AREA
CA
Lassen
WenAmad

GL03151

MEMORANDUM

January 28, 1982

TO: Jon Zeisloft

FROM: Bruce S. Sibbett

SUBJECT: Lithologies penetrated in the WEN-W1 hole, Geoproducts, Wendal, California

The lithologies penetrated in the WEN-W1 hole as interpreted from the cuttings and geophysical logs can be summarized into a few general units. The upper 2620' consist of lava flows with minor interbedded sediments. The Lake Lahonotan sediments occur at the surface but are not represented in the cutting because the top 110 feet were not sampled and the lake beds are less than 110 feet thick. From a depth of 110 feet to 640 feet basalt to basaltic-andesite lava flows are present. From 640' to 865' tuffaceous sediments and several zone with no returns were penetrated. The feldspar, quartz and biotite crystals present suggest the sediments are rhyolitic to latitic. The lack of geophysical logs in this interval precludes any inferences as to what was in the lost sample zones. The andesite at 865-895' may be a dike and there is evidence of faulting. The lithic tuff at 1010-1090 shows a low gamma response and is therefore basaltic to andesitic in composition. A minor fault may be present at the base of the tuff. Below the tuff and continuing to 2620' the rocks are basalt and andesite lava flows.

The middle part of the hole, 2620' to 4550' penetrated a monotonous interval of basaltic to andesitic volcanoclastics consisting of unsorted to poorly sorted coarse clast with a clay and sand matrix. The clays are iddingsite, chlorophaeite, probably saponite and palagonite group, the typical alteration products of olivine and basaltic glass. Some tachylyte remains. These clays probably formed at the time of deposition or soon after. The rocks were probably deposited as lahars and ash and cinder deposits with minor reworked sand zones.

The rocks penetrated in the bottom third of the hole are conglomerate and plutonic basement rocks. The conglomerate which extends from 4550 to 5050' consist of clast of meta-siltstone, quartzite, chert and diorite to granite. Chips of volcanic rock are present but these are probably contaminants from the volcanic rocks above. The fine matrix or intra clast material was not seen in the cuttings and whether it is permeable or not could not be determined with the electric logs. The lack of production from or drilling fluid loss when drilling the conglomerate suggest it is impermeable however.

From 5050' to T.D. at 5788 granodiorite and granite were penetrated. The nature of the intercepts suggest that the granite occurs as dikes in the

granodiorite. The change from granodiorite to granite at 5300' is a major change on the geophysical logs and hematite stained joint surfaces are evident just above 5300'. It is therefore concluded that a major fault is present at 5300' and subsidiary fracturing extends up to 5200'. The cutting size decreases significantly below 5300' suggesting the rock is more competent and less fractured below the fault.

The conglomerate may be important for interpreting the structure. For example if the conglomerate is much thicker in the WEN-1 hole than in the Gulf hole to the south, but the top of the conglomerate is at about the same elevation in both holes, this would suggest that faulting of the diorite basement rock occurred during or prior to depositiion of the conglomerate. If however, the conglomerate is the same thickness in the Gulf hole but at a different elevation, then the faulting postdates the conglomerate. The relative age of the basement rock faulting, which controls the geothermal system in the subsurface, is important because it has implications as to the probable orientation of the fault and whether it extends up into the basaltic lahars which seem to cap the system.

