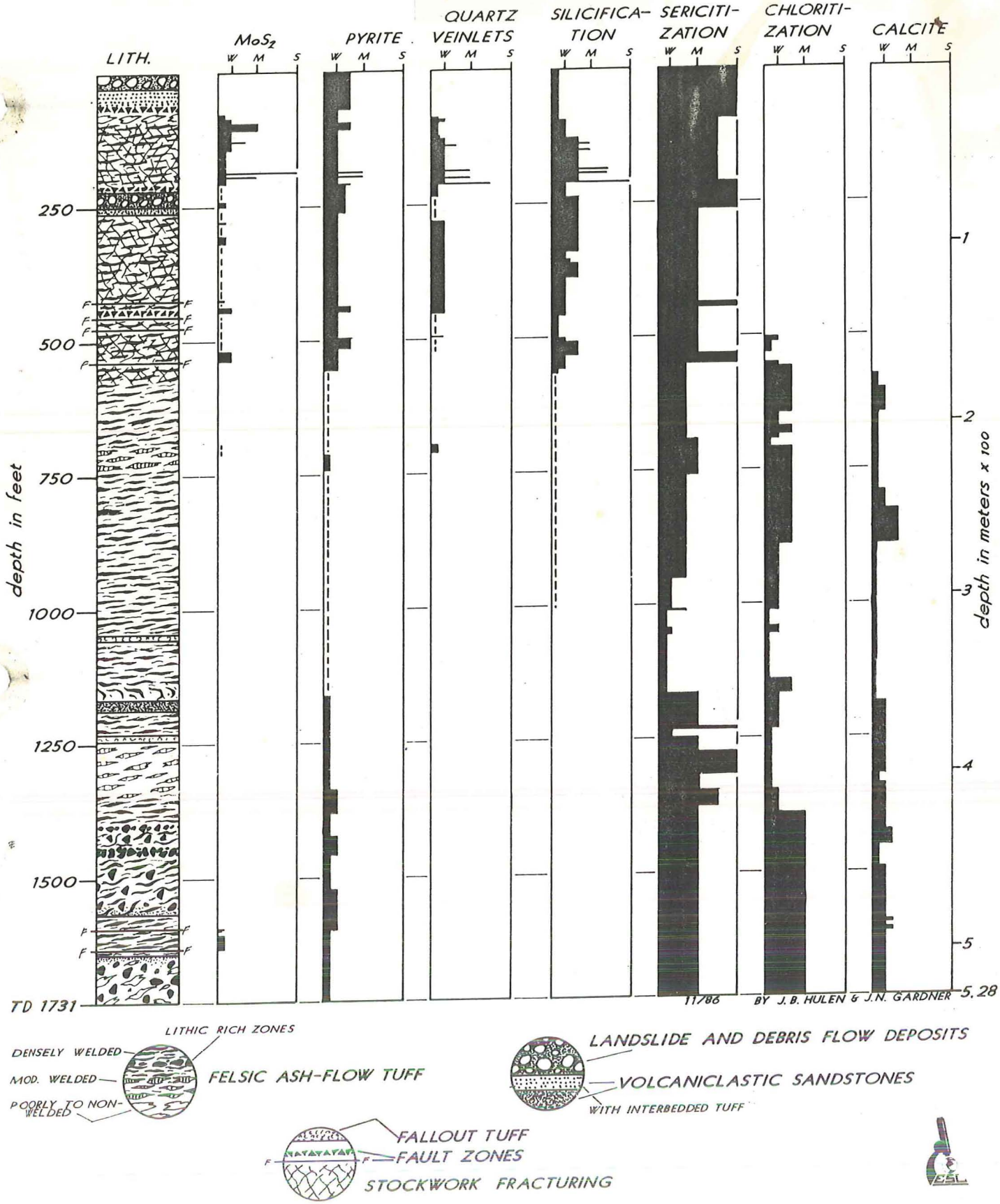
GL04705



Preliminary hydrothermal alteration and mineralization log for CSDP corehole VC-2A, Valles caldera, New Mexico

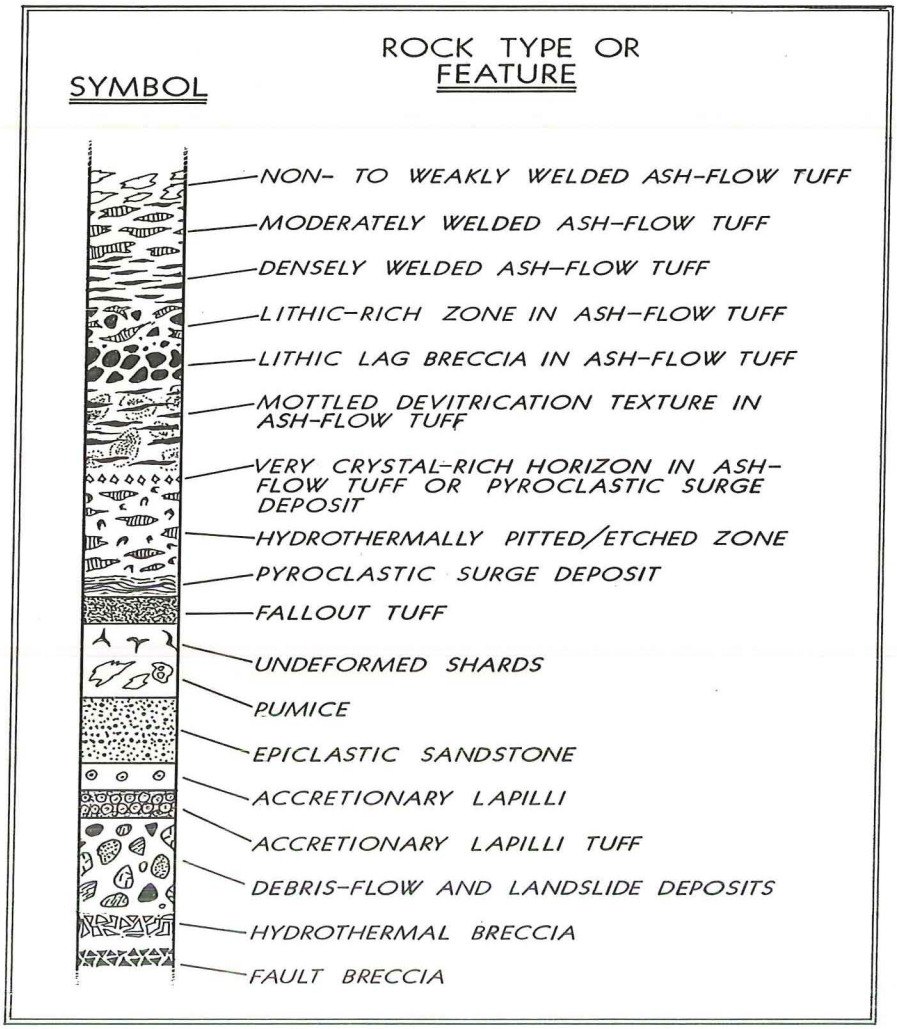
APPENDIX A

DETAILED LITHOLOGIC, STRUCTURAL, HYDROTHERMAL ALTERATION AND VEIN MINERALIZATION LOG FOR CSDP COREHOLE VC-2A, SULPHUR SPRINGS AREA, VALLES CALDERA, N. MEXICO

by

Jeffrey B. Hulen[1] & Jamie N. Gardner[2]

1—UNIVERSITY OF UTAH RESEARCH INSTITUTE, SALT LAKE CITY, UTAH 84108
2—LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, NEW MEXICO 87545



VC-2A: EXPLANATION OF LITHOLOGIC SYMBOLS

SEPT.-OCT. 1986
REVISED DEC. 1987

FOR U.S. DEPARTMENT OF ENERGY—OFFICE OF BASIC ENERGY SCIENCES
AGREEMENT NO. DE-FG02-86ER13555

CATEGORY	INTENSITY		
	WEAK (W)	MODERATE (M)	STRONG (S)
QUARTZ–SERICITE (PHYLLIC) ALTERATION	ORIGINAL PLAGIOCLASE PARTIALLY SERICITIZED. ORIGINAL K-FELDSPAR ≤10% SERICITIZED. GROUNDMASS <10% ALTERED TO MICROCRYSTALLINE QUARTZ–SERICITE AGGREGATE.	ORIGINAL PLAGIOCLASE >50% SERICITIZED. ORIGINAL K-FELDPAR 10-50% SERICITIZED GROUNDMASS 10-50% ALTERED TO MICRO-CRYSTALLINE QUARTZ–SERICITE AGGREGATE.	ORIGINAL PLAGIOCLASE COMPLETELY SERICITIZED. ORIGINAL K-FELDSPAR >50% SERICITIZED. GROUNDMASS >50% ALTERED TO MICRO-CRYSTALLINE QUARTZ–SERICITE AGGREGATE.
SILICIFICATION	GROUNDMASS ≤10% ALTERED TO ESSENTIALLY MONOMINERALIC MICROCRYST. QUARTZ.	GROUNDMASS >10–50% ALTERED TO ESSENTIALLY MONOMINERALIC MICROCRYSTALLINE QTZ.	GROUNDMASS >50% ALTERED TO ESSENTIALLY MONOMINERALIC MICROCRYSTALLINE QTZ.
CHLORITE–SERICITE ALTERATION	ORIGINAL PLAGIOCLASE <10% ALTERED TO SERICITE, MINOR CHLORITE AND PHENGITE. ORIGINAL K-FELDSPAR UNALTERED. ORIGINAL MAFICS ALTERED TO CHLORITE ± CALCITE, PHENGITE, LEUCOXENE. GROUNDMASS <10% ALTERED TO MICRO-CRYSTALLINE AGGREGATE OF SERICITE WITH CHLORITE, PHENGITE, CALCITE, AND (BELOW 420M) ALBITE.	SAME AS WEAK COUNTERPART EXCEPT PLAGIOCLASE 10–50% ALTERED, GROUNDMASS 10–50% ALTERED, ORIGINAL K-FELDSPAR FRESH OR <10% SERICITIZED.	SAME AS WEAK. COUNTERPART EXCEPT PLAGIOCLASE >50% ALTERED, GROUNDMASS >50% ALTERED, ORIGINAL K FELDSPAR <20% SERICITIZED.
CALCITE AFTER PLAGIOCLASE	≤10% OF ORIGINAL PLAGIOCLASE ALTERED TO CALCITE.	10–50% OF ORIGINAL PLAGIOCLASE ALTERED TO CALCITE.	>50% OF ORIGINAL PLAGIOCLASE ALTERED TO CALCITE.
DISSEMINATED PYRITE	≤1%	1–5%	>5%
FRACTURING	≤10 FRACTURES/M	10–30 FRACTURES/M	>30 FRACTURES/M
VEINING AND VUG–FILLING	≤10 VEINLETS/M ± ≤1% (VOL.) VUG-FILLING* PHASES	10–30 VEINLETS/M ± 1–5% VUG-FILLING* PHASES.	>30 VEINLETS/M ± >5% VUG-FILLING* PHASES

* HYDROTHERMAL

VC–2A: EXPLANATION OF ALTERATION, FRACTURING, AND VEINLET INTENSITY LOGS.

VC-2A: ABBREVIATIONS

AB--albite
ACCR--accretionary
ACC--accessory
AF--ash-flow
AGG--aggregate
ALT--altered
ALTN--alteration
AND--andesite
ANH--anhedral
APP--apparently
AVG--average
BX--breccia(s)
CAL--calcite
CALC--calcite
CH--chlorite
CHL--chlorite
CHLTZD--chloritized
CM--centimeter(s)
COMP FOL--compaction foliation
CPY--chalcopyrite
CRS--coarse
DEF--definitely
DIA--diameter
DISS--disseminated
DK--dark
DW--densely welded
E G.--for example
ESP--especially
EUH--euhedral
EXC--except
F--fine
FL--fluorite
FLUOR--fluorite
FLD--fluid
FM--formation
FSP--feldspar
GEN--generally
GR--grained
HYD--hydrothermal
HYDROVOLC--hydrovolcanic
IL--illite
INC--inclusion(s)
INTM--intermediate
IRREG--irregular
K--potassium
KF--potassium feldspar
KFSP--potassium feldspar
LAP--lapilli
LEUC--leucoxene
LIMEST--limestone
LST--least
LT--light
M--meter(s)
MED--medium
MICROXLN--microcrystalline
MM--millimeter(s)
MO--molybdenite
MOLYBD--molybdenite
MoS_2--molybdenite
MOD--moderate
PH--phengite
PHENG--phengite
PL--plagioclase
PLAG--plagioclase
POSS--possible,possibly
PPY--porphyry
PPYTIC--porphyritic
PR--primary
PY--pyrite
Q--quartz
QTZ--quartz
REL--relatively
RH--rhodochrosite
RHODOCHR--rhodochrosite
RHY--rhyolite
SEC--section
SEQ--sequence
SER--sericite
SL--slightly
SLTST--siltstone
SP--sphalerite
SPH--sphalerite
SPHALER--sphalerite
SS--sandstone
SUBH--subhedral
TRANSL--translucent
TR--trace
V--very
VAP--vapor
VNLT--veinlet
W/--with
WO/--without
WT--weight
XL--crystal
XLINE--crystalline
XLN--crystalline

SYMBOLS

& --and
$\sim$ --about
$\measuredangle$ --angular
$>$ --greater than
$<$ --less than
$\pm$ --with or without
$\perp$ --perpendicular

VC-2A: DEFINITIONS

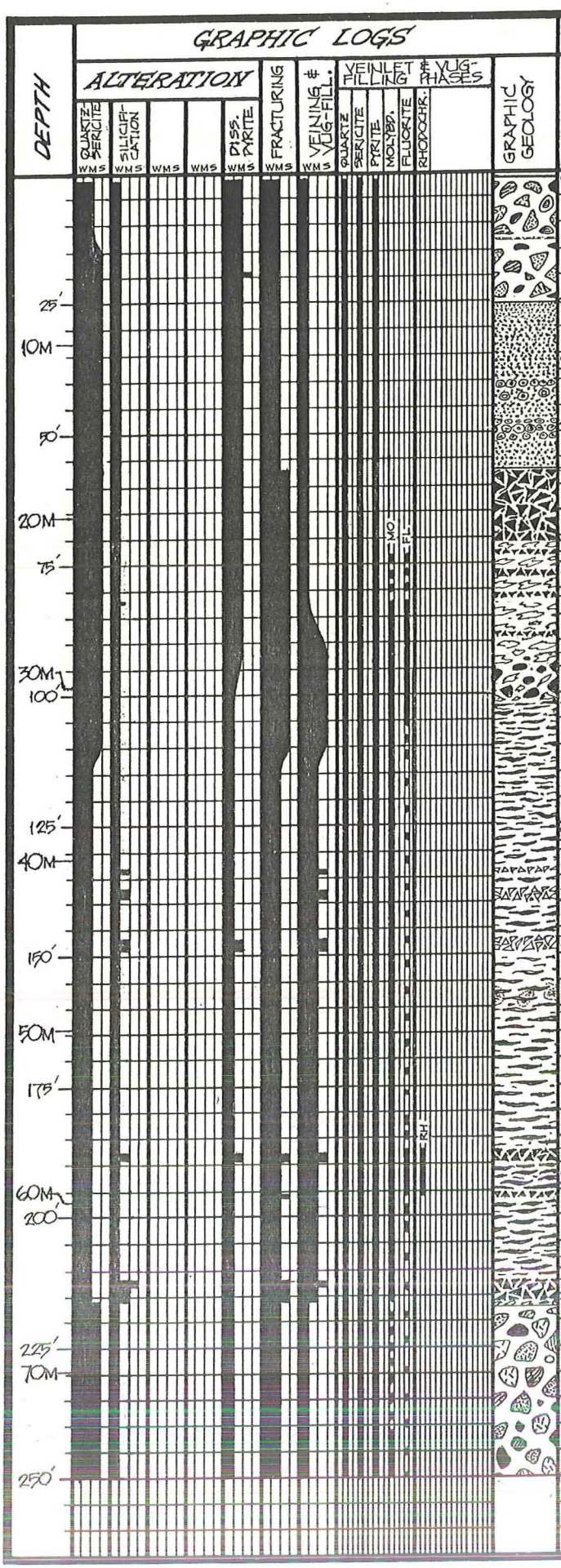
Illite--White or nearly white, clay-grade, essentially non-expandable potassium mica-like mineral similar to muscovite but with less potassium, more silica, and more bound water; may contain up to 5% interstratified smectite, an amount not readily detectable by routine X-ray diffraction.

Phengite--Brown to (characteristically) vivid gray-green, iron-rich illite analogue

Sericite--A general term encompassing both illite and illite-rich, mixed-layer illite/smectite

Smectite--Fully expandable, mica-like sheet silicate with charge deficiency of 0.2-0.6 per formula unit balanced by various interlayer cations (typically calcium and sodium) which readily adsorb water or polar organic molecules (such as ethylene glycol) to produce the characteristic expansion; commonly interstratified with illite to form partially expandable mixed-layer clay.

Leucoxene--White to light grayish-yellow, microcrystalline aggregate of sphene and anatase in various proportions with or without minor rutile.



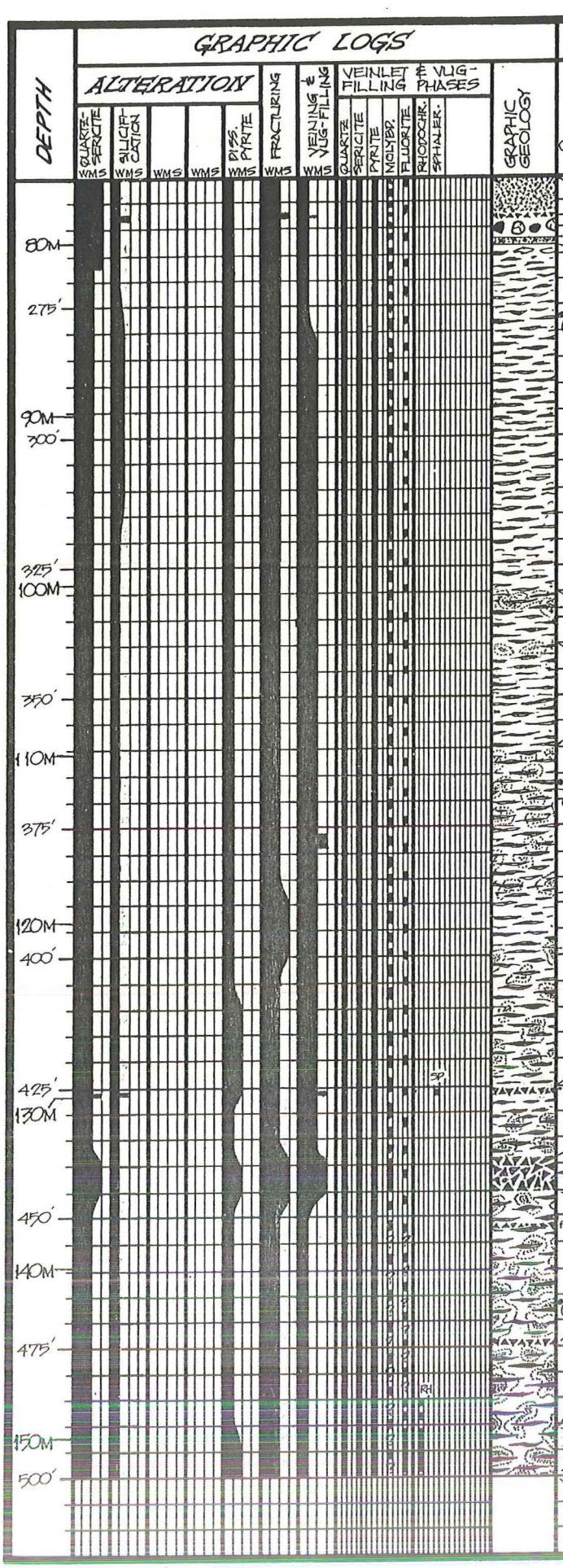
NOTES, COMMENTS	DESCRIPTIONS
0.61M (2')	0-0.61M: NO CORE
	0.61-7.92M: LANDSLIDE BRECCIA, SOFT, PUNKY, POROUS, LT. GRAY TO WHITE; HETEROLITHOLOGIC CLASTS, SUBANGULAR TO ANGULAR, UP TO 20 CM. DIA., COMPRISING MED.-GR. ARKOSE & EPICLAS-TIC SS, FLOW-BANDED RHYOLITE, RHY. ASH-FLOW TUFF, FINE-MED.-XLN. LIMESTONE; SEVERAL LIMEST. & SS. CLASTS
← CLAY-RICH (GOUGE?)	HAVE PY-RICH CORES & SURROUNDING PYRITIC BANDS; MATRIX IS CLAYEY SILT, SAND & GRIT, PROBABLY TUFFA-CEOUS, NOW EXTENSIVELY ALTERED TO QUARTZ-SERICITE ± PYRITE AGGREGATE; CLAY (SERICITE) SEAM FROM
7.92M (26')	4.12-4.27 M (POSSIBLE GOUGE ZONE)
	7.92-17.37 M: EPICLASTIC SEDIMENTS, SOFT, PUNKY LT. GRAY TO WHITE; DISTINCTLY BEDDED (APPARENT DIP 10-15°); ALTERNATING
● APP. DIP ← 10-15°	COARSE & FINE-MED. SAND; GRIT BEDS (COARSE SAND) ARE UP TO 5 CM. THICK, FINER-GR. SS BEDS GEN. < 15 MM THICK;
	GRIT BEDS LOCALLY CONTAIN LARGER (UP TO 25 MM) AN-GULAR FRAGMENTS; CLASTS CONSIST OF QTZ, FSP, &
← ACCRETION. LAPILLI TUFF	ABUNDANT LITHICS (FELSIC VOLCANICS, MOSTLY); ACCRETIO-NARY LAPILLI PRESENT -- THESE BECOME CONSPICUOUS
	AT 12.8 M, ACCRETIONARY LAPILLI TUFF 14.63-16.39 M. MIXED ACCR. LAP. TUFF & CRS. SS 15.39-15.85 M.
17.37M (57')	V. STRONG PHYLLIC (QUARTZ-SER.-PYRITE) ALTERATION THROUGHOUT THIS UNIT -- V. SIMILAR TO 0.61-7.92 M.
	FELDSPARS BOTH PARTIALLY TO COMPLETELY DISSOLVED, ALTERED TO F. XLN. SERICITE.
	17.37-21.64 M FAULT BRECCIA; ANGULAR CLASTS UP TO AT
21.64M (71')	LEAST 10 CM. DIA.; MOSTLY WELDED ASH-FLOW TUFF;
22.19M (72.8')	ALTN. AS ABOVE EXCEPT QTZ, SER. & PYRITE START TO
— FLT.	APPEAR IN VEINLETS & VUGS.
	21.64-22.19 M: NON-WELDED ASH-FLOW TUFF; ALTN. AS ABOVE
24.9M (81.7')	22.19-24.9 M: ALTERNATING ZONES OF FAULT BRECCIA & NON-POORLY WELDED ASH-FLOW TUFF; ALTN. AS ABOVE.
— FLT.	24.9-28.2 M: HIGHLY FRACTURED, INTENSELY ALTERED, NON- TO POORLY-WELDED ASH-FLOW TUFF; TR. FLUORITE & QTZ
28.2M (92.5')	IN VUGS. SOOTY MoS_2 "PAINT" APPEARS.
	28.2-31.1 M: LITHIC-RICH, NON-POORLY WELDED ASH-FLOW TUFF; POSS. LAG BRECCIA; QTZ-SER., SILICIFD., W/QTZ, SER., FL.,
31.1M (102')	& SOOTY GRAY MOLYBDENITE IN VEINS & VUGS; MINERALI-ZATION IS DISTINCTLY EPITHERMAL IN CHARACTER.
	31.1-64.8 M: DENSELY WELDED, XL-RICH, RHYOLITE ASH-FLOW
	TUFF, FRACTURED, QTZ-SERICITIZED, MINERALIZED W/MoS_2; PHENOCRYSTS ARE QTZ & K-FELDSPAR, THE LATTER
	COMMONLY PARTIALLY DISSOLVED, PARTIALLY ALTERED TO FINE-XLN. SERICITE; ROCK IS LOCALLY DISRUPTED BY
	HYDROTHERMAL BRECCIA, MATRIX OF WHICH IS SILICIFIED & SELECTIVELY ENRICHED IN MoS_2;
● APP. DIP 15°	QTZ VNLTS W/O PY LOCALLY PRESENT & POST-DATE QTZ-SER. ALTN.; DISSOLVED VUGS IN K-FELDSPAR
← HYD. BX	PHENOCRYSTS COMMONLY LINED WITH EUHEDRAL QUARTZ CRYSTALS. SERICITE REPLACES BOTH PUMICE
← HYD. BX	& FSP. AS WELL AS MATRIX & OCCURS AS VEINLETS.
42.7M (140')	39.3-39.5 M } SILICIFIED QTZ-SER. HYDROTHERMAL
	41.9-42.7 M } BX. ENRICHED IN MoS_2.
45M (147.5') ← HYD. BX.	45-45.6 M } (BX AT 45 M. COULD ALSO BE LAG BX)
	● XRD, 47.7M (%): Q-63, KF-19, PY-2, IL-15
	48.2-49.1 M BLOTCHY DEVITRIFICATION TEXTURE
47.7M (156.5 FT)	APPARENT EVEN THROUGH ALTERATION OVERPRINT
	50.9 M: FINE-XLN PYRITE COATING EUH. QTZ XL. IN VEINLET.
57.2M (187.8') ← FLT. BX	57.2-57.6 M: MoS_2-RICH, SILICFD., SER. BX W/ ABUNDANT, LATE-STAGE FLUORITE. ALSO LOCAL,
● APP. DIP 10°	DELICATE LIGHT PINK RHODOCHROSITE ROSETTES & IRREGULAR AGGREGATES -- BETWEEN 57.2M &
	57.7 M.
63.5M (208.5')	● XRD, 63.5M (%) Q-53, KF-24, PY-3, IL-19
64.8M (212.6')	64.8-65.8 M ALTERED FAULT BRECCIA
65.8M (216')	65.8-66.1': ALTERED, PUMICE-RICH TUFF, POSS. SOME
66.1M (217')	ACCRETIONARY LAPILLI. THIS MAY BE A CLAST IN THE UNDERLYING DEBRIS FLOW.
68.6M (225 FT.)	66.1-76.2 M: DEBRIS FLOW, POROUS, PUNKY, INTENSELY
	QUARTZ-SERICITIZED (MOST ORIGINAL FELDSPAR EITHER DISSOLVED OR ALTERED TO SERICITE); ROCK CON-
	SISTS OF >50% CLASTS, UP TO 0.6 M (AVG. ~1/2 CM.) DIA., COMPRISING BLEACHED, REDDISH SANDSTONE (APP. FM.),
	PORPHYRITIC ANDESITE, PORPHYRITIC RHYOLITE (W/ & W/O BIOTITE), WELDED ASH-FLOW TUFF & MINOR GRANITE
76.2M (250')	EMBEDDED IN A SILTY TO SANDY, ALTERED TUFFA-CEOUS MATRIX; SOME CLASTS SELECTIVELY
	PYRITIZED?
	● XRD, 68.6M (%): Q-53, PY-2, ANATASE-2, ILLITE-44

