GL04703

-16.5

26

27 HIGH SALINITY

n = 27

21.5 ± ~~1.97~~ 2.0% wt. %

15 Range

	SALINITY	21.54 ± 1.97	15.14 – 24.77 eq. wt.% NaCl
Tm	FP Depr.	−18.5 ± 2.6°C	−11.1 to −23.1°C
	Th	219.8 ± 18.0°C	189.4 – 261.8°C

GEO

n = 31 ALL LOW SALINITY

Tm =	0.9 ± 0.5°C	−0.1 to −1.8°C
SALINITY =	1.60 ± 0.77%	0.18 – 2.97%
Th =	258.8°C ± 20°C	229.8 – 323.8

n=6 PRIMARY LOW SALINITY

Tm =	1.40 ± 0.9% wt.%	0.18 – 2.56 wt%
SALINITY	0.8 ± 0.5°C	−0.1 to −1.5°C
Th =	270.9°C ± 11.6°C	248.5 – 279.6°C

GRAIN A

	LARGE			ALL		
180–190°C	2	(3.2)	(3.2)	4	3.5	(3.5)
190–200°C	4	(6.4)	(9.6)	4	3.5	(7.0)
200–210°C	4	(6.4)	(16.0)	5	4.3	(11.3)
210–220°C	5	(8.1)	(24.1)	8	7.0	(18.4)
220–230°C	7	(11.3)	(35.4)	11	9.5	(28)
230–240°C	13	(21.0)	(56.4)	17	14.8	(42.8)
240–250°C	6	(9.7)	(66.1)	16	13.8	(56.6)
250–260°C	7	(11.3)	(77.4)	16	13.8	(70.4)
260–270°C	5	(8.1)	(85.5)	11	9.5	(80.0)
270–280°C	7	(11.3)	(96.8)	12	10.5	(90.5)
280–290	1	(1.6)	(98.4)	6	5.2	(95.7)
290–300	0	—	—	3	2.6	(98.3)
300–310	0	—	—	0	—	(98.3)
310–320	0	—	—		—	(98.3)
320–330	1	(1.6)	(100)	2	1.7	(100)
	62			116		

97.8
2.1

97.7
1.7
99.4

97.8
2.2

9

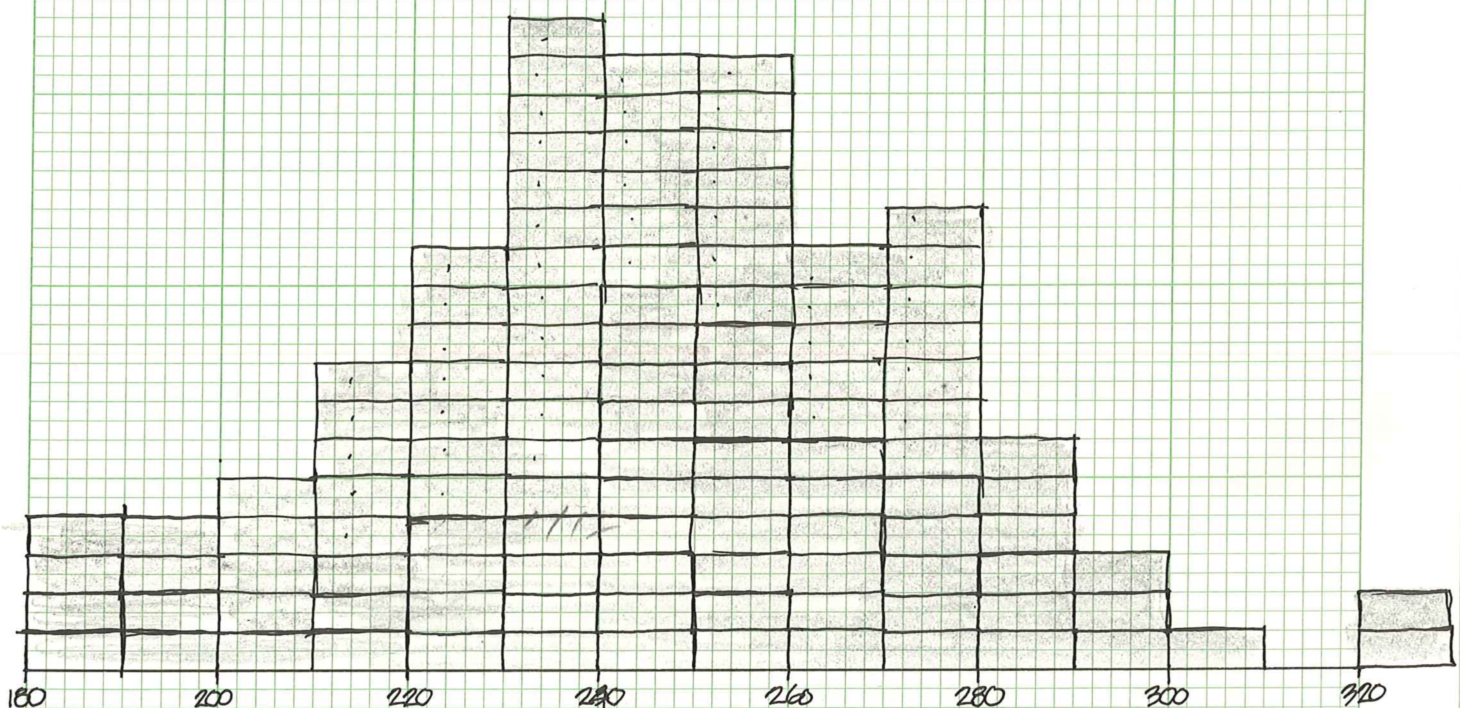
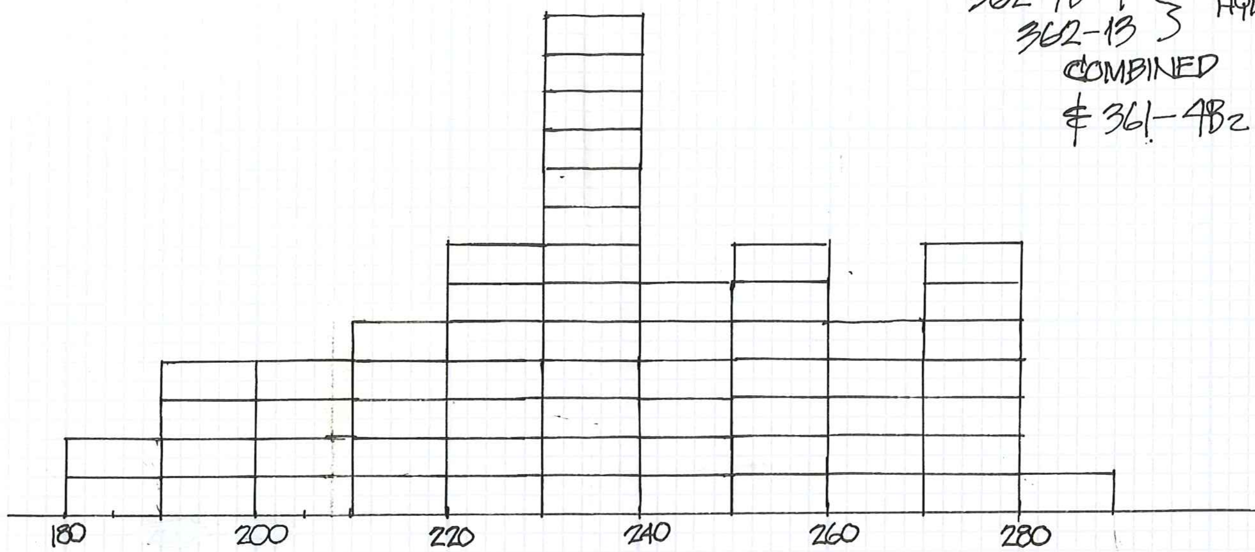
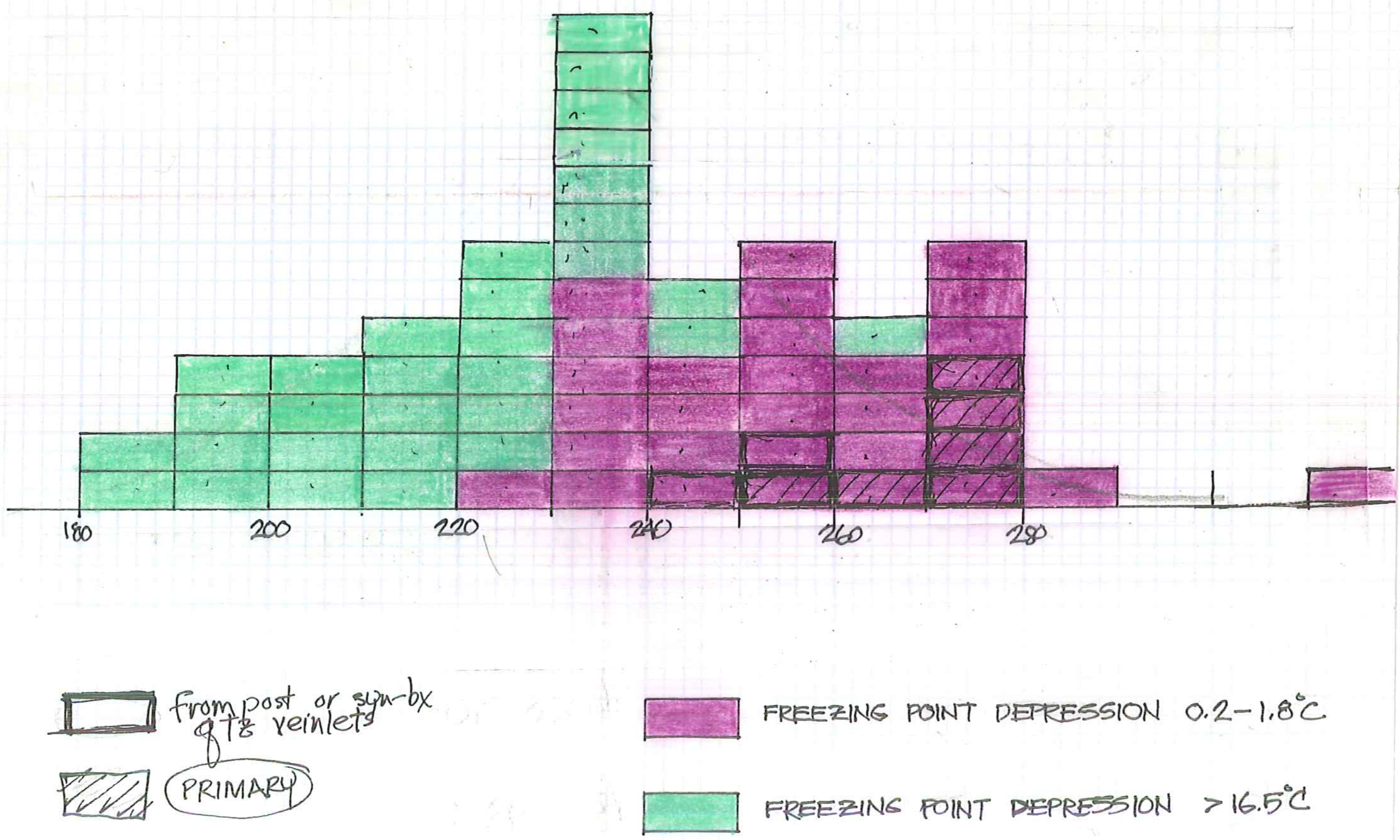

