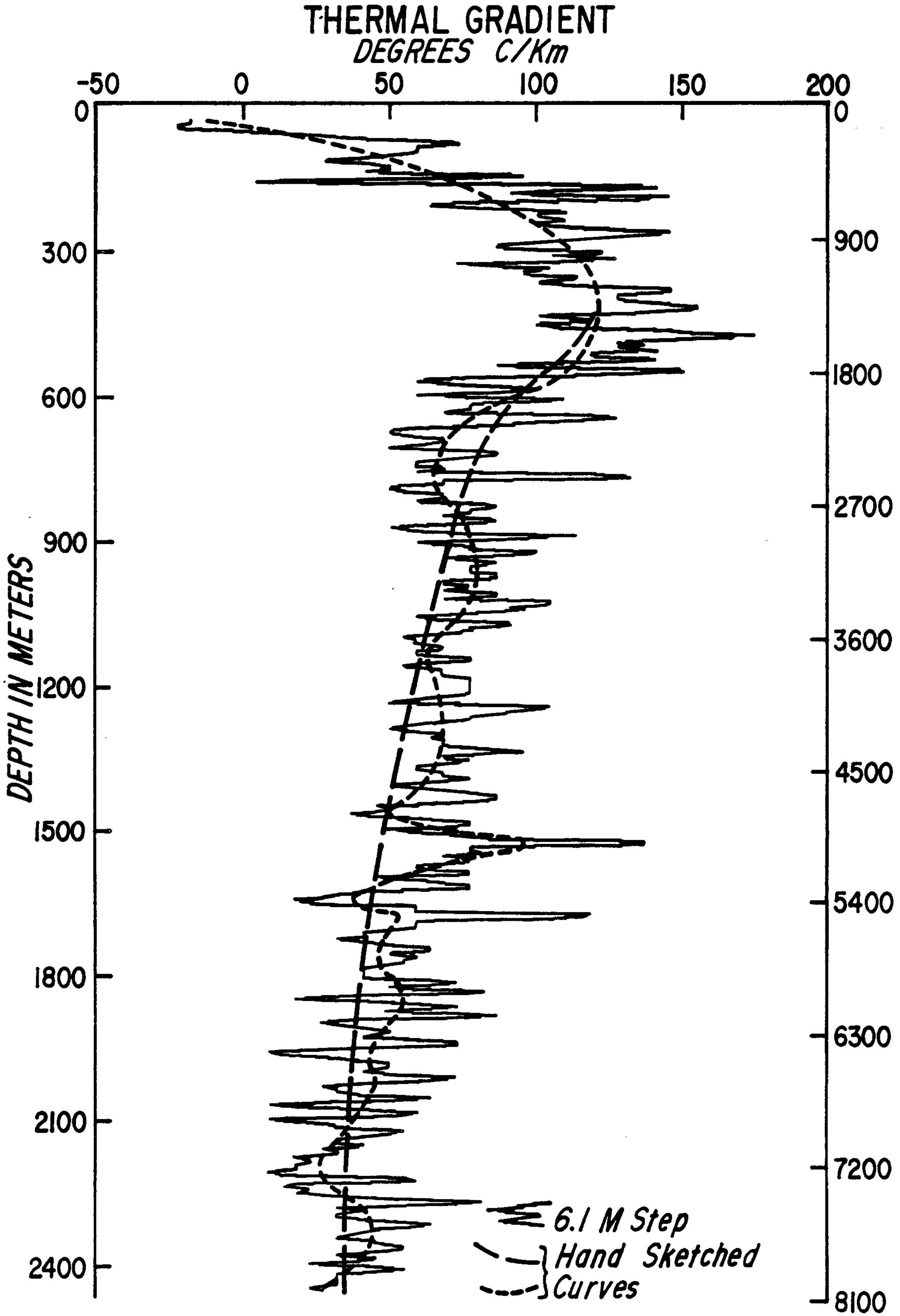
Of the two temperature logs shown in Figure 3, the log on 3/7/79 was obviously obtained before the well temperature equilibrated. The log obtained on 4/30/79 appears to have nearly reached the equilibrium subsurface temperature profile. Qualitatively, if the earlier temperature log can be interpreted in terms of a temperature injection profile, the log suggests some permeability below 5000 ft (1524.0 m), in particular associated with fractures within the calcareous slate, and below 7400 ft (2255.5 m) in the quartzite. The positive SP deflections at some of the fractured intervals either suggests that the formation water has less dissolved solids than the drilling fluid or indicates streaming potential. The mud resistivity logs indicate less than 1000 ppm TDS in the mud for all three logging runs, which makes it difficult to accept the first interpretation.

At depth, temperature gradients determined from the later temperature profile approach a uniform 34°C/km value which is close to the normal Basin and Range value. The thermal conductively of the slates may be half that of the quartzite and therefore a good part of the change in gradient with depth may be due to change in rock type and thermal conductivity (Figure 4). It would be useful to make thermal conductivity measurements on rock chips from this drill hole.

Figure 5 a, b, and c are three cross plots of log data. The cross plots show the effect of hydrous, and largely mafic, minerals on the well log. In the neutron-density cross plots the data do not follow a trend that would be expected if the rock were composed of a non-hydrous mineral component having a bulk density near 2.65 gm/cc and a hydrous mineral component having a bulk density greater than 2.65 gm/cc. The hydrous mineral component appears to be different in the two intervals plotted. The shallower interval has a greater