DRILL HOLE VC-2A

LOCATION VALLES CALDERA, N. MEXICO

LOGGED BY
J.B. HULEN AND J.N. GARDNER

SEPT.-OCT. 1986
REVISED DEC. 1987



NOTES, COMMENTS

DESCRIPTIONS

76.2M (250')

76.2 - 78.6 M: MASSIVE, FINE-MED. GR. EPICLASTIC SS., BLEACHED, PUNKY, INTENSELY QTZ-SERICITIZED

78.6M (258')

78.6 - 79.8 M: DEBRIS FLOW, SAME AS 66.1 - 76.2 M.

79.8M (262')
80.2M (263.2')

79.8 - 80.2 M: EPICLASTIC SANDSTONE, AS ABOVE; CONTACT W/ TUFF AT BASE — DIP 45°

80.2 - 80.7 M: MOD. WELDED, XL-RICH RHY. ASH-FLOW TUFF

80.7 - 215.5 M: Ddensely WELDED, CRYSTAL-RICH RHYOLITE ASH-FLOW TUFF, VARIABLY ALTERED, FRACTURED & MINERALIZED, BUT IN GENERAL LT.-MED. GRAY & SOME-WHAT FLINTY-APPEARING; AVG. 30-35% PHENOCRYSTS — QUART & K-FELDSPAR (POSS. ORIGINALLY MICROPERTHITE NOW WITH ALBITE ALTERED TO SER.); AVG. 5-7% LITHIC FRAGMENTS — MOSTLY PORPHYRITIC INTERMEDIATE VOLCANIC ROCK; MINOR COLLAPSED PUMICE COMMONLY VUGGY & ALTERED TO SERICITE. ROCK IS CUT BY NUMEROUS QTZ ± SER ± PY VNLTS — THESE SAME THREE MINERALS ALSO OCCUR SINGLY & IN VARIOUS COMBINATIONS AS VUG LINING/FILLING PHASES. DEPARTURES FROM THESE GENERALITIES NOTED BELOW. GROUNDMASS ORIGINALLY QTZ, ORTHOCLASE, ALBITE — LATTER NOW COMPLETELY SERICITIZED (THIS ACCOUNTS FOR THE TEXTURAL CONTRAST W/ ROCK ABOVE 81.4M; NOTE, THEN, ALBITE & KSPAR ARE EARLY

• DIP ∿ 45° (COMP. FOL.)

95.4 - 96M: VEIN UP TO 1 CM WIDE (QTZ-SER.) ALSO VUGS UP TO 15X10X5 MM

100.5M (330')
101.6M (333')

• XRD, 101.6M (%): Q-59, KF-23, PY-2, IL-15

100.5 - 101.8 M: ROCK TAKES ON MOTTLED APPEARANCE (DEVITRIFICATION TEXTURES)

103.6M (340')

103.6 - 105M: AS ABOVE.

105 - 105.5 M: POWDERY GOUGE ZONE, DIP ∿ 80°

109.7M (360')

• XRD, 112.3M (%): Q-54, KF-29, PY-5, IL-10, GYPSUM-1

• DIP ∿ 42° (COMP. FOL.)

112.3M (368.3')

113.4 - 114M: SPARSE, IRREGULAR VUGS, BUT THESE ARE UP TO 30X 12 MM — LINED W/ QUARTZ, THEN PYRITE, THEN PARTIALLY INFILLED WITH ILLITE.

109.7 - 118.3M: MOTTLED, DEVITRIFIED DENSELY WELDED ASH-FLOW TUFF, AS ABOVE.

118.3M (388')

118.3 - 121.6M: >100 FRACTURES/METER

121.6M (399')

123.1 - 129.6 M: IRREGULAR ILLITE-LINED VUGS UP TO 80X 15 MM — W/ QTZ & PYRITE; ILLITE ALSO MASSIVELY REPLACES SCATTERED FIAMME.

129.6 - 129.9 M: POWDERY, DARK GRAY, FINELY GROUND FAULT BRECCIA W/ HONEY-COLORED, LATE-STAGE SPHALERITE CRYSTALS.

SPHALERITE

129.6M (425.3')
MIN. FLT. BX

• XRD, 129.6M (%): Q-47, PY-4, IL-46, SPHAL-2

133.8M (439')

133.8 - 135.6 M: FAULT BRECCIA, RUBBLE STAINED & COATED SOOTY DARK GRAY W/ MICROCRYSTALLINE PYRITE, MOLYBDENITE!

MINERALIZED FAULT BX

135.6M (445')

FLT (137.8M 452')

135.6 - 150.6': BELOW THE ABOVE-MENTIONED RUBBLE ZONE, THE BLOTCHY DEVITRIFICATION TEXTURE IS ESPECIALLY PROMINENT, W/ LARGE (UP TO 5 CM. DIA.) "EYES" CORED W/ ILLITE/PYRITE, MANTLED BY QTZ-IL-KFSP — THESE ARE VERY IRREGULAR.

• DIP ∿ 43° (COMP. FOL.)

E.G.: V. LT. GRAY, INTM. GRAY, VUG, COMMONLY PARTIALLY FILLED WITH SERICITE & PYRITE

FAULT

147.4 M: 2.5X 1.5 MM. CPY BLEB IN GRANOPHYRIC MATRIX OF DENSELY WELDED ASH-FLOW TUFF

149.8M (491.5')

RHODOCHR.

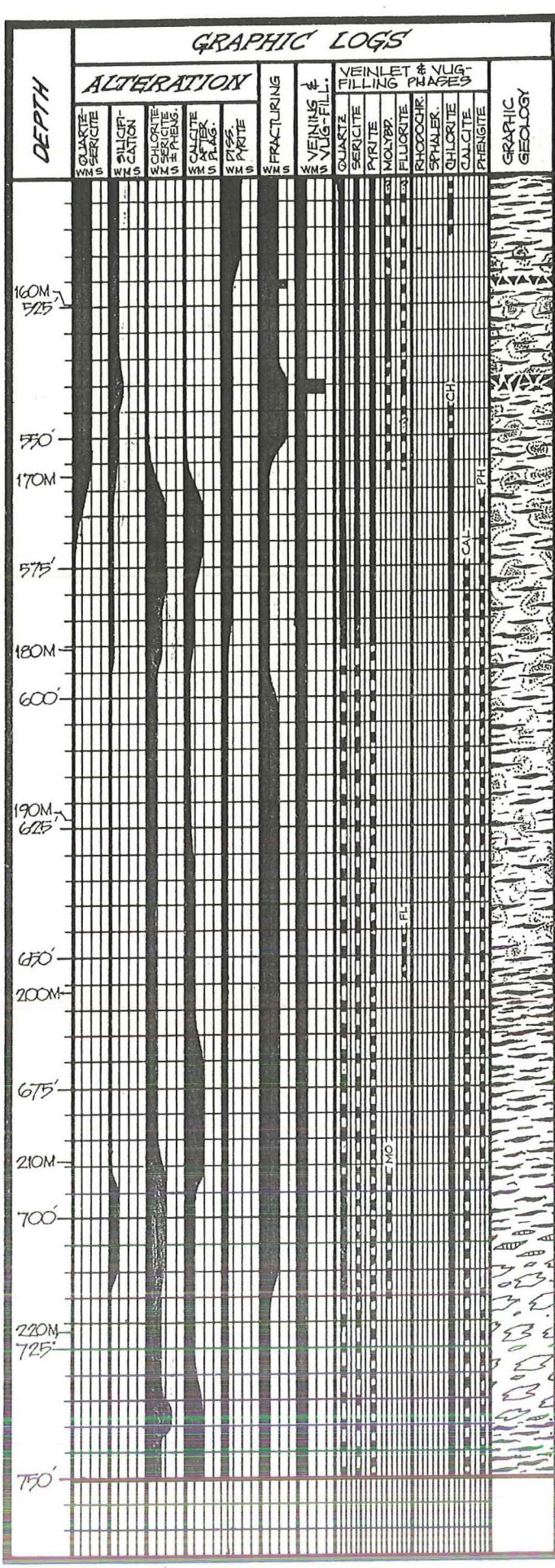
149.8 - 172.1 M: MINOR RHODOCHROSITE, SAME TEXTURE AS 57.2 - 59.7 M.

152.4M

DRILL HOLE VC-2A
LOCATION VALLES CALDERA, N. MEXICO

LOGGED BY
J.B. HULEN AND J.N. GARDNER

SEPT.-OCT. 1986
REVISED DEC. 1987

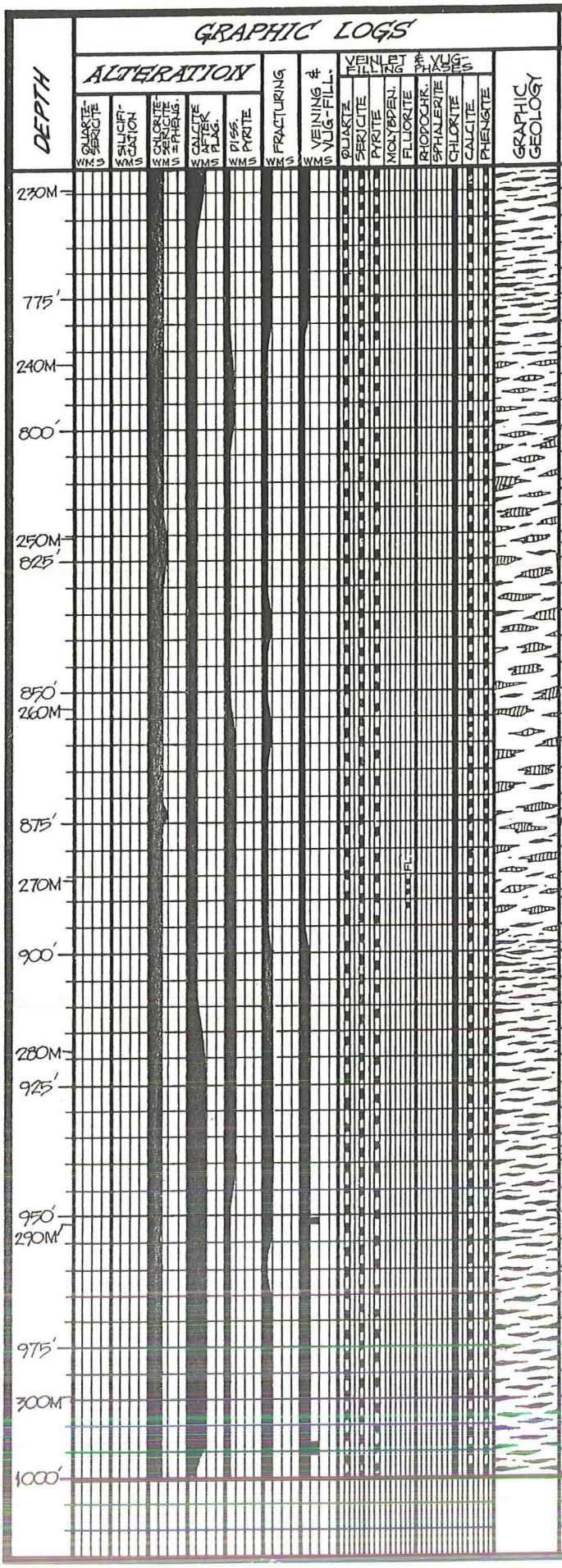


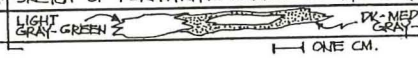
DESCRIPTIONS

NOTES COMMENTS	DESCRIPTIONS
	DENSELY WELDED, XL-RICH RHY. ASH-FLOW TUFF CONTINUES
	• XRD, 156.8M (%): Q-33, KF-22, PY-4, IL-18
RHODOCHR. 156.7M (514')	156.7 M + RHODOCHROSITE, AS ABOVE
158.5M (520')	158.5 - 159.1 M: RUBBLIZED FAULT ZONE W/ SOOTY MoS_2
• DIP ∿ 45° (COMP. FOL.)	
	BLOTCHY DEVITRIFICATION TEXTURE STILL PROMINENT (SEE PRECEDING PAGE)
164M (538.2')	• XRD, 164M (%): Q-54, KF-28, PY-2, IL-15
164.3M (539')	164.3 - 165.1 M: FAULT ZONE: CONTAINS TRANSL. APPLE GREEN FLUOR. -- ONE OCTAHEDRON IS 18 mm. DIA.
LARGE GREEN FLUOR. XLS.	
167.8M (550.6') CHL. APPEARS	167.8M: CHLORITE APPEARS AS A VEIN-FORMING MINERAL (POSS. TRACES FOR A FEW M ABOVE).
• DIP 30-40° (COMP. FOL.)	(VISIBLE IN HAND-SPECIMEN)
	IRREGULAR SERICITE CLOTS UP TO AT LEAST 90 X 40 MM IN X-SECTION; ALSO BLOTCHY DEVITRIFICATION TEXTURE AS ABOVE.
(VEINLET) CALCITE APPEARS	175.6M: CALCITE APPEARS IN VEINLETS; SOME CAL. APPARENTLY POST-DATES CHL.
178.6M (976.1')	
177.8M (582.4 FT)	FIAMME HERE & BELOW ARE WHITE TO LIGHT GRAY GREEN DUE TO ALTN. TO CHLORITE & SERICITE.
	• XRD, 177.5M (%): Q-53, PL-8, KF-14, CAL-3, PY-1, IL-16 CH-5
	BLOTCHY, MOTTLED DEVITRIFICATION TEXTURE BECOMING LESS CONSPICUOUS.
• DIP 35-40° (COMP. FOL.)	
	• XRD, 198.1M (%): Q-42, PL-23, KF-12, PY-1, IL-10, CH-4
198.1M (650 FT)	MOTTLED DEVITRIFICATION TEXTURE DIES OUT
198.5 M (651.3') (FL)	198.5 M: QTZ-CAL-CHL-SER-FLUORITE VEIN
• DIP 37° (COMP. FOL.)	
	• XRD, 209.6M (%): Q-46, PL-2, KF-26, CAL-3, PY-2, IL-10, CH-5
209.6M (687.6 FT)	211.6 - 215.8 M: SERICITIZATION STRONGLY INCREASES.
211.6M (694.2')	
212.4M QTZ-AB (697')	212.4 M: 2 MM WIDE QTZ-AB-CHL-SER. VEINLET AB IN DISTINCTIVE FAN-LIKE SHEAVES
	AB IN MICROPERTHITE LOCALLY REPLACED W/ CHL
216.2M (709.2')	
	216.2 - 225.8 M: NON-WELDED TO POORLY WELDED RHYOLITE ASH-FLOW TUFF, LT. GREENISH-GRAY TO WHITE, BLEACHED-APPEARING, LOCALLY POROUS; ∿ 7% QTZ. PHENOS. 10-12% FELDSPAR PHENOS, 12% (?) PUMICE, LARGELY UNCOLLAPSED. AB LOCALLY REPL. W/ CHL. ROSETTES; WIDELY-SCATTERED CHL ± SER ± QTZ ± CAL ± PY MICROVEINLETS; FIAMME SERICITIZED ± CHL. ± CAL.
225.6M (740.1 FT)	
225.8M (740.9')	• XRD, 225.6M (%): Q-35, PL-3, KF-23, CAL-4, PY-1, IL-17 CH-11
• DIP ∿ 40° (COMP. FOL.)	225.8 - ∿ 237.7 M: DENSELY WELDED, XL-RICH, RHY. ASH-FLOW TUFF (SEE FOLLOWING PAGE)

DRILL HOLE VC-2A
LOCATION VALLES CALDERA, N. MEXICO

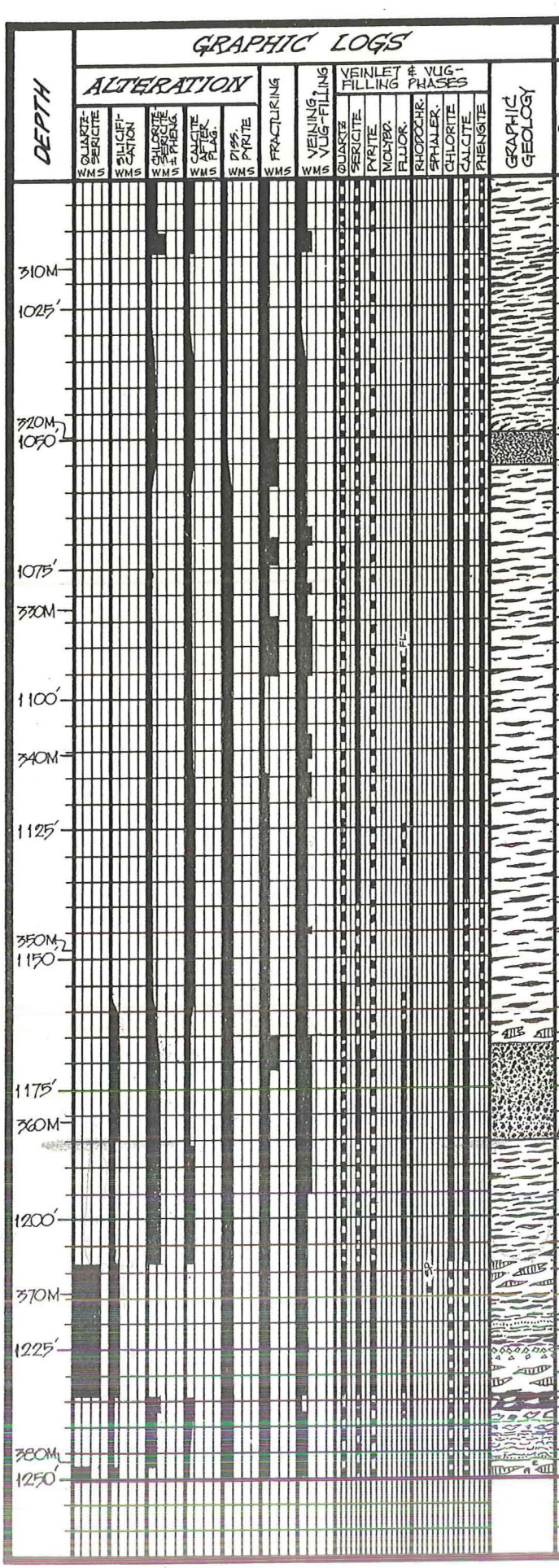
LOGGED BY
J.B. HULEN AND J.N. GARDNER
SEPT.-OCT. 1986
REVISED DEC. 1987



