GRAPHIC LOGS

GL04704

DESCRIPTIONS

ALTERATION 1. WEAK 2. MOD. 3. STRONG

DEPTH | ALTN INTENSITY 1 2 3 | CLAY 1 2 3 | SER 1 2 3 | QTZ 1 2 3 | CAL 1 2 3 | CHL 1 2 3 | EPID. 1 2 3 | HM 1 2 3 | CLAY 1 2 3 | GRAPHIC GEOLOGY | Tr TRACE 1. WEAK 2. MOD. 3. STRONG VEINLETS

100′
200′
300′
400′
500′
600′
700′
800′
900′
1000′

...TO ANDESITE (FLOW?) BRECCIA

① CHL-CAL. 140-240′: PORPHYRITIC, LITHIC-RICH ANDESITE, MED. PURPLISH TO GREENISH GRAY; 10% SUBH EUH. PLAG. LATHS UP TO 1.5X 0.7 MM, CLOUDY BUT SHINY; ∿ 3% CHLTZ. MAFICS (PROB. HBL.) DEPENDING ON THE CHIP, UP TO 40% ANGULAR LITHICS — TUFF, POSS. PUMICE, AUTO-FRAGMENTS — THESE APPEAR TO BE MORE INTENSELY ALTERED THAN THEIR MATRIX (ESP. CHLTZD.) & SOME HAVE THIN REACTION RIMS; RARE FRAGS RED MUDSTONE.

PROBABLY? PALIZA CANYON SLUMP.

← CHECK FOR SS. CLASTS IN ANDESITE BX.

240-310′: SANDSTONE, MED-GR., LT. GRAY, ARGILLIZED — QTZ. GRAINS COMMON

400-500′: CLASTIC SEDIMENTS, DOMINANTLY SANDSTONE, BUT RANGING FROM SILTSTONE TO POSSIBLY CGL. — SOME FREE ROUNDED CLASTS UP TO 7 mm. DIAMETER — SCATTERED GRAINS CONTAIN DISSEMINATED PYRITE ABUNDANT ROUNDED BIPYRAMIDAL QTZ. XLS. | A FEW CLASTS TUFF, RARE GRANITE & ANDESITE PORPHYRY ∠0.1% PYRITE, DISS., XLS ∠0.3 MM. DIA.

500-580′ (FROM UNION LOG): SAME AS ABOVE

580-600′: FELSIC TUFF, ALTERED; (SEE BELOW

⑧ Q±PY 600-700′: NW-PW TUFF, FELSIC, ARGILLIZED; 15-20% ARG. FSP. PHENOS; 2-3% CLEAR QTZ. PHENOS; VNLTS & IRREG. PATCHES OF SILICIF. ± PY (DISS.); SOME OF THE FSPS HAVE BEEN DISSOLVED, LEAVING IRREG. VUGS.

(MW)

PY ∿ 0.5-1% (PROBABLY MORE TOWARD UPPER LIMIT)

700-800′: SAME AS ABOVE

800-900′: AS ABOVE, SILICIF. NOT AS CONSPICUOUS

0.5% PYRITE CONSPICUOUSLY CUBIC

900-1000′: AS ABOVE, CHL BECOMING MORE ABUNDANT — DISS, IRREG. CLOTS ∠ 2MM SOME W/ OPEN-SPACE

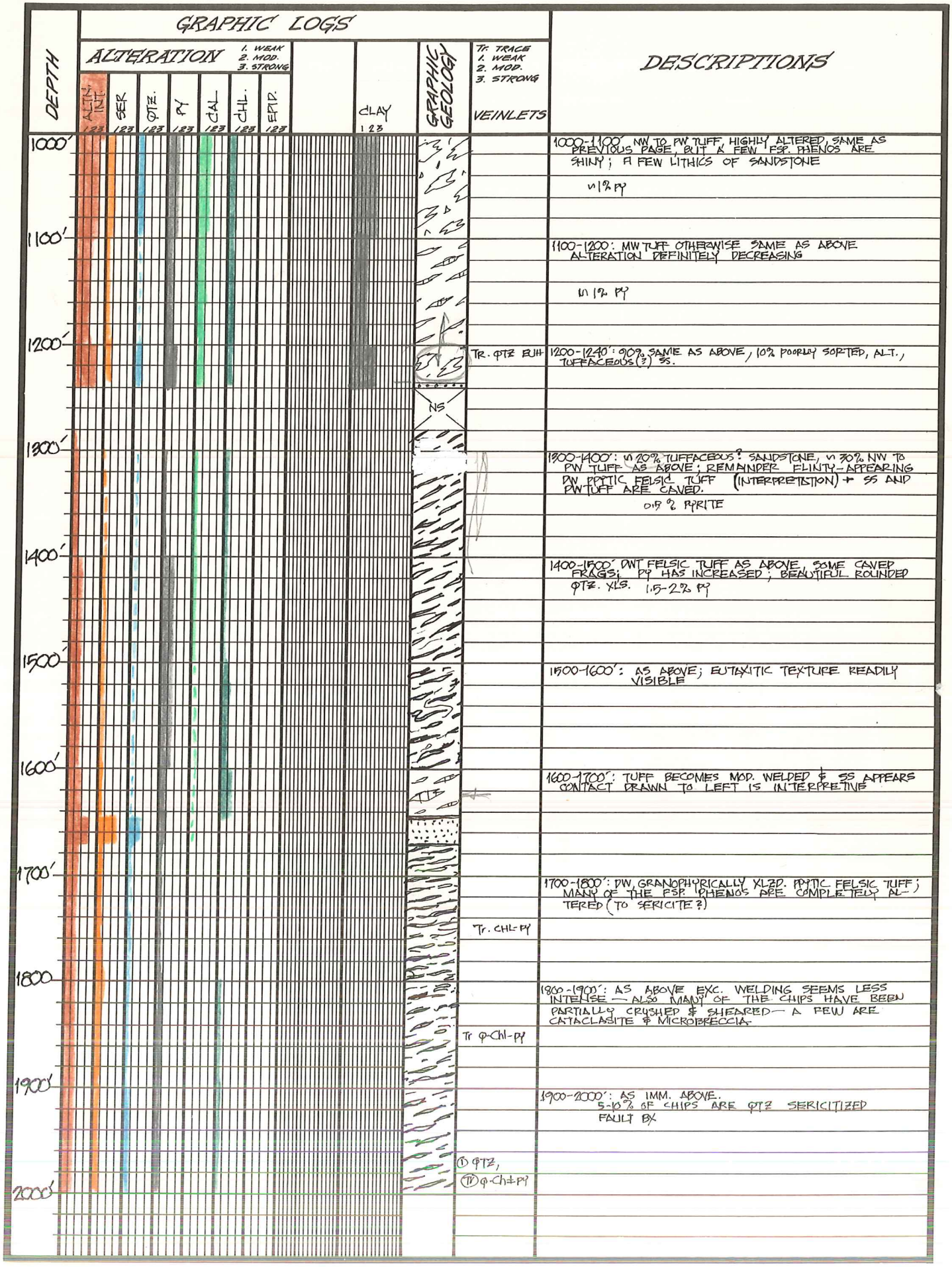
1% PY, CONSPICUOUSLY CUBIC; TUFF MAY BE MORE WELDED.