FIGURE 4

CAMPBELL E-2

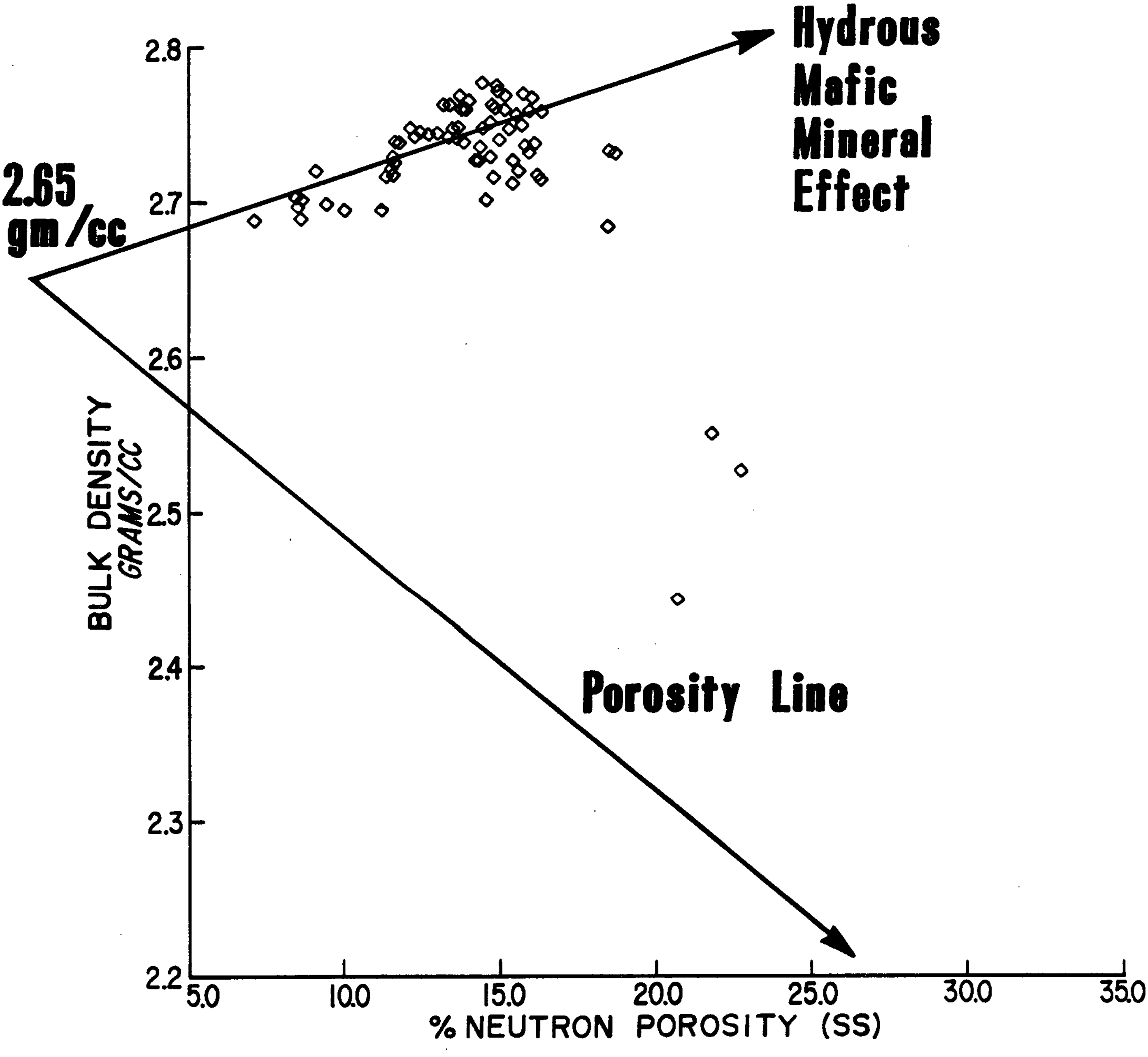


Nev/HH-005

FIGURE 5a

CAMPBELL E-2

BULK DENSITY VS NEUTRON POROSITY



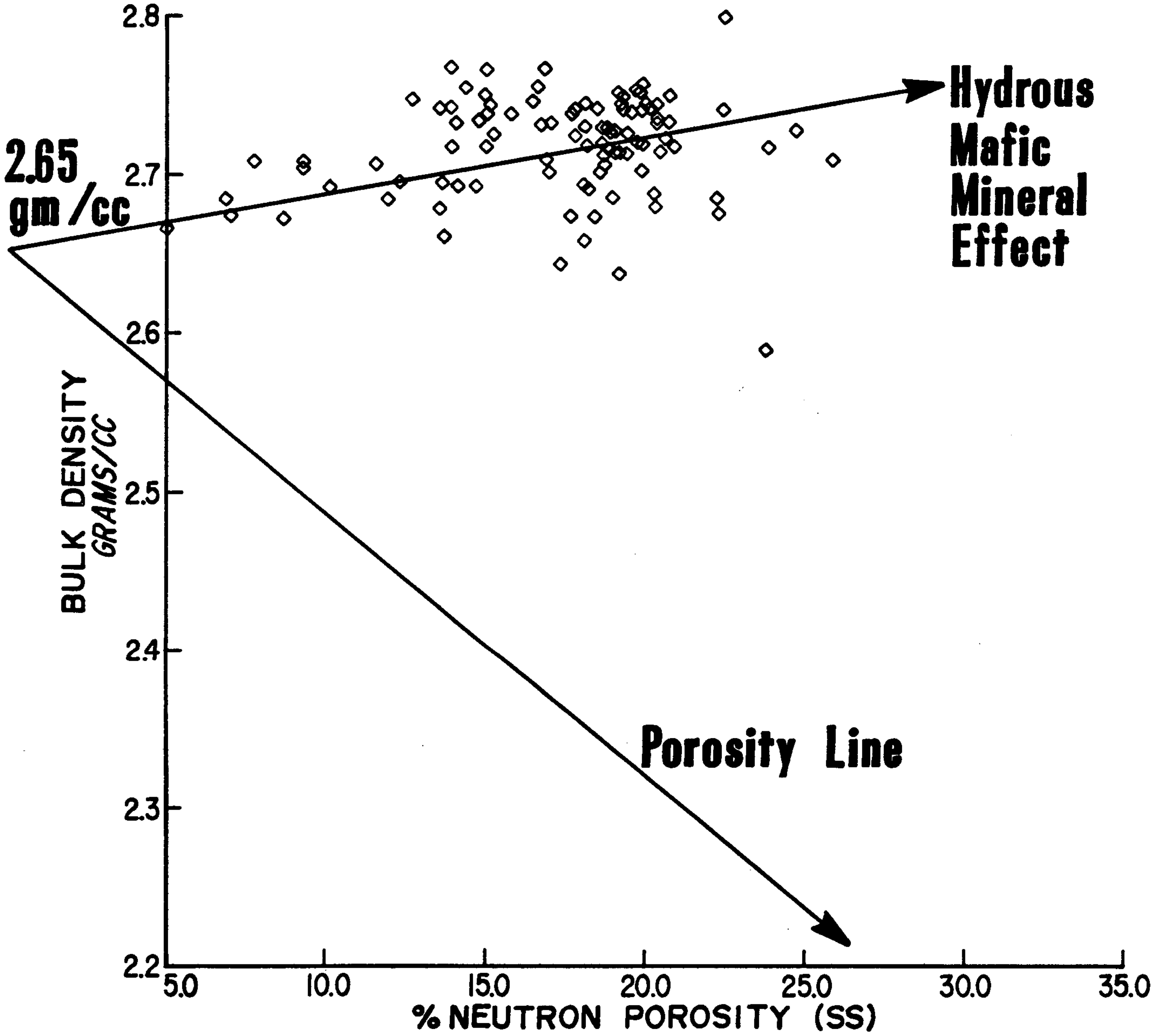
4902.00–5198.00 FEET AT
4.00 DEPTH UNIT INTERVALS