NOTES, COMMENTS	DESCRIPTIONS
	225.8 – ABT. 227.7 M (GRADATIONAL TOWARD LOWER CONTACT): DENSELY WELDED, CRYSTAL-RICH, RHYOLITE ASH-FLOW TUFF, LIGHT PINKISH-GRAY & LT. GRAY-GREEN; 25-30% PHENS-CRYSTS (QTZ. & MICROPERTHITE, MINOR PLAG); FIAMME ALTERED TO CHLORITE/ILLITE/PHENGITE, DISTINCTLY GRAY-GREEN IN CONTRAST TO PINKISH MATRIX; SCATTERED, COMMONLY BANDED, CHL-SER(ILL)-PHENGITE CALCITE AGGREGATES; TR. DISS. DARK/OPAQUE & LEUCOXENE.
• DIP 40-45° (COMP. FOL.)	SCATTERED TR. BRICK RED HEM; TR. ACC. ZIRCON; TR. ORIG. MAFICS ALTERED TO CH/CAL/LEUC./PHENGITE.
	* SEE BELOW
227.7 M (747 FT)	227.7 – 273.7 M: SAME AS ABOVE EXCEPT MODERATELY WELDED; DARK OPAQUES GONE -- APPARENTLY REPLACED W/LEUCOXENE; SCATTERED FIAMME UP TO 7 X 2 CM -- MOST SMALLER; SCATTERED TRACES REDDISH HEMATITE. GROUNDMASS VARIES FROM GRAY TO PINKISH-GRAY.
• DIP 35° (COMP. FOL.)	* SKETCH OF PORPHYRITIC PUMICE AT 776.6' (236.7M) 
247.5M (812')	247.5M: 1 CM-WIDE CAL-CH VNLT ⊥ TO FOLIATION
250.7M (822.6')	• XRD, 250.7M (%): Q-44, PL-10, KF-14, CAL-5, IL-23, CH-3
	(THESE ARE AVERAGE DIPS)
• DIP 35° (COMP. FOL.)	
261.8M (859.1 FT)	• XRD, 261.8M (%): Q-45, PL-15, KF-15, CAL-3, PY-1, IL-9, CH-3
266.1M (873')	266.1 – 266.4M: ESPECIALLY BLEACHED-APPEARING
270.7M (888.1')	270.7M: FLUORITE & CAL IN VUG IN PUMICE & REPL. ALBITE
278.7M (898')	
	278.7 – 319.8M: DENSELY WELDED, XL.-RICH RHY. ASH-FLOW TUFF, SAME AS 225.8 – 227.7'; AT LEAST 20% PHENO-CRYSTS (QTZ & MICROPERTHITE), BROKEN-EUHEDRAL UP TO 1 MM. IN DIA., AVG. ≈ 2 MM. IN DIA.; MICROPERTHITE (KF & AB) MAY BE OF BOTH REPLACEMENT & EXSOLUTION ORIGIN; FIAMME MOSTLY > 7:1 ASPECT RATIO, AVG. 10-15 MM. (UP TO 80 MM. LENGTH. FIAMME REPLACED PARTIALLY BY ILLITE, CHLORITE, MINOR PHENGITE -- ARE SLIGHTLY
• DIP 30-35° (COMP. FOL.)	GREENISH-GRAY; 0.1-0.3% DISS. PYRITE GRAINS, SUBH.-EUHEDRAL, < 0.5 MM IN DIA.; DISS. LEUCOXENE AS ABOVE; MATRIX IS GRANOPHYRICALLY DEVITRIFIED/CRYSTALLIZED W/FIAMME SELECTIVELY COARSE-CRYSTALLINE.
285.6M (937 FT)	• XRD, 285.6M, (%): Q-36, PL-13, KF-21, CAL-5, IL-10, CH-5
286.3M (939.3 FT)	286.3 – 2-12 MM. WIDE, LT. GREENISH-GRAY, SER-CHL-(PHENG.)-CAL. ZONE (ALTERED FAULT GOUGE?)
	NOTE: SOME LARGER PUMICES CURIOUSLY UNDEFORMED AND NOT PARALLEL TO FOLIATION.
294.1M (966 FT)	• XRD, 294.1M, (%): Q-46, PL-2, KF-23, CAL-3, IL-11, CH-3
• DIP 27° (COMP. FOL.)	
304.8M	

DRILL HOLE VC-2A
LOCATION VALLES CALDERA, N. MEXICO

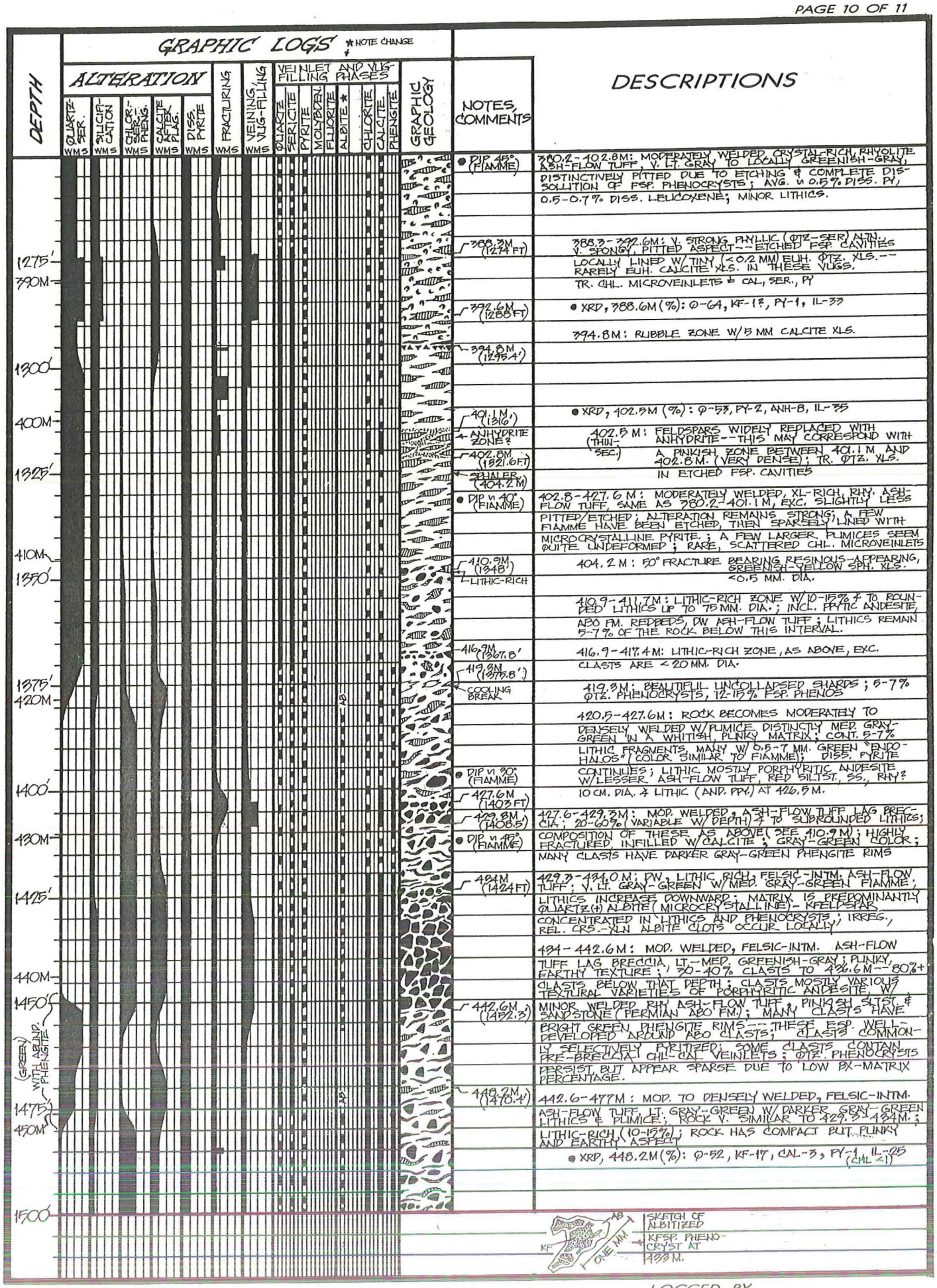
LOGGED BY
J.B. HULEN AND J.N. GARDNER
SEPT.-OCT. 1986
REVISED DEC. 1987



NOTES, COMMENTS	DESCRIPTIONS
	DENSELY WELDED, XL-RICH RHY. ASH-FLOW TUFF CONTINUES
306.6M (1006')	306.6 M: BEGIN TO SEE MINOR GLASS -- SOME SHARDS STILL SHINY DARK GRAY
● DIP ∩ AOR (FIAMME)	
309.1M (1014')	309.1-317M: DENSELY WELDED, CRYSTAL-RICH, PARTIALLY STILL GLASSY, RHYOLITE ASH-FLOW TUFF; MED., SLIGHTLY PURPLISH-GRAY WITH DARK GRAY-PURPLISH-GRAY FIAMME; 35-37% PHENOCRYSTS, AVG. 1.5-2 MM. DIA., 10-12% QTZ, 20-25% MICROPERTHITE (KF & AB -- REPLACEMENT & EXSOLUTION?); 0.3-0.5% FORMER MAFICS, EQUANT TO STUBBY LATH-SHAPED, MOSTLY SUBHEDRAL, NOW ALT. TO CHL/PHENGITE/CALCITE/DK OPAQUE ± LEUC. AGGREGATES -- MANY OF THESE MAFICS RIMMED W/DK. OPAQUE & INTERGROWN W/ NICROXLN. RELICT ZIRCON & APATITE ALSO: IRREG. AREAS IN MATRIX REL. CRS-XLINE. (AVG. 0.15 MM
317M (1040')	CRYSTALS) QTZ-KF ± AB AGGREGATES UP TO AT LST 3 MM DIA. -- MANY FIAMME SIMILARLY COARSELY-XLN.
319.8M (1049')	317-319.8M: AS ABOVE, EXC. MORE BLEACHED-APPEARING.
FALLOUT TUFF*	319.8-321.9M: FALLOUT TUFF V. LT., SL. GREENISH-GRAY, DENSE, VERY F. GR., BUT CONTAINING A FEW, SCATTERED PUMICE
321.9M (1056')	LAPILLI & LITHICS, BOTH SELECTIVELY CHLTED. -- THESE CONCENTRATED TOWARD TOP OF UNIT; AT UPPER CONTACT, FIAMME ARE DISCORDANT, SUB-1, BUT CHANGE RAPIDLY UPHOLE TO CONCORDANT
	321.9-355.7M: DENSE, WELDED, XL-RICH, RHY. ASH-FLOW TUFF, AS ABOVE, EXC: GENERALLY A BIT MORE (THOUGH STILL WEAKLY) ALTERED; SOME FORMER MAFICS UP TO 0.5 MM. DIA., DEF. SOME FORMER PYROXENE, NOW ALT. TO CHL-CAL-PHENG.-LEUCOX.
	NOTE: THROUGHOUT THIS UNIT ARE BEAUTIFULLY DEVELOPED SPHERULITIC, AXIOLITIC & "SHELL WITHIN SHELL" DEVITRIFICATION TEXTURES.
	QTZ-CHL-CAL-PHENGITE-FLUORITE VEINLETS. THESE CONTAIN ABUNDANT VAPOR-RICH PRIMARY FLUID INCLUSIONS (BOILING INDICATED)
	342-347.2 M: MOD. CAL-CHL VEINING; WHERE VNLTS. COALESCE LOCALLY, FORM IRREG. MASSES UP TO
342M (1122 FT)	30M. IN DIAMETER.
	DISS. DK OPAQUES, AS ABOVE, SOME RIMMED W/LEUC.
	●XRD: Q-37, KF-16, PL-24, CAL-3, PY-1, IL-2, CH-2 (APP. WT. %, 348.9 M)
347.2M (1139 FT)	
	AT 349.1 M, GLASS DISAPPEARS, FIAMME BECOME LT. GREENISH-GRAY, & MATRIX CHANGES FROM
349.1M (1145.5')	LT. PURPLISH-GRAY TO LT. GRAY
	●XRD, 354.1 M: Q-36, KF-15, PL-25, CAL-3, PY-1, FL-3, IL-1, CH-7 (%)
	FIAMME EXTENSIVELY REPLACED WITH CHL-QTZ ± SER. AGGREGATES
355.7M (1167 FT)	355.7-361.7M: EPICLASTIC SANDSTONE, V.V. LT. GREENISH-GRAY, MED.-GRAINED, MODERATELY SORTED, V. IMMATURE; ∩ 30% MICROCRYSTALLINE MATRIX, ORIGINALLY ASH?
	NOW: QUARTZ, ILLITE, CHL. AGG.; MINOR SCATTERED VUGGY PUMICE UP TO AT LEAST 20MM. DIA. (AVG. 2 MM.) --
SLIP PLANE	THESE ALTERED & INFILLED W/ VARIOUS COMBINATIONS OF CAL, SER, CHL, FLUOR. & QUARTZ; GRAINS ARE
361.7M (1186.7FT)	QTZ, KF, MICROPERTHITE, VARIOUS LITHICS, POSS. LARGE, ALTERED GLASS SHARDS.
	361.7-371.5M: MODERATELY TO DENSELY WELDED, XL-RICH RHYOLITE ASH-FLOW TUFF, SIMILAR TO 321.9-355.7M, BLEACHED, PUNKY-APPEARING, V. LT. GREENISH-GRAY,
	WITH MED. GREENISH-GRAY FIAMME.
	367.7': COMPLEX QTZ-CHL-CALC-FLUOR VEINLET†
367.7M (1206.3')	369.8-370.1 M: QTZ-SER-PY VEINLET W/TR. ELIH. SPHALERITE CRYSTALS
	371M: QTZ-CHL-CAL-ADULARIA VEINLET
371.5M (1219 FT)	371.5-372.6M: SEQ. OF V. DISTINCTLY BEDDED DENSELY WELDED TUFFS (WELDED SURGES?); BEDS AVG 2 CM THICK.
372.6M	372.6-373.5 M: DW, XL-RICH, RHY. ASH-FLOW TUFF.
373.5M	← V. CRYSTAL-RICH (UP TO 70%) HORIZON (373.5-373.8M) MUST BE A SURGE DEPOSIT
376M (1233.8')	376-376.8M: MYSTERY TUFF BRECCIA; 30% ± TO SUBROUNDED
376.8M (1236.4')	CLASTS OF ASH-FLOW TUFF IN DARK GRAY GLASSY MATRIX.
	376.8-377.4 M: LITHIC & PUMICE-RICH NON-WELDED A.F. TUFF
● DIP 27°	377.4-377.6 M: DISTINCTLY BEDDED, FINE-GR TUFF
	377.6-378.3 M: SAME AS 376.8-377.6M
380.2M (1247.5 FT)	378.3-378.6 M: V. WELL-BEDDED FINE-GR. TUFF
	378.6-380.2M: XL-RICH, BEDDED TUFF
	* SKETCH OF CONTACT OF FALLOUT TUFF W/ OVERLYING ASH-FLOW TUFF
	→ DOWN
	† THIS VEINLET SHOWS EVIDENCE OF BOILING (COEXISTING PR. VAP. & LIQUID-RICH FLD. INC.

DRILL HOLE VC-2A
LOCATION VALLES CALDERA, N. MEXICO

LOGGED BY
J. B. HULEN AND J.N. GARDNER
SEPT.-OCT. 1986
REVISED DEC. 1987

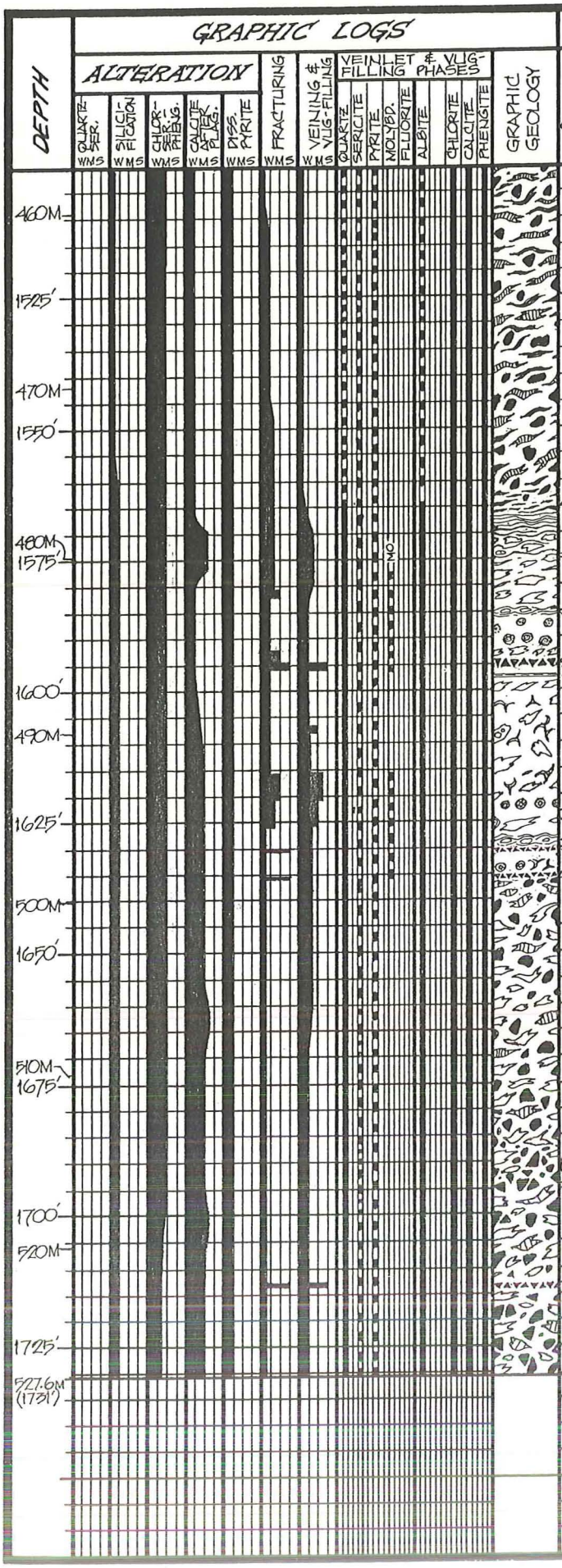


NOTES, COMMENTS	DESCRIPTIONS
• DIP 45° (FIAMME)	380.2-402.8M: MODERATELY WELDED CRYSTAL-RICH, RHYOLITE ASH-FLOW TUFF, V. LT. GRAY TO LOCALLY GREENISH-GRAY, DISTINCTIVELY PITTED DUE TO ETCHING & COMPLETE DISSOLUTION OF FSP. PHENOCRYSTS; AVG. ν 0.5% DISS. PY, 0.5-0.7% DISS. LEUCOXENE; MINOR LITHICS.
388.3M (1274 FT)	388.3-392.6M: V. STRONG PHYLLIC (QTZ-SER) ALTN. V. SPONGY, PITTED ASPECT--ETCHED FSP CAVITIES LOCALLY LINED W/ TINY (<0.2 MM) EUH. QTZ. XLS.--RARELY EUH. CALCITE XLS. IN THESE VUGS. TR. CHL. MICROVEINLETS ± CAL., SER., PY
392.6M (1288 FT)	• XRD, 388.6M (%): Q-64, KF-1?, PY-1, IL-33
394.8M (1295.4')	394.8M: RUBBLE ZONE W/ 5 MM CALCITE XLS.
401.1M (1316')	• XRD, 402.5M (%): Q-53, PY-2, ANH-8, IL-35
ANHYDRITE ZONE? (THIN-SEC.)	402.5M: FELDSPARS WIDELY REPLACED WITH ANHYDRITE--THIS MAY CORRESPOND WITH A PINKISH ZONE BETWEEN 401.1M AND 402.8M. (VERY DENSE); TR. QTZ. XLS. IN ETCHED FSP. CAVITIES
402.8M (1321.6FT)	
SHALER (404.2M)	
• DIP ν 40° (FIAMME)	402.8-427.6M: MODERATELY WELDED, XL-RICH, RHY. ASH-FLOW TUFF, SAME AS 380.2-401.1M, EXC. SLIGHTLY LESS PITTED/ETCHED; ALTERATION REMAINS STRONG; A FEW FIAMME HAVE BEEN ETCHED, THEN SPARSELY LINED WITH MICROCRYSTALLINE PYRITE.; A FEW LARGER PUMICES SEEM QUITE UNDEFORMED; RARE, SCATTERED CHL. MICROVEINLETS
410.9M (1348')	404.2M: 50° FRACTURE BEARING RESINOUS-APPEARING, GREENISH-YELLOW SPH. XLS. <0.5 MM. DIA.
LITHIC-RICH	410.9-411.7M: LITHIC-RICH ZONE W/ 10-15% ± TO ROUNDED LITHICS UP TO 75 MM. DIA.; INCL. PRYTIC ANDESITE, ABO FM. REDBEDS, DW ASH-FLOW TUFF; LITHICS REMAIN 5-7% OF THE ROCK BELOW THIS INTERVAL.
416.9M (1367.8')	416.9-417.4M: LITHIC-RICH ZONE, AS ABOVE, EXC. CLASTS ARE < 20 MM. DIA.
419.3M (1375.8')	419.3M: BEAUTIFUL UNCOLLAPSED SHARDS; 5-7% QTZ. PHENOCRYSTS, 12-15% FSP. PHENOS
COOLING BREAK	420.5-427.6M: ROCK BECOMES MODERATELY TO DENSELY WELDED W/ PUMICE, DISTINCTLY MED. GRAY-GREEN IN A WHITISH, PUNKY MATRIX; CONT. 5-7% LITHIC FRAGMENTS, MANY W/ 0.5-7 MM. GREEN "ENDO-HALOS" (COLOR SIMILAR TO FIAMME); DISS. PYRITE
• DIP ν 30° (FIAMME)	CONTINUES; LITHIC MOSTLY PORPHYRITIC ANDESITE W/ LESSER, ASH-FLOW TUFF, RED SILTST., SS., RHY?
427.6M (1403 FT)	10 CM. DIA. ± LITHIC (AND. PPY.) AT 426.5M.
429.8M (1408.5')	427.6-429.3M: MOD. WELDED, ASH-FLOW TUFF LAG BRECCIA; 20-60% (VARIABLE W/ DEPTH) ± TO SUBROUNDED LITHICS;
• DIP ν 45° (FIAMME)	COMPOSITION OF THESE AS ABOVE (SEE 410.9M); HIGHLY FRACTURED, INFILLED W/ CALCITE; GRAY-GREEN COLOR; MANY CLASTS HAVE DARKER GRAY-GREEN PHENGITE RIMS
434M (1424 FT)	429.3-434.0M: DW, LITHIC RICH, FELSIC-INTM. ASH-FLOW TUFF; V. LT. GRAY-GREEN W/ MED. GRAY-GREEN FIAMME; LITHICS INCREASE DOWNWARD; MATRIX IS PREDOMINANTLY QUARTZ(+) ALBITE (MICROCRYSTALLINE)- K-FELDSPAR CONCENTRATED IN LITHICS AND PHENOCRYSTS; IRREG., REL. CRS.-XLN ALBITE CLOTS OCCUR LOCALLY
442.6M (1452.3')	434-442.6M: MOD. WELDED, FELSIC-INTM. ASH-FLOW TUFF LAG BRECCIA, LT.-MED. GREENISH-GRAY; PUNKY, EARTHY TEXTURE; 30-40% CLASTS TO 436.6M--80%+ CLASTS BELOW THAT DEPTH; CLASTS MOSTLY VARIOUS TEXTURAL VARIETIES OF PORPHYRITIC ANDESITE, W/ MINOR WELDED RHY ASH-FLOW TUFF, PINKISH SLTST ± SANDSTONE (PERMIAN ABO FM.); MANY CLASTS HAVE BRIGHT GREEN PHENGITE RIMS--THESE ESP. WELL-DEVELOPED AROUND ABO CLASTS; CLASTS COMMONLY SELECTIVELY PYRITIZED; SOME CLASTS CONTAIN PRE-BRECCIA-I CHL-CAL VEINLETS; QTZ. PHENOCRYSTS PERSIST, BUT APPEAR SPARSE DUE TO LOW PX-MATRIX PERCENTAGE.
448.2M (1470.4')	442.6-477M: MOD. TO DENSELY WELDED, FELSIC-INTM. ASH-FLOW TUFF, LT. GRAY-GREEN W/ DARKER GRAY-GREEN LITHICS & PUMICE; ROCK V. SIMILAR TO 429.3-434M.; LITHIC-RICH (10-15%); ROCK HAS COMPACT BUT PUNKY AND EARTHY ASPECT
	• XRD, 448.2M (%): Q-52, KF-17, CAL-3, PY-1, IL-25 (CHL <1)

SKETCH OF ALBITIZED KFSP. PHENOCRYST AT 439M.