DRILL HOLE 88

LOCATION SULFUR SPRINGS AREA, VALLES CALDERA

LOGGED BY HULEN

04/17/85

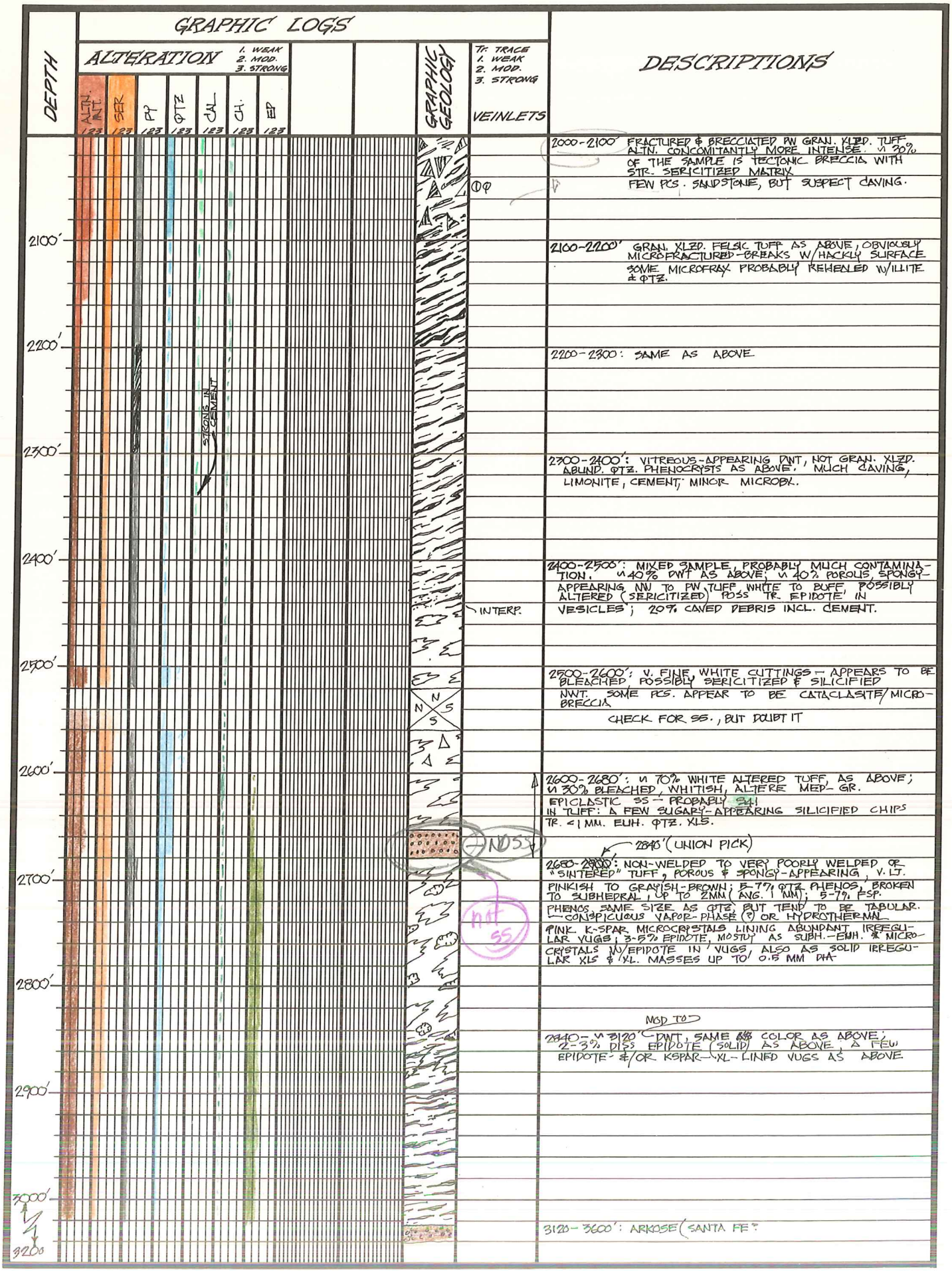


DRILL HOLE B8

LOCATION SULPHUR SPRINGS AREA, VALLES CALDERA

LOGGED BY HULEN

04/17/85



DRILL HOLE BB

LOCATION ALAMO CANYON - N of SULPHUR SPRINGS

LOGGED BY J. HULEN

UNION 76

GEOTHERMAL DIVISION

SUBSURFACE TEMPERATURE SURVEY

B8-53-Temp

OWNER UNION OIL COMPANY OF CALF. FIELD VALLE GRANDE WELL NAME BACA #8

CASING 13 3/8" TO 340' : 9 5/8" TO 2281' ELEV 8631 DATE 9/5/74

LINER DESCRIPTION: NONE ZERO POINT GL + 7

TUBING - 2 3/8" FROM SURFACE TO 4225' DEPTH 4384

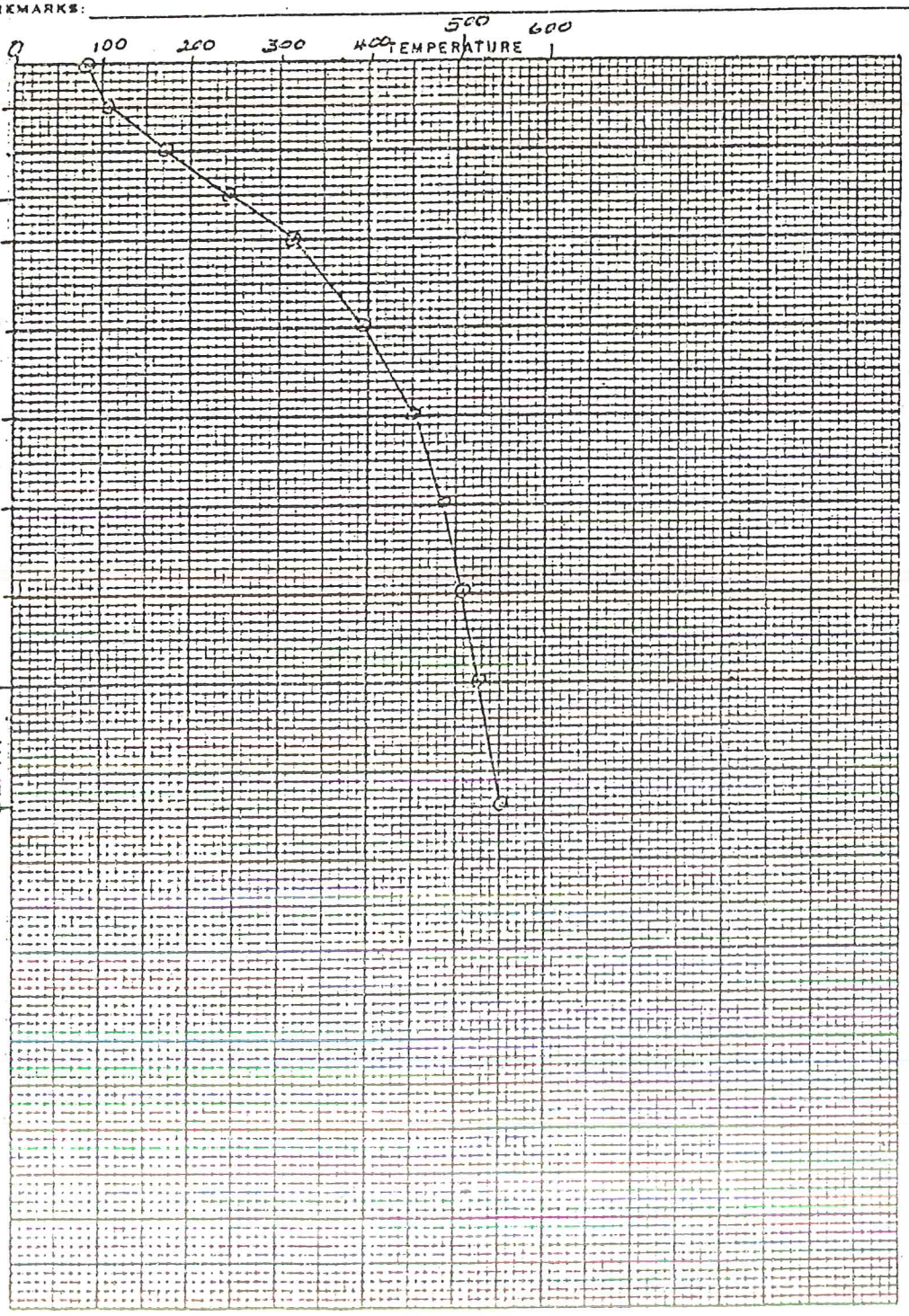
HOLE DESCRIPTION: INSTRUMENT KTB 80°C-646°C F.H.