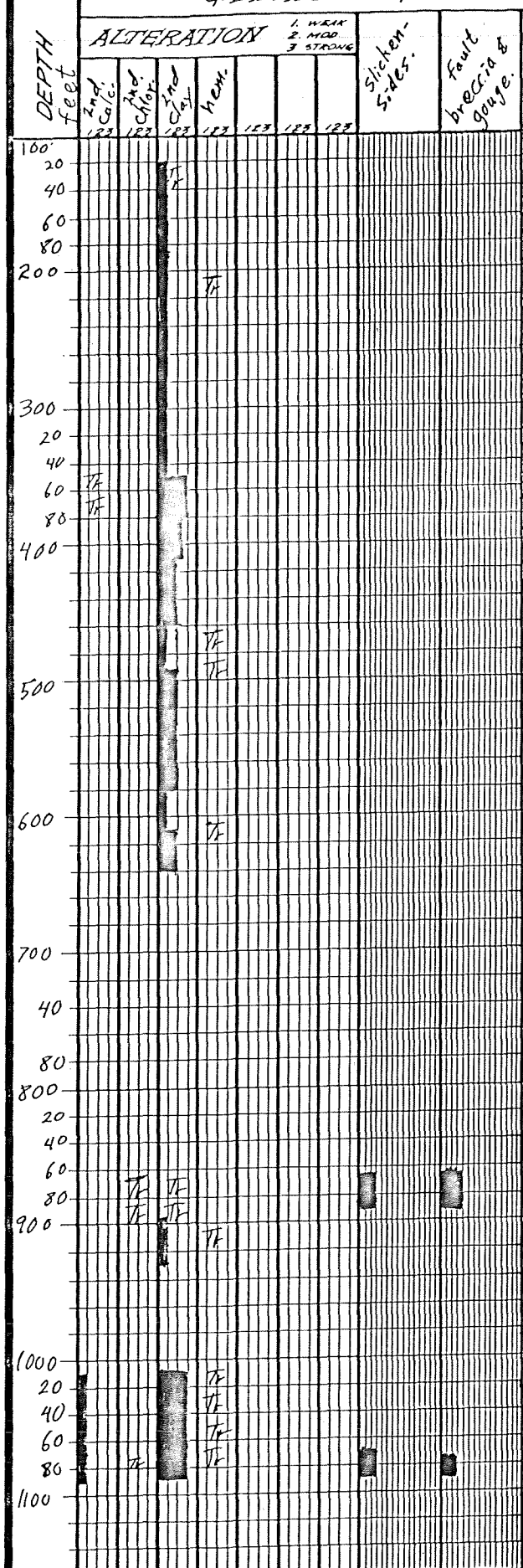
Alteration

The alteration in the Tertiary volcanic rocks is probably deuteric in origin because pyrite, hematite, calcite and quartz veins are all lacking. Pyrite and calcite is present within the conglomerate and some of both occur as coatings on polished chert clast indicating they postdate deposition of the conglomerate. In the granodiorite where the thermal fluids are produced pyrite was not observed but epidote, quartz veinlets and hematite stained joints are present. It is important to determine from the water chemistry whether the thermal fluids are precipitating pyrite or hematite. The general lack of calcite in the subsurface is surprising in light of the large tufa mounds at Wendel Hot Spring. If the thermal fluids are carrying that much calcite, where does the calcite come from?

Bruce S. Sibbett

BSS:nlr

GRAPHIC LOGS



DESCRIPTIONS

30' Sample intervals

0-100' no cuttings

110-140 ½ tuffac. Ss w/ pumice, q, fz - feldsp. xls
½ basalt, m. gy, 1-2m pheno.

140-430 Basalt, brn, vasicular, few sand grains,
200-230 ⅔ cement, ⅓ basaltic
redish-brn alt., prob. Iddingsite ← Olivine

270-350 red scoria w/ dense dk gy chi
minor palagonite type clay in vesicles

350-410 Strong alt. matrix & feldsp → clay
olivine alt. to iddingsite,
Poss. andesite or basaltic-andesite
410- argilic. alt. cont. w/ few fresh

430-640 Basaltic-andesite? - li. brnish gy, li. gy, oliv
~30% ½ mm xls, few ~1mm pyrox. & plag. xl
Multicolored chips, gy, yel., orange,
490-520' V.F. cuttings, red-brn.
deuteric alteration.

clear zeolite xls.

Sidermolone - (glass)

640-805 Tuffac. sed., m. gy. vitric Vol. clast in a
sandy - tuffac. matrix, free 2mm feldsp. xls
fresh bio. xls., few hornb., quartz pres.
rhy - latitic tuffac. sed., Cong. & Ss.

crystal rich tuffac. Ss.

865-895? Andesite? blk - dk. gy. fine gr. xl.
no pheno., poss. dike.

895-1010 Andesite lava flow, amygdaloidal
palagonite & blk. metallic ~ psilomelane?
↳ waxy wh:-pale grn clay, deuteric
poss. zeo.
980- brn clay mix. w/ blk chips
½ lithic mudstone.

1010-1090 lithic Tuff, compact., argil. alt, brn.
Cont. at 1070 on chip board but at 1090 on GR.

1090-1300 Andesite, dk. gy, dense, few
plag. pheno. - alt. calc. & serc.
few planar surfaces - poss. slick. or join
Jointing, no spec. alt. on joints

DRILL HOLE WEN-W-1, GeoProducts Corp.
LOCATION SW¼ SW¼ sec. 13, T29N, R15W, Lassen Co. Calif.