DRILL HOLE VC-2A
LOCATION VALLES CALDERA, N. MEXICO

LOGGED BY
J. B. HULEN AND J. N. GARDNER
SEPT.-OCT. 1986
REVISED DEC. 1987

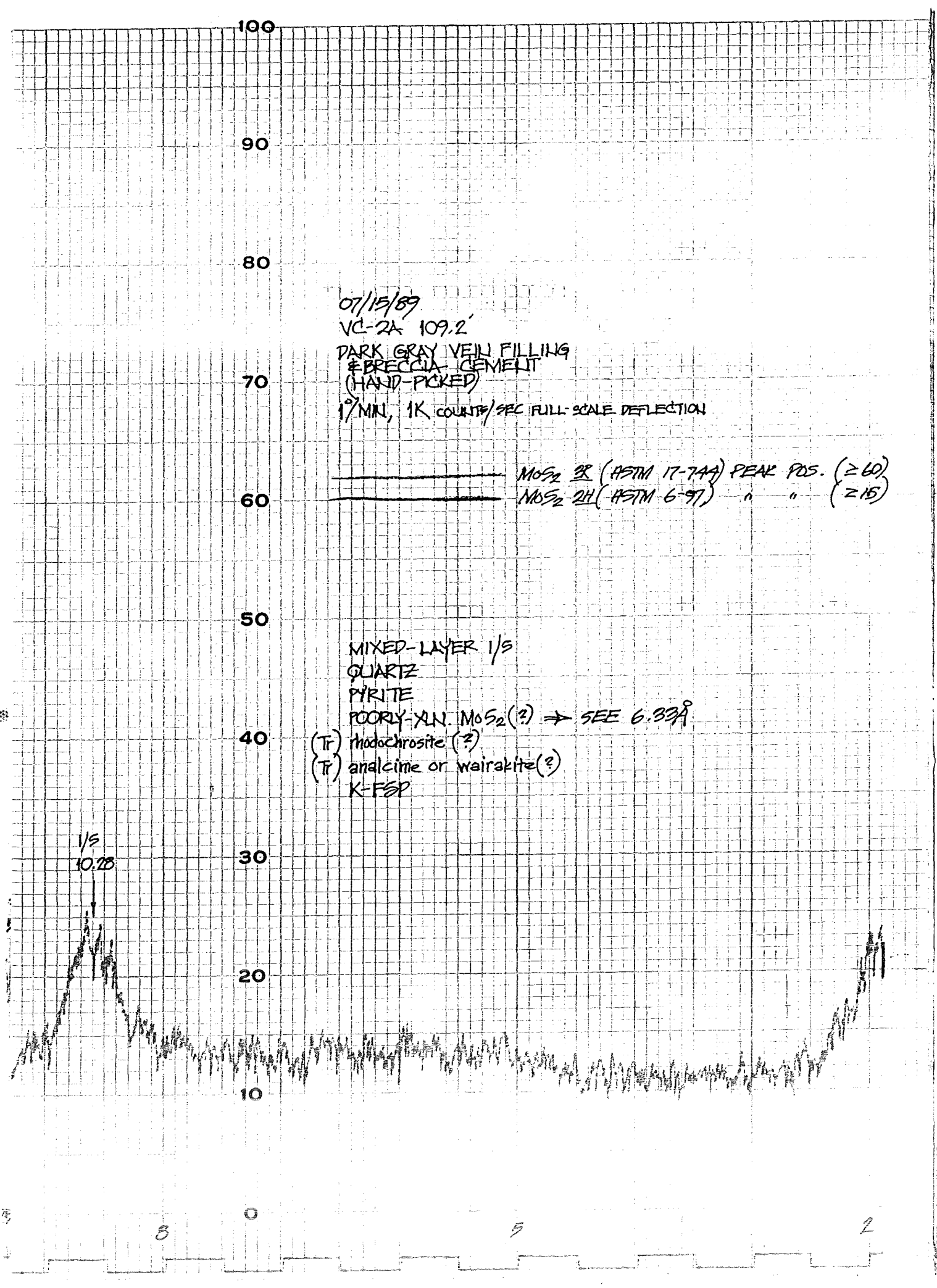


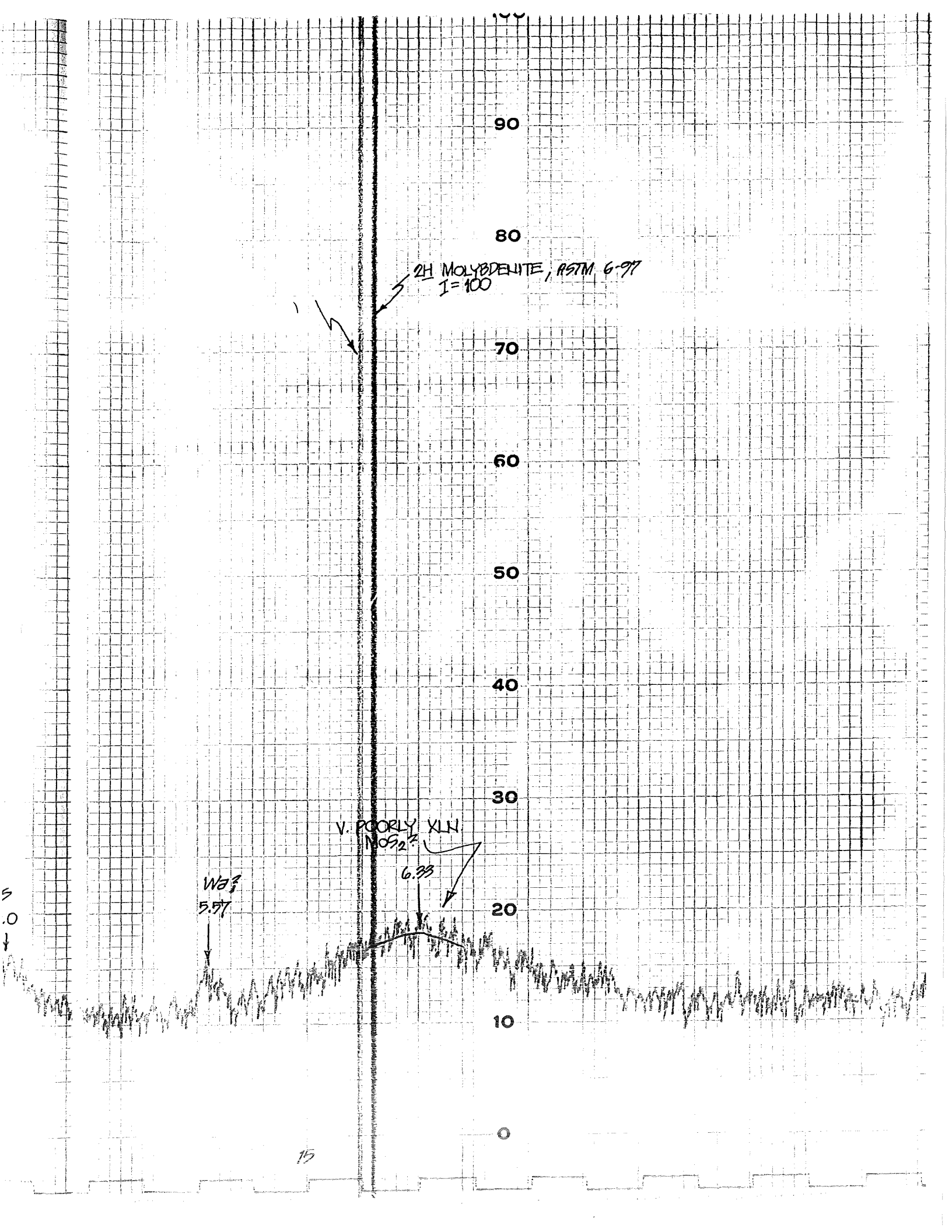
NOTES, COMMENTS	DESCRIPTIONS
	MOD. TO DENSELY WELDED, FELSIC-INTM., ASH-FLOW TUFF CONTINUES TO 477 M; QUITE COHERENT BUT HAS A PUNKY, EARTHY TEXTURE; DISTINCTIVE LT. GRAY-GREEN COLOR, DUE TO PHENGITE W/MINOR CHLORITE; AVG. 12-15% ANGULAR TO SUBROUNDED LITHIC FRAGS., UP TO AT LEAST 40 MM. IN DIAMETER; LITHICS ARE ABT. 50% PPYTIC. INTM. VOLCANICS W/LESSER RW RHY. ASH-FLOW TUFF, MINOR ABO FM. PINKISH SILTST. & SANDSTONE; MANY CLASTS HAVE BRIGHT GRAY-GREEN PHENGITE RIMS; FELSIC. WELDED TUFF CLASTS ARE WHITISH IN CONTRAST TO MATRIX. NOTE: SCATTERED OTHER CLASTS INCLUDE QTZ. LATITE & FINE-XLN QTZ. MONZONITE (PRECAMBRIAN?)
• DIP 35-40°	• XRD 466.1 M Q-42, KF-11, PL-13, CAL-5, PY-1, IL-23, CH-3
	476.4-477M: FAINT "BEDDING" DEFINED BY LAYERS OF COMPACTED GREENISH-GRAY PUMICE.
477M (1565')	477-477.8 M: AS ABOVE, BUT WELL-DEFINED "BEDDING"-- POSS. A WELDED SURGE DEPOSIT
← WELDED SURGE?	477.8-498.6M: ALTERED, V. WEAKLY TO NON-WELDED, (FUSED?) PUMICE-RICH TUFF; RX. IS BASICALLY A DENSE, V. LT GREENISH-GRAY, MICROCRYSTALLINE QTZ-ALBITE-SER-CHL-PHENG. AGGREGATE W/ ABUNDANT PUMICE UP TO AT LST 30MM.
480M (1575 FT)	DIA. (AVG. 1.5 MM DIA.) & SCATT., LOCAL, WELL-FORMED, ROUND TO SUBROUND ASH BALLS 0.1-0.7 MM (AVG. 0.2 MM.) DIAMETER--
MoS2 "PAINT" ON FRACS.?	SOME OF THESE HAVE VAGUE "SHELLS" & MAY BE ACCRETIONARY LAPILLI; ALSO AVG. 5-7% SUBRND-ANGULAR LITHICS UP TO AT LEAST 20 MM (AVG. 7 MM) DIAMETER-- THESE AND PPY, PPYTIC. DACITE, RHY. ASH-FLOW TUFF;
483.1M (1585')	ONLY ABOUT 0.5-1% QTZ, FSP. PHENOCRYSTS, ONLY AVG 0.3-0.5 MM. DIAMETER; QTZ-ALBITE VUG-FILLING, AS ABOVE;
486M (1594.5')	NOTE: THIS COULD BE IN PART PHREATOMAGMATIC, BUT WHATEVER ITS ORIGIN, HAS BEEN SLIGHTLY COMPACTED & DEFORMED (WHILE WET?) TO YIELD A LOCAL "PSEUDOMYLONITIC"
← FAULT ← 486.7 M	
• DIP ∿ 40°	
UNDEFORMED SHARDS	TEXTURE W/ PUMICE & LITHIC "ALIGEN" (PARTICULARLY 496.2-497.1M, 477.8-480M; 483.1M)
	486.7 M: 0.2M DK. GRAY-GREEN, F.XLN. SHALE-LIKE ROCK
UNDEFORMED SHARDS	494.7 M: ABUNDANT COARSELY VESICULAR PUMICE & COMPLETE, DELICATE BUBBLE SHARDS (THIN-SEC.)
494.7 M (1623 FT)	
"PSEUDO-MYLONITE"	
FAULTS	• XRD, 498.3M (%): Q-40, PL-15, KF-9, CAL-5, PY-1, IL-25, CH-4
498.6M (1636 FT.)	498.3 M: AS ABOVE, EXC. SCATTERED ASH BALLS, SAME AS IN MAIN DESCRIPTION (?)
• DIP ∿ 40°	
	498.6-527.6M: LITHIC-RICH, NON- TO WEAKLY WELDED (OVERALL), MODERATELY ALTERED, ASH-FLOW TUFF, LT. GRAY-GREEN DUE TO PHENGITE & CHL. ALTERATION; EARTHY, PUNKY TEXTURE, BUT VERY COHERENT; PUMICES REL. DARKER GRAY-GREEN; MATRIX IS MICROXLN AGG. OF AB, QTZ, ILLITE, PHENGITE & MINOR CHL.--- KFSP STAIN SHOWS NO KFSP IN MATRIX-- ALL KFSP APPARENTLY IN CLASTS; CLASTS PREDOMINANTLY PORPHYRITIC, INTERMEDIATE-COMPOSITION VOLCANIC ROCKS (ANDESITE-RHYODACITE), W/ SUBORDINATE RHYOLITE ASH-FLOW TUFF (COMMONLY GRANOPHYRICALLY DEVITRIFIED/RECRYSTALLIZED W/ MICROPEGMATITIC TEXTURES; MANY CLASTS HAVE PARTIAL, DARK, BRIGHT GRAY-GREEN, PHENGITE RIMS; MANY CLASTS SELECTIVELY PYRITIZED (DISS.); OVERALL 0.5-1% PYRITE.-- SOME CLASTS 2-3% PYRITE; 0.1% DISS. V.F. XLN HEMATITE (REDDISH) PARTIALLY REPLACING PRIMARY DARK OPAQUES (PRINCIPALLY IN INTM.-COMPOSITION VOLCANIC CLASTS)
515.1M (1690FT.) (POINT COUNT)	ALSO TR. <1MM. EUH. SP. XLS
516.3M (1694 FT) ('HYDROTH. RUTILE) & SP	516.3 M: FRACTURE SURFACE SPARSELY COVERED W/ ≤ 1MM CALCITE & RUTILE CRYSTALS.
	• XRD, 515.1 M (%): Q-33, PL-19, KF-17, CAL-4, PY-1, IL-18, CH-5 (THIN-SEC. 2% LEUCOXENE)
522.1M (1713 FT.)	522.1-522.4 M: FAULT GOUGE & BRECCIA W/ ABUND. CALCITE; ONE 5 X 2 CM. VUG CALCITE-FILLED
FAULT	
527.6M (1731 FT)	• XRD, 527.6 M (%): Q-41, PL-22, KF-17, CAL-4, PY-1, IL-10, CH-2 (THIN-SEC 2% LEUC)

POINT COUNT, 515.1 M:	%	LITHIC-FREE BASIS:	%
• QTZ. PHENOCRYSTS	3.2	• QTZ. PHENOCRYSTS	4.8
• K-FELDSPAR PLUS MICROPERTHITE PHENOCRYSTS	5.3	• K-FELDSPAR PLUS MICROPERTHITE PHENOCRYSTS	7.9
• PLAGIOCLASE PHENOCRYSTS	0.7	• PLAG. PHENOCRYSTS	1.0
• PUMICE	12.3	• PUMICE	18.1
• LITHIC FRAGMENTS	41.3	• GROUNDMASS	67.9
• GROUNDMASS	27.2		

DRILL HOLE VC-2A
LOCATION VALLES CALDERA, N. MEXICO

LOGGED BY J.B. HULEN AND J.N. GARDNER
SEPT.-OCT. 1986
REVISED DEC. 1987


100
90
80
70
60
50
40
30
20
10
07/15/89
VC-2A 109.2'
DARK GRAY VEIN FILLING
& BRECCIA CEMENT
(HAND-PICKED)
1°/MIN, 1K COUNTS/SEC FULL-SCALE DEFLECTION
MoS2 3R (ASTM 17-744) PEAK POS. (≥60)
MoS2 2H (ASTM 6-97) " " (≥15)
MIXED-LAYER I/S
QUARTZ
PYRITE
POORLY-XLN. MoS2 (?) ⇒ SEE 6.33Å
(Tr) rhodochrosite (?)
(Tr) analcime or wairakite (?)
K-FSP
I/S
10.28


90
80
2H MOLYBDENITE, ASTM 6-97
I=100
70
60
50
40
30
V. POORLY XLN
MoS2
6.33
Wad
5.57
20
10
0

JBH PRELIMINARY

FOOTAGE	GYPSUM	QUARTZ	PLAGIOCL.	K-FELDSPR	CALCITE	PYRITE	MoS_2	FLUORITE	MoS_2	ANATASE + RUTILE	SMECTITE	MIXED-LAYER ILLITE/SMECT.	ILLITE	KAOLIN	CHLORITE	CLASTS BY THEMSELVES CLASTS OTHER
MINERALOGY, APPROX. WT. %																
2.0-2.3'		72		14	1?	TR				1			8		2	3 GYPSUM // SANDSTONE CLAST (CLAST? DON'T USE
7.8'		63		7	6	2							22			LANDSLIDE BRECCIA
12.6-12.8'		42	1		17	3				2			35			LANSLIDE BRECCIA
14.3'		63			11	1							25			" "
19.3'		47				9				2			42			" "
25.8-25.9'																"SLIP PLANE" @ BASE OF LANDSLIDE
31.5'		58				5				2			35			VOLC. SS tr, z, ap.
34.5'		70				6				1			23			" "
46.8'		55				3				1			41	tr.		VOLC. SS W/ ACCR. LAPILLI
50.0'		50				5				2			43			ACCRETIONARY LAPILLI TUFF tr. z., ap.
53.5'		63				3				1			33			VOLC. SS
59.6'																FAULT BRECCIA
71.5'		51				3				1						NON-WELDED A.F. TUFF
88.0'		53				4		2		2 TR			38	3		" " " "
89.0'																" " " "
96.0'		61		1		3		7	TR	1			27			HYDROTHERMAL BRECCIA W/ MoS_2
96.3'																" "
98.0'																" "
100.0'																" "
103.0'																M-DW TF W/ stkwk
106.0'	1	52		1		3		TR	TR	1			42			M-DW TF w/ stkwk MoS_2 (CLAST) 1 Rerun 1 gyp
110.0'																" " "
118.5'																" " "
124.0'		58		23		3				1?			15			" " "
129.0'																HYDROTHERMAL BRT
138.0'		61		7		3				1			28			HYDROTHERMAL BX W/ MoS_2
138.5'																
143.0'																
156.5'		63		19		2				1			15			M-DWTF W/ MoS_2 Rerun
170.0'																
188.1'		66		3		6		1		1			22			FAULT BRECCIA W/ MoS_2
191.4'																
200.5'																
208.5'		53		21		3				1 gp			19			
217.0'																
225.0'		53				2				1			41			S2 DEBRIS FLOW
239.9-240.3'																
240.0'		35				32				2			60			