SERIAL NO 10052

PURPOSE MAX TEMP 552 °F @ 4175'

REMARKS:

STABLIZATION PERIOD



PRESSURES.	GAUGE	BOYS
CASING, PSI	228	
TUBING	149	153.5

DEPTH	TEMP.	DEPTH °C	TEMP
0	80.7	27.1	
250	109.5	43.1	
500	173.0	78.3	
750	243.8	117.7	
1000	318.7	159.0	
1500	393.3	201.0	273.7
2000	[illegible]	452.7	
2500	485.4	251.9	
3000	509.6	265.3	
3500	524.7	273.7	
4175	552.0	288.9	

BY:

subscr. p = petrographic Raw %'s

COMPOSITE SAMPLE NUMBER:	MINERALOGY, APP. WT. %																		
	QUARTZ	ALBITE	K-FELDSP.	CALCITE	PYRITE	SPHENE/LEUCOXENE	EPIDOTE	HEMATITE	CEMENT	SPHENE	SMECTITE	I/S/M	IL	CH	KAOLIN	SPHENE	FLUORITE / EPIDOTE	
100-340'	44	17	5	6	1			2			4	13	3	2	3	10?	—	0.2d	
340-400'	42	21	5	10	1							12	4	3	2	0.3?		—	
400-500'	44	4	5	29	2							4	5	3	—	0.5?		Tr	
500-600'	40	7	9	25	5							3	6	3	2	1.0		Tr	
600-700'	52	2	6	17	5								13	2	3	1.5	—	0.5d	
700-800'	65	1	4	7	3								15	1	4	1.2	—	—	
800-900'	56	2	15	2	5								17	3	Tr	1.5	—	—	
~~900-1000~~	~~41~~	~~32~~	~~15~~	~~3~~	~~2~~								~~34~~	~~3~~	—	~~1.3~~	—	—	
1000-1100	42	31	16	(2p)	(1.5p)								5	2		1.5		—	
1100-1200	42	30	16	(1p)	(1p)								8	2		1.5		Tr 0.1??	
1200-1240	44	26	18	(2p)	(1.5p)								9	2		2.0		Tr? 0.1??	
1300-1400 (1345)	58	10	20	7	2								7	2		0.7		Tr?	
1400-1500	59	20	25	(2p)	6								4	2		0.7		0.1 Tr	Tr?
1500-1600	45	11	33	(0.5p)	2								1	3		1.0		0.3	
1600-1700	46	6	27	1	3								10	6		1.5	—	0.5	poss. u 0.1-0.2 pumpell.
1700-1800	46	9	27	(0.5p)	1								7	2		1.5	—	0.3	
1800-1900	63	2	21	(1.5p)	1								11	2		1.0	—	0.5d	?
1900-2000	50	5	31	5	1								7	2		0.7-1	—	0.3	?
2000-2100	56	7	27	3	1								5	1		0.7	—	0.2?	Tr + ?
2100-2200'	50	7	35	Tr	1								6	1		1.0	—	0.5	
2200-2300'	51	7	34	—	1								5	2		0.7	—	0.5	
2300-2400'	55	2	35	—	2								5	1		1.0	Tr	0.3	
2400-2500'	52	2	39	—	1								5	1		0.3	0.3	0.1	
2500-2600'	55	2	37	Tr.	1								5	Tr		0.5	0.3	0.3	
2600-2700'	50	—	32	Tr.	3								3	2		u 0.7	0.1	0.5	b
2700-2800'	48	—	37	Tr	2								3	2		u 0.5	0.2	much u 5	
2800-2900'	51	—	35	1	1								3	2					
2900-3000'	52	—	30	Tr?	1								2?	2					
3000-3100'	52	—	33	1	1								4	2		u 0.5?	0.3	u 0.7? (p)	
3100-3200' tuff	53	—	30	1	1								3	2		u 0.5	0.3	u 0.5? (p)	
3100-3200 (35)	70	—	23	Tr	0.3								3?	2?		u 0.5	0.1-0.3??	(2?)	

Warsak ??

d - detrital

BACA 8 — BULK XRD: PETROGRAPHIC BACK-UP FOR PHASES BELOW DETECTION LIMIT

LAYER SILICATE MINERALOGY, APP. WT. %

COMPOSITE SAMPLE DEPTH	SMECTITE	MIXED-LAYER ILLITE-SMEC.	ILLITE	MIXED-LAYER CHLOR-SMEC.	CHLORITE	KAOLIN	% EXPANDABLE IN CHLOR.	% EXPANDABLE INTERLAYERS IN I/SM	CRYSTALLINITY INDEX OF 10-11Å PEAK (°2θ)	
100-340′	12	50	13	3	7	15		17	1.80	
340-400′	2	54	21	—	13	9		14	1.28	
400-500′	—	41	41	—	18			GET	1.23	
500-600′	1	25	45	—	10	19		6	1.08	
600-700′	—	—	76	—	5	19		<5	0.50	
700-800′			79		3	18		<5	0.58	
800-900′	1		88		8	3		<5	0.70	
900-1000	TR		63		37	—		<5	0.48	
1000-1100′	TR		72		28	—		<5	0.42	
1100-1200′	TR		83		17	—		<5	0.43	
1200-1240′	TR		84		16	—		<5	0.50	
1300-1400′			87		13	—		<5	0.40	
1400-1500′			72		28	—		<5	0.42	
1500-1600′			32		68	—		<5	0.40	
1600-1700′			50		50	—		<5	0.45	
1700-1800′	1		84		15	—		<5	0.45	poss chl-smec. ✓
1800-1900′	TR		81		19	—		<5	0.40	
1900-2000′			80		20	—		<5	0.33?*	
2000-2100′			88		12	—	<5	<5	0.39 (OK)	
2100-2200′			95		5	—		<5	0.42	
2200-2300′			83		17	—		<5	0.39	
2300-2400′			82		18			0	0.21 *	
2400-2500′			87		13			0	0.27	
2500-2600′	TR		94		6			0	0.28	
2600-2700′	3		59		38			0	0.23	
2700-2800′			37		63			0	0.20 *	
2800-2900′			48		52			0	0.26 *	
2900-3000′			41		59			0	TOO LITTLE FOR RELIABLE MEAS.	
3000-3100′	3		23		74			0	0.22 * ??	