LOGGED BY Sibbett
Jan, 1982

GRAPHIC LOGS

DESCRIPTIONS

30' sample interval

ALTERATION 1. WEAK 2. MOD. 3 STRONG

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

DEPTH feet	2nd Calc 123	2nd Chlor 123	2nd Clay 123	hem 123	seric. 123	123	123	Slicken-sides	fault breccia & gouge	GRAPHIC GEOLOGY	VEINLETS	DESCRIPTIONS
1100			Tr								1090-1370	Andesite, dk gy, uniform. GR. log. few < 1 mm pheno. plag, alt.
20			Tr									softness of chips suggest minor. alt.
40			Tr									
60			Tr									
80			Tr									
1200			Tr									⅓ chips of alt tuff as above 1200-1250 but GR. log suggest uniform andesite cont.
			Tr									
			Tr									
			Tr									clay-sericite alt. of some andesite chips increases., minor Tra calc.
1300				Tr	Tr							1300-1370 prob. flow base, more fract. & flow brec., poss. minor tuffac. sed.
				Tr								lignite LCM.
60				Tr								
			Tr								1370-2620	Basalt, dk. gy. to olive gy., ~30% pheno.
1400			Tr									2mm plag. xls, olivine,
			Tr									Dk. grn. alt. clay, chlorophaeite or chlor+
			Tr									clay mix., few smal vesicles
			Tr									
			Tr									clay alt. is prob. deuteric
1500			Tr									
20			Tr									
40			Tr									
60			Tr									1580-1620 diff. lava flow, fresher, poss.
80			Tr									basaltic-andesite comp.
1600												
			Tr									1620-1650 mix bas. & tuff. Flow base &
40				Tr						N. S.		interbedded tuffac. sed.
				Tr								1650- Flow top, vesicular, few amygdules,
		Tr										dk. grn, few red chips, grn. clay.
1700		Tr										40% 1mm plag laths, olivine alt →
		Tr										Chlorophaeite, clear zeolites.
		Tr										zeo. amygdules. - prob. analcime
												Dk. grn. alt. material prob. a mix.
1800												of mont. & chlorophaeite clays plus
20												poss. chlor. & caladonite, prob.
40										no Sample		deuteric alt.
60												
80												zeo. amygdules. with grn. coating.
1900												
												part. alt. pyroxene xls are hem. stain.
												Olive alt. to iddingsite
				Tr								stilbite - sheaflike xls.
2000												euh. analcime crystals
												abundant zeolite amygdules.
2100												

DRILL HOLE WEN-W-1, GeoProducts

LOCATION

LOGGED BY Sibbett

GRAPHIC LOGS

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

DEPTH feet	2nd Calc. 123	2nd Chlor 123	2nd clay 123	hem 123	Seric 123	123	123

Slicken-Sides | Fault breccia & gouge | GRAPHIC GEOLOGY | Tr: TRACE 1. WEAK 2. MOD. 3. STRONG VEINLETS