VC-2A BULK XRD

JBH PRELIMINARY

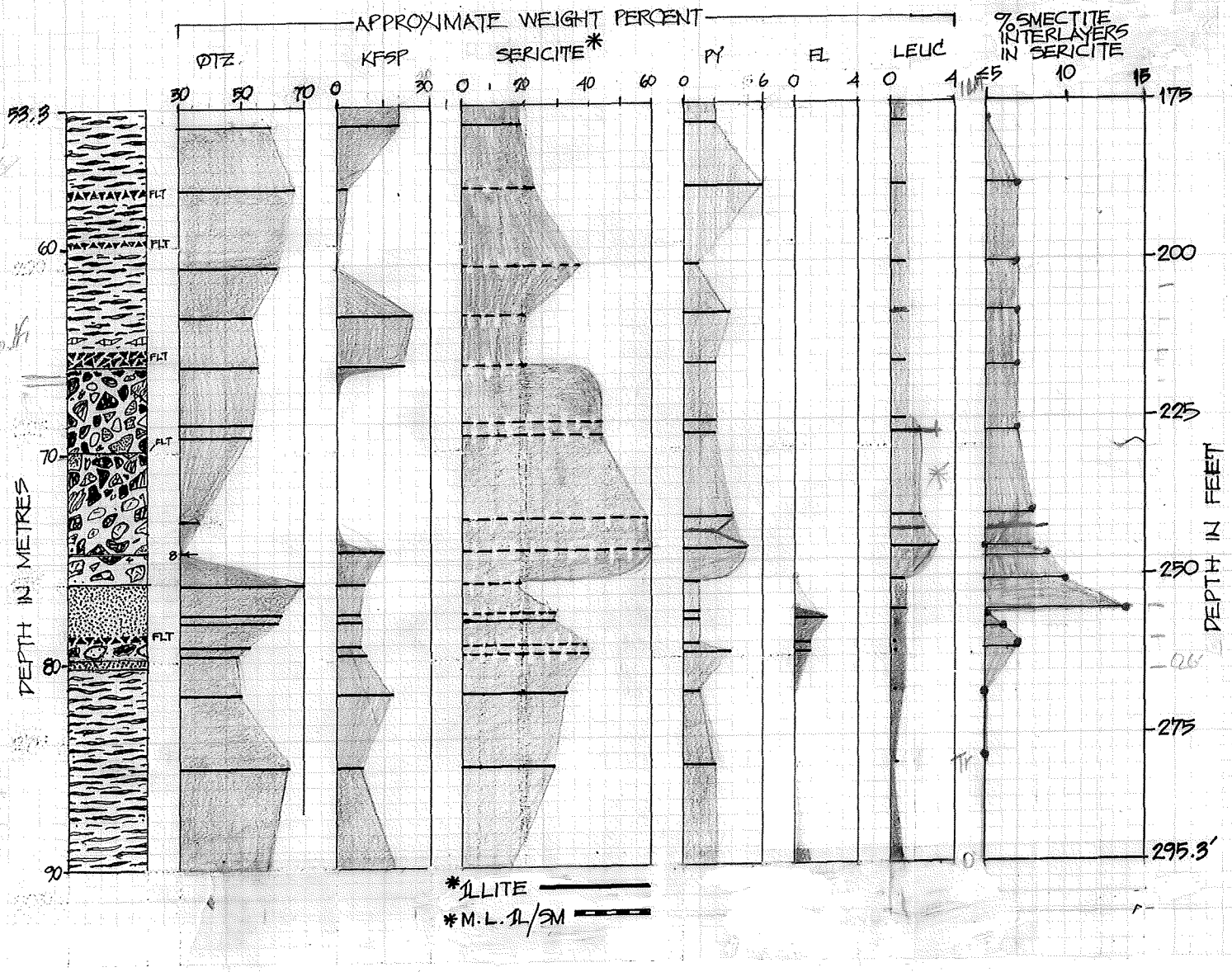
	MINERALOGY, APPROX. WT. %														
	QUARTZ	PLAGIOCL.	K-FELDSP.	CALCITE	PYRITE	MOSS	GLASS	LEUCOXENE	(N)	SMECTITE	MIXED-LAYER ILLITE-SMEC.	ILLITE	KAOLIN	CHLORITE	OTHER
~~BELOW 245.3'~~ (425.3)	47				4			1				46			3 SPHALERITE
255.4'	62		7	12	1			1	(AN)		25				← 58 SAND
258 - 258.2'															
268.0'															
279.1	61		7		2			TR				30			
305.7	57		25		1			1				15			
333.3'	57		23		2			1				15		TR	
337'	49	10	15		1			TR				11		2	
345.2	53		25		2			1				19			
359.2															
368.3	54		29		5			1				10			1 gyp.
387.8'	55		31		3			TR				11			
401.3'	56		27		3			1				13			
404.0'															
409.5'	55		25		5			TR				15			
[illegible] 425.3	47				4			TR				46			3 SPH.
443.5'	53	1?	2		3			TR				41			
463.2	50		23		2							15			
491.5'	56		23		3			1				17			
514.5'	55		22		4			1				18			
519.8'															
538.2'	54		28		2			1				15			
553.4'												20			
562.4'	51		21	—	1			TR				23	4		
582.4'	53	8	14	3	1			TR				16	5		
602.2'															
612.3'	43	21	21	—	—			TR				5	4		6 AMORPH (GLASS)?
632'															
636.8 - 637.0'															
650.0'	42	23	12	—	1			1	TR			10	4		7 amorph
687.6'	46	2	26	3	2			1				10	5		
697.0'															
709.5'	51		28	—	TR			1				10	5		5 AMORPHOUS
718.1'	47	1	23	2	1			2				13	7		
740.5'	35	13	23	4	1			1				17	12		5 AM
771.0'	45	11	19	2	1			1				13	3		15 AMORPH
790.9'															
822.6'	44	10	14	5	TR			1				23	3		
859.1'	45	15	15	3	1			1				9	3		8 am. (glass?)

VC-2A BULK XRD, CONTINUED

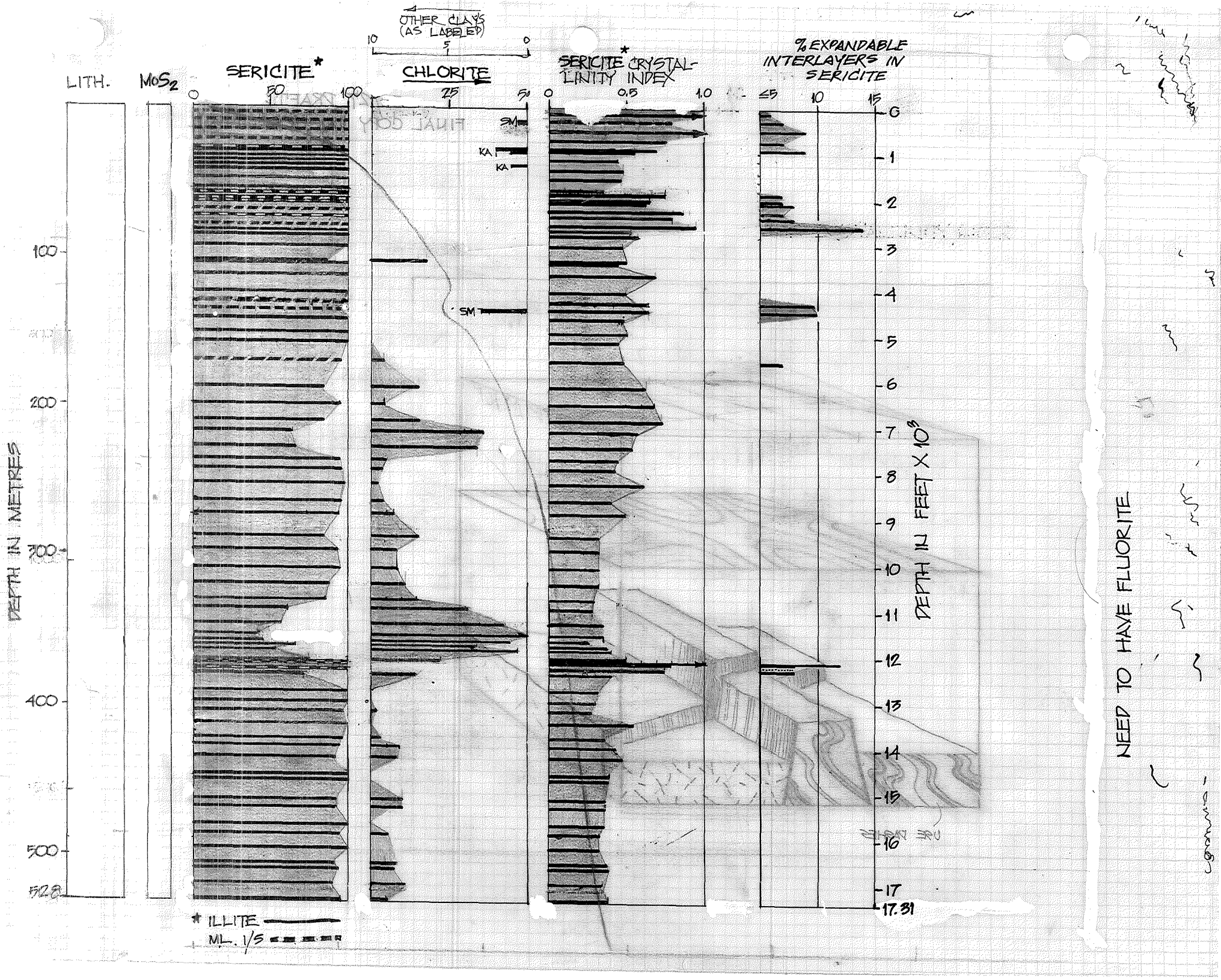
JBH PRELIMINARY

	MINERALOGY, APPROX. WT. %															
	QUARTZ	PLAGIOCL. (ALBITE)	K-FELDSPR.	CALCITE	PYRITE	ANHYDRITE	FLUORITE	for SMECTITE	MIXED-LAYER ILLITE/SMEC.	ILLITE	KAOLIN	CHLORITE	OTHER (mostly amorph.)			
916'																
937'	36	13	21	5	—			1			10	5	9			
966'	46	2	23	3				1			11	3	11			
1006'	41	17	16	2	1			1			5	2	15			
1020'	39	21	19	—	1		TR	1			2	2	16			
1044.5'	36	18	15	2	1			1			1	2	25			
1066.0'	41	23	17	1	1			1			1	3	10			
1077.6'																
1095.2'	37	24	17	3	1			2			2	2	12			
1128.2'	37	24	16	3	1		TR	2			2	2	13 am			
1161.6'	36	25	15	3	1		3	2			7	7	—			
1166.0'	60	—	19	4	TR		4				19	4				S3 ✓
1170.5'																
1206.3'	43		28	3	1	TR	1	1			13	5	5 AMORPHOUS			
1226.0'	62			—	1		3	2			32	—	—			
1234.6'	55	2	15		1		1				8	—	18			MYSTERY BRECCIA
1238.0'																
1275.0'	64		1?		1		—	1			33		TR. PYROPHYLLITE?			
1295.4'	53	1	23		3			1			19					
1320.6'	53	—	—		2	8		2			35		PLAGIOCLASE SERICITIZED			
1349.8'	54	—	—		2			1			43		NO CHLORITE			— Tr kaol
1375.8'	46		28	9	1		—	1			15	—	Alg			V. HIGH 2.5/10Å RATIO ILLITE LOW?
1396.8'																
1420.8	44	27	7	4	1			1			14	2				
1457.0'	54				1			1			44					
1470.4'	52		17	3	1			2			25	Tr				Tr kaol
1510.8'	37	15	12	6	2			1			23	4				Tr kaol
1529.2'	42	13	11	5	1			2			23	3				
1565.3'																
1571.4'	46	13	6	6	1/1			1			?	?				
1591.5'																
1596.7'																
1617.0'	48	12	6	7	1						23	3				
1623.0'																
1634.9'	40	15	9	5	1			1			25	4				
1650.7'	41	13	14	3	1			2			19	3				
1660.0'	35	13	16	6	Tr			2			23	5				
1690.0'	33	19	17	4	1			3			18	5				
1731.0'	41	22	17	4	1			3			10	2				

VC-2A BULK XRD, CONTINUED



S2 "SANDSTONE" — VC-2A


LITH.
MoS2
SERICITE*
0
50
100
OTHER CLAYS (AS LABELED)
10
5
0
CHLORITE
0
25
50
SM
KA
KA
SM
SERICITE* CRYSTALLINITY INDEX
0
0.5
1.0
% EXPANDABLE INTERLAYERS IN SERICITE
≤5
10
15
DEPTH IN METRES
100
200
300
400
500
528
DEPTH IN FEET X 10³
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
17.31
* ILLITE
ML. I/S
NEED TO HAVE FLUORITE

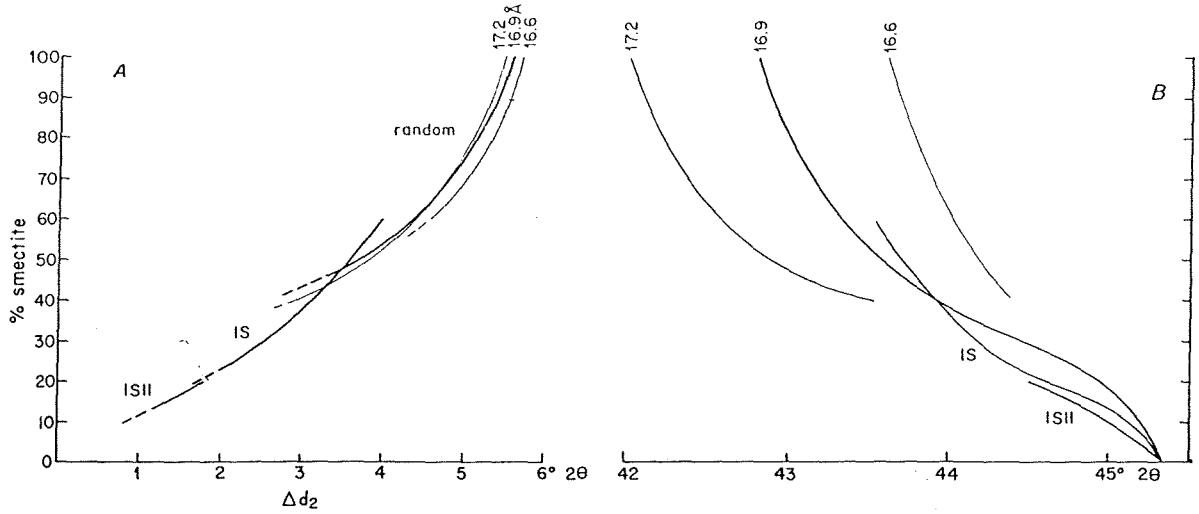


Figure 5. The plot for measuring the smectite:illite ratio, based on the angular distance Δd_2 between reflections in 42°–48°2θ region. The reflection between 42° and 45°2θ is used to select the proper thickness of the ethylene glycol complex for smectite-dominated compositions. Dashed parts of the curves represent the composition range beyond which Δd_2 cannot be measured because of merging of analytical reflections.

First, it can be noted that a reflection occurs between 5.2° and 8.7°2θ (at 6.44°2θ), therefore the sample is ordered to some extent. An initial percent smectite is then determined using the "IS" curve in Figure 5A, yielding a value of 41% smectite. Using this value the degree of ordering can now be determined from Figure 6. Δd_1 = 3.29°, and 41% smectite yields a value close to ½ ordered (see Reynolds and Hower, 1970, for a discussion of degree of ordering). A return to Figure 5A allows a value of 43% smectite to be determined for Δd_2 = 3.20 and random interstratification. Interpolation half way between the IS ordered and IS random results in a final value of 42% smectite layers.

The thickness of the ethylene glycol complex layer can now be determined from Figure 5B as approximately 16.8 Å based on the peak spacing at 44.00°2θ and the percent smectite of 42%.

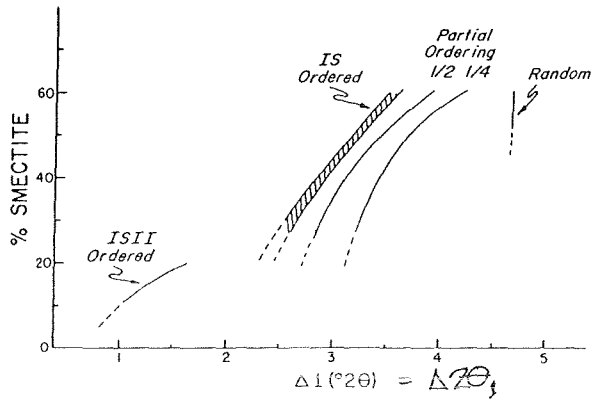


Figure 6. The plot for estimation of the degree of ordering using the initial value of percent smectite obtained using plots in Figures 5, 7, or 8 and the angular distance Δd_1 between the reflections in the range 10–5°2θ. The variations in Δd_1 as affected by the thickness of the ethylene glycol-smectite complex and domain size differences are shown for maximum IS ordering to illustrate their influence. All other curves were calculated assuming 1–14 layer domain size and 16.9-Å ethylene glycol-smectite complex thickness.

Method II

This method uses, for most of the compositional range, the stronger of the two reflections between 42° and 48°2θ (the 42°–45°2θ migration peak) and the strong reflection that migrates from about 26° to 27°2θ. The determination is slightly affected by domain size and strongly affected by the manner of interstratification and the ethylene glycol-smectite layer thickness. Figure 7 shows the migration curves for these reflections, calculated for 1–8 layers for the randomly and ordered interstratified cases, and for ethylene glycol-smectite layer thicknesses of 16.6, 16.9, and 17.2 Å. The figure also includes points of the migration curve for domains of 1–14 layers and an ethylene glycol-smectite layer thickness of 16.9 Å. It can be seen from these points that the domain size effect is apparent, but minor. Figure 7 includes an additional curve at low smectite contents for the 17.2-Å, ethylene glycol-smectite complex, using the peak that migrates from 45 to 48°2θ. The change to using this peak is caused by the fact that the 42–45°2θ peak is weak in the 17.2-Å, ethylene glycol-smectite complex and cannot be resolved at low smectite contents.

Example: Sample Sr-1M6

The reflections at 26.57° and 44.0°2θ yield the following results:

REYNOLDS, 1980

DEPTH	SMECTITE		MIXED-LAYER ILLITE/SMEC.		ILLITE		CHLORITE	KAOLIN		IL002/SM001 (GLY) (1pk=0)	% SMECTITE INTERLAYERS IN M.L. IL/SM	SM % SRODON & EBERL 1984	10-11Å CRYSTAL-LINITY INDEX °2θ		OTHER
2.0-2.3′													0.69		
7.8′					93		7		1PK / 8.83		0	(<5)	0.83		
12.6-12.8′					100		--		1.2 / 8.37	5.09 / 5.0	<5	0 / 13	0.99		IL & IL/SM — don't use
14.3′			100						0.80 / 8.75	(5.01 ?)	<5	(6)	0.92		
19.3′					100								0.80		
25.8-25.9′															
31.5′ *	1		99						0.67 / 8.65	(5.04)	4	(7)	0.80		
34.5′			100						0.7 / 8.65	(5.03)	3	(7)	0.83		
46.8′			100						0.6 / 8.55	(5.05)	5	(8)	0.90		
50.0′			100				TR		0.74 / 8.50	(5.05)	5	(9)	1.01		
53.5′			100						0.7 / 8.5	(5.05)	5	(9)	0.81		
59.6′			100												
71.5′			100						8.57 / 0.65	(5.03)	3	(7)	0.75		
88.0′			98					2	0.52 / 8.55	(5.05)	5	(9)	0.69		
89.0′															
96.0′					99			1	1PK / 8.8	(5.03)	3	(<5)	0.55		
96.3′															
98.0′															
100.0′															
103.0′															
106.0′					100								0.50		
110.0′															
118.5′															MILITARY
124.0′					99			1	0 / 8.85	(5.03)	3	(<5)	0.39		
129.0′															
138.0′ *					100			—	0 / 8.8	(5.03)	3	(<5)	0.48		
138.5′															
143.0′															
156.5′					100				0 / 8.8	(5.02)	2	(<5	0.46		
178.0′															
188.1′			100						0.55 / 8.58	(5.05)	5	7	0.75		
191.4′															
200.5′									? 7						
208.5′					100				0.35 / 8.80	(5.04)	4	(<5)	0.60 / 0.56 — (2)		
217.0′															
225.0′					100				0 / 8.80	(5.02)	2	<5	0.86		
239.9-240.3′															
240.0′															

APPROXIMATE WEIGHT %

VC-2A CLAY XRD (<5μ)

	APPROX. WT. %											
	SMECTITE	M.L. ILLITE/SMECTITE	ILLITE	CHLORITE	% SM in I/S (Reynolds)	I1002/SM003 (GLY)	SM in I/S (Srodon & Eberl 1984)	10-ÅTR CRYSTALLINITY INDEX, °2θ		
245.3'										
255.4'		100			(10)	5.09	1.0/8.3	(14)	0.94	S_2 SANDSTONE "CH" PK
258 - 258.2'										
268.0'										
279.1'			100			5.08/5.02	ONE PK/8.8	(<5)	0.57	
305.7'			100	TR	(2)	5.03	1 PK/8.83	(<5)	0.48	
333.3'/337'			100	—	(1)	5.02	ONE PK/8.81	(<5)	0.54/0.50	
345.2'			100	16				(<5)	0.44	
359.2'										
368.3'			100		(2)	5.03	1 PK/8.85	(<5)	0.68	
387.8'										
401.3'			100					(<5)	0.50	
404.0'										
409.5'			100		(2)	(5.03)	1 PK/8.87	(<5)	0.54/0.70	
435.0'			(97)		(9)	(5.08)	0.55/0.60	15	(10)	0.64
443.5 463.2'	3	97/100	100		(6)	(5.04)	8.80	(5)	0.	
491.5'			100		(2)	(5.09)	1 PK/8.75	(<5)	0.50	
514.5'			100		(2)	(5.03)	1 PK/8.72	5	0.57	
519.8'										
538.2'										
553.4'			96	4	(2)	(5.03)	1 PK/8.66	7	0.48	
562.4'										
582.4'										
602.2'										
612.5'			85	15	(1)	(5.02)	<0.8/8.8	<5	0.69	
632.0'										
636.8 - 637.0'										
650'.			96	4	(<1)	(5.01)	1 PK/8.74	<5	0.68	
687.6'			85	15					0.72	
697.0'										
709.5'			64	36		(5.03)	NO SM/8.79	<5	0.57	
718.1'										
740.5'			66	34	(2)	(5.02)	1 PK/8.83	<5	0.54	
771.0'			95	5	(0)	4.99	1 PK/8.75	<5	0.45	
790.9'			95 97	3	(0)	(4.99)	1 PK/8.87	<5	0.46 3	
822.6'			98	2	(1)	(5.01)	1 PK/8.76	<5	0.61	
859.1'			96	4	(0)	4.99	1 PK/8.80	<5	0.40	
888.1 *			93	7	(0)	5.01	8.78	<5	0.52	0.50

VC-2A CLAY XRD (<5u) CONTINUED

DEPTH	APPROXIMATE WEIGHT % ±5% SMECTITE	MIXED-LAYER ILL/SMEC	ILLITE	CHLORITE	KAOLIN	d 11.00Å SMOOS (A)	% SMECTITE INTERLAYERS IN ILL/SM	10-14Å CRYSTAL. INDEX ±0.08	IC Gly
DO 916'±									
DO 937'			85	15				0.35	0.34
966'			93	7				0.32	
DO 1006'			93	7				0.35	
1020'									
1044.5'			89	11				0.32	
1066'									
1077.6'			86	14				0.29	
1095.2'			69	31				0.28	
1128.2'			57	43				0.35	
1161.6'									
1166.0'									
1170.5'									
1206.3'			77	23				0.50	
1226.0'			100	—				0.46	
1234.6'									
1238.0'			87	13				0.44	
1275.0'			100	—				0.35	
1295.4'			100	—				0.30	
1320.6'			99	1				0.28	
1349.8'			100	—				0.55	
1375.8'			97	3				0.36	
1396.8'			92	8				0.43	
1420.8'			91	9				0.48	
1457.0'			100	—				0.38	
1470.4'			100	—				0.38	
1510.8'			90	10				0.32	
1529.2'			92	8				0.42	
1565.3'									
1571.4'			100	—				0.36	
1591.5'									
1596.7'									
1617.0'									
1623.0'			100	—				0.33	
1634.9			95	5				0.45	
1650.7			91	9				0.37	
1660.0'			93	7				0.38	
1690.0'			90	10				0.35	
1731.0'			95	5				0.38	

VC-2A CLAY XRD (<5U)

S_2: 216 - 263.3'