180
200
220
240
260
280
300
320

FIGURE .

362-7B & } MoS2-BEARING HYDROTH. BX.
362-13 }
COMBINED
& 361-4B2 (GRNT)





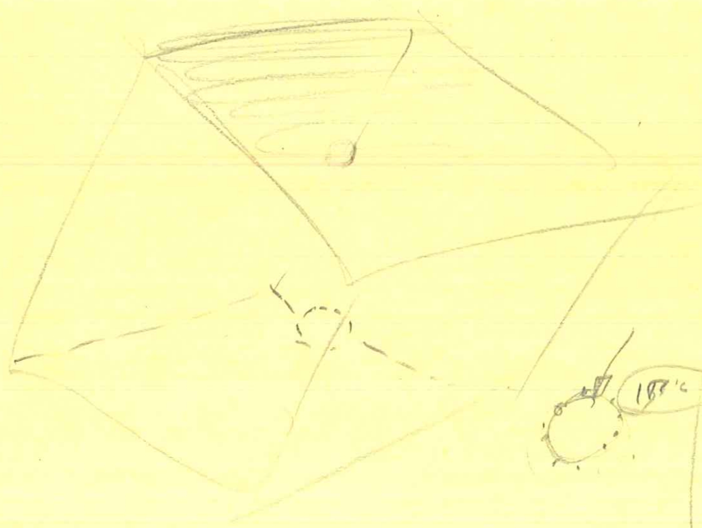
−11.1°C	261.8°C	← Together (not included) →	−1.3°C	323.8°C

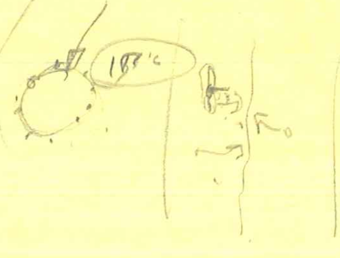
361-4b2 (2nd pc.)

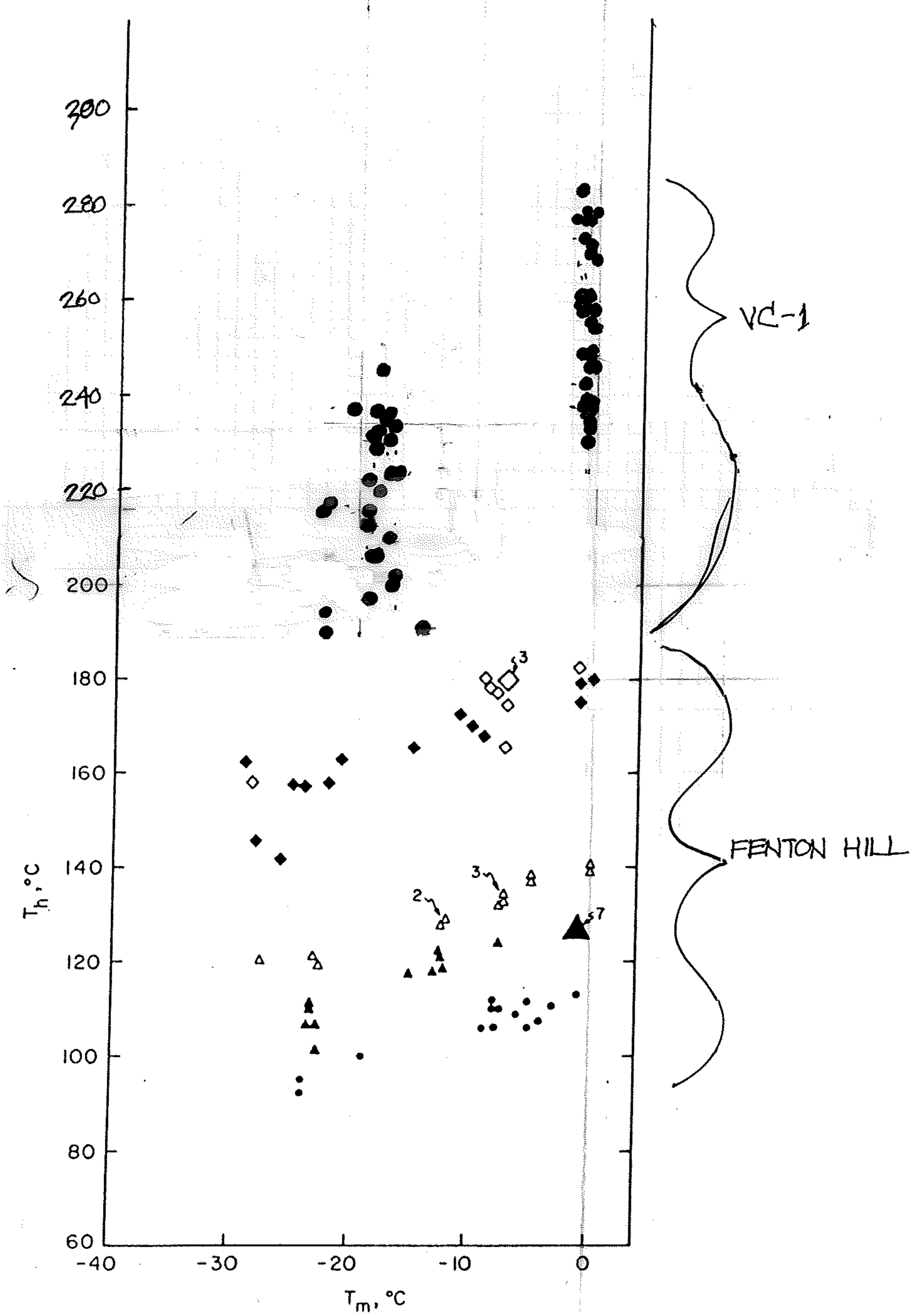
−18.3°C	245.7°C
−17.8°C	234.5°C
−17.7°C	233.2°C
−19.3°C	221.3°C
−17.5°C	209.5°C
−17.4°C	223.2°C
−14.6°C	190.7°C
~~−11.1°~~	
−19.2°C	215.8°C
−18.7°C	206.8°C
n=9 −17.8 ± 1.4°C	220.1 ± 16.6°C

−0.8°C	276.9°C ✓
−0.6°C	233.1°C ✓
−0.6°C	245.6°C ✓
−0.5°C	243.6°C ✓
−0.6°C	249.7°C ✓
−0.5°C	254.5°C ✓
−0.6°C	239.6°C ✓
−0.9°C	272.2°C ✓
−0.6 ± 0.1°C	251.9° ± 15.4°C