* V. LITTLE CLAY POSSIBLY INVALID — KC

BACA 8 — CLAY XRD

(A) qtz. post-dates phengite

$ in ffs at high levels

	VEINLETS														
	QTZ	CALCITE	QTZ-CALCITE	KF-QTZ-CALCITE	SMECTITE	CLAY (KAOLIN)	ILLITE/PHENG	QTZ-PHENG-Φ-CO3	CHLORITE	PY-CHL-LEUCOX-KF-QTZ	CHL-KF-QTZ	KF ± QTZ	FLUOR ≠ Φ, KF, CAL	HEM ± GOE (LIMONITE)	OTHER NOTES
100 - 340'	✓				✓	✓	✓		✓ vg					✓	
340 - 400'	✓	✓	✓				✓								
400 - 500	✓	✓	✓			✓	✓								
500 - 600	✓	✓	✓				✓ Φ								
600 - 700	✓	✓	✓			✓	✓ Φ NIL		✓			✓ Φ rep			CHL-EP PY-LEUCOXN-QTZ
700 - 800	✓	✓	✓ py			✓	✓	✓							LEUCOXENE
800 - 900	✓	✓	✓			✓?	✓								
900 - 1000	✓	✓	✓				✓								CALCITE-ILLITE-PYRITE
1000 - 1100	✓	✓	✓	✓			✓		✓						CAL-LEUCOXN-PYRITE
1100 - 1200	✓	✓	✓				✓ py Φ								CAL-KF-Φ-PHENG CAL-CHL
1200 - 1240 CHL REPL CALCITE	✓ (A)	✓	✓	✓			✓ py								Φ-KF-PHENG-CHLOR Φ-CAL-CHL
1300 - 1400	✓	✓	✓				✓ Φ		✓ Φ						ΦTZ-LEUCOXN
1400 - 1500	✓	✓	✓				✓		✓		✓ & VP				do
1500 - 1600	✓	✓	✓						✓		✓ VP				
1600 - 1700'	✓	✓	✓				?		✓ qtz		✓				CAL-CHL-LEUC.
1700 - 1800	✓	✓	✓				✓		✓		✓ (VP)				LEUCOXN
1800 - 1900	✓	✓	✓				✓				✓ VP				LEUCOXN ; CALCITE LEUCOXN
1900 - 2000'	✓	✓	✓				✓		✓		✓ VP				Φ, KF-CAL-PY (leuc) & CALCITE-LEUCOXN.
2000 - 2100'	✓	✓	✓				✓		✓		✓ VP				ch-Φ-leuc-Φ-cal
2100 - 2200	✓?						✓		✓		VP				ch-leuc.-Φ-py-ilm
2200 - 2300'	✓						✓		✓		VP				K
2300 - 2400	✓						✓		✓ Φ		✓				& KF-QTZ-LEUCOXN
2400 - 2500	✓		✓ py				✓ ch		✓		✓ py	✓			
2500 - 2600	✓		✓				✓ leuc		✓		✓	✓ F, F-IL-Φ			ep repl. qtz.
2600 - 2700	✓	✓	✓ ep				✓		✓	✓	✓ py leuc	✓ F-KF-Φ			ep repl. calcite
2700 - 2800	✓		✓ ep	✓ ±							✓	✓			ep repl. calcite ≠ calc. repl. some/KP ±
2800 - 2900															
2900 - 3000															
3000 - 3100.	✓		✓				✓ cuts qtz				✓	✓ py F-KF-Φ			ep repl. KFsp., calcite
3100 - 3206	✓		✓ ep							✓	✓				↓ "
notes: 2400-2500': qtz vns. post-date chl. & ser ± qtz vnlts (also ΦTZ-KF VEINS POST-DATE THESE)															

VP = vapor phase

IN VUGS

chl/plag

calcln/fsp & pumice

sim. post-dates cal

chl/plag

chl. clots

1st "plume" rosette

grad. repl. fsp by ser

mod. seriecth

cal repl. qtz, FL, CHL repl FSP

ep/calcite

possible pumpectivite

KF, Φ, CHL, IL leuc ep

EP, Φ

KF, Φ, rare EP, ap, CHL

KF, Φ, FL, CHL, ser

KF-Φ ± CHL ± CO_3, ± leuc

KF, Φ, FL, CHL

Φ-KF-EP (FL) ± CAL-CHL ep repl. cal, KFsp

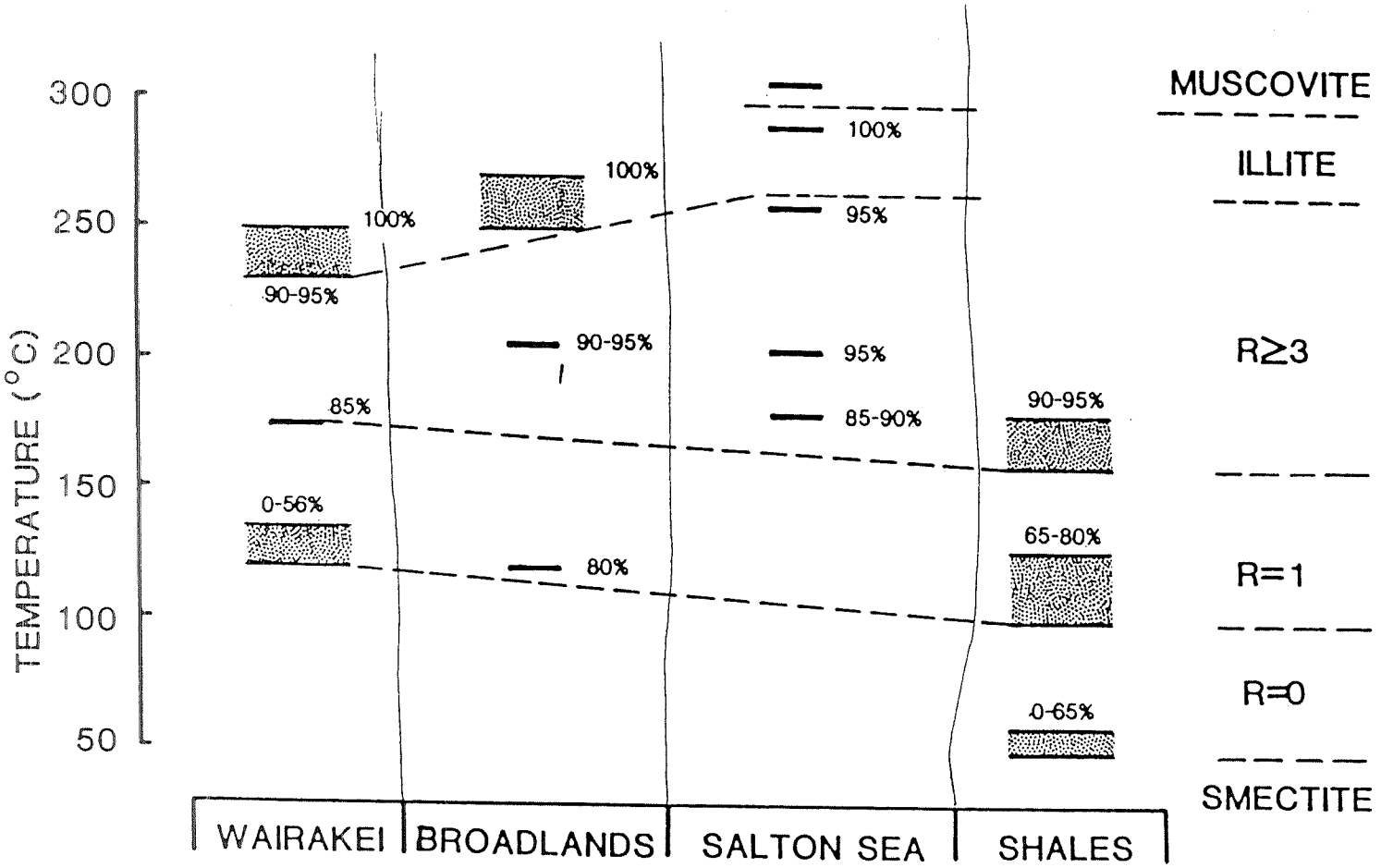


Figure 6. A summary of the temperature dependence of I/S composition from active geothermal areas and deeply buried shales. See text for explanation. (Hower, pers. comm.).

Baca 8

4/3/86

Reaction relation

albite → illite
I/S → I

100-340

Calcite replaces fs phenocryst - probably a plag. - microclines appear unaltered.

One pyroxene armored and apparently fresh. Amphiboles rimmed w/ Fe ox. - some mafics have apparently been completely altered to green grunge.

Open space vein filling of clay w/ possible qtz (?) at final stages of filling

Most slide is a volcaniclastic sand - some granite fragments

340-400

Continued replacement of plag by Calcite. One fragment is a calcite cemented sandstone.

400-500

Calcite vein w/ fluidized, cutting qtz sandstone. Calcite also ~~cem~~ cement ss

Cse muscovite and microcline grains probably from granite
Micritic calcite w/ cubes of pyrite (?)

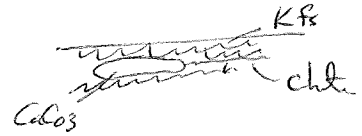
500-600 - Similar to above.