	APPROXIMATE WT. %															
	MIXED-LAYER ILLITE/SMECT.	ILLITE	CHLORITE	KAOLIN	SMECTITE	d (Å) (001)/(060)	$\Delta 2\theta_1$	$\Delta 2\theta_2$	% SM IN I/SM (REYNOLDS, 1980)	% SM IN I/SM (ŚRODOŃ & EBERL '84)	IL OF I/SM	IC (Kübler)	IC INDEX	$\Delta 2\theta_A$
191.4' 178		100				5.01	—	8.98	(0)	(<5)	0.31			0.11
188.1'	100					5.05	8.58	0.55	(5)	(7)	0.75			
200.5'	100					5.02	0.58	8.77	(3)	(7)	0.65			0.18
								8						
208.5'	100										0.62			
217.0'	100					5.02	0.90	8.78	(2)	(7)	0.60			
225.0'	1													
227.3'	100					5.01	0.75	8.75	(0)	(7)	0.88			
240.0'	100					5.02	0.80	8.65	(3)	(8)	0.80			
245.3'		100				5.01	0.67	8.83	(0)	(<5)	0.53			
247.6'											1.02			
250.1	100					5.08	0.89	8.87	(9)	(11)	0.96			
255.4'	100					5.09	1.0	8.90	(10)	(14)	0.94			
256.3'		100									0.52			
258.1	100					5.01	0.72	8.80	(0)	(6)	(0.83)	0.83		
261.7-261.8'	100					5.01	0.70	8.70	(0)	(7)	(0.82)			
268.0'		100				(5.00)	—	8.8	(0)	(<5)	(0.54)			
279.1		100				5.03	—	8.8	(3)	(<5)	(0.57) 0.55			
286.2'														

VC-2A: S_2 SANDSTONE SAMPLES — CLAY XRD

APPROXIMATE WEIGHT %

	QUARTZ	PLAGIOCL.	K-FSP.	CAL	PY	MOSS	LELICOXENE	FLUORITE	SM.	IL/SM	IL	KAOLIN	CHL	OTHER
~~191.4'~~ 178	59		20		2	0.5	1				18			
														191.8-FL
200.5'	61		—		1		1			37				tr hem, ap
208.5'	53		24		3		1	—		19				
216.5	50		—		2		1	—		47				
217.0'	51		—		3		1			45				
225.0'	53				2		1			44				
227.3'	52				2		3 AN			44				
240.0'	~~35~~/37				2/4		2/1			6/36				
245.3'	8		15		5		3 AN			69				
247.6'														
248					2		3/21							
250.1'	73		8		1					18				
255.4'	62		7		1		1			29				
256.3'	61		7		1			2			29			
258.1'														
260.0'	52		7		1			1		39				
261.8'	47		9		3			1		40				
	49													
268.0'	50		17	Tr	1			t		~~38~~	32			
279.1'	6/66		7/6		2/1					~~30~~/28	30/28			
286.2'														

YC-2A : S_2 SANDSTONE - BULK XRD

KF 250
PL 330

DEPTH	QTZ	PLAG.	KFSP.	CALCITE	PY	FLUORITE	ANATASE		IL/SM (IL-RICH)	IL	CH		AM.	
1128.2′	37	24	16	3	1	TR	~~2~~ TR			2	2		~~15~~ 5	0.5 ILM 0.2 HEM
1137.0′	35	23	16	3	TR	—	—			1	2		20	
1149.0′	35	17	24	—	1		23			1	2		~~18~~	
1161.6′	~~34~~	~~26~~	16		1	3	2			~~9~~	~~8~~		~~5~~	
1166.0′	60		19	1	TR	4				9	4			
1167.0′	56	17	12	1	TR	—				11	3			
1170.5′	58	18	14	5	1	TR				8	6			
1171.3′														
1174.5′														
1177.0′	55	—	19	5	TR	2	—			15	3			
255-1A 1180.1′	57	6	16	4	TR	TR	—			12	4			
1182.0′	57		19	6	TR	1				14	4			
1183.6′	53	11	14	17	12	—				7	6			
1186.5′	60		23	2	TR	TR	—			8	7			
1206.3′	47		29	13	1	1	TR			~~10~~ (13)	~~8~~ 5		~~4~~	
1212.2′	55	—	—	6	2	—			38					
1214.0′	54	—	—	5	7	1			33		—			
1226.0′	57			—	1	3			39					
1234.2′	50	3	14	—	1	1				8	3		20	
1238.0′	44	11	17	—	2	—								
1196.0′	45		27	3	1	1				11	4		8	

VC-2A

53 SANDSTONE SAMPLES

53 : 1167-1186.7′

DEPTH	M-I ILLITE/SMECTITE	ILLITE	CHLORITE	d(060) / SMOOS	Δ2θ1	Δ2θ2	% SM IN IL/SM (REYNOLDS, 1980)	% SM IN IL/SM (SRODON, & ELBERT 84)	IL OF IL/SM KUBLY INDEX	AD → EG (GLY) in XRD	IL(001) moves slightly upon glycol?	how much	shift in 1.02
1128.2′		57	43	5.00	—	8.90	0	<5	(0.35?)		✓		
1137.0′		43	57	5.00	—	8.87	0	<5	0.30				
1149.0′		43	57	5.00	—	8.88	0	<5	(0.30?)		✓		
1161.6′		55	45	4.99	—	8.90	0	0	0.25		(NO)		
1166.0′		89	11	5.02	—	~~8.69~~ 8.81	1	<5	0.42		✓		
1167.0′		81	19	5.00	—	8.82	0	<5	0.52		✓		
1170.5′		72	28						0.39				
252-A 1171.3′		66	34						0.39				
1174.5′		77	23	4.98	—	8.78	0	<5	0.38				
1177.0′		85	15	4.98	—	8.78	0	<5	0.54		✓		
1180.1′		72	28	5.00	—	8.82	0	<5	0.53		✓		
1182.0′		86	14	5.00	—	8.80	0	<5	0.45 0.43		✓	0.13° 2θ	0.08° 2θ
1183.6′		53	47	5.00	—	8.86	0	<5	0.40		✓		
1186.5′		52	48	4.98	—	8.85	0	<5	0.49		✓		
1206.3′		77	23	5.00		8.85	0	<5	0.50		✓	0.05° 2θ	
1212.2′	100			5.01	0.88	~~8.91~~ 8.36	0?	12	1.02				
1214.0′	100	—	—	5.03		8.60	3	8	0.78		✓	0.28° 2θ	
1226.0′	100	—	—	5.03		8.67	3	8	0.70		✓	0.19° 2θ	
1234.5′		71	29						0.40				

VC-2A

S3 SANDSTONE SAMPLES
CLAY XRD

S3 : 1167-1186.7′

ILSEMANNITE $Mo_3O_8 \cdot nH_2O$

d	I
4.23	50 *
3.36	100 *
3.23	10
3.14	20
3.04	10
2.72	40
2.44	30 *
2.22	30
2.12	10 *
1.932	30
1.823	10 *
1.641	50
1.55	20 *
1.458	20 *

* PARTIALLY DUE TO ADMIXED QUARTZ

JORDISITE - colloidal MoS_2
no X-ray pattern.

MoS_2 - MOLYBDENITE

2H

d	I
6.15	100
2.737	16
2.674	10
2.277	45
2.049	14
1.830	25
1.581	12
1.538	12

→ 3R

d	I
6.09	100
2.71	70
2.63	60
2.34	60
2.194	60
2.034	30
1.889	40
1.755	30
1.581	70
1.529	70

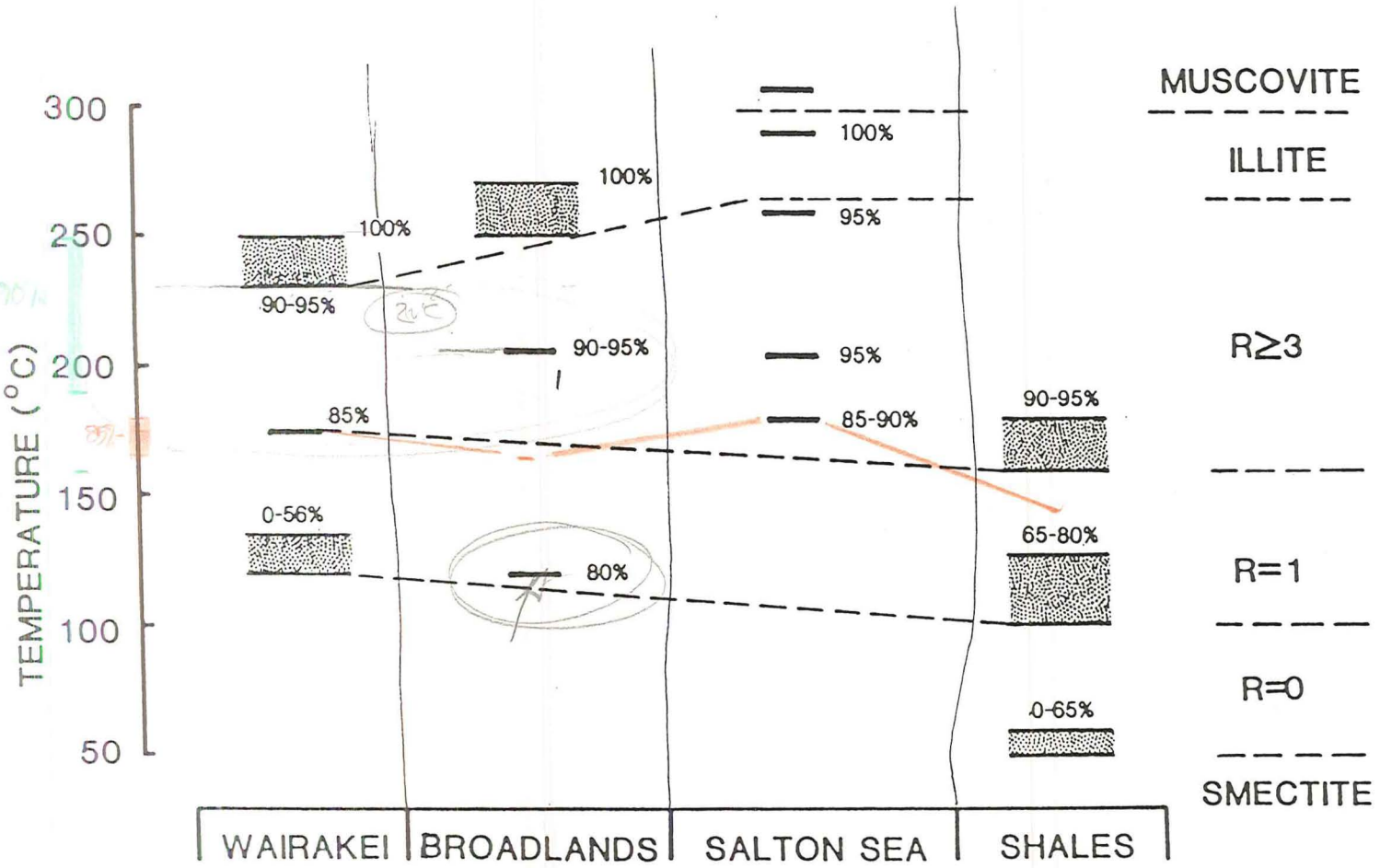


Figure 6. A summary of the temperature dependence of I/S composition from active geothermal areas and deeply buried shales. See text for explanation. (Hower, pers. comm.).

DEPTH
1128.2'
1137.0'
1149.0'
1161.6'
1166.0'
1167.0'
1170.5'
1171.3'
1174.5'
1177.0'
1180.1'
1182.0'
1183.6'
1186.5'
1206.3'
1212.2'
1234.6

VC-2A

S3 SANDSTONE SAMPLES

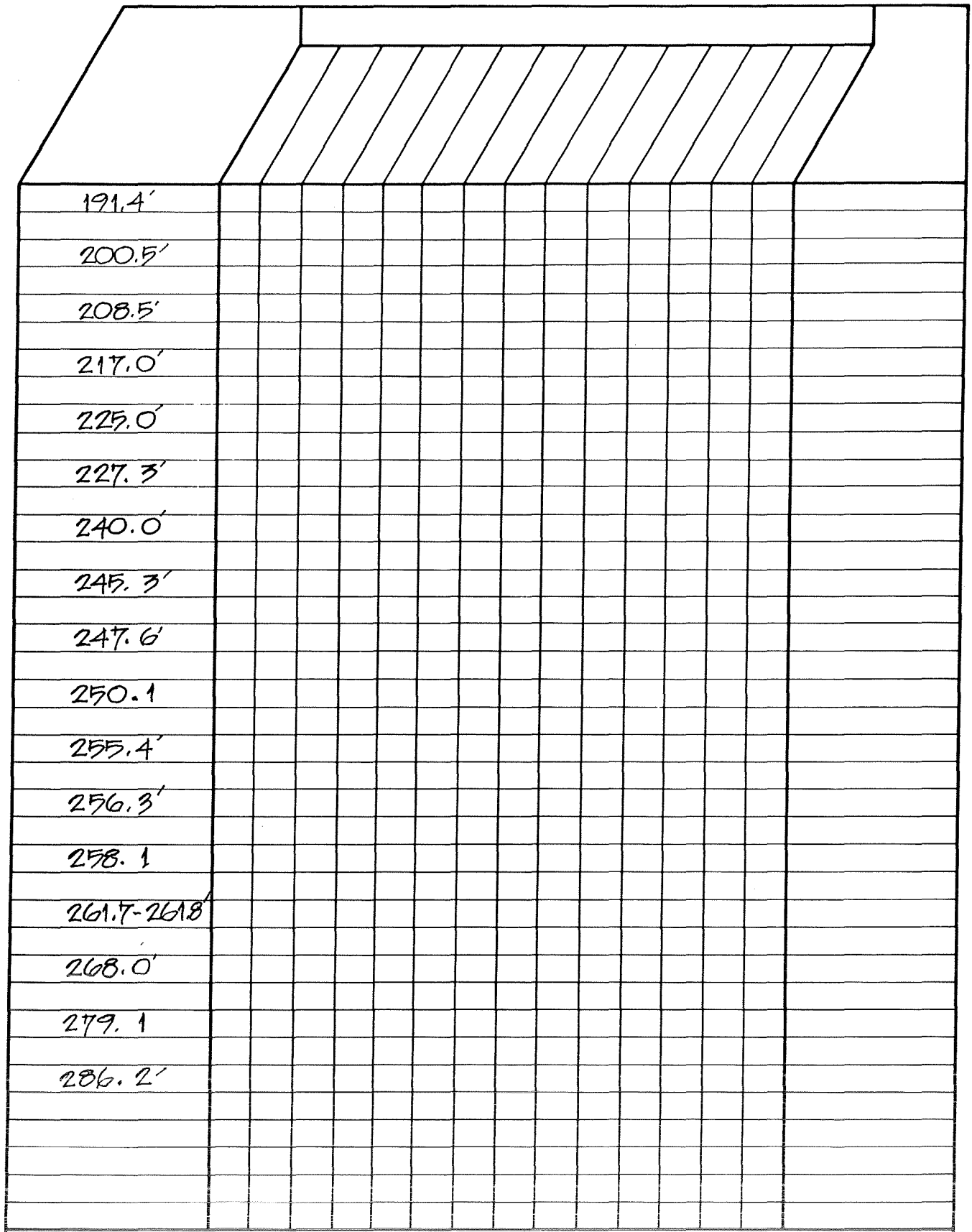
S3 : 1167-1186.5'

S_2: 216-263.3'

~~191.4'~~
200.5'
208.5'
217.0'
225.0'
227.3'
240.0'
245.3'
247.6'
250.1
255.4'
256.3'
258.1
261.7-261.8'
268.0'
279.1
286.2'

VC-2A: S_2 SANDSTONE SAMPLES

S2: 216-267.3'



VC-2A: S2 SANDSTONE SAMPLES

VC-2A [illegible]

ELEMENT		CONCENTRATION
NA	% OX.	[illegible]
K	% OX.	[illegible]
CA	% OX.	[illegible] → 0,87 Ca ≡
MG	% OX.	0.443
FE	% OX.	2.28
AL	% OX.	[illegible]
SI	% OX.	76.30
TI	% OX.	0.339
P	% OX.	[illegible]
SR	PPM	9
BA	% OX.	0.017
V	PPM	< 250
CR	PPM	13
MN	% OX.	0.029
CO	PPM	14
NI	PPM	9
CU	PPM	10
MO	PPM	< 50.0
PB	PPM	33
ZN	PPM	63
CD	PPM	< 5.00
AG	PPM	2
AU	PPM	< 4.00
AS	PPM	108
SB	PPM	< 30.0
BI	PPM	< 100
U	PPM	< 2500
TE	PPM	< 50.0
SN	PPM	10
W	PPM	< 1200
[illegible]	PPM	5
[illegible]	PPM	2.3
[illegible]	PPM	< 400
ZR	PPM	157
[illegible]	[illegible]	26
[illegible]	PPM	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
	[illegible]	[illegible]
		98,7[illegible]

JEFF

5 VC-2A100-/10.2

ELEMENT			CONCENTRATION
NA	% OX.		0.015
K	% OX.		1.88
CA	% OX.		3.94
MG	% OX.		[illegible]
FE	% OX.		1.72
AL	% OX.		5.24
SI	% OX.		80.20
TI	% OX.		0.293
P	% OX.		0.057
SR	PPM		24
BA	% OX.		0.013
V	PPM	<	250
CR	PPM		40
MN	% OX.		0.035
CO	PPM		25
NI	PPM		18
CU	PPM		17
MO	PPM		3340 ≡ 0.554% MoS_2
PB	PPM		442
ZN	PPM		[illegible]
[illegible]	PPM		[illegible]
AG	PPM		[illegible]
[illegible]	PPM	<	[illegible]
[illegible]	PPM		[illegible]
[illegible]	PPM	<	[illegible]
[illegible]	PPM	<	100
[illegible]	PPM	<	2500
[illegible]	PPM	<	50.0
SN	PPM		[illegible]
[illegible]	PPM	<	1200
[illegible]	PPM		[illegible]
[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	<	[illegible]
[illegible]	PPM		[illegible]
[illegible]	PPM		[illegible]
[illegible]	[illegible]		[illegible]
[illegible]	[illegible]		2.57
S	[illegible]		1.38

JEFF

ANALYSIS BY INDUCTIVELY COUPLED PLASMA SPECTROMETRY (SILICA BY COLORIMETRY) (S - LECO SULF ANALYZER)

14 VC-2A 130-130.35'

ELEMENT		CONCENTRATION	
NA	% OX.	0.064	
K	% OX.	5.33	
CA	% OX.	0.080	
MG	% OX.	0.152	
FE	% OX.	2.93	
AL	% OX.	10.60	
SI	% OX.	76.10	
TI	% OX.	0.189	
P	% OX.	0.022	
SR	PPM	20	
BA	% OX.	0.035	
U	PPM	< 250	
CR	PPM	29	
MN	% OX.	0.011	
CO	PPM	16	
NI	PPM	14	
CU	PPM	6	
MO	PPM	949	= 0.141 % MoS2
PB	PPM	26	
ZN	PPM	119	
CD	PPM	< 5.00	
AG	PPM	4	
AU	PPM	< 4.00	
AS	PPM	154	
SB	PPM	< 30.0	
BI	PPM	< 100	
V	PPM	< 2500	
MO	PPM	< 50.0	
W	PPM	8	
LI	PPM	< 1200	
BE	PPM	8	
B	PPM	2.0	
ZR	PPM	< 400	
Y	PPM	158	
LA	PPM	65	
CE	PPM	111	
TH	PPM	< 150	
S	%	2.31	
	TOTAL	95.519	

SEMI-QUANT. BULK XRD=

5 PYRITE
10 K-FELDSPAR
30 ILLITE (SERICITE)
55 QUARTZ

JEFF

7 VC-2A 188-188.3

ELEMENT			CONCENTRATION
NA	% OX.		0.011
K	% OX.		1.95
CA	% OX.		0.408
MG	% OX.		0.228
FE	% OX.		5.16
AL	% OX.		7.01
SI	% OX.		79.45
TI	% OX.		0.100
P	% OX.		0.017
SR	PPM		9
BA	% OX.		0.006
V	PPM	<	250
CR	PPM		3
MN	% OX.		0.022
CO	PPM		38
NI	PPM	<	5.00
CU	PPM		9
MO	PPM		3416 ≡ 0.567 % MoS_2
PB	PPM		43
ZN	PPM		95
CD	PPM	<	5.00
AG	PPM		11
AU	PPM	<	4.00
AS	PPM		235
SB	PPM	<	30.0
BI	PPM	<	100
U	PPM	<	2500
TE	PPM	<	50.0
SN	PPM		8
W	PPM	<	1200
LI	PPM		23
BE	PPM		2.2
B	PPM	<	400
ZR	PPM		100
LA	PPM		41
CE	PPM		69
TH	PPM	<	150
S	%		4.05
	TOTAL		94.359

		ppm Ag	ppm Au
VC-2A	83.2-83.3	–	–
	100 - 100.2	1.7	<0.02
	130 - 130.3	1.1	0.02
	188 - 188.2	9.5	0.02

(by AA)

Baca VC-2A. Samples with sericite potentially coarse enough to probe.

Depth	Sericite size μm	Assoc^{n} Feld.	Mafic or frag	Matrix	Vn.	T°C	
12	50 max						
30-50 50	10-20			x		~25	Inlandslide. Alt^{n}
95 106	10-400	x	x	x		~40	
-148	5-10μ 10-50	x	x		x	~70	
188.1				x	x	~85	
278 279.1	10-20	x	x	x	x	~120	
345.2 345.2	10-20 up to 100.	x	x	x	x	~130	
432 434.9	10	x	x	x	x	~135	
632-635 632?	10-30				x	~160	
1238 1238	10-20		x			~195	
1320.6	10-20		x	x		~200	
1575 1571.4				x			
1623	20-50 Green phengite, Abt Adularia in vugs.					~210	
1635 1631.4	10-30			x		~210	

Possibly hydrothermal.