Nev/HH-006

FIGURE 5b

CAMPBELL E-2

BULK DENSITY VS NEUTRON POROSITY

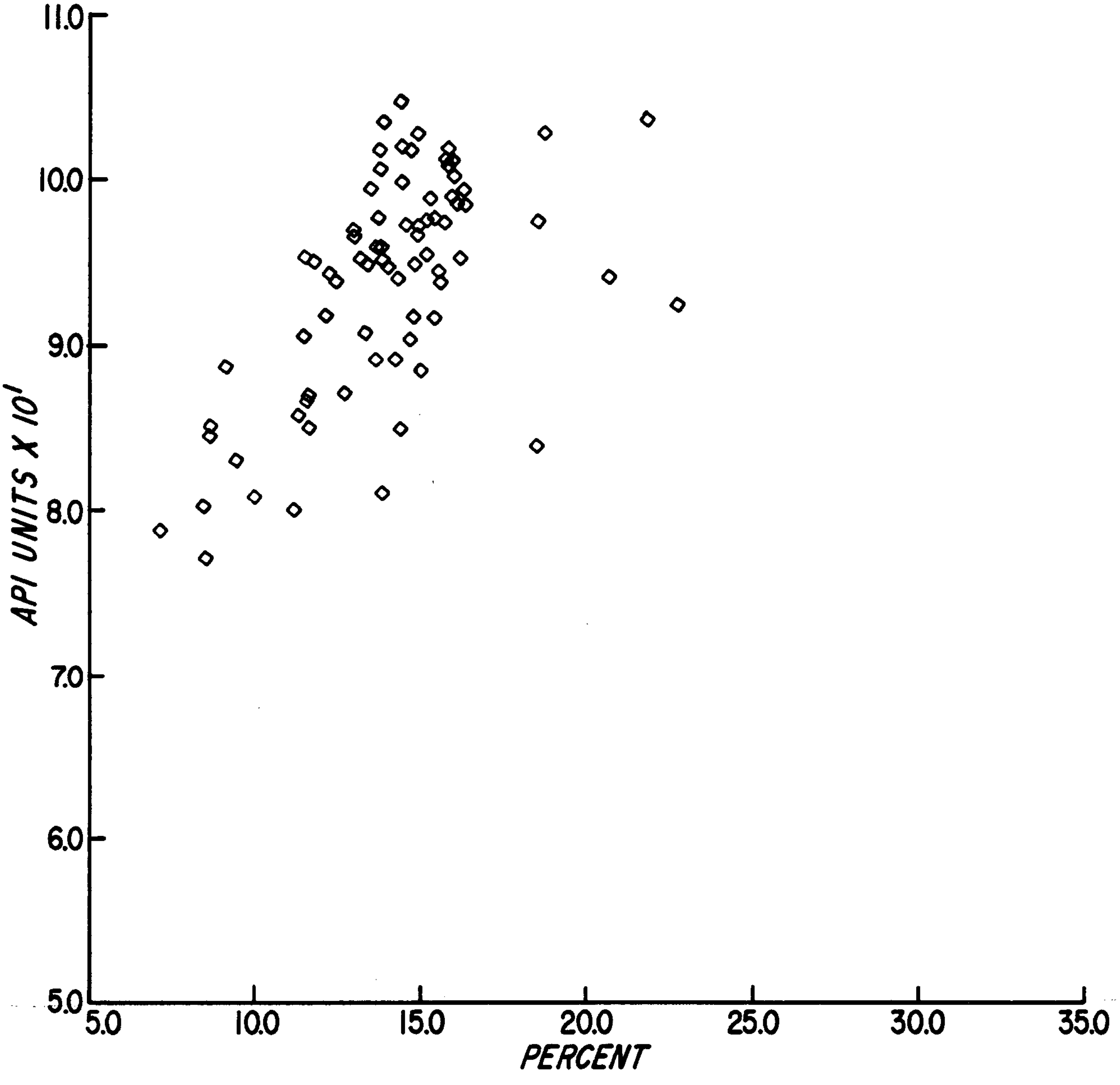


3202.00–3598.00 FEET AT
4.00 DEPTH UNIT INTERVALS

Nev/HH-007

FIGURE 5c
CAMPBELL E-2

GAMMA RAY VS NEUTRON POROSITY



4902.00-5198.00 FEET AT
4.00 DEPTH UNIT INTERVALS

neutron "porosity" variation and a probable lower hydrous mineral density than the deeper interval. This result suggests that either the hydrous minerals are dehydrated with depth or additional hydrous minerals are developed by hydrothermal alteration, that is, clay minerals in the upper interval are replaced in part by micas in the lower interval. The gamma ray neutron porosity cross plot in Figure 5c shows a correlation between higher "porosity" and higher gamma ray response. This result again supports the interpretation that potassium rich, hydrous minerals such as clays and micas contribute to the observed neutron and bulk density log responses.

CONCLUSIONS

In light of the cuttings and geophysical logs from the Campbell E-2 hole, it seems unlikely that a geothermal reservoir exists in the horst block of the Humboldt House area. All known sinter deposits occur in the graben block in the valley, northwest and southwest of Campbell E-2. The range front fault, which may serve as a conduit for deeply circulating fluids, dips to the west and intersects the hole at 890 feet (271.3 m). The presence of sinter deposits and the deeper extension of the fault to the west suggest that the geothermal system may be located to the west of the Campbell E-2 hole.

The Grass Valley Formation and the Auld Lange Syne Group in general are fine-grained argillaceous and slaty rocks. These rocks have a very low intergranular permeability and may not be competent enough to maintain a significant fracture permeability necessary for a geothermal reservoir rock.

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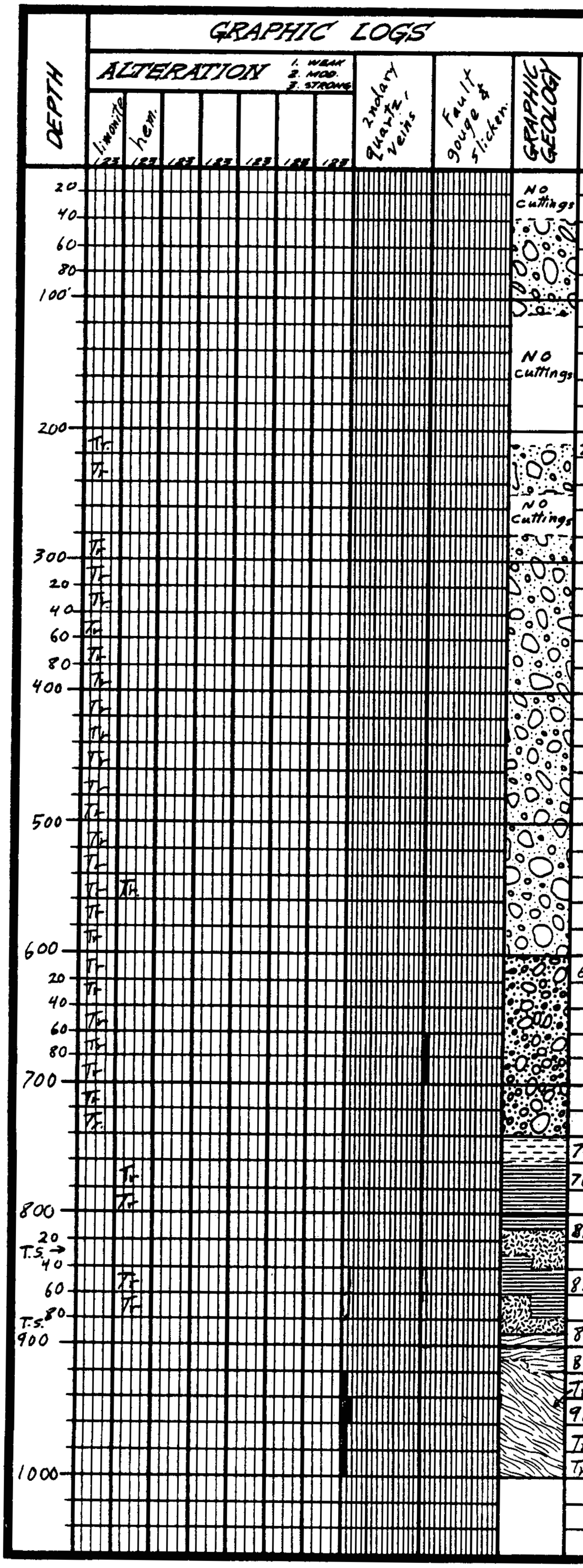
APPENDIX