4/4/86

600-700 - Replacement of plag by calcite continues - Dmc sed w/ carbonate cement. Also granite fragments. Greenish clots replace former pyx (?) phenocrysts Abundant well developed epidote + plag + clots - May be proto green or developed due to more calcic composition of host rock Clots veins Kaolinite appears to post date illite. Clot veins and K-spar veinlet cuts qtz phenos. Calcite preferentially replaces plag

Tuffaceous groundmass has been flooded w/ clays - some relict textures visible show non-welded character

700-800 Close association between pyrite and calcite.



Kfs + q calcite + chl
vein

Abundant large calcite replacements

800-900 Some large $CaCO_3$ grains, but much of the glass is not replaced. May be reason for abrupt increase in albite

Illite increases down to 900' then abruptly decreases @ 900-1000. The 900-1000' interval then is marked by an abrupt increase in albite

900-1000 Some replacement of glass by $CaCO_3$ - matrix on many frags appears to be granophyrically xllized. This would explain abrupt decrease in illite - little glass and permeability available for alteration to occur. Those frags which are definitely non-welded do appear to have radiating clay aggregates replacing matrix glass

1000-1100 Most frags appear granophyrically xllized. A few more frags show brown clay alteration However section is predominantly densely welded w/ granophyric xllization

1100-1200 Similar to above - even have an apparent relict pyroxene. Some $CaCO_3$ veining - qtz as fragment w/ clays surrounding rounded grains - pyrite occurs w/ clays - only find 1 as grain in entire thin section.

1200-1240 Carbonate veins common. Frag of red siltstn. - Matrix of aft granophyrically xllized. Microbreccias common - matrix similar to granophyrically xllized tuff but contain more qtz frags - some highly angular - Probably more xll-rich portions of HFT.

1300-(1400?)1340) Minor amounts of subangular qtz-rich sed w/ carbonate cement, possibly dropping in from LCZ above. AFT densely welded and granophyrically xllized

1400-1500 Qtz vein cutting carbonate vein. Rock mostly in granophyre which is little touched by alteration. Some plag replaced by $CaCO_3$. Calcite + chlo vein

1500-1600 Granophyre - py assoc w/ granophyre - weak chlo wash but no intense alteration

1600-1700 Densely welded AFT. Texture still clearly visible although glass has devitrified - Qtz + chlo vein - some $CaCO_3$ replacement of fs. Sed. is arkosic and immature w/ $CaCO_3$ cement. Large frag composed of $CaCO_3$ + illite, may be a large vein filling - Relict pisolitic primary devitrification textures. Also altered w/ muscovite flags. & clay matrix

1700-1800 $CaCO_3$ - pyrite veining. Illite replaces fs. Granophyric xllization of AFT matrix

1800-1900 Many frags show welded texture clearly visible ~~but devitrified~~ ~~others be~~. Other frags are granophyrically xllized. $CaCO_3$ replacement of matrix and fs

1900-2000 Granophyrically xllized AFT. Many relict textures remain visible. Frags of "coarse-grained" gt. - probably lithic frag. $CaCO_3$ veining.

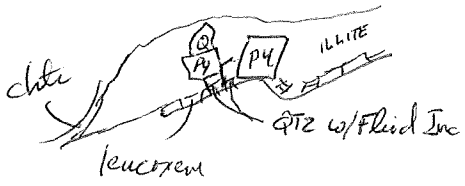
2000-2100 Matrix similar to that described above - some shows extensive illite replacement. Some "micro breccias" as were noted at 1200-1240 IBH has logged breccias in cuttings

4/7/86

2100-2200 Qtz vein. w/ large fluid inclusions - qtz apparently along a ~~vein~~ very straight fracture cutting densely welded ash flow tuff.

This may be a phenocryst w/ secondary inclusions

Tuff densely welded ~~to~~ and primarily devitrified but w/o granophyric xllization. Tuff matrix picks up most of yellow stain - also pyrite cubes common throughout matrix



The above sketch is a well defined vein w/ leucoxene followed by QTZ + Pyrite followed by the entire vein being flooded w/ illite. This illite flooding would clearly shut off the permeability along the vein system. This could be a result of cooling of the system or changes in a_K/a_H - see Fig 9 of White. If this is true, cooling here is a self perpetuating process - cooling results in precip. of clays which cuts off permeability and causes additional cooling.

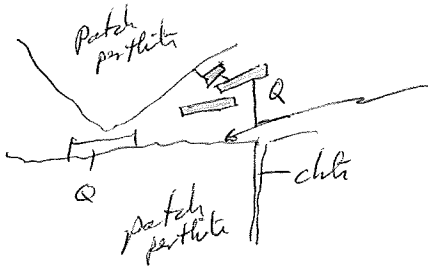
There are excellent secondary inclusions cutting qtz phenocrysts

More likely was vuggy or replaced pumice. Stain gives appearance of illite replacement

Illitic vein which probably replaced a pre-existing K-spar vein as evidenced by pseudomorphs after prismatic xtls. This texture can be contrasted with the illite flooding noted above. Looking at White Fig 9, could also be illite replacing albite. There is some qtz w/in the above vein - may be possible to collect some fluid inclusion data.

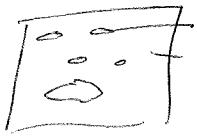
One frag of "microbreccia" contains the only $CaCO_3$ seen in the section. May be contamination from unit above.

2200-2300 Contains a cavity like described above - again looks like illite replacement of Fs
Vein cutting patch perthite



Filling is clay + illite w/ clay being the first to precipitate

Vugs ~~surrounded~~ lined by radiating clay. Clay ~~often~~ often grows preferentially @ contact between perthite and matrix
Splay of ~~splay~~ epidote growing into patch perthite
The clay in the rock is much more pervasive than seen in vugs both definitely assoc. w/ perthite and as veinlets through matrix - Clay also floods open space in vugs.
Epidote forms w/in ploy grains - small bundles of acicular xls. At this time this is the first occurrence @ ~ 240°C



Ep Forms along the ploy exsolution features in the perthites - often assoc. w/ illite veining although not in direct contact.

ploy → epidote ± clay
One vein cutting perthite shows illite + pyrite + epidote

2300-2400 There is a dramatic decrease in the amount of epidote for the above sample - have apparently passed through a structure and are beneath a production zone. There is no indication of this on the temp log

2400-2500 Qtz_3 vein cutting densely welded ASH.
First occurrence of fluorite. Assemblage is Qtz_3 + Fluorite + Epidote
Epidote again assoc w/ pelt perthite ⇒ also fluorite. Fluorite is present in trace concentration. No calcite.

2500-2600 CH_3 + fluorite vein

In Y-11 fluorite appears @ 95m and a temp of approx. 180°C. First occurrence in B-8 is at about 250°C.

LITHOLOGIC DESCRIPTIONS

(in 100-340')

140-240' Probable debris flow, strongly argillized: consists of angular to subrounded, commonly subequant lithic fragments up to at least 3 mm. dia, mostly < 1mm dominantly altered porphyritic (pyroxene?) andesite, subordinate carbonate (probably from limestone, but could be partially hydrothermal; anyway: discrete fragments, rel. crs. xln. → also subordinate v. mi/vor felsic volcanic fragments and many fragments argillized/sericitized beyond recognition 3-5% qtz xls, broken subh to up to 1st 1.0mm dia. 5% subh-broken fsp xls incl. oligoclase-andesine, sanidine and rare microcline roughly same size as quartz - commonly $CO_3^=$, clay altd.

Rock is strongly alt. to microxln clay-illite ± chl. (v/strong) aggregate; andesitic lithic fragments tend to be enriched in kaolin rel. to groundmass; probable smectite veinlets

- vest of sample med-gr. tuffaceous

Sandstone in this smpl. is immature lithic arkose w/ ~~sb~~ common felsic volc. clasts; qtz., K-sp, and ^ matrix (rare metam. rx frags; uparthite, plag. tuffaceous) ^ mod- strongly altered to sericite (~~or~~ I/S w variable minor qtz and chl. (and kaolin) ^ traces of hydroth. leucox.