DESCRIPTIONS

30' sample interval

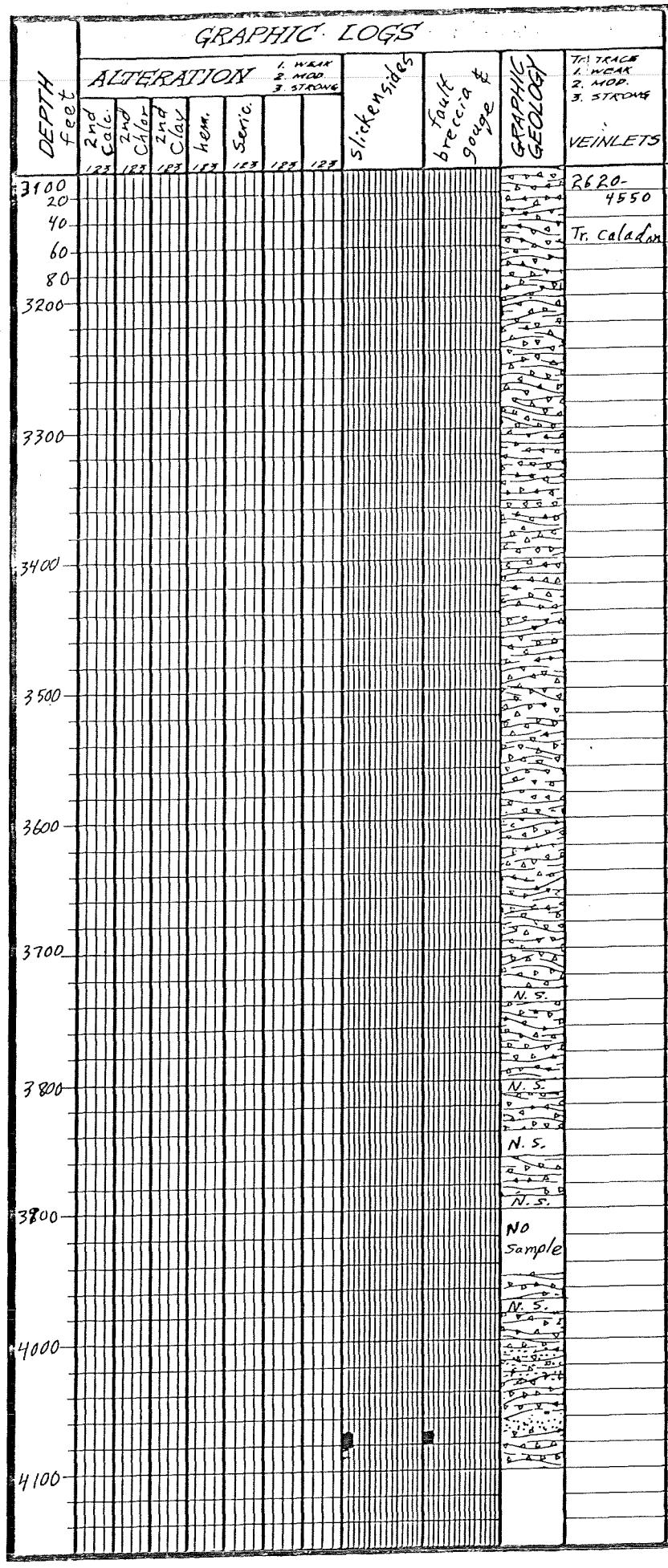
2100
20
40
60
80
2200
2300
2400
2500
2600
2700
2800
2900
3000
3100

1370-2620	Basalt lava flows (cont.) dk. grnish blk. amygdules of zeolites, analcime & stilbite. Olivine alt. to iddingsite and chlorophaeite.
	G. R. log shows no change in unsampled
	few red scoria chips.
	large caved chips of alt tuff from above.
	Some tachylyte very fine grain aphanitic to glass, no phenocrysts.
	2510-2620 ~ 2/3 Tachylyte zeo. abundant.
	Base of massive bas. flows at 2620'
2620-4550	Basaltic-andesite ash or poss. Lahars virable basaltic litho. & tachylyte clast in a dk. grn- clay + sand matrix. abundant lithic-crystal sand grains. poor sort, angular. fresh olivine xls, zeolites, iddingsite plag. xls. alt. similar to flows above.
Note:	Geophy. logs suggest flow base at 2630'
	clay alt. primarily of the matrix ash probably occurred at time of deposition.
	3000- basalt + andesite? clastics. ↳ more mix. litho & med. grn poss. caladonite traces.
	Most of clay & fines of matrix probably lost with drilling.

DRILL HOLE WEN-W-1

LOCATION

LOGGED BY Sibbett



DESCRIPTIONS

10' sample intervals-

Basaltic ash or lahars (cont.-)
Mixed basalt-andesite litho in clast chips w/ few olive-brn chips of mudst. w/ coarse sand grains of lithic crystal sand more abundant in some zones

Chalcedony amygdule.

Note:
Appears to to all volcanoclastic or ash-lahar type deposit but isolated lava flows may be present and over looked depending on sample mixing & caving.

3700-3710 possible basalt lava flow

4010-30 probable Ss. zone

4060-70 sand zone
Mixed basaltic-andesite litho. continued.