DETAILED LITHOLOGIC LOG OF CAMPBELL E-2 HUMBOLDT HOUSE THERMAL AREA



DESCRIPTIONS

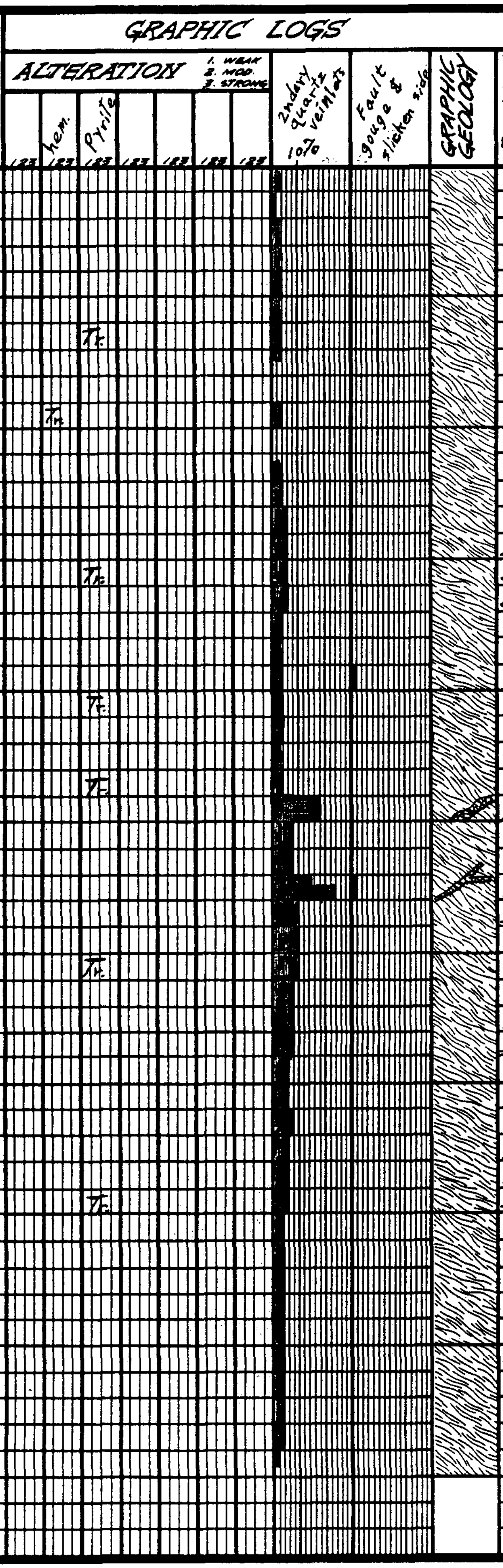
T.s. - Thin section from indicated interval

Tr TRACE 1. WEAK 2. MOD. 3. STRONG VEINLETS	DESCRIPTIONS
40-110	Gravel, coarse, clast of slate,
	volcanic rx. xline intrusive, qtzite,
	dk gray ls.
210-600	Gravel, or cong. coarse, clast of quartzit
	white to dk gray & yellow, slate,
	porphyritic volc., siltst, clacite
	limonite stain in qtzt chips.
	dk. gray ls. is a major componen
	~40% dk gray ls. & 40% wh. qtzt.
	also a few volc. frag. & yellow qtzt.
	Below 460' ls. content increases
	to ~60% of cuttings.
	a few small rounded grains
	Lithification of the gravel can
	not be determined from cutting.
	The unit may be gravel or cong.
	or grade into cong.
600-740	Conglomerate, ~90% dk gray ls.,
	few wh-yel qtzt chips, and
	rounded med. gray slate clast.
	and med. gray siltst. clast.
740-760	Clay-mudst., pale brn, sand grn., poss. Paleo-soil.
760-810	Shale, 75%, pale brn, 25% chert or siltst
	pale. yel. brn.
810-830	Dacite alt. vol., li. brn-gray to li. gray.
	wh. Plag. pheno., poss. bio., 830-840 mixed.
835-870	Shale, mod. brn, some pale brn, wh. clay.
	860-880 mixed sample, shale & vol.
870-890	Dacite, flow-dike? porphyritic, alt. bio, plag, Am
890-915	Slate, li. olive gray, few brn, few Calc
Tr. qtz	910-920 Mixed sample, olive & dk. slate
915-4610	Slate, med. dk. gray., foliated, mica
Tr. qtz	sheen, foliation is folded into open ripples
Tr. qtz	of <1mm amplitude and crest spacing,
	few li. brn. chert or silic. slate chips,
	quartz is milky to clear. Calcite cont
	is minor, but a few wh.-clear calc. chip

DRILL HOLE Campbell E #2 Phillips Petro.

LOCATION Sec. 15, T. 31 N., R33E., Humboldt House.

LOGGED BY Sibbett



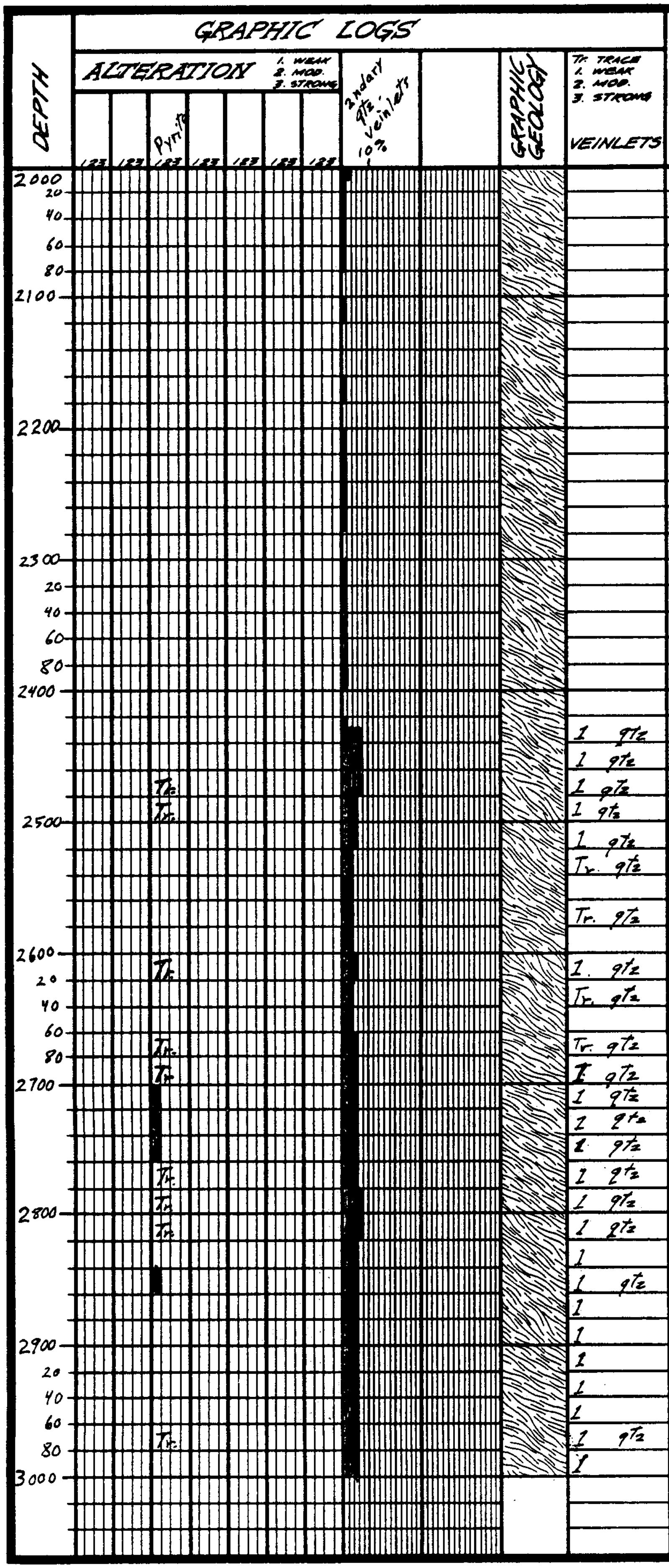
DEPTH	hem.	Pyrite	Tr. TRACE 1. WEAK 2. MOD. 3. STRONG VEINLETS	DESCRIPTIONS
1000			915-4670	slate, med. dk gray (Continued).
20				The microfolding of foliation
40				suggest larger structures are
60				present.
80				Qtz is gen. in free chips, but when
1100				in a slate frag. the qtz occurs
		Tr.		both crosscutting and parallel to
				schistosity.
	Tr.			hem. in qtz. frag.
1200				Half or more of the foliation planes
				are unfolded or wrinkled.
			1 - qtz	
			1 qtz	
1300		Tr.	1 qtz	
20			1 qtz	
40			Tr.	Trace calcite
60			Tr	
80			Tr	poss. slicken side parallel to foliation.
1400		Tr.	Tr	py. in slate, not qtz.
			Tr	1440 - frag. of calcite.
			Tr	
		Tr.	Tr	
T.S.			2. qtz	Veinlet aphanitic to fine gr. phaneritic,
1500			1 qtz	qtz and chl., 1/3 of sample
			1 qtz	
			2 qtz	
			1 qtz	
			1 qtz	m. dk gray Slate
1600		Tr.	1 qtz	
20			1 qtz	
40			1 qtz	
60			1 qtz	
80			1 qtz	
1700			1 qtz	
			1 "	frag. of siltstone
			1 "	
			1 "	
		Tr.	1 qtz	
1800			Tr. qtz	& —
			Tr	
			Tr	clay or zeolite, white, soft.
			Tr	
			Tr	
1900			Tr	
20			Tr	
40			Tr	m. dk. gray Slate
60			Tr.	
80				
2000				