- shards, relict, visible in some pcs.

→ 1 pc crs-xln calcite being replaced by diss chl & epidote (clastic?)

→ 1 pc microcline granite

340-400' smpl. consists of argillaceous to slightly to sandy silty micrite, sandy fine-crystalline sparite, immature tuffaceous med-gr. lithic arkose (as in 100-340) altered porphyritic andesite, felsic crystal-vitric (ash-flow?) tuff sand grains in sparite similar to those of associated sands.

400-500 qtz xln Metamorphosed microcline granite and grains derived from it; aphyric, pilotaxitic andesite; micrite, as above; sparite, as above; fine-med gr. tuff. lithic arkose as above, except addition in some fragments of minor coarse xln. biotite and muscovite
Pyrite replaces calcite in sparite
Afth. of ss matrix same as 100-340'

500-600' — see above, except appearance of tuffs, to be described below.

600-700' — Dominantly altered felsic ash-flow tuff poorly to moderately welded, depending on the piece; 3-5% qtz xls, subh-broken up to 0.3 mm dia; 3-5% partially altered = Kspr phenocrysts, subh-broken, up to 0.7x0.4 mm; 7% kaolinized fsp(?) phenocrysts; at least 20-25% irregular to slightly elongate masses, up to at least 1.5 mm. max dimension, now all various combinations of qtz, calcite, sericite, kaolin, which may have been pumice lapilli (some may have been vapor-phase cavities.

600-700 cont'd.

Altn kaolin forms rare vuglts and common irregular to fsp-shaped masses up to at least 1 mm. max. dimension consisting of aggregate of 2-10μ crystals with v. low bluish-gray biref. — commonly intergrown with calcite/sericite.; sericite form vuglts and clots up to at lst 1 mm max dimension (see pumice, above) composed of a mats of irregularly arranged intergrown flakes & fibers <2-20μ (avg 3-5μ) max dimension.

Calcite forms 1) irreg., commonly branching med xln aggregates, prob. repl. pumice, up to at least 1 mm. max. dimension. - Leucoxene → irreg. semi-opaque, yellowish-brown to brown masses up to 0.4 mm. dia consisting of xls. mostly less than 10μ dia. — masses commonly w finger-like projections.

A least 2 generations of illite - vuglt dark, cutting large aggregate

700-800 Altered, Mod welded, xl-vitric felsic ash-flow tuff as above, except more CO_3 after fsp

leucox post-dates calcite & illite
py replaces nothing preferentially

pyrite, as above, occurs as diss subhedral to euhedral, commonly cubic grains up to 0.3 mm. dia. (avg ≤ 0.1 mm)

also qtz up to 1.5 mm

800-900': ALTERED, MOD. WELDED CRYSTAL-VITRIC FELSIC ASH-FLOW TUFF

As above, except fsp. phenocrysts rarely up to 2 mm. dia — many of these are microperthites (patch) w/ sericite clearly replacing the albite patches —— Also lithic fragments (siltstone, w/crs. sandstone, mic.) more common, up to at least 3 mm (5%?)

Calcite clearly partially to completely replaces many fsp phenocrysts — also forms irregular branching masses in groundmass, up to 1.5 mm

Kaolin clots have dropped out rutile, leucoxn, as above

PHENOS
7% qtz.
15% microperthite (fresh & altered)

MICROPERTHITE: same as Redondo Creek (see 2ath paper for description)

900-1000 | Mod. to densely welded xl-vitric felsic ash-flow tuff; much more xl-rich than tuffs above. Beautiful microperthites.

PHENOCRYSTS — ~20% microperthite subhedral-euhedral or broken, commonly tabular, up to 1.6 mm (avg. ~0.7 mm) diameter, consisting of ~20-50% albite stringers, patches and rare microveinlets within, and partial rims around alkali feldspars — many of these show "chessboard twinning" 1-2% apparently discrete alkali feldspar with curious bluish-gray birefringence and mottled extinction — these mostly < 0.15 mm. dia.

700-1000, cont'd.

7% quartz, as immediately above

- 2% plagioclase, euhedral or fragmentary, definite tendency to be tabular, up to 1 x 0.4 mm — show albite and chessboard twinning

2% lithics — ±, up to 1.15 mm — ppytic andesite, argill. siltstone

→ tr. altered mafics elongate laths (upto 0.3X 0.1mm) now chl-ser-leucoxn ± $CO_3^=$ aggreg.'s

GROUNDMASS — devitrified, locally beautiful spherulitic, axiolitic textures - "salt & pepper" texture, but not granophyre — shards still visible in many places

albite in the microperthite is commonly replaced by brownish green chlorite, as irregular aggregates and fans to rosettes upto 0.1 mm dia consisting of flakes & fibers up to 10μ long or in dia. the chl. is often intergrown w/ phengitic/illite, giving the mass a slightly higher birefringence.

phengitic/illite clots also repl. ab w/o chl. also pty repl. discrete plag. phenocrysts.

1000-1100' As above, except gmass dense-appearing; more opaque-brown chl buttons ± ser, carb, replace plag (also leucoxn)

Altn. continues to decrease

A few apparent vapor-phase amygdules "miarolitic"? up to at least 1 mm. maximum dimension surrounded, in groundmass, by narrow rim (< 0.2 mm) irreg., of spherulitic-axiolitic texture. filled w/ aggregate of euh. qtz & K-spar, xls < 0.25 mm (avg < 0.1 mm.) length or dia.; also minor pyrite & chlorite adjacent (inward) to rim — may have replaced (?) pre-existing ab or calcite

1200-1240 SS & tuff

SS is v. immature tuffaceous lithic arkose, med-gr. some pcs contain abund (up to 5%) relatively coarse mica; lithics-felsic volc- & perthite grains are common matrix weakly-strongly qtz-sericite (see sss, higher in hole

Tuff as above

1300-1340' Mostly DW (xl-lithic) felsic ash-flow tuff, far fewer phenocrysts than in overlying DW tuffs (overall ~17%) — same proportions & sizes as above INCIPIENT GRANOPHYRIC XLZN.

1400-1500' DW, mostly gran. xlzd. tuff as above exc. more gran. xlzn. - phenocrysts increased to ~20% same proportions as above w/ discrete plagioclase.

This rock differs in containing ~7% apparent miarolitic (see Keith & Muffler) qtz-KF amygdules These vary from irregular to ~~blorgete~~ to commonly crudely lensoid — mm max dimension they are lined w/inward-projecting pinkish ~ lc spr. xls, euhedral rhombohedral to tabular to pseudohexagonal intergrown w/ euh to subh. qtz xls similar size (avg <0.05mm up to 0.15 mm) both speckled w/ unidentified microlites (<2N) birefringent to opaque — quartz commonly infills these amygdules in masses up to 0.2 mm dia (more crsly xln. than There are occasionally discontinuous stringers of leucoxene partially rimming the adularia.

V. few of these →

qtz-adularia vein

delicate, slightly pinkish-tinged euh. adularia, commonly rhomboidal, trapezoidal ⏥ to pseudohexagonal (in X-section), quite free of inclusions (solid) which typify "miarolitic" KFspr. qtz hex, columnar both xls ~ 0.12 mm. maximum dimension.

1500-1600': As above — one qtz. phenocryst at lst 3 mm diameter some bipyramidal
same pheno. % & comp's.
- qtz. infilling the amygdules is ppb 0.4 mm dia — much coarser than linings.
- many of the amygdules are elongate — may have originated as pumice lapilli.

1600-1700' as above, not granophyre,
still, some pc. non-welded to pw tuff (above S_3?)
micaceous ss (S_7) same as mica rich ss's abv
pkg plevo 1.2 mm x 0.5 mm partly repl. by chlorite.
includes euh. apatite 5-6 x/s upto 0.1 x 0.05 mm (euh).