2765.3 − 2765.6′

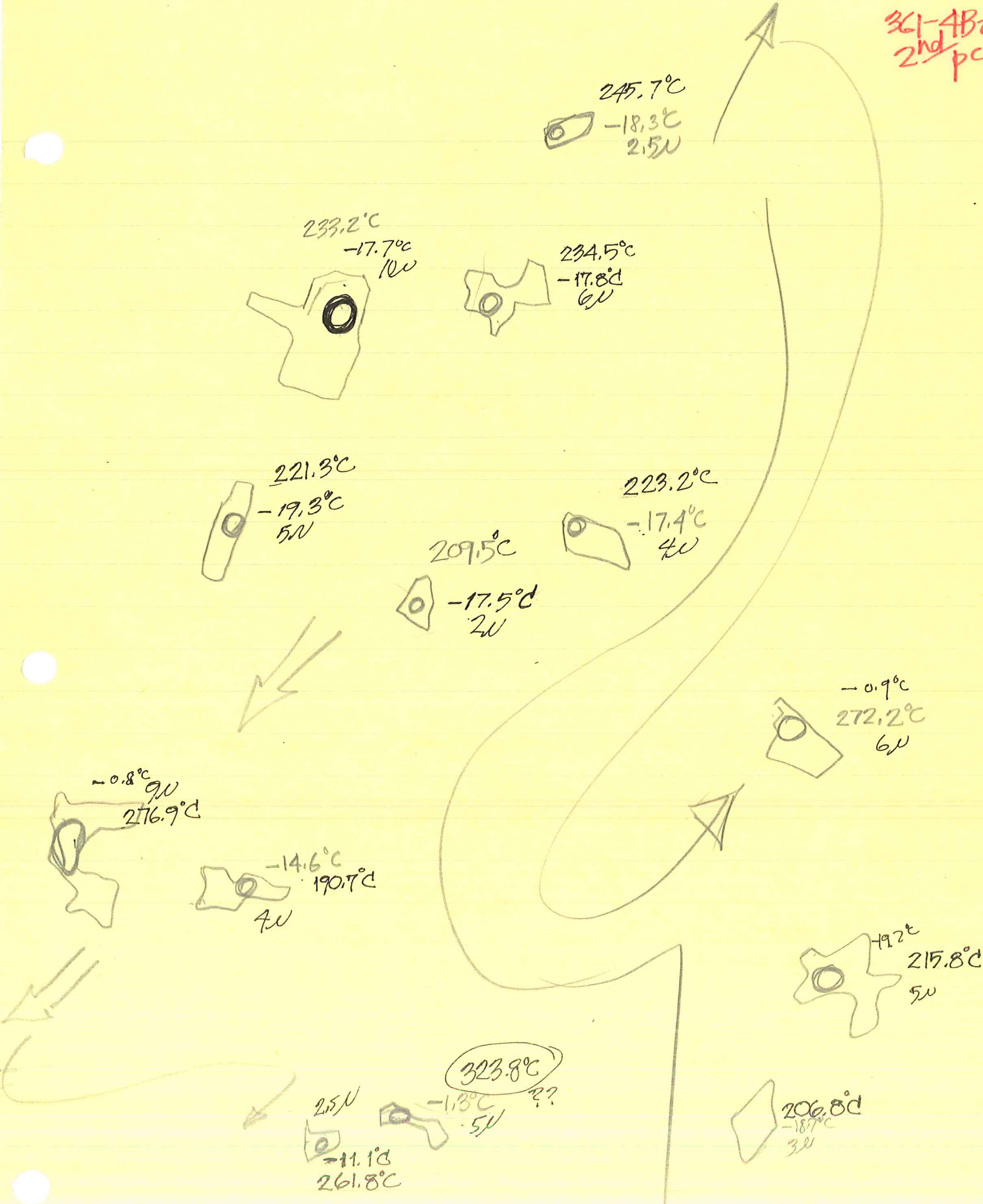




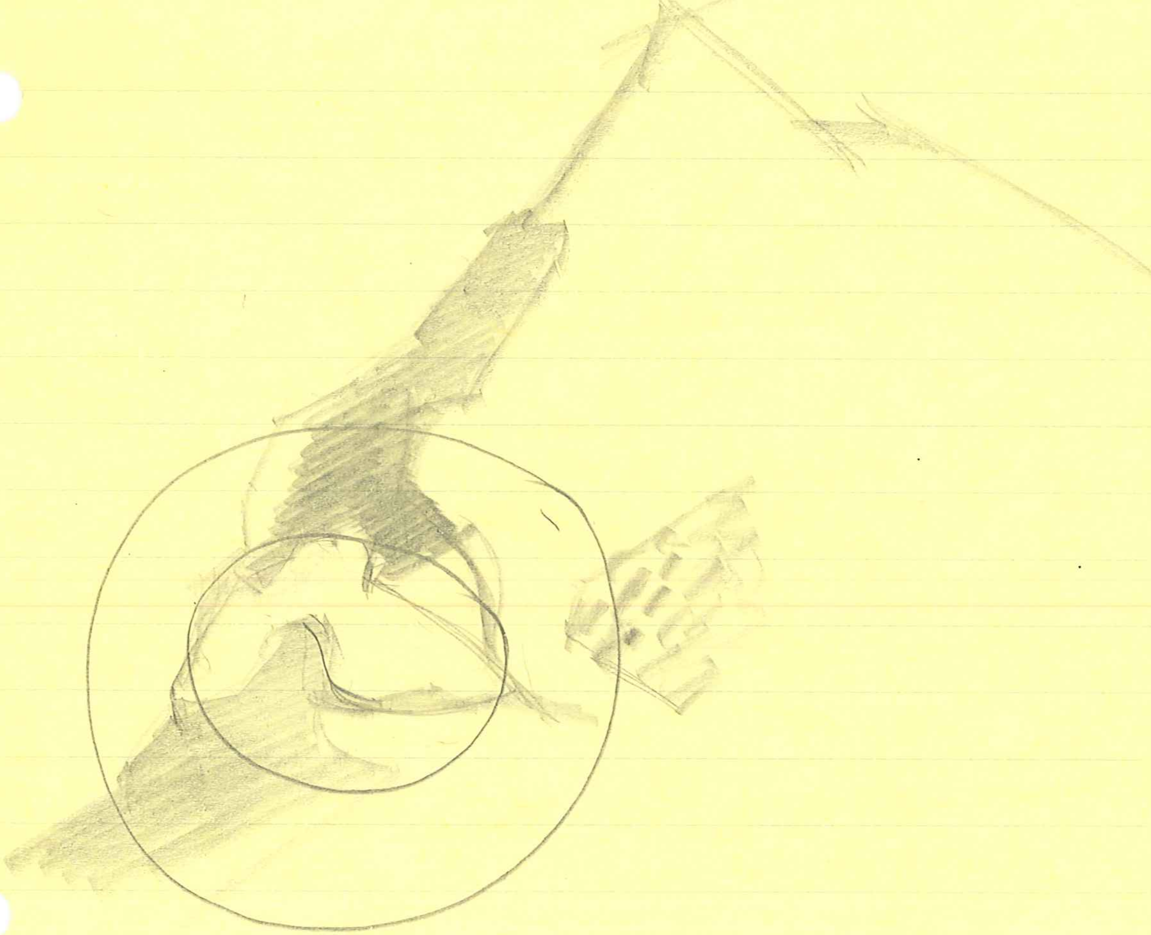


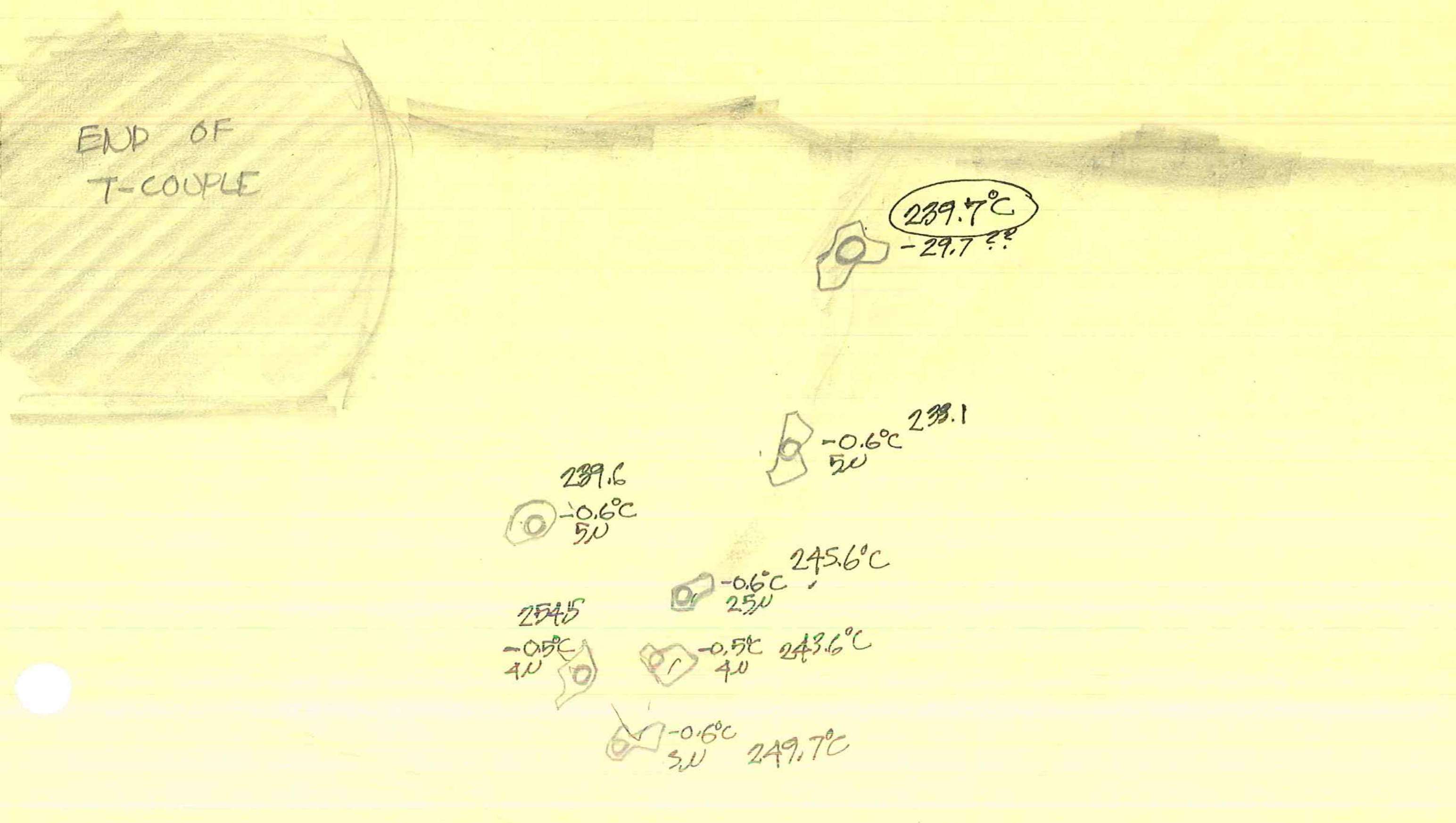
300
280
260
240
220
200
180
160
140
120
100
80
60
T_h, °C
-40
-30
-20
-10
0
T_m, °C
VC-1
FENTON HILL

361-4Bz
2nd pc.