DRILL HOLE Campbell E #2 Phillips Petro.

LOCATION Humboldt House, Pershing Co., Nev.

LOGGED BY Sibbett

p. 3



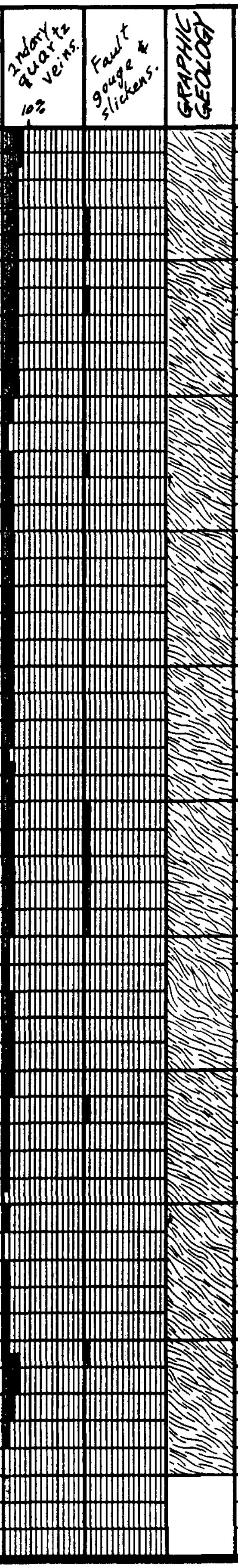
DEPTH	Pyrite	VEINLETS (Tr. TRACE, 1. WEAK, 2. MOD., 3. STRONG)	DESCRIPTIONS
2000			Slate, med. dk gray (continued from 915')
20			
40			
60			
80			foliation planes not folded.
2100			very uniform slate
			Trace of calcite in slate.
2200			
			Med. dark gray slate (continued)
2300			
20			The slate is soft and therefore low grade slate, but the mica and foliation is moderately well developed.
40			
60			
80			
2400			
		1 qtz	
		1 qtz	
	Tr.	1 qtz	pyrite not in the qtz.
	Tr.	1 qtz	
2500		1 qtz	
		Tr. qtz	
		Tr. qtz	
2600	Tr.	1 qtz	
20		Tr. qtz	
40			
60	Tr.	Tr. qtz	
80	Tr.	1 qtz	wrinkled foliation surfaces.
2700		1 qtz	
		2 qtz	Pyrite occurs as free frag. or in slate chips.
		1 qtz	
	Tr.	1 qtz	
	Tr.	1 qtz	
2800	Tr.	1 qtz	
		1	
		1 qtz	
		1	
		1	
2900		1	
20		1	
40		1	
60	Tr.	1 qtz	
80		1	slate continued from 915', and is unchanged, very uniform with only qtz content varying.
3000			

DRILL HOLE Campbell E #2 Phillips Petro.
LOCATION Sec. 15, T. 31 N., R. 33 E., Humboldt House, Nev.