WAGNER PETROGRAPHIC

95 South 700 East • AMERICAN FORK, UTAH 84003
(801) 756-2172

SAMPLE SUBMITTAL

BY JEFFREY B. HULEN/ULRI DATE 10/16/86

SAMPLE NUMBER	DESCRIPTION for JBH	Thin Section	Polished Section	Need Impregnation	Polished Thin Section	1.25" Microprobe Slide	Large Polished Section	* K-Spar Stain	Calcite Stain	
2.0-2.3'	CORE	✓						✓		
12.6'	CORE (CLAST IN LSL)	✓						✓		
32-32.2	"	✓		✓?				✓		
46.8-46.9' (A)	"	✓		✓?				✓		
50'	" (ACCR. LAPILLI)	✓		✓?				✓		
83.2'	" (TUFF)	✓		✓?				✓		
96' (A)	"	✓						✓		
96' (B)	"	✓						✓		
106'	" (DWT)	✓						✓		
118.5'	" (DWT)	✓						✓		
138' (A)	" (PWT)	✓						✓		
147.9'	" (PWT)(& BX)	✓						✓		
148.5'	" (BX-Tf?) CONTACT	✓						✓		
160.0'	" (DWT)-devit.	✓						✓		
178.0'	" (DWT)- silicif-devit.	✓						✓		
188.1'	" (MoS_2 BX)	✓						✓		
200.5'	" (PWT)	✓						✓		
208.5'	" (")	✓						✓		
213	" (SIL. BX)	✓						✓		
216.5'	" (NWT)	✓						✓		
(B) 227.2-227.5'	" (DEBRIS FLOW)	✓						✓		see below
248'	"	✓						✓		
(B) 250-250.25'	" (SS)	✓						✓		see below
(B) 256.2-256.5	" (SS)	✓						✓		see below
268.2'	" (DWT)	✓						✓		
279.1'	" (DWT)	✓						✓		
305.7	CORE (DWT)	✓						✓		
333.3	" "	✓						✓		
345.2	" "	✓						✓		
359.2	" "	✓						✓		
368.3'	" " (silicf)	✓						✓		
387.8'	" "	✓						✓		
401.3'	" "	✓						✓		
34.9'	" "	✓						✓		

REMARKS * PLEASE STAIN ½ OF SLIDE. ONLY.

SAMPLES MARKED YELLOW PLEASE RUSH.

(A) YELLOW AREA

(B) PLEASE SAW CORE AS INDICATED, POLISH ONE OF THE FACES, THEN PREPARE THE THIN-SECTION FROM THE OTHER HALF.

WAGNER PETROGRAPHIC

95 South 700 East • AMERICAN FORK, UTAH 84003
(801) 756-2172

SAMPLE SUBMITTAL

BY J.B. HULEN DATE

SAMPLE NUMBER	DESCRIPTION	Thin Section	Polished Section	Need Impregnation	Polished Thin Section	1.25" Microprobe Slide	Large Polished Section	K-Spar Stain	Calcite Stain	
VC-2A 463.2'	CORE (DWT) (ser, sil)	✓						✓		
491.5'	" " (")	✓						✓		
514.5'	" " (ser)	✓						✓		
538.2'	" " "	✓						✓		
553.6'	" " "	✓						✓		
562.4'	" " "	✓						✓		
582.4'	" " "	✓						✓		
612.5'	" " "	✓						✓		
632	" " "	✓						✓		
636.8-657'	" " "	✓						✓		
651.4	" " "	✓						✓		
687.6'	" " "	✓						✓		
697'	" "	✓						✓		
718.1	" "	✓						✓		
740.5'	" "	✓						✓		
771'	" "	✓						✓		
790.9	" "	✓						✓		
822.6	" "	✓						✓		
859.1	" "	✓						✓		
888.1	" "	✓						✓		
No. 226-6B	" Fallout Tuff	✓						✓		
No. 227-3B	" " contact with welded tuff	✓						✓		
No. 255-2A**	" S3 S5	✓						✓		SEE NOTE BELOW
No. 252-4B**	(1183.6') S3 S5	✓						✓		SEE NOTE BELOW

REMARKS * PLEASE STAIN ½ OF SLIDE ONLY

** SAW ALONG LINE INDICATED, POLISH ONE OF THE FACES, THEN PREPARE THE THIN-SECTION FROM THE OTHER HALF

WAGNER PETROGRAPHIC

95 South 700 East • AMERICAN FORK, UTAH 84003
(801) 756-2172

SAMPLE SUBMITTAL

BY J. HULEN / URI/ESL 391-C CHIPETA WAY SLC, UT. 84108 DATE 12/9/86

SAMPLE NUMBER	DESCRIPTION	Thin Section	Polished Section	Need Impregnation	Polished Thin Section	1.25" Micro-probe Slide	Large Polished Section	(B) K-Spar Stain	Calcite Stain
NM/SS 86-1	ROCK	✓		✓				✓	
NM/SS 86-2	ROCK	✓		✓				✓	
NM/SS 86-4A	ROCK	✓						✓	
NM/SS 86-4B	ROCK	✓						✓	
NM/SS 86-4C	ROCK	✓						✓	
916'	CORE	✓						✓	
937'	"	✓						✓	
966'	"	✓						✓	
1020'	"	✓						✓	
1044.5'	"	✓						✓	
1077.6'	"	✓						✓	
1095.2'	"	✓						✓	
1128.2'	"	✓						✓	
1161.7'	"	✓						✓	
1206.3'	" (INCLUDE VEIN)	✓						✓	
1226'	"	✓						✓	
1238'	"	✓						✓	
1275'	"	✓						✓	
1295.4'	"	✓						✓	
1320.6'	"	✓						✓	
1349.8'	"	✓						✓	
1375.8'	"	✓						✓	
1396.8'	"	✓						✓	
1420.8'	"	✓						✓	
1446'	"	✓ (A)						✓	
1457'	"	✓						✓	
1470.4'	"	✓						✓	
1510.8'	"	✓						✓	
1529.2'	"	✓						✓	
1565.3'	"	✓						✓	
1571.4'	"	✓						✓	
1591.5'	"	✓						✓	
1628'	"	✓						✓	
1634.9'	"	✓						✓	
1660'	"	✓						✓	

REMARKS (A) CUT SECTION ⊥ TO CORE AXIS AS INDICATED BY INKED LINES & MAKE IT A ~~LARGE~~ SECTION (3X2"?)

(B) PLEASE STAIN ONLY ½ OF SLIDE.

WAGNER PETROGRAPHIC

95 South 700 East • AMERICAN FORK, UTAH 84003
(801) 756-2172

SAMPLE SUBMITTAL

BY _____ DATE _____

SAMPLE NUMBER	DESCRIPTION	Thin Section	Polished Section	Need Impregnation	Polished Thin Section	1.25" Microprobe Slide	Large Polished Section	K-Spar Stain	Calcite Stain
1690'	CORE	✓						✓	
1731'	CORE	✓						✓	
GB-1	ROCK	✓							
GB-2	ROCK	✓							
TS-OT	ROCK	✓							
NO-AU No.1	ROCK	✓							

REMARKS _____

Keith et al., 1986 — Pine Grove moly system, Utah

Pine grove moly deposit, ~125 mt of 0.3% MoS_2 → occurs in eroded vent of 22-23 m.y. rhyolite ash-flow tuff

It (the vent) is comagmatic with the tuff, as proved by nearly identical compositions of accessory almandine/spessartine in each.

Tpfi – "phase five porphyry" is the intrusive "most dominantly ore-related" (now 4593-4921' / 1400-1500 m below surface)

→ 24 m.y. old.? 19-21 my ±0.3 (5,578 ± 984')

prob erroneous

- the vent has been eroded ~ 1.7 km below the "pre-eruption" (immediately post-eruption??) surface. (this based on stratigraphic reconstruction)
-

  ↳ so: the orebody (if at the top of the phase five porphyry) was developed at a depth of about 3100 – 3500 m below (contemporaneous) surface.

MARYSVALE

Cunningham and Steven, 1978.

- suggest that ~~porph~~ U-Mo-F veins of Central District are situated in a fractured roof or hood zone of a concealed, ~~fe~~ hypabyssal felsic pluton

- Mo in veins increases in relative and absolute abundance with depth. most common in deepest levels of Central District mines.

→ They suggest that a "porphyry-type" moly deposit may underlie the U-Mo-F vein system at or near the top of the postulated, concealed stock.

because: 1) see Mo increase, above. 2) U-Mo-F veins ~~occur~~ coincide with local area of distension within an area of concurrently active intrusion and extrusion.

PRELIMINARY FLUID INCL. STUDIES: T_h on fluorite cogenetic with pitchblende — approx 150°C.

... prob. deeper & hotter where molybdenite occurs.

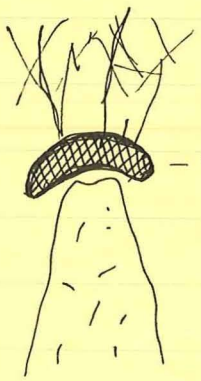
Cunningham, et al., 1982 **Marysvale**

pitchblende, jordisite, molybdenite, pyrite, marcasite, quartz, fluorite → coffinite, uraholite (U-Mo hydrate)

central mng. district

U- and Mo-bearing hydrothermal veins in fractures above a postulated, concealed stock (in stkwk. zone above) ("hood zone"? like Questa?)

AGE = 18-19 m.y.



← URANIUM & Mo-BEARING VEINS W/FLUORITE

← POSTULATED PORPHYRY MoS_2

← POSTULATED STOCK

Cunningham & Steven, 1979b

1978

w/(occ). chalcedonic silica.

Molybdenite does occur sparsely in the U-bearing veins also jordisite

---

JORDISITE – Black, powdery, ~~Mo~~ colloidal form of what may be MoS_2 – alters to ilsemannite.

Palache, et al., 1944

~~I~~ILSEMANNITE – $Mo_3O_8 \cdot nH_2O$ (molybdenum blue)

found only as earthy masses or crusts, as a stain or disseminated pigment. Black, blue-black or blue, becoming blue on exposure. Readily peptized by water giving a deep blue sol

2nd mi'nrl. – oxd'n of molybdenite – ~~found~~ may color associated minerals BLUE

Thomas & Galey, Jr., 1982 — Mt. Emmons / Redwell Basin

@ surface: "base metals" and silver in veins
Pb, Zn, Ag & Au (• ONLY ORE PRIOR TO MOLY DISCOVERY)

MOLYBDENITE OCCURS IN TRACE OR MINOR AMOUNTS IN VEINS & VEINLETS (these)

ALTERATION | MINERALIZATION

- Upper Redwell Basin Bx (pipe) deposit:
  Pervasive, intense PHYLLIC ALteration in pipe above (to surface) & completely enclosing & including ore ~~bodies~~ upper ore body
  Moly in qtz. vnlts & as "paint" on fracture surf.
  pyrite, fluorite & sericite are common w/Mo
- MoS_2 < 10 ppm ~~down~~ from surface to ~ 3000 ft

in deeper part of deposit: weak KF-Q-MoS_2 veining — mutually crosscut qtz-ser vnlts

- Lower Redwell Basin deposit (100 MT @ 0.16% MoS_2 [>0.12])
  → BELOW ~~Fm~~ moderate pervasive phyllic alteration.
  → ~~Q-KF, Vnlts~~ Qtz-MoS_2 VNLTS w/ tr KF, FL, & PYRITE POSSIBLY within weak potassic alteration zone
- Mt Emmons Deposit → (155 MT @ 0.44% MoS_2 [>0.1%])
  classic cupola deposit
  - pervasive, intense phyllic alteration above ~~ore~~
  - " " phyllic + potassic [within ore body]
  - intense potassic beneath ~~ore~~ ore (at stock apex)
    qtz-orthoclase ± biotite

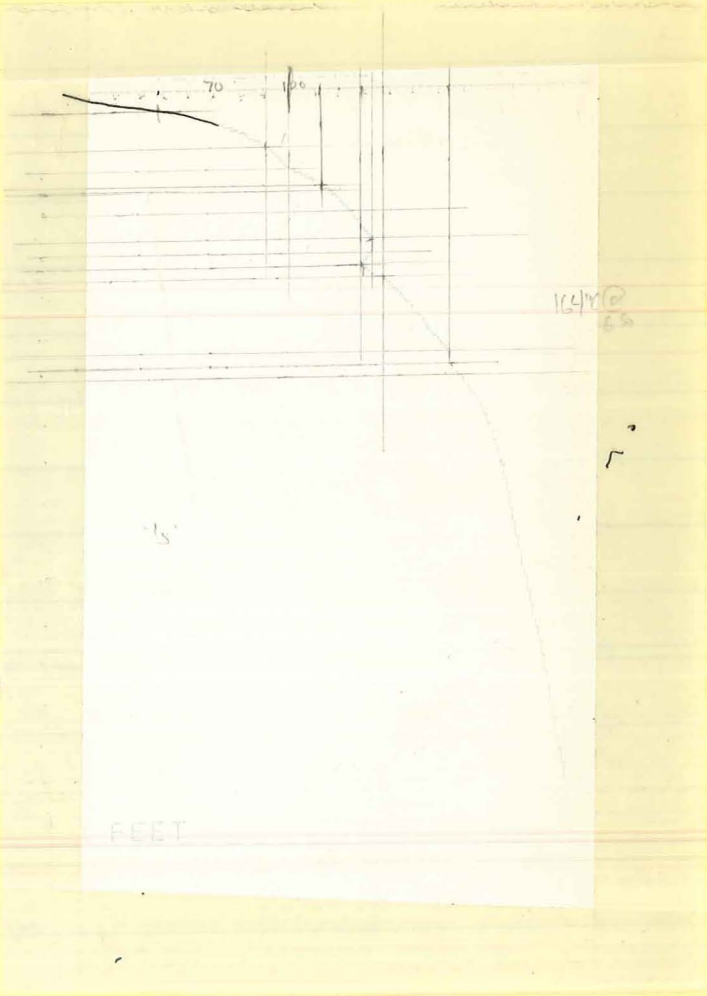
→ → WITH VEINLETS OF ORTHOCLASE, ~~Fl~~ QUARTZ, FLUORITE & MOLYBDENITE, PYRITE

DEPTH TO OREBODY (present)		WHEN DEVELOPED
Upper Redwell Basin (0.1% cutoff):	2200-2400 feet →	~ 4000' (M. Sharp, 1978 Fig. 7)
Lower " "	3700-4200 feet →	~ 5700' (inferred from Sharp 1978 fig. 7)
Mt. Emmons (0.1% cutoff)	900-1100 feet →	??

VC-2A TEMP. LOG SANDIA

E 11/10
53-03
L R009
ETH L06
CABLE
Y NICE DAY
TH FROM FLANGE TO GROUND 68
TH 0.0 FT DEG C 9.15
TH 100.0 FT DEG C 73.28
TH 200.0 FT DEG C 102.28
TH 300.0 FT DEG C 124.35
TH 400.0 FT DEG C 133.49
TH 500.0 FT DEG C 143.60
TH 600.0 FT DEG C 156.29
TH 700.0 FT DEG C 166.10
TH 800.0 FT DEG C 170.14
TH 900.0 FT DEG C 183.97
TH 1000.0 FT DEG C 187.96
TH 1100.6 FT DEG C 191.24
TH 1200.0 FT DEG C 194.65
TH 1300.0 FT DEG C 198.06
TH 1400.0 FT DEG C 201.74
TH 1500.6 FT DEG C 204.67
TH 1600.0 FT DEG C 206.96
TH 1700.0 FT DEG C 210.41
DEPTH 1720.0 FT DEG C 210

MIN TEMP 9.15DEG C
MAX TEMP 210.9 DEG C
TIME IN MIN 173.1
LOGGED 3433
TIME 15:47:35
LOGGED 0.0
DEPTH LOGGED 1720.0
1720 FEET
WATER DEPTH
FEET



TO DO

	bulk		clay, AD#		64 clay											
SS-1	✓															
2			✓		✓											
3																
4					✓											
6	✓		✓		✓											
7																
8			✓		✓											
9	✓		✓		✓											
10			✓													
11	✓		✓													
13			✓													
14			✓		✓											
15			✓		✓											
16	✓		✓													
17	✓		✓													
20																
21																

SULPHUR SPRINGS ... TO DO

SAMPLE No.	QUARTZ	PLAG.	KFSP.	CAL	GYPSUM	SULPHUR	PYRITE	ALUNITE	SMEC.	IL/SM	ILLITE	KAOLIN	CHLORITE	
SS-1						✓								
-2														
-3														
-4														
-5														
-6														
-7														
-8														
-9														
-10														
-11														
-12														
-13														
-14														
-15														
-16														
-17						✓								
-18														
-19														
-20														

SULPHUR SPRINGS SURFACE - BULK XRD

CLAY MINERALOGY, APP. WT. %

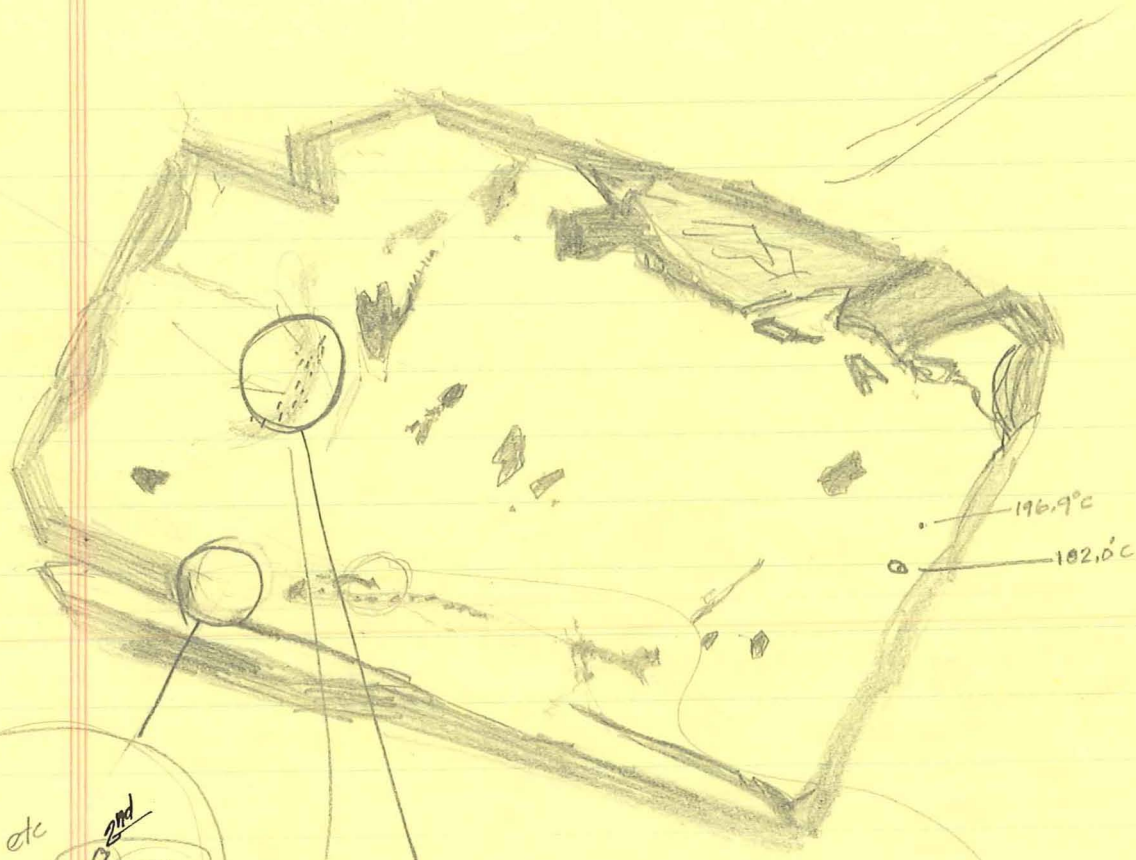
SAMPLE No	SMECTITE	M.L. ILLITE/SMEC.	ILLITE	CHLORITE	KAOLIN	% ILLITE IN M.L. / ILLITE/SMEC (APP.)	HINCKLEY INDEX
55-1							
2		93			7	(∞)	1.00
3							
4							
5							
6							
7							
8		100			—		1.04
9		100			—		1.12
10							
11							
12							
13		—			—		NO CLAY; ALL SiO_2
14		98			2		0.74
15					—	(>∞)	0.98
16							
17		—			—		NO CLAY – gyp sulfur
18							
19							
20							

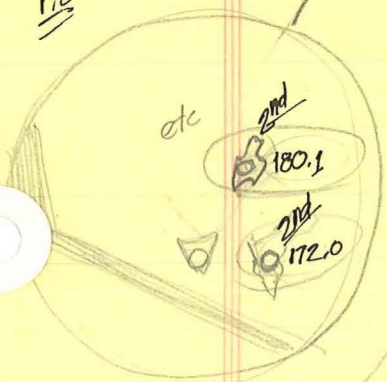
SULPHUR SPRINGS – SURFACE – CLAY · XRD

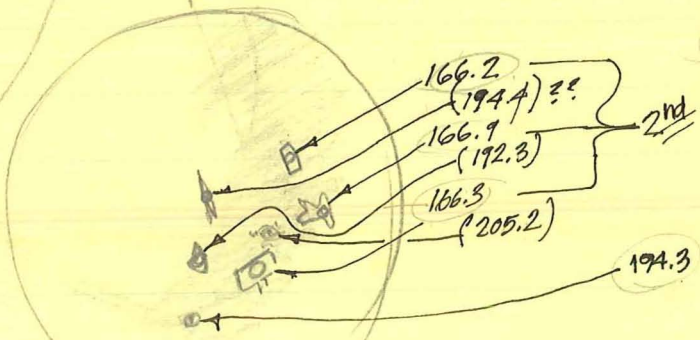
138′ prim	2nd	(58.5m) 191.8′	(164.3m) 539′
-0.1	-0.3	0	-0.3 d
-0.3	-0.1	-0.4	0 d
0	0	-0.1	0
-0.1	-0.2	-0.1	0
0	-0.1	0	-0.3 d
-0.2		-0.1	-0.1
-0.1		-0.3	0 d
-0.3		-0.1	0
0		-0.2	-0.2 d
-0.1		-0.1	0
AVG. -0.1 ± 0.1°	-0.1 ± 0.2	-0.1 ± 0.1°C	-0.1 ± 0.1°C

-0.3 ≡ 0.527 wt % Val
-0.1 ≡ 0.177 "
-0.2 ≡ 0.352 "
0 ≡ 0
-0.4 ≡ 0.701 "

VC-2A 138' EUHEDRAL QUARTZ







166.0 GIANT SECONDARY
37μ L

REVERSED

203.1°C

neg. xl.
193.1

188.7°C

194.3

190.7

(1 s.d.)