361-4B2
2nd piece



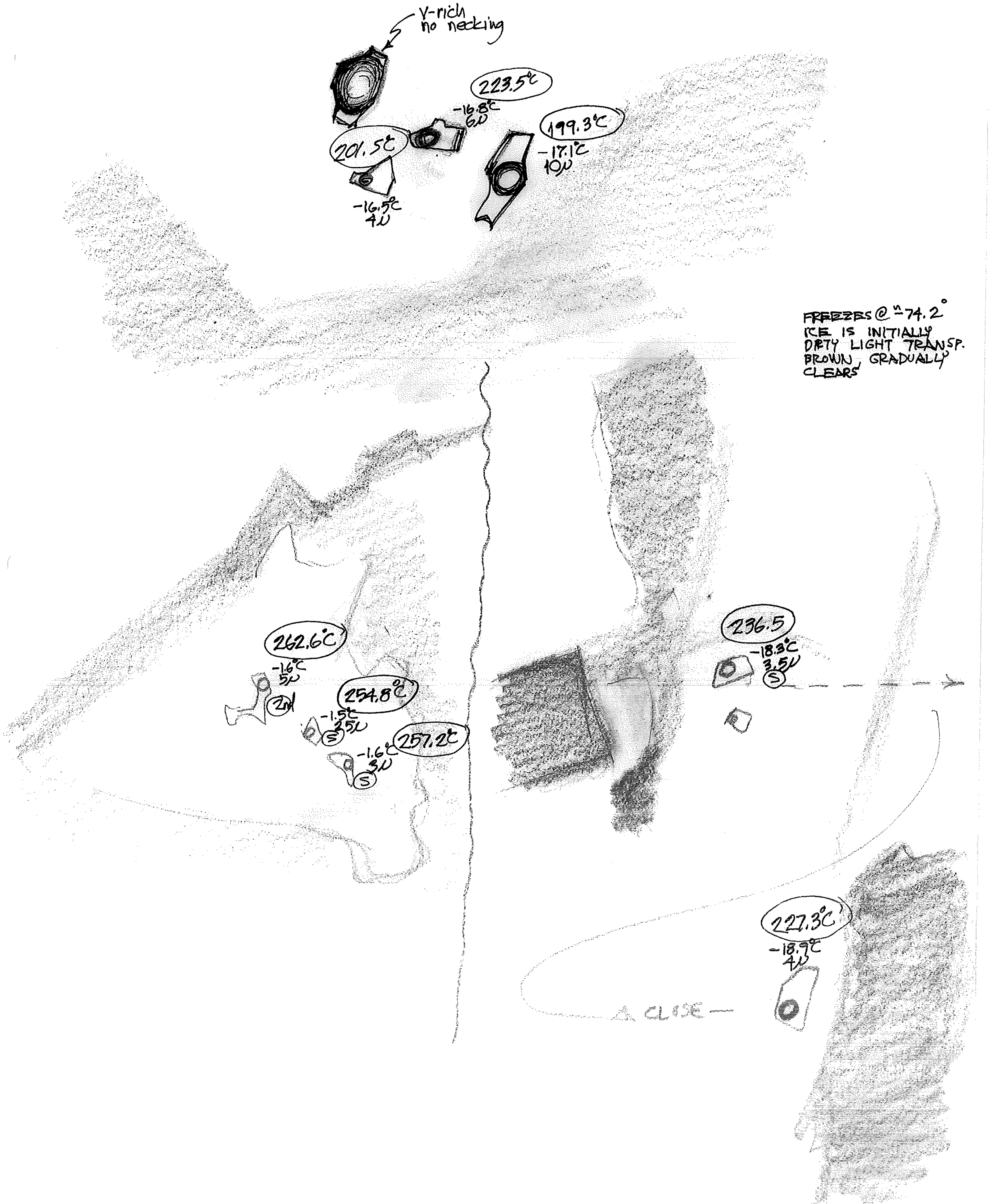


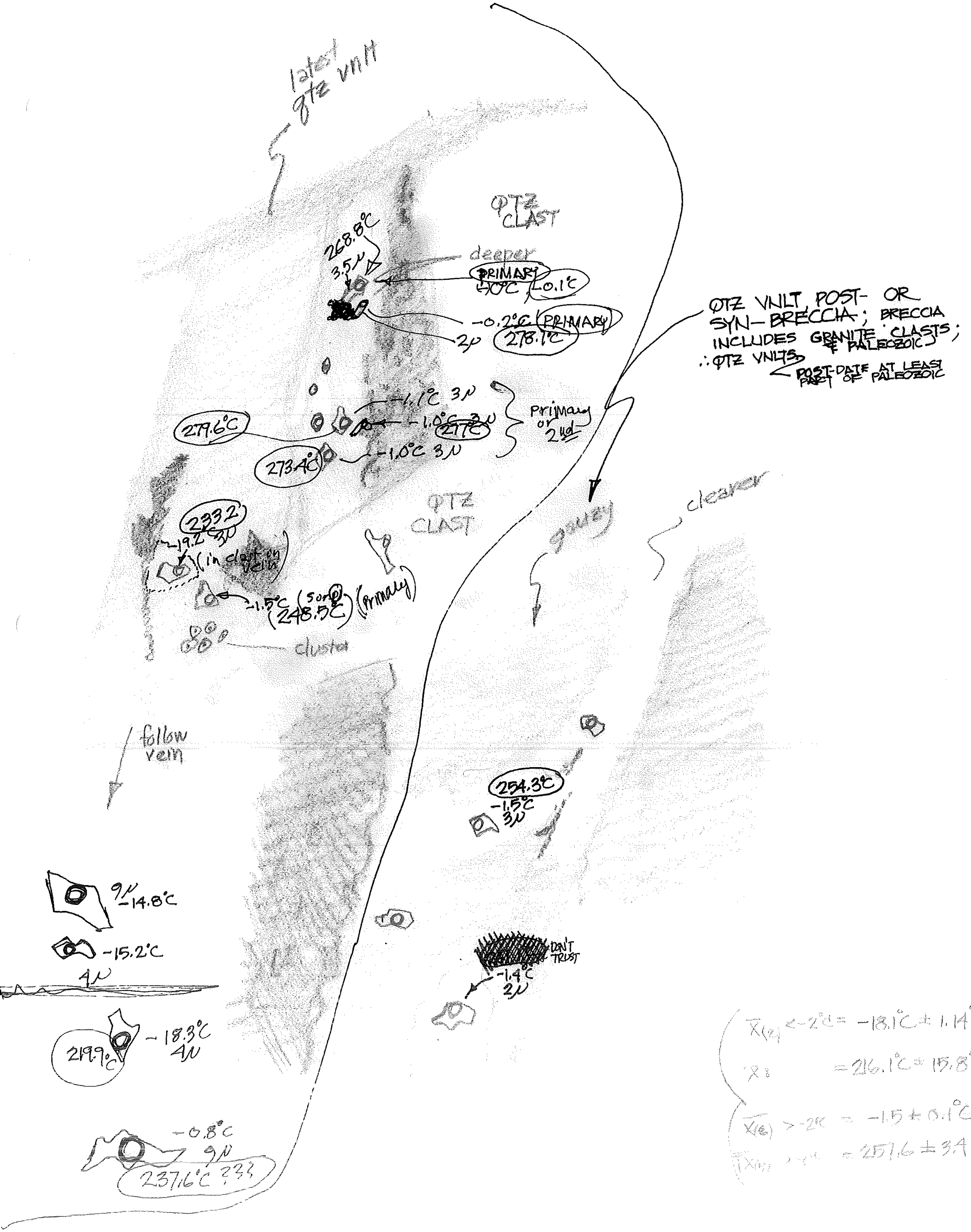
362 – 13
HYDROTHERMAL
BRECCIA

−0.2°C	278.1°C	3μ	P
−0.1°C	268.8°C	3.5μ	P
−1.1°C	279.6°C	3μ	P?
−1.0°C	277.0°C	3μ	P?
−1.0°C	273.4°C	3μ	P?
−1.5°C	248.5°C	3μ	P or S
−0.8°C	237.6°C	9μ	S
−1.5°C	259.3°C	4μ	P
−1.6°C	262.6°C	5μ	S
−1.5°C	254.8°C	2.5μ	S
−1.6°C	257.2°C	3μ	S
−1.1 ± 0.5°C	263.4 ± 13.5°C		

−18.9°C	227.3°C	4μ	S
−18.3°C	236.5°C	3.5μ	S
−17.1°C	199.3°C	10μ	P or S
−16.8°C	223.5°C	6μ	S
−16.5°C	201.5°C	4μ	S
−19.2°C	196.8°C	7μ	P?
−19.0°C	232.3°C	6μ	S
−19.2°C	211.3°C	4μ	P or S
−18.3°C	219.9°C	4μ	S
−19.2°C	233.2°C	3μ	S
−18.3 ± 1.1°C	218.2 ± 15.0°C		

200


V-rich
no necking
223.5°C
-16.8°C
6µ
199.3°C
-17.1°C
10µ
201.5°C
-16.5°C
4µ
FREEZES @ ~-74.2°
ICE IS INITIALLY
DRTY LIGHT TRANSP.
BROWN, GRADUALLY
CLEARS
262.6°C
-1.6°C
5µ
2nd
254.8°C
-1.5°C
2.5µ
S
257.2°C
-1.6°C
3µ
S
236.5
-18.3°C
3.5µ
S
227.3°C
-18.9°C
4µ
∆ CLOSE