LOGGED BY Sibbett

GRAPHIC LOGS

ALTERATION 1. WEAK 2. MOD. 3. STRONG

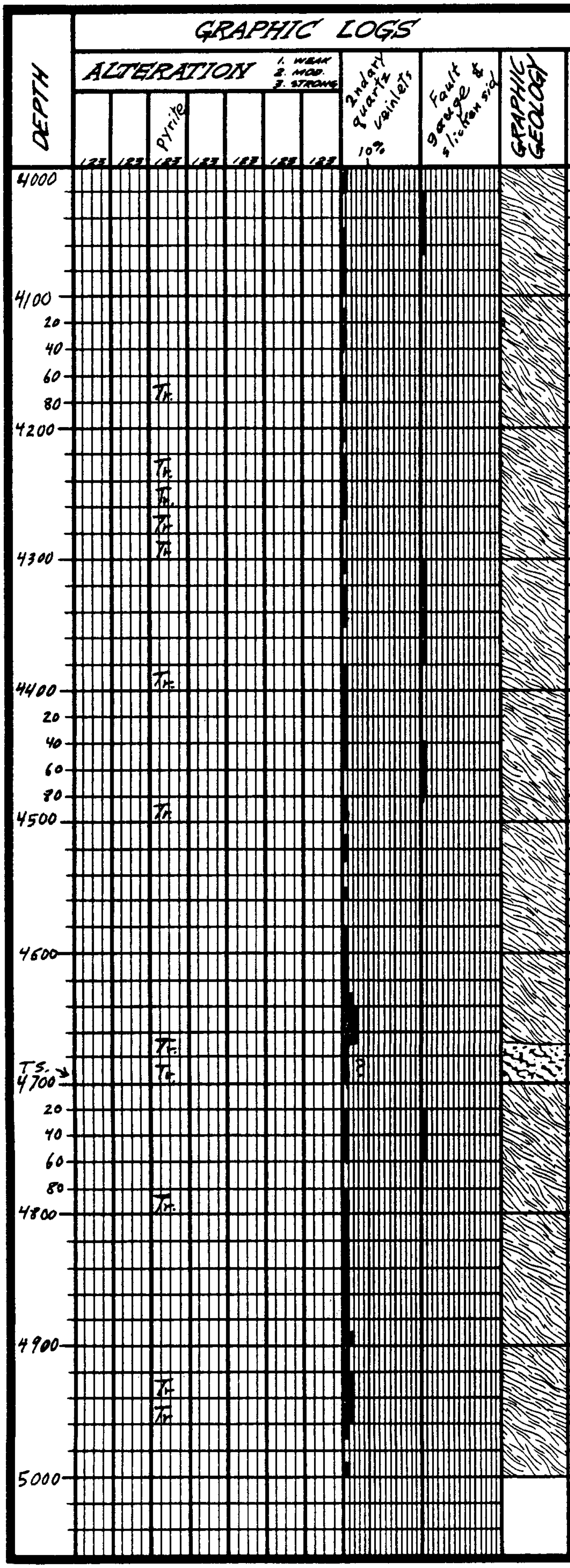


DEPTH	pyrite	VEINLETS & type (Tr. TRACE 1. WEAK 2. MOD. 3. STRONG)	DESCRIPTIONS
3000		1 qtz	Slate, med. dark gray and mod.
20		1 qtz	soft, continued from 915'.
40	Tr	1 qtz	
60		1 qtz	
80		1 qtz	Trace calcite, white, fine grained
3100		1 qtz	
	Tr	1 qtz, py	Tr. anh. py. in qtz.
	Tr.	1 qtz	
	Tr	1	
	Tr	1	
3200	Tr	Tr. qtz	milky qtz
		Tr	
	Tr	Tr	
		Tr. qtz	
3300	Tr	Tr	foliation plane rippled in 2 directions
20	Tr	Tr	
40	■	Tr. qtz	
60	Tr	Tr	milky to clear qtz
80	Tr	Tr	There is no alteration of the
3400	Tr	Tr	slate around the qtz veinlets.
3500	Tr.		
	Tr.		
	Tr		Scattered hem. stain from drill
			bit steel.
3600			
20	Tr		
40			
60	Tr		
80		Tr.	
3700	Tr		
	Tr		
	Tr		Very uniform med. dk gray slate
			continued.
3800	Tr		
	Tr		
	Tr		
	Tr		
3900		Tr.	
20		1 qtz	
40		Tr.	
60			
80			Slate, med. dk. gray.
4000			

DRILL HOLE Campbell E #2 Phillips Petro.

LOCATION Sec. 15, T. 31N., R. 33E., Humboldt House, Nev.

LOGGED BY Sibbett



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

VEINLETS & type.

DESCRIPTIONS

T.S. - Thinsection of the interval marked.

Slate, med. dark gray, continued from 915'. mod. soft.

scattered hem. stains are from drill bit steel in the cuttings

Trace calcite

A few chips of slate are med. gray.

some of the qtz may be quartzite.

4670-4700 Quartzite, clear to light milky, ≈15% slate at least partly recrystallized. | minor veining

4700-5280 Slate, dark gray, foliated, graphite? 4700-4720 ~ 20% qtzite.

few frag. of orange waxy mat. poss. drillg additive (4740-4770).

Slate is the same as the thick slate interval above but slightly darker.

Trace wh. calcite 4890-4910.

dark gray slate continued from 4700'.

DRILL HOLE Campbell E #2 Phillips Petro.

LOCATION Sec. 15, T. 31 N., R. 33 E., Pershing Co., Nev.

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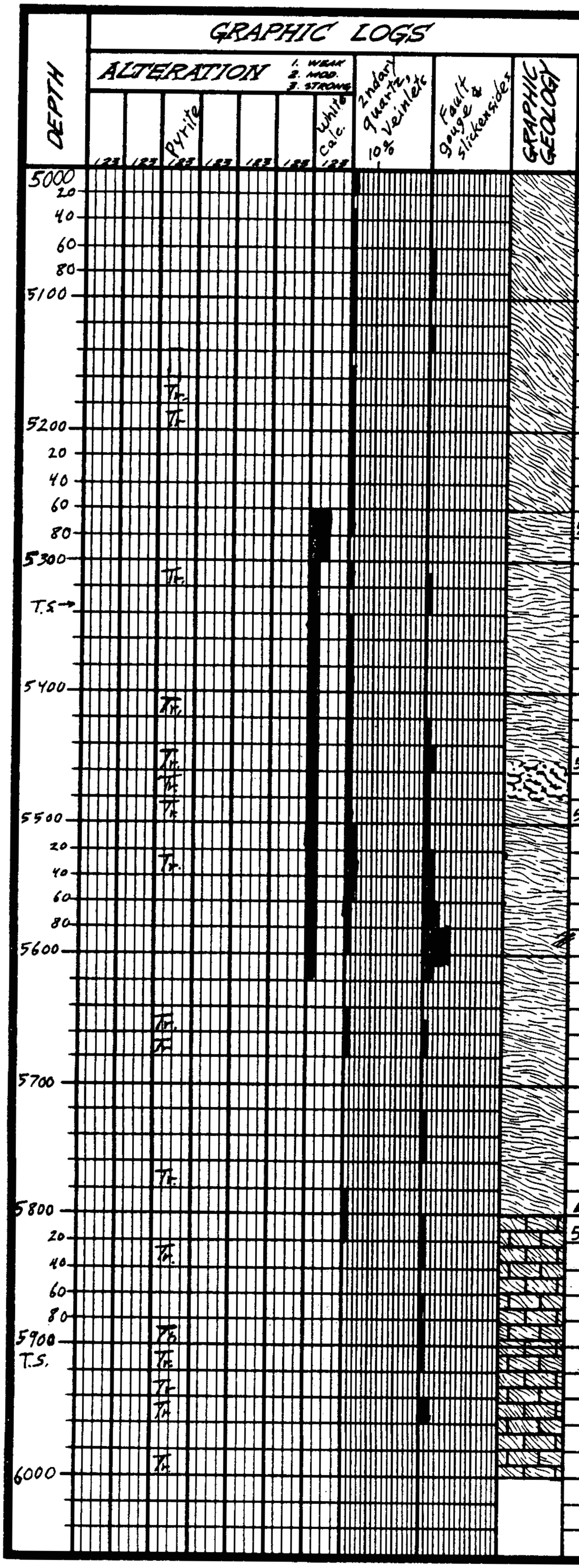

Tr. TRACE 1. WEAK 2. MOD. 3. STRONG VEINLETS & type	DESCRIPTIONS T.S. THIN section for interval indicated
4700-5260	Slate, dark gray, foliated, soft.
	uniform color and texture.
	Tr. gypsum, possible graphite.
	Tr. calcite
	dark gray to grayish black.
	pyrite in qtz. (5160-5280)
	Trace calcite, wh.
	few dolomite? & calcite frag. 5220'-60'
5260-5450	Calcareous Slate, grayish black, foliated, med-hard
1, calc	5330-40 is 30-40% calcite in slate
	5280- ≈ 10% calcite, wh. - clear
	Possible slickensides and fault gouge,
	but difficult to distinguish from foliation.
	Slate has a metallic luster, graphite.
	x-ray def. indicates graphite at 5300'
5450-5480	Quartzite, light gray meta siltst.
	with 10-30% slate chips mixed., 10% calc
5480-5800	Slate, calcareous, gray-black to dk gray, w/ graphite
	5480-5500 10% qtzt plus 10% calcite or mbl.
	hem. stains from drill steel.
	5520-5560 ≈ 25% marble + 25% qtzt
	5560-5610 cement chips ≈ ½ of cuttings
	5550 - heavy hem. stain from drill still.
	≈ 20% calcite or marble. to 5640'
	cement? ≈ 40% to 5650
	5640-5800 ≈ 10% calcite chips. white.
	Slate has high calcite content through out.
	(Dual Induction log indicates the top
	of the marble may be at 5770'.)
5800-6250	slaty marble, foliated arg. in calcite
	≈ ⅓ is calcareous siltst.
	grayish black, cystalline calcite & graphite
	Calcite content increases with depth
	and foliation decreases.
	slicken side on clear calcite
	5960-5970 ~40% cement.