$\overline{Th}$ primary = 195.3°C ± 5.2°C

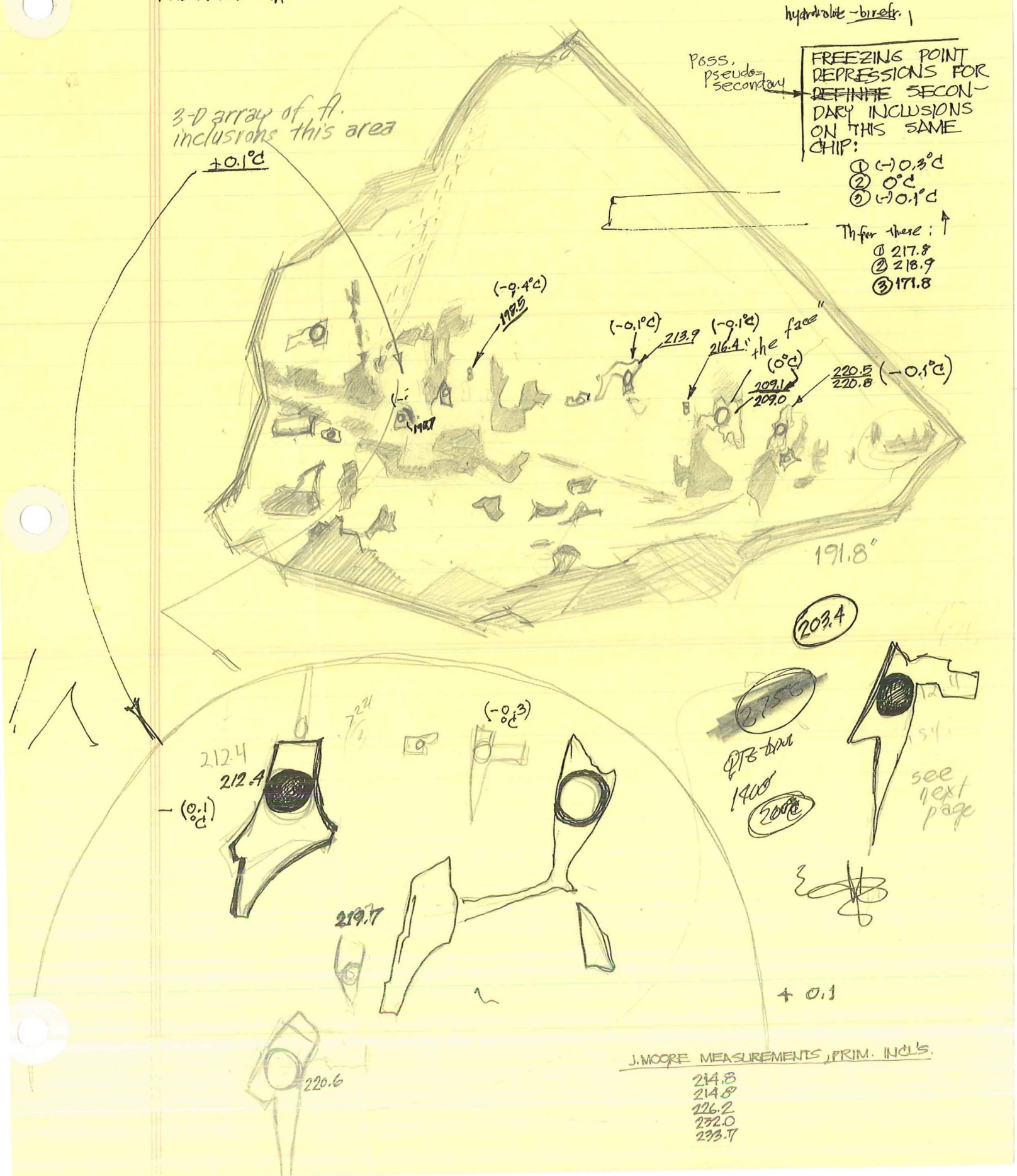
$\overline{Th}$ secondary = 171.4°C ± 7.0°C

DEFINITELY TWO GENERATIONS OF INCLUSIONS —
- ONE PRIMARY
- ONE SECONDARY (THESE TEND TO BE FLAT, 2-D)

VC-2A FLUID INCLUSIONS

SKETCH CHIP A 191.8' – VC-2A 09/25/86

AVERAGE T_h = 215.3°C ± 10.9°C (1 st.dv.) n = 15



939.1' FLUORITE: RECON. | MOSTLY PRIMARY INCLUSIONS

 — These quite common

PR. 208.2°C
PR 212.2°C
PR 197.8°C
PR 196.1°C
PR 203.2°C

ps 2nd 196.2°C
PR 208.6°C

$\overline{T_h}$ = 203.2°C ± 6.6°C

1713' CALCITE RECON.

2nd - 211.3'
PR - 219.7'
PR - 217.7'
PR - 217.6'
PR - 217.4'

Monterey Shales

Shell Golco 7672

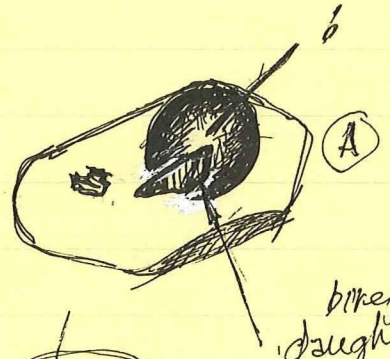
6 copies

dst 7 carbonates Mobil 3/8

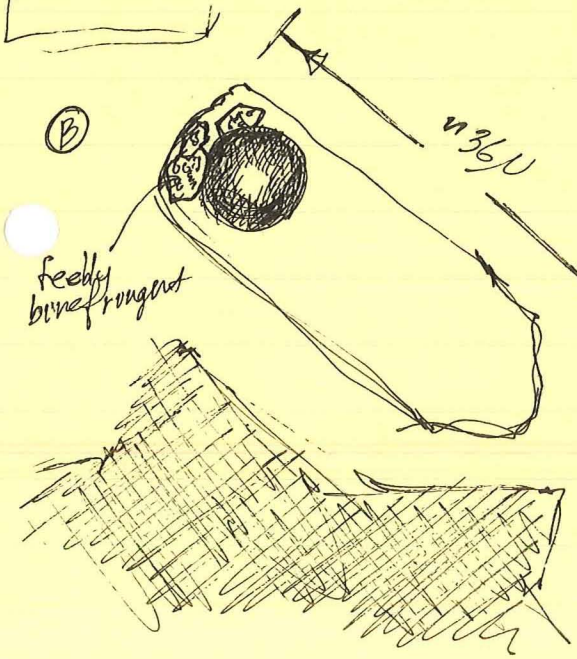
5 bulks – R.O CS 057071 Area Sues ~~Shell Golco~~

539

FREEZING POINT DEPRESSIONS

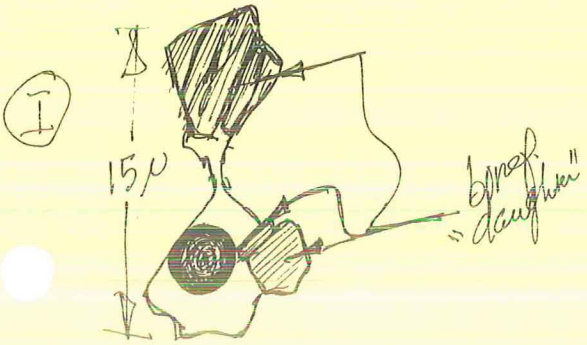


8½ rutiles



(A) (+)0.3 °C — daughters.
(B) 0 — daughters
(C) 0.2°C ?
(D) 0.°C
(E) -0.3°C daughters
(F) -0.1°C
(G) 0 — daughters
(H) -0.2°C — daughters
(I) 0 — no daughters

539



✓ = TO BE DONE
Ⓥ = POLISHED

DEPTH	MINERAL: QUARTZ	FLUORITE	CALCITE	ADULARIA	SPHALERITE	ANHYDRITE	
42.06m 138.0′	✓						
48.71m 159.8′	✓						
57.33m 188.1′	✓						
58.46m 191.8′		✓					
59.13m 194.0′		✓					
64.92m 213.0′	✓						
87.26m 286.3′							
93.17m 305.7′-Ⓐ		✓					
〃 305.7′-Ⓑ			✓				
〃 305.7′-Ⓒ	✓						
122.31m 401.3′							
129.53m 425′					✓		VERY TINY CRYSTALS
149.80m 491.5′	✓						
164.31m 539.1′		✓					
171.41m 562.4′			✓				
192.62m 632.0′			✓				
198.54m 651.4′-Ⓐ							GREEN
〃 651.4′-Ⓑ			✓				WHITE
231.94m 761.0′			✓				
306.61m 1006.0′			✓				
333.8m 1095.2′			✓				
343.86m 1128.2′			✓				
360.26m 1182.0′			✓				
367.66m 1206.3′	✓	✓	✓	✓			ALL MINERALS INTIMATELY INTERGROWN
394.82m 1295.4′			✓				
452.45m 1484.5′			✓				
522.10m 1713.0′			✓				
95.79m 314.3′		✓					

VC-2A FLUID INCLUSION SAMPLES

J.HULEN 12/86

-0.1°C ≡ 0.177 wt% NaCl
-0.2°C ≡ 0.352 " "
-0.3°C ≡ 0.527 " "
-0.4°C ≡ 0.701 " "

DETERMINING SALINITIES OF FLUID INCLUSIONS

A. Freezing Data

When a fluid inclusion has no daughter salts, salinity may be approximated by using the following formulas:

$$\text{wt \% NaCl equivalent} = 1.76958\Theta - 4.2384 \times 10^{-2}\Theta^2 + 5.2778 \times 10^{-4}\Theta^3 \pm 0.028$$

$$\text{molality NaCl equivalent} = 0.30604\Theta - 2.8598 \times 10^{-3}\Theta^2 + 4.8690 \times 10^{-6}\Theta^3 \pm 0.007$$

Θ = Temperature in ^{o}C at which last ice crystal in inclusion melts.

$-20.8\,^{\circ}C < \Theta < 0^{\circ}C$

Reference: Potter, Clynne, and Brown, 1978, Freezing point depression of aqueous NaCl solutions: Econ. Geol., V. 73, p. 284-285.

B. Salt Dissolution Data

When daughter salts are present within fluid inclusions, by noting the temperature at which the last bit of salt finally dissolves, salinity may be determined.

1. If only halite is present:

$$\text{wt \% NaCl equivalent} = 26.218 + 0.0072t + 0.000106t^2 \pm .05 \text{ wt \% NaCl}$$

Reference: Potter, Babcock, and Brown, 1977, A new method for determining the solubility of salts in aqueous solutions at elevated temperatures: Jour. Research U. S. Geol. Survey, V. 5 (3), p. 389-395.

2. If both halite and sylvite are present and the temperatures at which each salt crystal finally disappears is noted, then

wt % NaCl + KCl equivalent

is determined by using the chart in Figure 7 as explained at the bottom of the figure.

Reference: Roedder, 1971, Fluid inclusion studies on the porphyry-type ore deposits at Bingham, Utah, Butte, Montana, and Climax, Colorado: Econ. Geol., V. 66, p. 98-120.

DEPTH INTERVAL	SAMPLE LENGTH	BOX NO.	RUN NO.	PIECE NO.	SAMPLE TYPE	UNIT	DATE TAKEN	DATE RETURNED							PURPOSE TAKEN
2.0-2.3′	0.3′	1	2	1	CORE	LAND-SLIDE	SEPT. 1986								STRATIGRAPHIC, STRUCTURAL, ALT'N. RESEARCH
12.6-12.8′	0.2′	2	4	7A	〃	〃	〃								〃
32.0-32.4′ (¼ CORE)	0.4′	3	9	4	〃	SAND-STONE	〃								〃
46.8-47.0′	0.2′	5	14	2C	〃	〃, TUFF	〃								〃
50′	≈0.1′	5	16	4	〃	TUFF	〃								〃
59.5-59.6′ (½ CORE)	0.1′	6	18	6	〃	BX	〃								〃
69′	≈0.1′	7	20	4	〃	BX	〃								〃
83.2-83.6′ (½)	0.4′	9	25	6	〃	NW TUFF	〃								〃
95.7-96.0′	0.3′	11	27	8B	〃	HYP. BX.	〃								〃
100′	RUB-BLE	12	28	7	〃	DW TUFF	〃								〃
101.5′	〃	12			〃	〃	〃								〃
109.1-109.5′	0.4′	13	30	5	〃	〃	〃								〃
130-130.3′	0.3′		34		〃	〃	〃								〃
138-138.3′	0.3′	17	36	4A	〃	〃	〃								〃
159.8-160.1′	0.3′	20	40	6B	〃	〃	〃								〃
178.0-178.2′	0.2′	25	47	4B	〃	〃	〃								〃
180.0-180.2′	0.2′	26	49	4	〃	BX 〃	〃								〃
208.4-208.7′	0.3′	29	53	7A	〃	〃	〃								〃
213.5′	RUB-BLE	30	54	7	〃	SiO$_2$ 〃	〃								〃
227.2-227.5′	0.3′	31	57	2C	〃	DEBRIS FLOW	〃								〃
239.9-240.3′	0.4′	32	60	3	〃	〃	〃								〃
247.5-247.9′	0.4′	34	62	3A	〃	〃	〃								〃
250.0-250.25′	0.25′	34	62	4A	〃	SS	〃								〃
255.4-255.5′	0.1′	35	63	8B	〃	〃	〃								〃
258.0-258.2′	0.2′	35	64	4B	〃	〃	〃								〃
260.0-260.25′	0.25′	35	64	6B	〃	〃	〃								〃
256.2-256.5′	0.3′	35	64	2A$_1$	〃	〃	〃								〃
1206.0-1206.7′	0.7′	159	260	1A	〃	DW TUFF	〃								〃
261.7-261.8′ (½ CORE)	0.2′					SS	〃								〃
268.0-268.3′	0.3′	36	66	2	〃	DW TUFF	〃								〃
279.0-279.2′	0.2′	38	68	3	〃	〃	〃								〃
286.0-286.4′ (½ CORE)	0.4′	39	69		〃	〃	〃								〃
305.5-305.8′	0.3′	41	75	5	〃	〃	〃								〃
314.3-314.6′	0.3′	42	75	3C	〃	〃	〃								〃
333.0-333.3′	0.3′	44	79	5	〃	〃 BX	〃								〃
345.0-345.3′	0.3′	46	81		〃	DW TUFF	〃								〃
362.7-363.1′	0.4′	48	85	3	〃	〃	〃								〃
368.0-368.3′	0.3′	49	86	4	〃	〃	〃								〃

VC-2A SAMPLES TAKEN FOR RESEARCH BY J. HULEN

UURI/ESL
391-C CHIPETA WAY
S.L.C., UTAH 84108

DEPTH INTERVAL	SAMPLE LENGTH	BOX NO.	RUN NO.	PIECE NO.	SAMPLE TYPE	UNIT	DATE TAKEN	DATE RETURNED								PURPOSE TAKEN
373.6 - 374.0'	0.4'	50	87	5B	CORE	TSHIR. DWTF	SEPT. 1986									STRATIGRAPHIC, STRUCTURAL, ALTN. RESEARCH
387.6 - 387.9'	0.3'	51	90	3	"	"	"									"
403.3 - 403.65'	0.35'	53	94	2	"	"	"									"
413.6 - 414.0'	0.4'	55	96	7B	"	"	"									"
434.8 - 435.0'	0.2'	58	100	12	"	"	"									"
440 - 440.4 (1/2 CORE)	0.4'	59	102		"	GOUGE BX	"									"
458.1 - 458.4'	0.3'	61	105	5A	"	TSHIR. DWTF	"									"
468.5 - 468.85'	0.35'	63	107	8A	"	"	"									"
491.5 - 491.80' (1/2 CR)	0.3'	66	113	3	"	"	"									"
501.5 - 501.9'	RUB-BLE	67	NEAR 115	3	"	"	"									"
514.0 - 514.2 (1/2)	0.2	69	117	5	"	"	"									"
519.8'	RUB-BLE	69	118		"	"	"									"
534.9'	"	71	120		"	"	"									"
546.2 - 546.4'		73	123	11	"	"	"									"
553.4 - 553.6'	RUB-BLE	74	NEAR 125	5	"	"	"									"
562.2 - 562.7'	RUB-BLE	75	127	3	"	"	"									"
582.3 - 582.6'	0.3'	78	131	3	"	"	"									"
602.3 - 602.6'	0.3'	80	135	2	"	"	"									"
612.0 - 612.5 (1/2 CORE)	0.3'	81	137	4A	"	"	"									"
621.0 - 621.5 (1/2 CORE)	0.5'	83	139	1A	"	"	"									"
636.8 - 637.0	RUB-BLE	85	142		"	"	"									"
645 - 645.2'	0.2'	86	145	RUB-BLE	"	"	"									"
651.3 - 651.6'	0.3'	87	146	3	"	"	"									"
674 - 674.3'	0.3'		150	RUB-BLE	"	"	"									"
687.6'	~0.1'	92	153	"	"	"	"									"
697.6'	~0.1'	93	155	"	"	"	"									"
701.5 - 701.7'	0.2'	94	156	2	"	MW"	"									"
718.0 - 718.2'	0.2'	96	159	2A	"	"	"									"
728.9 - 729.4' (1/2 CORE)	0.5'	98	161	3	"	"	"									"
740.5' (1/2 CORE)	0.1'		163		"	"	"									"
760.7 - 761'	0.3'		167	4	"	"	"									"
790.8 - 791'	0.2'		173		"	"	"									"
808.9 - 809.1'	0.2'		177	3A	"	"	"									"
822.5 - 822.75'	0.25'		180	1C	"	"	"									"
839.6 - 839.9'	0.30		183	5	"	"	"									"
859.0 - 859.3'	0.3'		187	2C	"	"	"									"
888 - 888.3'	0.3'		193	1C	"	"	"									"
908.3 - 908.7' (1/4)	0.4'		197	3A	"	"	"									"

NC-2A SAMPLES TAKEN FOR RESEARCH BY J. HULEN
UURI/ESL
391-C CHIPETA WAY
S.L.C., UTAH 84108

DEPTH INTERVAL	SAMPLE LENGTH	BOX NUMBER	RUN NUMBER	PIECE NUMBER	SAMPLE TYPE	UNIT	DATE TAKEN	DATE RETURNED							PURPOSE TAKEN
916'	RUB-BLE		199		CORE	TSHIR. DWT	11/03/86								STRATIGRAPHIC, STRUCTURAL, ALTN. RESEARCH
926'	"		200		"	"	"								"
937'	"		203		"	"	"								"
946'	"		204		"	"	"								"
966.6'	0.1'		209	3	"	"	"								"
976.3-976.5'	0.2'		211	2C	"	"	"								"
1006'	RUB-BLE				"	"	"								"
1020	"		220	1B	"	"	"								"
1033.5'	"		226	6A	"	"	"								"
1044.5'	"		225	2C	"	"	"								"
1070.0'	0.1'		229	7A	"	"	"								"
1077.6'	RUB-BLE				"	"	"								"
1095-1095.4' (1/2 CORE)	0.4'		235	4	"	"	"								"
1109.7-1110.1	0.4' RUB.				"	"	"								"
1117'	RUB-BLE				"	"	"								"
1128.2'	"				"	"	"								"
1137.0'	"		245	1C	"	"	"								"
1149.0'	"		247	11	"	"	"								"
1212.2'	"				"	OTOWI DWT	"								"
1214.0'	"		261	$2B_3$	"	"	"								"
1234.5-34.7'	0.2'		265	$2A_2$	"	BX	"								"
1254-1254.2'	RUB-BLE		269	4B	"	MW AFT	11/04/86								"
1269.5'	"		272	3		"	"								"
1275-1275.2'	0.2'		273	7B	"	"	"								"
1283.6-1283.8'	0.2'		275	$2A_3$	"	"	"								"
1295.4 1295.6'	0.2'		277	5A	"	"	"								"
1304.5-1304.9'	0.4'				"	"	"								"
1313.5-1313.8'	0.3'				"	"	"								"
1320.6-1320.7'	0.1'		282	2A	"	"	"								"
1330.8-1331.0'	0.2'		284	9B	"	"	"								"
1340.3-1340.5'	0.2'		286	6	"	"	"								"
1349.7-1349.9'	0.2'		288	4A	"	"	"								"
1364.0-1364.2'	0.2'		291	4A	"	"	"								"
1375.8-1375.9'	0.1'		293	4A	"	"	"								"
1383.7-1383.8'	0.1'		295	2B	"	"	"								"
1404-1404.4'	0.4'		299	6A	"	LAG BX	"								"
1420.7-1421.0'	0.3'		302	3	"	"	"								"
1430.7-1430.8'	0.1		304	3A	"	"	"								"

VC-2A SAMPLES TAKEN FOR RESEARCH BY

J. HULEN
LIURI/ESL
391-C CHIPETA WAY
S.L.C, UTAH 84108

DEPTH INTERVAL	SAMPLE LENGTH	BOX NUMBER	RUN NUMBER	PIECE NUMBER	SAMPLE TYPE	UNIT	DATE TAKEN	DATE RETURNED								PURPOSE TAKEN
1439.7 - 1440'	0.3'		306	1E	CORE	OT. AFT ff	11/04/86									STRUCTURAL, STRATIGRAPHIC, ALTN. RESCH.
1445.6 - 1446'	0.4'		307	3D	"	"	"									"
1450.7 - 1451'	0.3'		308	3	"	"	"									"
1448.3 - 1448.6'	0.3'		308	$1b_3$	"	"	"									"
1460.8 - 1461'	0.2'		310	$2e_2$	"	"	"									"
1470.3 - 1470.6'	0.3'		312	3D	"	"	"									"
1484.4 - 1484.6'	0.2'		317	D_1	"	"	"									"
1500.7 - 1501.0'	0.3'		320	C_2	"	"	"									"
1510.8 - 1511.0'	0.2'		322	C_3	"	"	"									"
1520.7 - 1521.0'	0.3'		324	J_2	"	"	"									"
1550.7 - 1551.0'	0.3'		330	15	"	"	"									"
1529.0 - 1529.4'	0.4'		326	G	"	"	"									"
1540.6 - 1541.0'	0.4'		328	L	"	"	11/06									"
1565.6 - 1566.0'	0.4'		333	M	"	"	"									"
1568'	RUB-BLE		334	E	"	"	"									"
1571.3 - 1571.5'	0.2'		335	A_2	"	"	"									"
1585.3 - 1585.6'	0.3'		337	K	"	CAL VEIN	"									"
1596.5 - 1596.7'	0.2'				"	CHL ROCK	"									"
1596 - 1596.3'	0.3'					FLT BX	"									"
1601 - 1601.3' (1/2)	0.3'		341	A_1		MW AFT	"									"
1610.9 - 1611'	0.1'		342	H_2		"	"									"
1617'	RUB-BLE					"	"									"
1622.7 - 1622.9'	0.2'		345	3B		"	"									"
1629.0 - 1629.3'	0.3'		346	2B		"	"									"
1630.8 - 1631.0'	0.2'		346	4B		"	"									"
1635.2 - 1635.6'	0.4'		347	5		"	"									"
1634.8 - 1635.2	0.6'		347	4C		"	"									"
1641.4 - 1641.7'	0.3'		349	2A		PW AFT	"									"
1650.7 - 1651.0'	0.3'		350	3B		"	"									"
1660.7 - 1661.0'	0.3'		352	$4B_2$		"	"									"
1670.7 - 1671.0'	0.3'		354	3B		"	"									"
1680.7 - 1681.0'	0.3'		356	3C		"	"									"
1700.8 - 1701.0'	0.2'		360	4B		"	"									"
1710.8 - 1711.0'	0.2'		362	5B		"	"									"
1721.0 - 1721.3'	0.3'		365	A_1		"	"									"
1730.8 - 1731.0'	0.2'		366	F_3		"	"									"