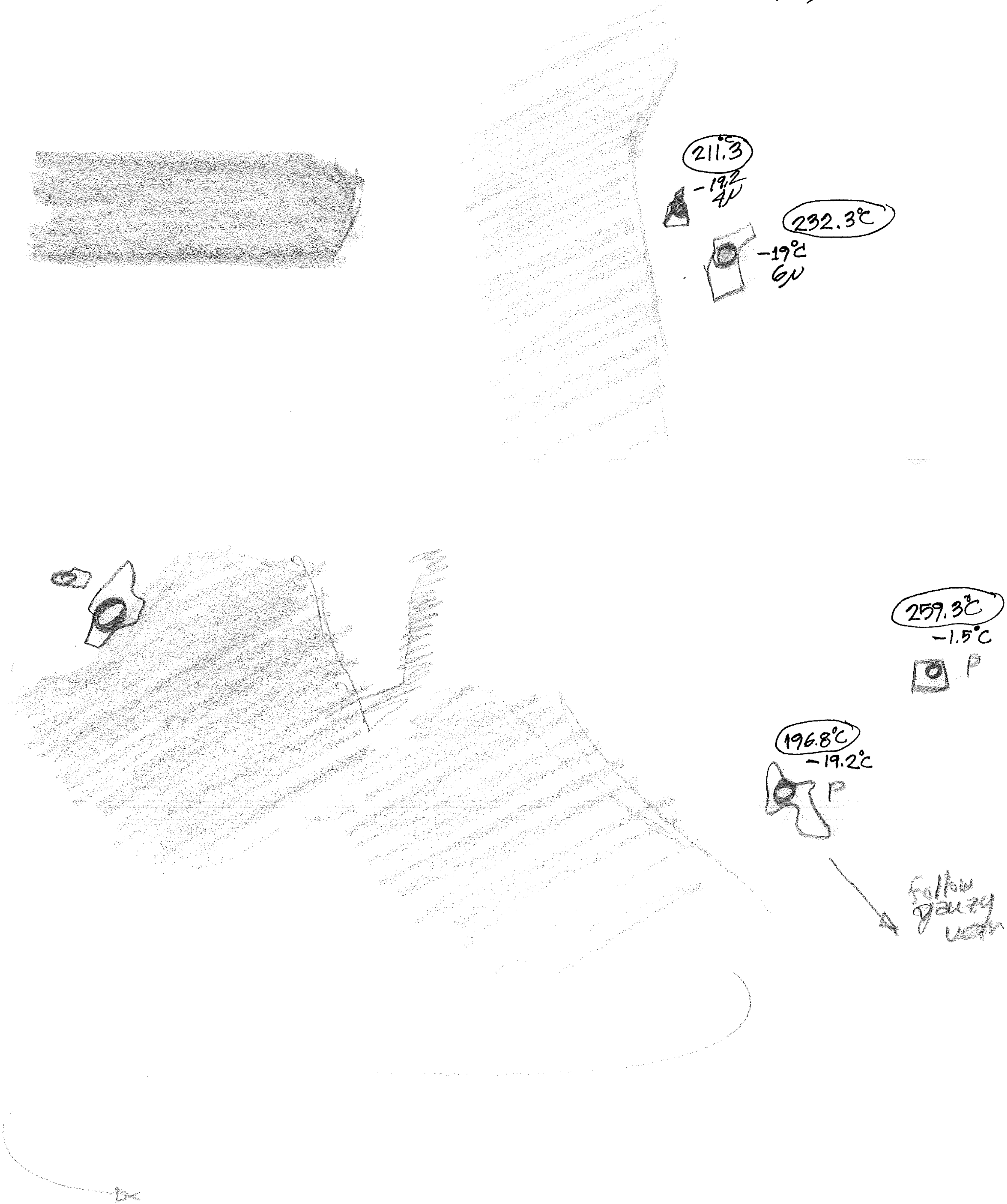


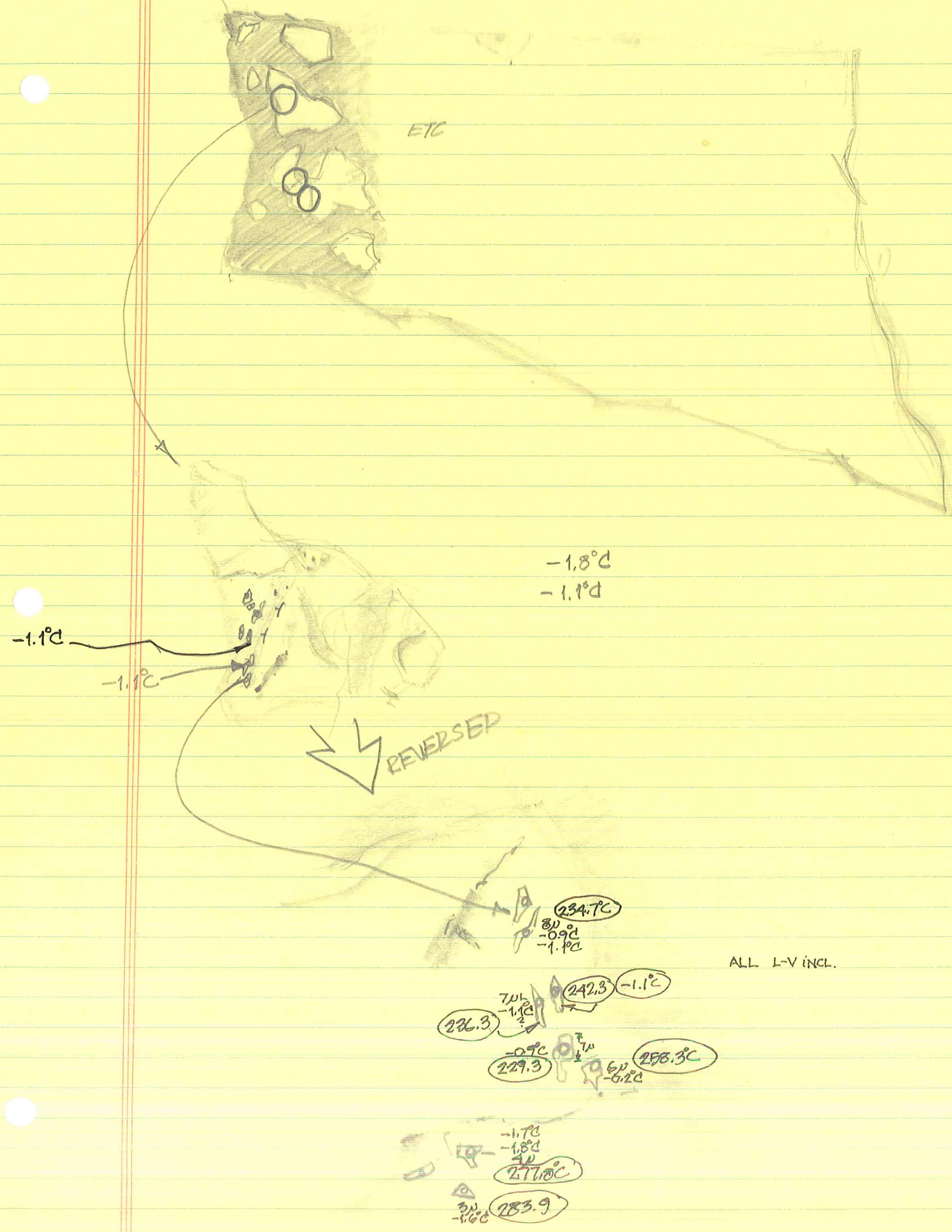
$\overline{X}_{(2)} < -2°C = -18.1°C \pm 1.14°C$