DRILL HOLE Campbell E #2 Phillips Petro.

LOCATION Sec. 15, T.31N., R.33E., Humboldt House

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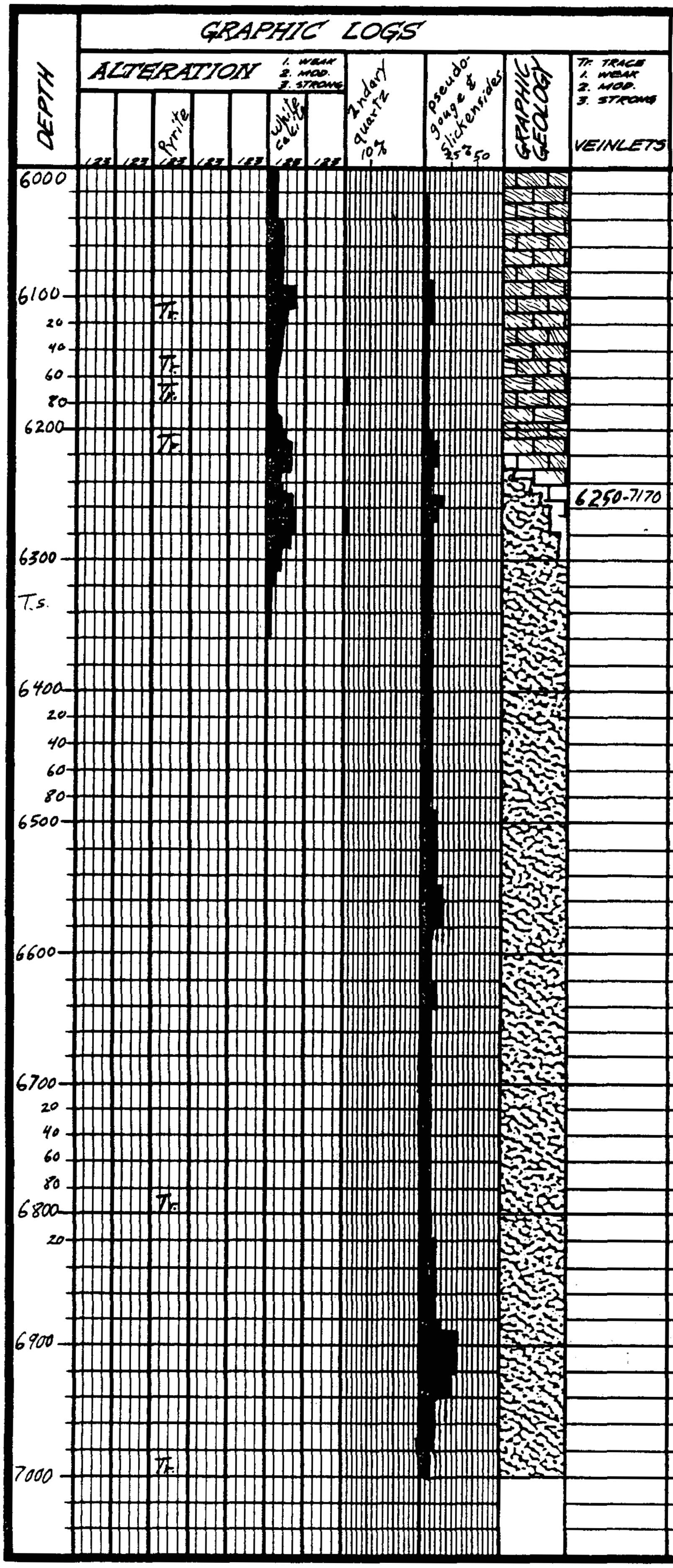

DESCRIPTIONS

Marble, slaty, Continued from 5800'.
grayish black, crystalline, calcite &
graphite & poss. clay & silt.
10% of chips are white xl calcite
6090-6110 2/3 wh. calcite
6110-6140 1/3-1/2 wh. calcite

6180-6230 wh. calc. content incr. to 1/2 sam

Quartzite, clear to white, sand grain
not visible, high calcite content at
contact decreases with depth.
slate % decreases to ~10% at 6280
slate cont. is prob. contamination
There may be a dol. + marble bed 6260-6280
strong orange hem. stain appears due to drill
steel.
~5% slate chips content.
Quartzite contains minor white-li. grn
sericite.

High content of gouge-like material
with slicken sides of chips
produced by drilling operation.

Very clean qtzite, v. well sorted.

Sand grains v.f. to silt size

well sorted, clean quartzite

pseudo-gouge is prob. drilling-produced
material.
increase of white, soft gouge
also increase in calcite, – in pale grn
chips. Gouge chips often have black
coating on the slickenside surface.
Muscovite - probable drilling additive.

DRILL HOLE Campbell E #2 Phillips Petro.
LOCATION Sec. 15, T. 31 N., R. 33E., Humboldt House, Nev.

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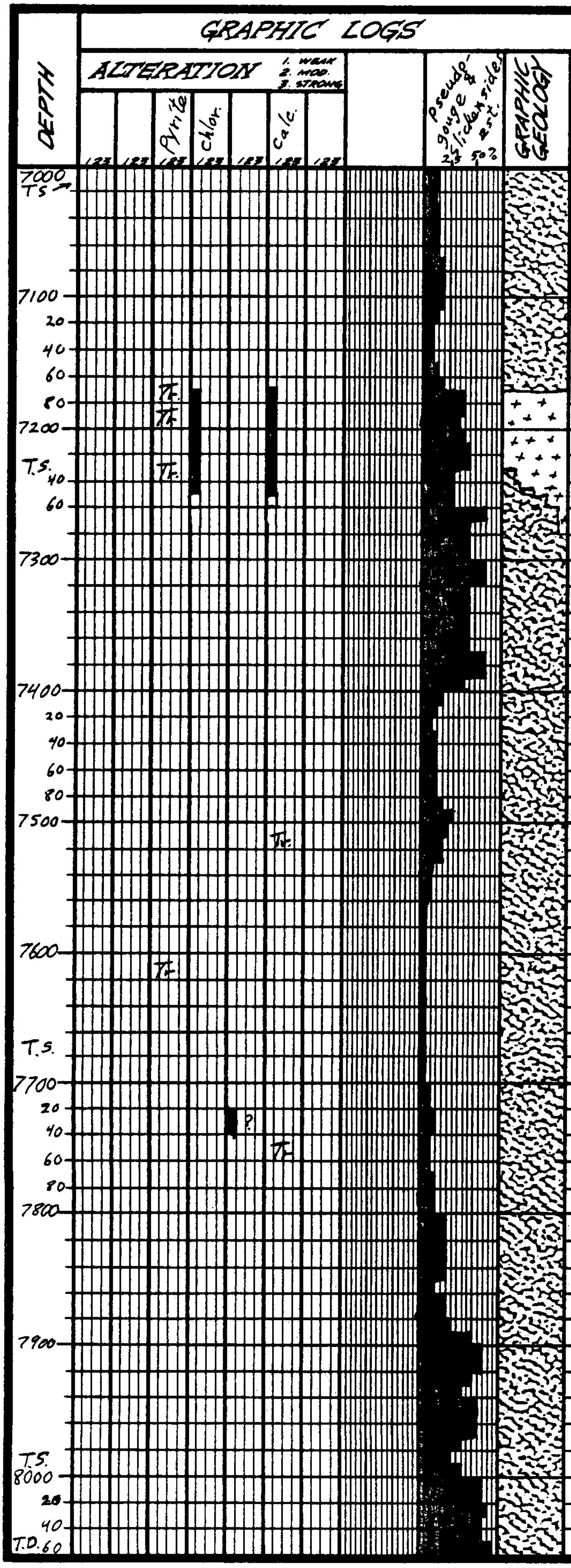