1900-2000' nice inclusions in adularia in vein
same rx as above

2100-2200 not granophyre — but still w/ miarolitic cavities
qtz. x/s. rel. more abundant.
"holes" inward of adularia rims in miar cav's occ. filled w/ illite in this sample
nice spherulites.

1800-1900 cont'd — beautiful epidote ± chl. rosettes in some samples. (in microperthites, possibly replacing plagioclase.

1600-1700': beautiful green sprays & rosettes in plagioclase which look more like pumpellyite than anything else — ✓ this out later (2nd op's)

1200-1240' leucoxene definitely replacing calcite in a veinlet.

THOM: SEM → Aluminum standing sky elf | sulfur would be masked | no Zn | Br | no silica | Aluminum and silver (10)

Ag Na

2300-2400' first appearance (uphale) of large up to 0.5 mm. clots of microcrystalline sericite.

mineral: Tabular

Ag Br

Al & Ag

Si no

2200-2300' → some euh albite in vugs, amygdules

Si, Na, K Fe, (possibly)

2000-2100 → possible wairakite in vug lined w/ euhedral kspar, quartz, & fibers of flakes of illite and chlorite. xl. mass is 0.1 mm wide

581-6698

Ag Bromide

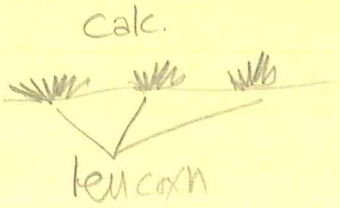
Na

1900-2000 Many large vein fragments — various combinations of quartz, adularia, calcite, pyrite — nice inclusions!

SiO_2 K_{sp} Fe

SiO_2 K_{sp}, Fe

1800-1900 as above, chl, ep repl. plag.



B-8 EPIDOTE CLEARLY REPLACES CALCITE (& does replace some K-spar at least) 04/05/85 (17)

ILLITE REPLACES MOSTLY GROUNDMASS

2700-2800': Poorly welded, vitric-crystal rhyolite ash-flow tuff; vuggy, w/ vapor-phase alkali fsp. druses & yellow epidote lining the cavities. Numerous altered, but mostly uncollapsed pumice lapilli up to at least 1.5 mm. maximum dimension, attesting to degree of welding

PHENOCRYSTS: ~7% alkali feldspar, subhedral-(rarely) euhedral or fragmentary; bimodal size distribution -- about half range in size from 0.4-1.0 mm. These tend to be subhedral to (rarely) euhedral - a few are aggregates (glomeroporphyritic). The remainder are almost all < 0.1 mm dia. and tend to be fragmentary. One larger is carlsbad-twinned A few of the larger K-sp phenocrysts contain sparse irregular albite inclusions up to 0.1-0.2 mm maximum dia. These are identical to the albites of the Redondo Creek Bandelier - probably exsolution. Many K-spar phenos show a curious mottled extinction and anomalous blue-gray intf. reminiscent of serpentine.

~3% quartz, euhedral-subhedral or broken, up to at least 0.8 mm. dia. (one composite is 1.2 mm. dia.)

LITHIC FRAGMENTS -- ~5%, subrnd-subt, up to at least 1.5 mm. dia, mostly rel. crs-xln. granophyrically xtzd felsic volc.; ~~rare~~ one? is crs-xln calcite, later epidotized.

contd →

B-8
2700-2800', cont'd.

04/05/85

(12)

note - there is one large free lithic fragment on this smpl. that looks granophyrically x'lzd, but which is poorly welded at best — also mimicing granophyric x'lzn.?

PUMICE < 2% unambiguous examples — these have aspect ratios < 2/1 relatively uncollapsed-appearing - perhaps somewhat elongate when ejected — up to 1.5 mm L.

GROUNDMASS — devitrified ash; presently a µx'ln "salt-and pepper" qtz-KF aggregate w/ind. x'ls < 2% diameter

ACCESSORY MINERALS —

Tr. zircon — stubby euh. prisms up to 0.1 x 0.03 mm

Tr. apatite —

cont'd.

VUGS & AMYGDULES — at least 15% of the rock, irregular to commonly crudely ovoid or lensoid, up to at least 1.0 mm. maximum dimension — partially lined to filled w/ K-spar, qtz, epidote, chlorite, sph, and rare fluorite in various proportions epidote & chl. ± sph are prob. hydrothermal — others may be both vapor-phase and hydrothermal. K-spar in these vugs/amygdules forms subhedral to euhedral, commonly rhombohedral crystals avg ~ 0.03 mm dia (up to 0.10 mm); qtz is rarer, tends to be similar size, but interstitial to K-sp; fluorite forms subhedral x/s up to 0.15 (avg < 0.05) mm in dia — conspicuously ~~purple~~ slight purplish cast, low relief, n< epox — good oct. cleavage — overall only a trace of fluorite. Epidote overall makes up about 5 vol. % of the rock and up to 15% of some chips. It is a yellow to greenish- and brownish yellow variety which occurs as 1) diss. irregular microcrystalline aggregates up to 0.3 mm. in dia., and commonly intergrown with texturally similar secondary sphene 2) subh-euh. columnar crystals up to 0.2 mm x 0.03 mm and radiating sprays and rosettes of these x/s up to 0.3 mm. dia. This type tends to occur in, but is not confined to, vesicles, where some is open-space growth, some is replacement of alkali feldspar. (cont'd)

20th

hydroth.? leucoxene/sphene est. ~0.3-0.5% texturally similar to & intergrown with microcrystalline epidote

B-8 2700-2800' cont'd

chlorite ~1-2% occurs as microcrystalline (<5μ) greenish-brown masses interstitial to kspar, ep & qtz in vugs 2) "berlin-blue" intf, light green fibrous aggregates intergrown w/epidote in some fans & rosettes 3) irreg microcrystalline clots < 0.03 mm dia. disseminated through groundmass

sericite occurs principally as disseminated fibrous x/s & flakes < 0.04 mm max dimension and irregular clots of these crystals up to 0.15 mm. dia also some vug filling illite texturally similar to chlorite

calcite, <2% partially fills a few scattered vugs and amygdules, — possibly one lg. lithic - "crs." x/n (>0.3 mm x/s) calcite definitely being replaced by epidote.

3000-3100' densely welded, gran. xlzd crystal-vitric, felsic ash-flow tuff strong epidote altn, abundant miarolitic cavities

PHENOCRYSTS:

5% quartz, anhedral to subhedral (rarely euh.) or broken, up to 1.2 mm. dia. many of the larger ones have irregular, overgrowths separated from main crystal by "dust rings". (silicification of matrix

10% alkali feldspar - anh-subeh, (rarely euh) or broken, up to 1.5 mm x 0.7 mm. mostly fragmental and <0.5 mm. — curious mottled extinction and anomalous bluish-gray birefringence. tr. albite in these as irreg patches <0.05 mm.

At least 15, maybe 20% miarolitic cavities, as at 2700-2800' (same descrip.) v. commonly containing epidote xls and aggregates.

epidote appears to replace both qtz & alkali feldspar

definitely K-spar — cuts right through euhedral crystal of alkali fp

17

BAGA 8

14 600-700

ELEMENT			CONCENTRATION
NA	% OX.		0.421
K	% OX.		3.75
CA	% OX.		4.87
MG	% OX.		0.505
FE	% OX.		2.20
AL	% OX.		12.51
SI	% OX.	<	1.60 (57.9)
TI	% OX.		0.298
P	% OX.		0.080
SR	PPM		147
BA	% OX.		0.091
V	PPM	<	250
CR	PPM		7
MN	% OX.		0.095
CO	PPM		2
NI	PPM		6
CU	PPM		6
MO	PPM	<	50.0
PB	PPM	<	10.00
ZN	PPM		64
CD	PPM	<	5.00
AG	PPM		3
AU	PPM	<	4.00
AS	PPM	<	25.0
SB	PPM	<	30.0
BI	PPM	<	100.0
U	PPM	<	2499
TE	PPM	<	50.0
SN	PPM	<	5.00
W	PPM	<	1200
LI	PPM		10
BE	PPM		2.1
B	PPM	<	400
ZR	PPM		141
LA	PPM		62
CE	PPM		103
TH	PPM	<	150
LOI	%		5.52
S	%		0.99
	TOTAL		97.29