$\overline{X}_{3} = 216.1°C \pm 15.8°C$

$\overline{X}_{(6)} > -2°C = -1.5 \pm 0.1°C$

$\overline{X}_{(6)} > -2°C = 257.6 \pm 3.4°C$

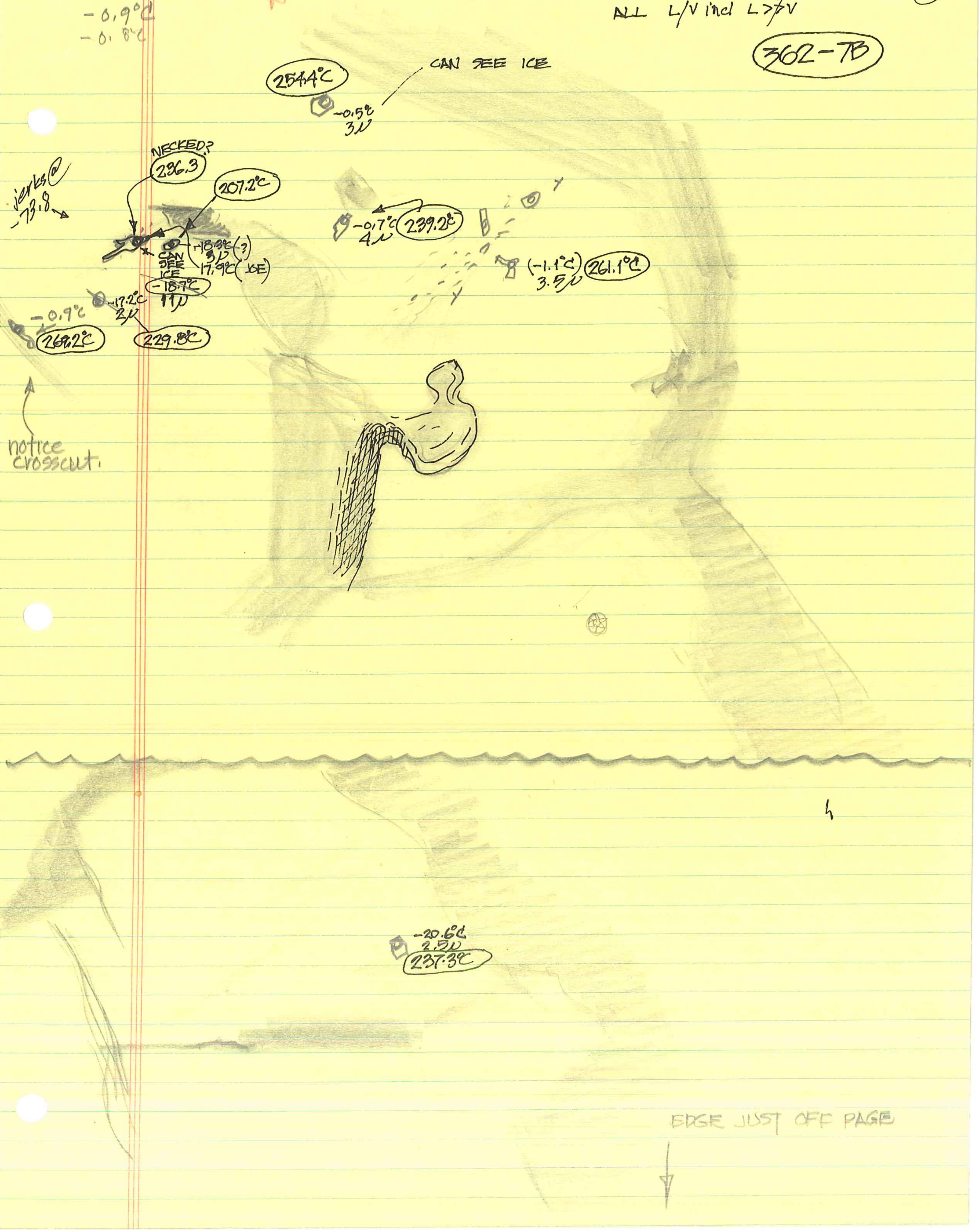

211.3°C
-19.2
4N
232.3°C
-19°C
6N
259.3°C
-1.5°C
P
196.8°C
-19.2°C
P
follow quartz vein


ETC
-1.8°C
-1.1°C
-1.1°C
-1.1°C
REVERSED
234.7°C
8μ
-0.9°C
-1.1°C
ALL L-V INCL.
242.3
-1.1°C
7μL
-1.1°C
226.3
-0.9°C
229.3
7μ
258.3°C
6μ
-0.2°C
-1.7°C
-1.8°C
4μ
277.0°C
3μ
-1.6°C
283.9

362-7B

ALL L/V incl L>>V

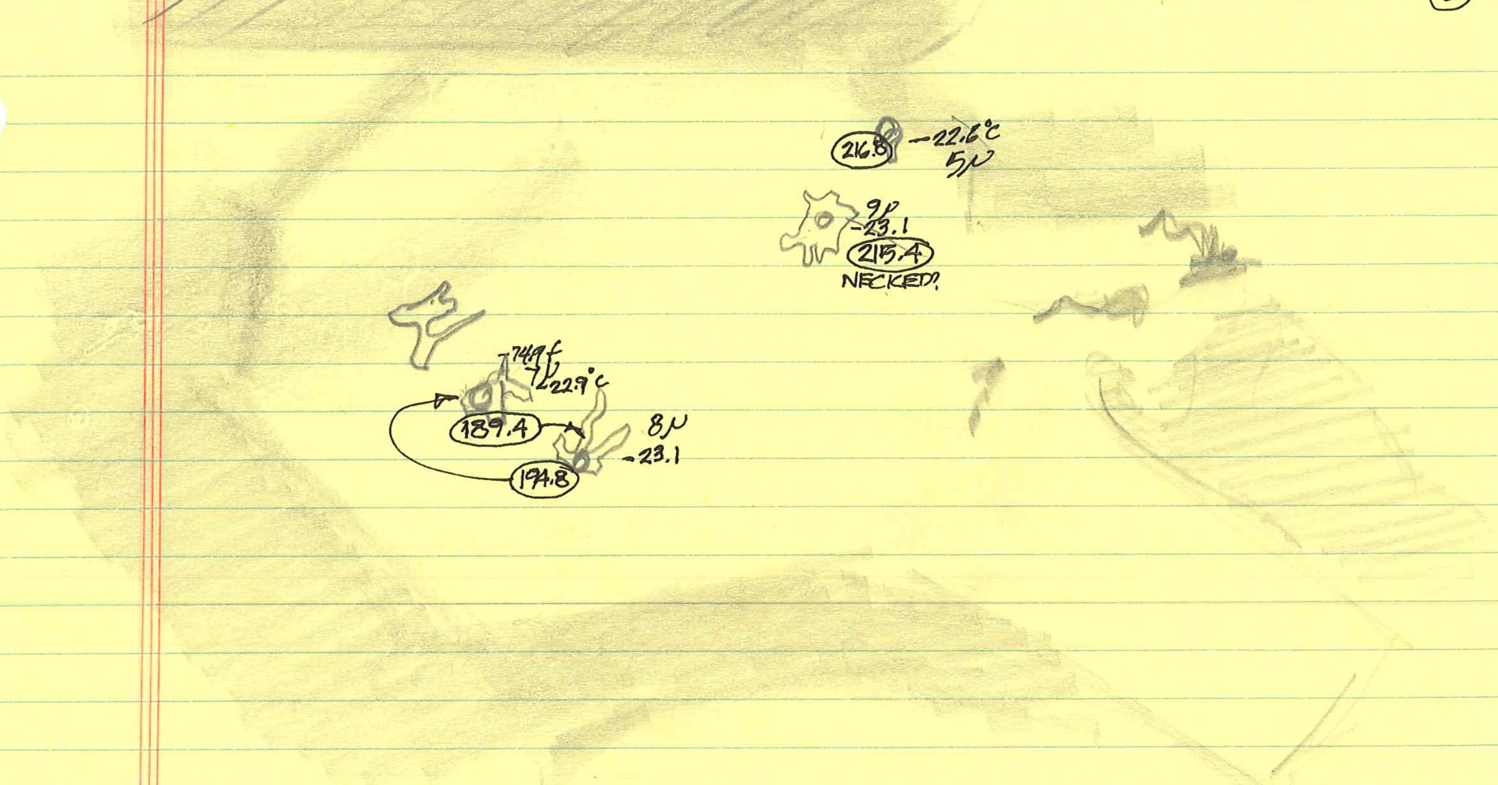
-45°c



362-7B

(3)

THERMOCOUPLE



$\overline{8} = -20.8 \pm 2.5°C$	$\overline{8} = 215.9°C \pm 18.1°C$ (AVGS. FOR ~~SALINITY > 1.8%~~ FPP > 1.8)
$\overline{11} = -1.0 \pm 0.4°C$	$\overline{11} = 253.3 \pm 18.5°C$ (AVGS. FOR ~~SALINITY < 1.8%~~ FPP < 1.8)

MADERA

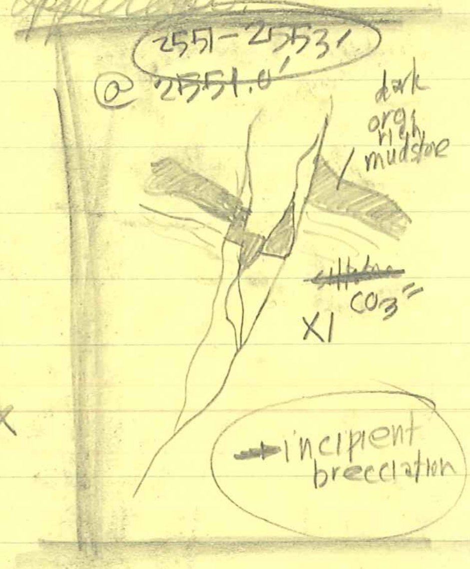
VC-1

11/04/85
OBES CSDP Repository ✓✓

2494 –

Shaley mudstone

2496.8 – 2497.6 – very brecciated appearing but overall aspect of bedding is apparent.



is this tectonic mixing or "rip-up"

→ would actually call this an interval of interbedded silty to **sandy** shale/and mudstone with scattered beds of shaly siltstone and sandstone lt-med. gray to greenish-gray, locally dark grey probable organic content

in widely scattered thin beds (< 1.5') there are breccias which appear to be intraformational "rip-up" type breccias — clasts of more resistant rock in shaly matrix — mostly, though, the unit is very recognizably sedimentary in origin

* 2557 – 2558.3 – fault bx zone w/nodular pyrite as exemplified by sample 339-1

* 2531.7 – 2533.7' – fault breccia

VC-1 cont (smpl 2537' – 2558' – highly fractured shale, org-rich, above fault) 11/4/85

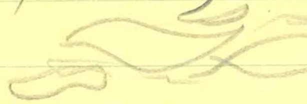
2561.3 – 2565.3' beautiful example of stressed (compressed) silty mudstone with ser? - chl.? - cal? veinlets and bleaching highlighting a braided compressional fracture network (see sample 339–17b)

2571.7 – 2577.3 – Highly disrupted organic-rich v. dk. gray shale

2577.3 – 2580' — high disrupted & contorted dark org-rich & org-poor lt. gray shale

2580 – 2582' — mixed zone - mostly contorted shaly brecccia with widely scattered limestone clasts sub∠ to subrnd.

2582 – 2593' — LS. v. lt. gray breccia contorted bedding? or cataclastic folialiation — clasts subrnded, generally elongate, commonly sub-lenticular, up to at lst 2" length 1" wide few calcite veins.



2593 – 2597.3' → as above, but matrix dark (muddy?, org?)