VEINLETS Tr. TRACE 1. WEAK 2. MOD. 3. STRONG	DESCRIPTIONS
1. qtz, cal.	Quartzite (Cont. from 6250') clear to wht.
	clean, well sorted, with minor
	sericite, white to light grn. and minor
	calcite, white & light grn.
	Few black slate or marble chips. also-
	probably contamination.
	Few qtz veins & calc. veinlets.
	Large sheet of muscovite - could be circulatio
	material.
7170-7250	-Latite ? V.f. grain to aphanitic,
	grnish to bluish gray. prop. alt, chlor.
	and calcite, ~10% qtz. from above.
	7230-7260 qtzt % of cuttings increase
7250-	Quartzite, clear-white, clean, w. sort.
	few igneous clast cont. in 7250-
	few black min. (bio. or hem.?) spread
	thru. qtzt chips.
	Specks are 1-2% of rock.
	7360' - few slate chips with tr. py.
	pseudo-gouge is prob. drilling produced.
	Meta-siltstone with micas minor.
	Many of the chips are platy in
	shape, but no Foliation is eviden
	Few chips of slate
	Rock is med. light gray 7540-7890
	Contains magnetite
	Few sheets of muscovite - prob. addit.
	Abundant green mica - celadonite ?
	lower grade than biotite.
	? cement chips? 7750-7780
	Poss. chor. giving rock a green tint.
	or talc.
	7850 - Poss. gypsum chip.
	the cement-like material. looks
	like the fault gauge material but
	the cement contains significant
	calcite and the gouge has very
	little calcite.
	7860' - muscovite sheets to 7900'
	Abundant cement-like frag. in the
	bottom ≈ 200' of cuttings
	Mostly qtzite but ~⅓ alt. diorite?

DRILL HOLE Campbell E #2 Phillips Petro.

LOCATION Sec. 15, T. 31 N., R. 33E., Humboldt, Nev.

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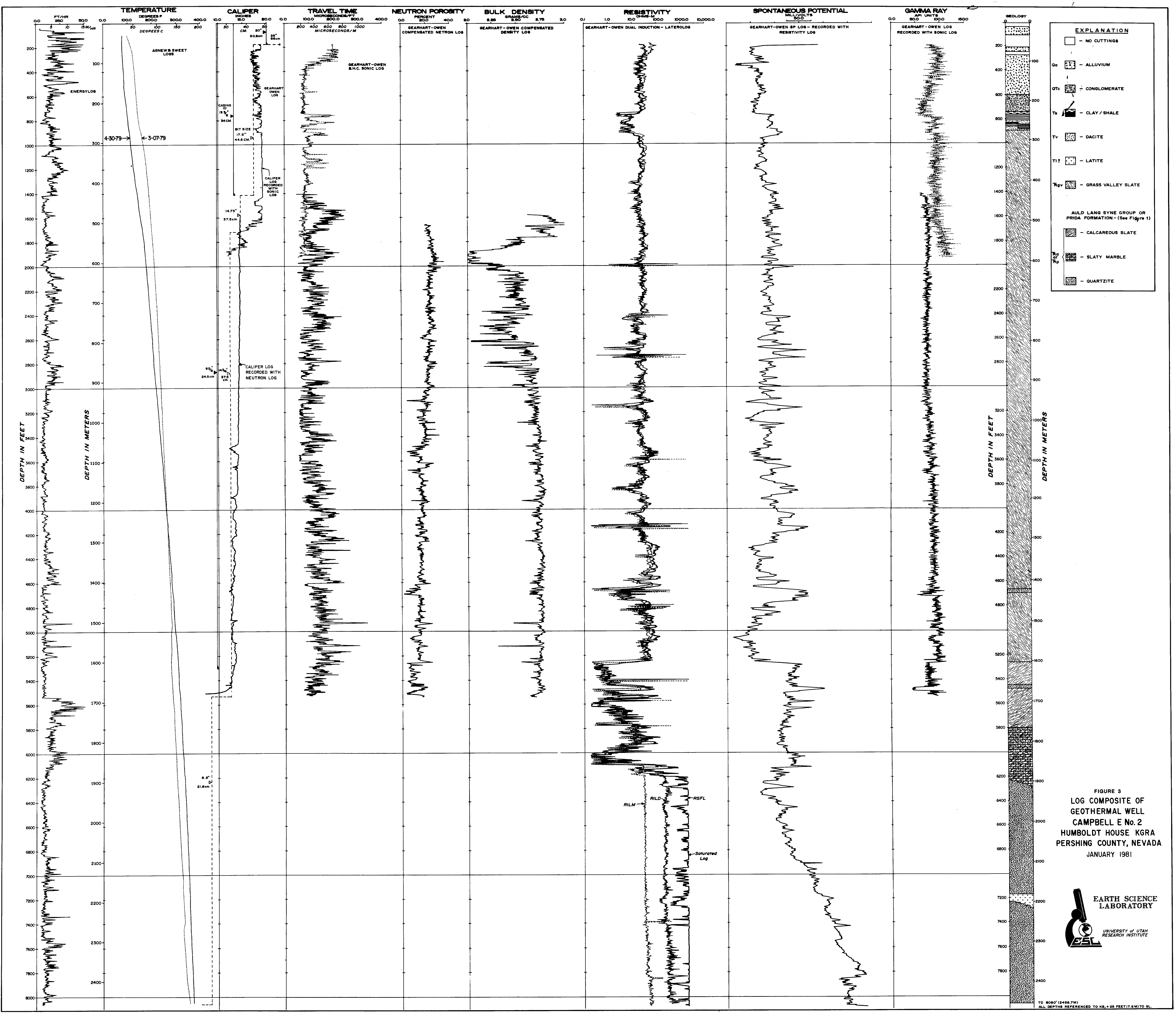

FIGURE 3
LOG COMPOSITE OF
GEOTHERMAL WELL
CAMPBELL E No. 2
HUMBOLDT HOUSE KGRA
PERSHING COUNTY, NEVADA
JANUARY 1981

EARTH SCIENCE
LABORATORY

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