BACA 8

15 1600-1700

ELEMENT			CONCENTRATION
NA	% OX.		1.94
K	% OX.		5.89
CA	% OX.		3.30
MG	% OX.		1.61
FE	% OX.		2.30
AL	% OX.		13.30
SI	% OX.	<	~~1.60~~ 69.5
TI	% OX.		0.292
P	% OX.		0.040
SR	PPM		89
BA	% OX.		0.033
V	PPM	<	250
CR	PPM		16
MN	% OX.		0.083
CO	PPM		4
NI	PPM		10
CU	PPM		8
MO	PPM	<	50.0
PB	PPM	<	10.00
ZN	PPM		67
CD	PPM	<	5.00
AG	PPM		4
AU	PPM	<	4.00
AS	PPM	<	25.0
SB	PPM	<	30.0
BI	PPM	<	100.0
U	PPM	<	2499
TE	PPM	<	50.0
SN	PPM		6
W	PPM	<	1200
LI	PPM		59
BE	PPM		2.9
B	PPM	<	400
ZR	PPM		148
LA	PPM		60
CE	PPM		102
TH	PPM	<	150
10?	%		3.98
	%		0.37
5	TOTAL		99.306
			101.4%

BACA 8

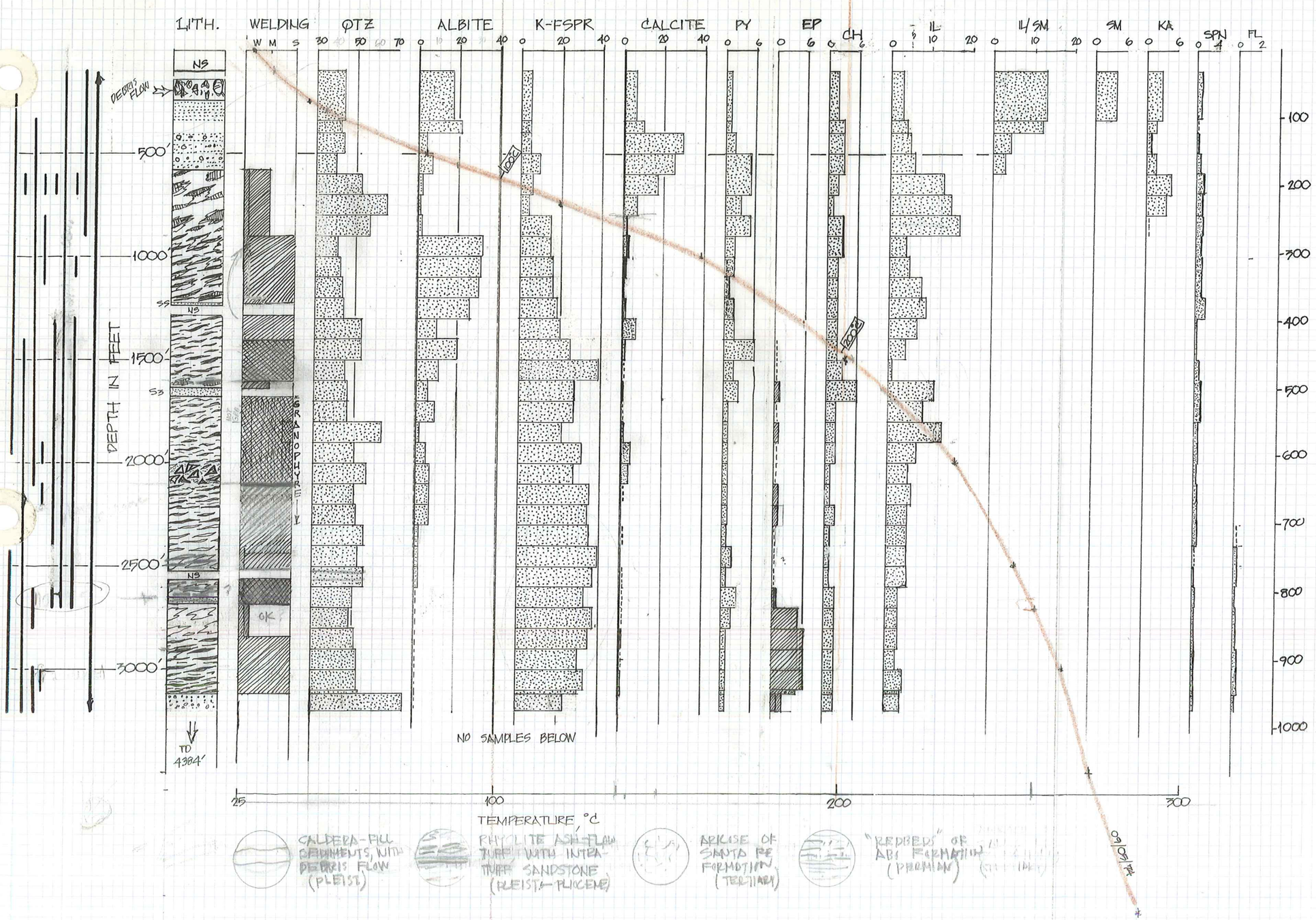
16 1900-2000

ELEMENT			CONCENTRATION
NA	% OX.		0.545
K	% OX.		5.84
CA	% OX.		1.63
MG	% OX.		0.161
FE	% OX.		1.30
AL	% OX.		10.97
SI	% OX.	<	~~1.60~~ 75.8
TI	% OX.		0.149
P	% OX.		0.015
SR	PPM		69
BA	% OX.		0.028
V	PPM	<	250
CR	PPM	<	2.00
MN	% OX.		0.089
CO	PPM		1
NI	PPM	<	4.99
CU	PPM		9
MO	PPM	<	49.9
PB	PPM		14
ZN	PPM		65
CD	PPM	<	4.99
AG	PPM		5
AU	PPM	<	3.99
AS	PPM	<	25.0
SB	PPM	<	30.0
BI	PPM	<	99.9
U	PPM	<	2497
TE	PPM	<	49.9
SN	PPM	<	4.99
W	PPM	<	1198
LI	PPM		47
BE	PPM		2.5
B	PPM	<	399
ZR	PPM		158
LA	PPM		50
CE	PPM		87
TH	PPM	<	150
LOI	%		2.47
S	%		4.52
	TOTAL		99.406
			99.5%

BACA 8

17 3100-3200

ELEMENT			CONCENTRATION
NA	% OX.		0.212
K	% OX.		5.15
CA	% OX.		1.87
MG	% OX.		0.234
FE	% OX.		1.95
AL	% OX.		7.45
SI	% OX.	<	~~1.60~~ 80.8
TI	% OX.		0.131
P	% OX.		0.033
SR	PPM		130
BA	% OX.		0.071
V	PPM	<	250
CR	PPM		6
MN	% OX.		0.199
CO	PPM		4
NI	PPM		7
CU	PPM		9
MO	PPM	<	49.9
PB	PPM		57
ZN	PPM		68
CD	PPM	<	4.99
AG	PPM		4
AU	PPM	<	3.99
AS	PPM	<	25.0
SB	PPM	<	30.0
BI	PPM	<	99.9
U	PPM	<	2497
TE	PPM	<	49.9
SN	PPM	<	4.99
W	PPM	<	1198
LI	PPM		26
BE	PPM		1.8
B	PPM	<	399
ZR	PPM		107
LA	PPM		33
CE	PPM		53
TH	PPM	<	150
LOI	%		2.23
S	%		.84
	TOTAL		18.909
			101.199



IL/TE

BB DISTRIBUTION OF ROCK-FORMING & HYDROTHERMAL ALTERATION MINERALS IN 30.1 m COMPOSITE SAMPLES

—CLAY MINERALOGY—