2597.3 – 2598.4 → ls. bx more equant clasts, avg < 1" up to at lst 3" dia., highly fossiliferous sub∠ – ∠ – subrnd

– 98.4 → — 99.7 → shaly(?) well laminated limestone fossiliferous dark

– 99.7 – 2600.5' → ls. bx. as 2582-2593' v. irregular clasts many re-entrants, dia up to 2½"

2600.5 – 2603' → same as 2598.4 – 99.7'

2603' — 2611.6' dense v lt. gray micrite

2611.6 – 2612.2' – bx as above, but smaller clasts

2612.2 – 2613.6 – micrite

2613.6 – 2616.0' → bx

16.0 – 2619.7 → mixed micrite & bx

2619.7 – 2622.2' – dark shale (black shale)

smpl 2622.2 – 2624.2 – probable fault zone w/abundant sulfide highly disrupted shale

5

2624.2 - 2627.3' — light gray ~~rubblized~~ shale highly fractured

2627.3 - 2628.3 — ls., bxtd some py

2628.3 - 2629.8' bx — calcareous shale matrix & micrite clasts up to at least 4" dia subrnd, commonly elongate, lensoidal diss. & unlt. pyrite present locally fossiliferous

2629.8 - 2636.4 - mixed bx and micrite as above minor diss. pyrite

---

2636.4 - 2639 Probable fault zone: highly fractured calcareous light gray-green shale

→ 2639 - 2641 — BRECCIA (pc 347-8)

2641 - 2642 BRECCIA — calc. lt. gray-green shale w/clasts of med. xln. ls. breccia

→ 2642 - 2642.1' vuggy chl-qtz-ser rock with some hollowed fossils ~~in~~ & other vugs lined w/ qtz. crystals

→ 2642.1 - 2648' — BRECCIA white, irregular ls. clasts up to at least 3" dia or length (see 2646.6 - 2647' sample) some w/discontinuous green reaction rims in matrix of red shaly siltstone — ~~see~~ contorted foliation

2648 - 2650 as above except gray-green shaly matrix

2650 - 2655' highly contorted & fractured laminated lt. gray green and med. gray shale

2655 -

OLC

349-8

~2666 variably calcareous matrix

2655' - COARSE SS., LOCALLY CONGLOMERATIC white to v lt greenish-gray ~~tee~~ bleached-appearing

local * dissem. pyrite commonly appears

(349-24) ⟹ 2658.8' - 13 mm qtz-py vein

~2666-2671 - brxtd. equivalent of above w/ qtz x/s (350-13)

(2671-2679') Shale-carbonate breccia ; >85% $CO_3^=$ similar to breccias above - clasts up to at least 3" dia sub4 - subrounded - bands of CO_3 up to 6" wide which could be clasts. (351-14)

2679 - 2680.2 2683 - fault bx - much hematite

2680.2 - ~~lt.~~ greenish-gray quartz ss. mod. fractured altered (2683) few $CO_3^=$ clasts to ~~at~~ 2680.5'

2683 - 2683.5' - fault gouge & bx.

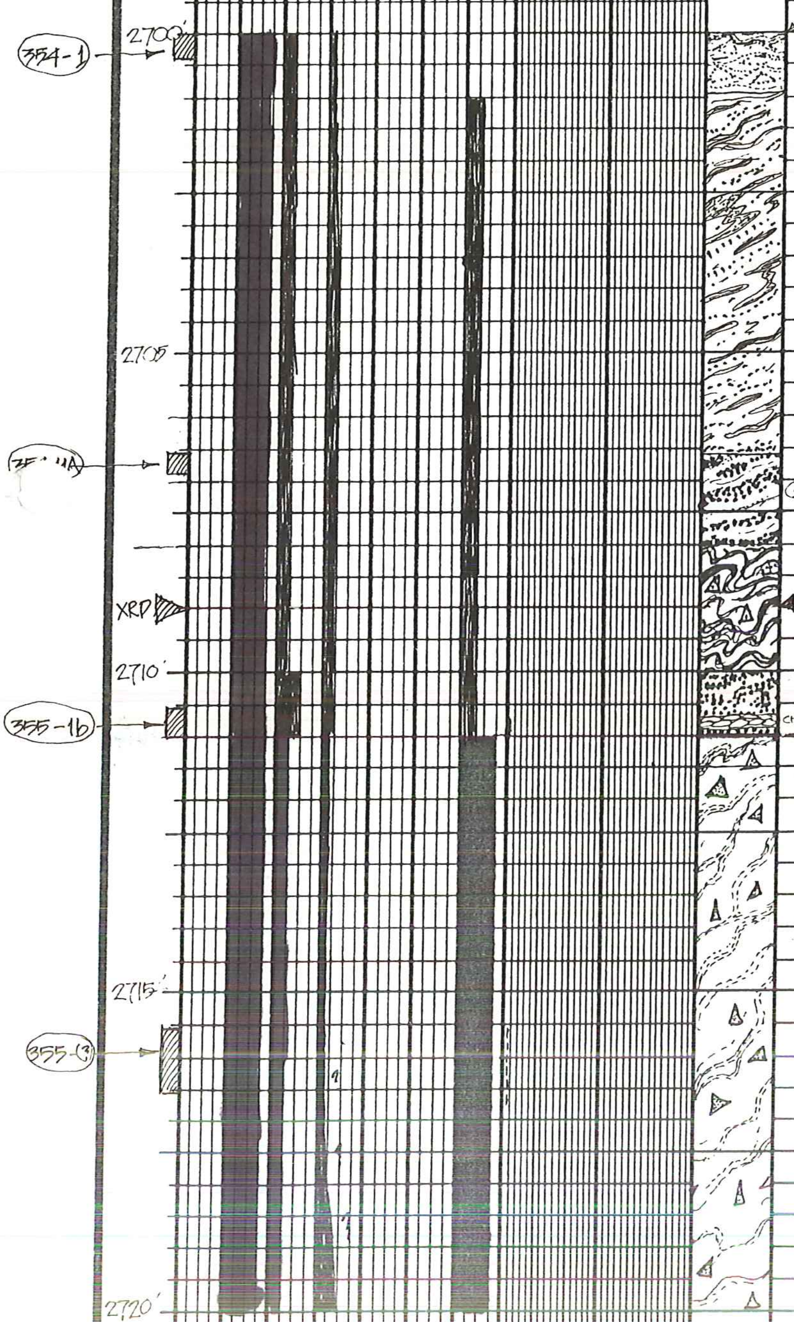
2683.5 - 2690 - highly contorted & fractured ~~@~~ med. ~~grayish~~ purplish gray shale - possibly faulted

2690 - 2692 - As above, except less fractured

2692 - 2695 - mostly greenish-gray shale w/ minor maroon as imm. above

2695 - 2700.15' mottled shale purple & gray

RL. PIECE No.	DEPTH	GRAPHIC LOGS: ALTERATION (1. WEAK 2. MOD. 3. STRONG) QTZ, SER, CHL, CAL, HEM (1 2 3); EST. VOL. % PY; GRAPHIC GEOLOGY	VEINLETS (Tr. TRACE 1. WEAK 2. MOD. 3. STRONG)	DESCRIPTIONS



3 ch
1 chlorite

BXTP. & REHEALED,
2700–2700.94': ALTERED, SILTY MUDSTONE V. LT., V. SLIGHTLY YELLOWISH-GRAY, NO CO_3; DENSE, APPARENTLY MASSIVE, BUT SUBTLY BXTD. – ANGULAR TO SUBROUNDED FRAGS OF THE SILTSTONE, UP TO AT LEST 10 MM. DIA, BUT AVG. < 3MM. DIA. EMBEDDED IN IDENTICAL MATRIX; SEVERAL OF THE LARGER FRAGS APPEAR TO HAVE BEEN ROTATED.; TR. DISS. DARK OPAQUES < 0.3 MM. DIA; SPARSE CHL. VEINLETS < 1MM WIDE, RANDOMLY ORIENTED; ROCK HAS SUBTLE SHEARED ASPECT – UNDULATING MICACEOUS (?) LAMINAE — SEE ALSO "ROTATION" ABOVE. @ 2700' 1 MM. BAND OF ABUND. CHL. VNLTS., LOCALLY W/ LENSOID VUGS LINED W/ CHL. XLS.

2700.94 – 2706.55': V. LT GREENISH-GRAY AND REDDISH TO PURPLISH-GRAY, MOTTLED AND SWIRL-TEXTURED, LOCALLY SPECKLED WITH ROUNDED HEMATITE CLOTS UP TO 2 MM. DIAMETER

① CHL
① PY

2706.55'–2708': SHEARED, INTERLAMINATED ARG. SLTST. & SILTY ARG. SS, NO HEM., CHLORITIC, LT–MED. GREENISH-GRAY; BEDDING AND SHEARING ~ 70° TO CORE AXIS; ~ 0.3% DISS., EQUANT, DK. GRAY-GREEN CHLORITE CLOTS AVG. 0.5-1 MM. DIA; SPARSE, IRREG. CHL. VNLTS, DISCORDANT, ALSO DISC. PY. MICROVEINLETS & A FEW FRAGS OF SS TECTONICALLY INCORPORATED IN ARG. SLTST. LAYERS

2708-2710' HIGHLY CONTORTED, LOCALLY BXTED, BUT REHEALED, SHALE & ~~SS~~ INTERBEDDED SHALY SILTSTONE & SHALY SS. MOTTLED & RIBBONED MED. GRAY, & V. LT. GREENISH-GRAY; OVERALL TALCOSE ASPECT

2709' – SEE SUPPLEMENT

2710-2711': SHEARED, BRECCIATED, CHLORITIZED SANDSTONE (OR INTRUSIVE BRECCIA)

CHT

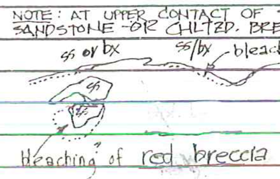
(2710.76 – 2710.94: MASSIVE PINK CHERT, CUT BY VEINLETS OF CHLTZD. " " BRECCIA (OR SS) → 2710.94 – 2711', + CONTORTED GREEN SS ^ OR BX