DRILL HOLE WEN-W-1

LOCATION

LOGGED BY Sibbett

GRAPHIC LOGS

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

DEPTH Feet	2nd Calc 123	Chlor 123	2nd Clay 123	Py. 123	123	123	123	slickensides	fault breccia & gouge	GRAPHIC GEOLOGY
4100										
20										
40										
60										
80										
4200										
4300										
4400										
60				Tr						
4500										
20										
40										
60										
80										
4600				Tr						
40				Tr						
60				Tr						
4700				Tr						
4800				Tr						
4900				Tr						
5000				Tr						
20				Tr						
40				Tr						
60	Tr			Tr						
80	Tr			Tr						
5100										

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

VEINLETS

DESCRIPTIONS

10' Sample interval

-4550 Mix basaltic-andesite lithologies, fresh and clay-chlor? alt., abundant coarse sand lithic & xl. grains. Few mudst. chips, poss. clay matrix lost by drilling & washing. Few zeo. amygdules, Poss. lahars, ash cone?

Chalcedony chip. - amyg.?

Fresh pyroxene xls.

Change to coarser chips at 4360, < sand euh. qtz xl., few gry Chalcedony or qtzt

Increased chert or meta siltst. dk gy.

clear qtz chips or grains?
Few qtzt chips.

Fault. GR. & Caliper log indicate fault at 4470

Few mudst. & lithic Ss. chips.

4550-5050 Conglomerate, clast of meta siltst, qtzt, plutonic rock of diorite to monz.?, poss. few vol. clast but may be caving.

pyrite is within clast.

Few rounded chert clast - blk.

Mix litho. of chert, qtzt & plutonic
Few rounded clast - chert, lithic Ss. chip

Rounded & polished chert clast.

Few carbonate chips.
py. coating on rounded chert pebble.
calc. inter granule in qtzt clast.

Matrix material not seen in cuttings. Poss. lost during drilling & washing.

5050-5100 Bio. Granite?, medium grain, bio. fresh abundant qtz

Litho change in samples at 5070 by logs ind. 5050

DRILL HOLE WEN-W-1

LOCATION

LOGGED BY Sibbett

GRAPHIC LOGS

DEPTH feet	ALTERATION (1. WEAK 2. MOD. 3 STRONG) chlor.		py.	epidot	Joint surf.	slicken-sides	fault breccia & gouge	GRAPHIC GEOLOGY	Tr. TRACE 1. WEAK 2. MOD. 3. STRONG VEINLETS	DESCRIPTIONS
	123	123	123	123	123	123				
5100'								N.S.	5110-5130	Diorite - Granodiorite? fine gr. abund. bio
20				Tr				+ + + +		Mudst. chips are cont., also granite & chert.
40								N.S.		
60								// = //	5160-5210	Bio. Granite, m. gr. some hornb.
80				Tr	Tr			// = //		5180-90 ½ contam. more hornb. 7% bio.
5200								// = //		magnetite.
								N.S.		
								+ + + +	5220-5311	Granodiorite? fine gr., abund. qtz.
								N.S.		Poss. Qtz. Monz. 10-15% bio., poss. qtz ve.
								+ + + +		hem. stain on joint surface.
					Tr			+ + + +		
								N.S.		
								+ + + +	note	cuttings change at 5290 but elec. logs show 5300
5300								// = //	5300-30	Granite, qtz rich, bio. ~7%, med. gr.
				Tr				// = //		rust stain from drill steel.
								+ + + +	5330-5400	Granodiorite, f. gr., bio. ~10-15%, alt.-chl.
								+ + + +		Prob. qtz veinlets
								+ + + +		Mix granod. & granite? abund. qtz.
5400								+ + + +		V. fine cuttings, ave. ~1 mm
								NO sample	5430-5500	Mixed. granite to granodiorite chips.
	Tr							// = //		litho as above, bio. gen. fresh.
	Tr							// = //		abundant pseudo-gouge → hard rock.
								// = //	1-qtz	
5500								// = //	2-qtz	
								N.S.	5530-5788	Granodiorite, f. gr., ~10% bio,
								+ + + +		abund. clear qtz from? granite dike & vein
								N.S.		
								+ + + +		
								+ + + +	1-qtz	The few large qtz chips & bio x/s ~1mm
5600								+ + + +		are far larger than the granodiorite
				Tr				+ + + +		grain size and suggest granite
				Tr				+ + + +		dikes cutting the granod.
								+ + + +		
								N.S.		
5700								+ + + +		
								+ + + +		
	Tr			Tr				+ + + +		
40								+ + + +		
	Tr			Tr				N.S.		
60								+ + + +		
	Tr							+ + + +		
80								+ + + +		
	Tr									
5788 T.D.										

DRILL HOLE WEN-W1

LOCATION

LOGGED BY Sibbett