TR-1 PYRITE

2711 – 2721 HEMATITIC ARGILLACEOUS SANDSTONE BRECCIA, MED. TO DARK BRICK- TO MAROON-RED (HEMATITE), WITH MOSTLY WHITE & LESSER DARK GRAY GREEN CLASTS; 85-90% MATRIX, WHICH IS A UNIFORM ARGILLACEOUS HEMATITIC SILTSTONE VARYING FROM MASSIVE TO SUBTLY FOLIATED. ~ 7% WHITE CHERT * FRAGS — VARIABLE SHAPES, FROM EQUANT, ANGULAR TO SUBROUNDED TO ELONGATE — SOME IN SHARP CONTACT WITH MATRIX, OTHERS SEEMS TO BE A GRADATIONAL CONTACT — SIZE UP TO 30 MM. MAXIMUM DIMENSION, AVG. < 3 MM. 2% DARK GRAY-GREEN ANGULAR CHLORITE CLOTS, & HEAVILY CHLTZD. CHERT? SLTST? CLOTS, UP TO 12 MM DIA, AVG. < 2 MM. DIA. 2-3% LT. GREENISH-GRAY, LIGHTLY CHLTZD. CHERT * CLASTS < 10 MM. DIA. TR. ANGULAR CHLORITIC CHERT CLASTS. A FEW CLASTS ARE ESSENTIALLY IDENTICAL TO THE MATRIX, ANGULAR, UP TO 20 MM. IN DIA. SOME OF THESE HAVE RIMS OF HEMATITE CONCENTRATION. SOME OF THE WHITE "CLASTS" WITH IRREGULAR OR WISPY OUTLINES COULD ACTUALLY BE REDUCED PATCHES. TR. LATE-STAGE PYRITE MICROVEINLETS. TR. SUBROUNDED HEMATITIC MUDSTONE CLASTS < 10 MM DIA.

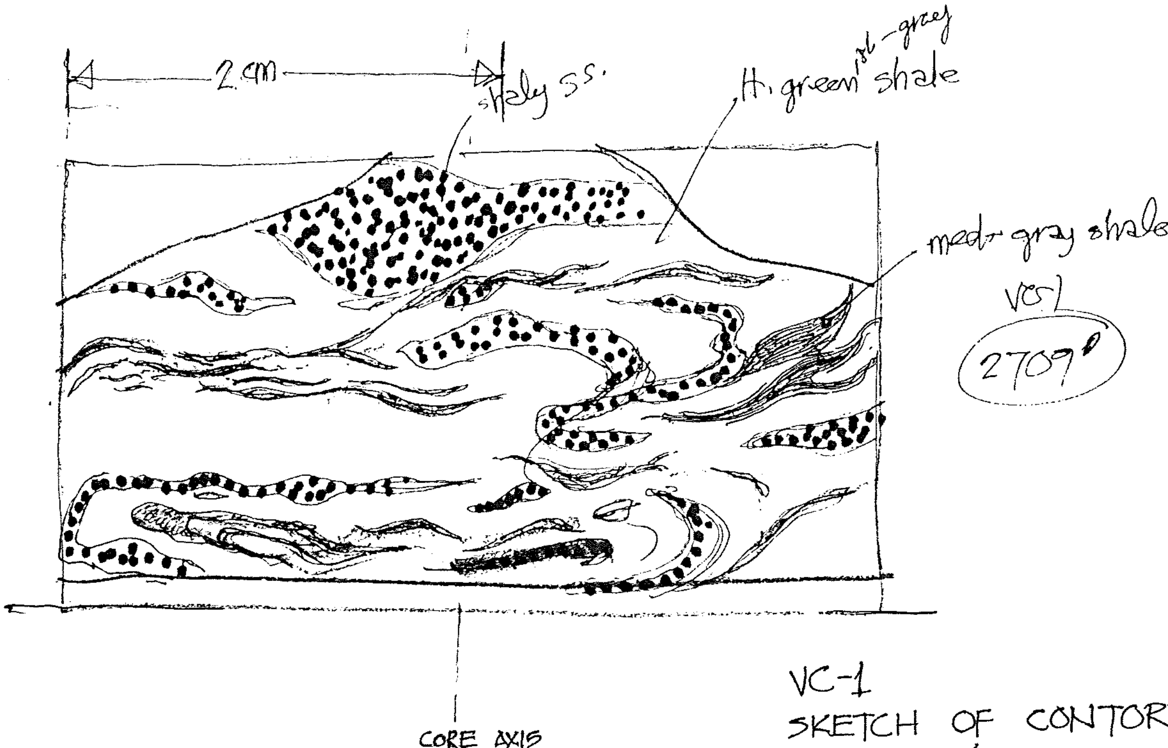
* SOME OF THE CHERT CLASTS COULD BE SILICF. SILTST. OR SS

NOTE: AT UPPER CONTACT OF THIS RED BRECCIA WITH SANDSTONE -OR CHLTZD. BRECCIA.



DRILL HOLE VC-1 (2700-2809' INTERVAL
LOCATION VALLES CALDERA, NEW MEXICO

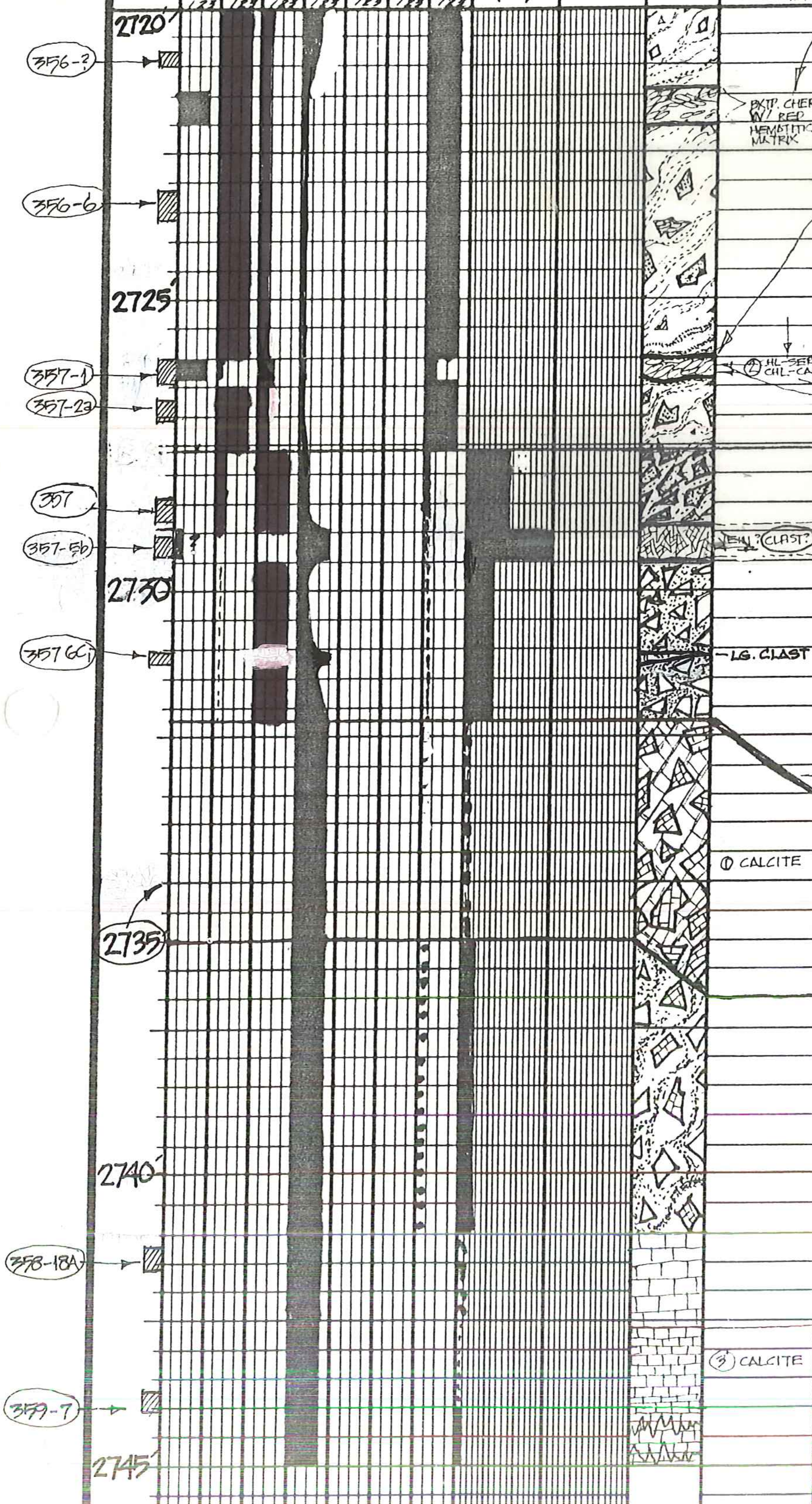
LOGGED BY J. HULEN AUG. 10, 1985



VC-1
SKETCH OF CONTORTED SHALE/SLTST/SS
AT 2709'

GRAPHIC LOGS

RUN & PIECE NO. | DEPTH | ALTERATION (1. WEAK 2. MOD. 3. STRONG): QTZ, SER., CHL, CAL, HEM | EST. VOL % PYRITE | GRAPHIC GEOLOGY | VEINLETS / OTHER NOTES (Tr. TRACE 1. WEAK 2. MOD. 3. STRONG) | DESCRIPTIONS



NOTE: THESE CHERTS ARE PROBABLY CLASTS IN THE HEMATITIC BRECCIA.

2721–2727.6': HEMATITIC, ARGILLACEOUS SILTSTONE BRECCIA SAME AS 2711–2721 EXCEPT MUCH LARGER CLASTS PRESENT (UP TO 4 CM DIA.) – THESE MOSTLY ANGULAR & MOSTLY V.V. LT. GREENISH-GRAY CHERT (&SILIC. SLTST?) — WHICH ITSELF HAS BEEN BRECCIATED & REHEALED WITH SILICA — CHERT CLASTS COMMONLY CONTAINS IRREGULAR QTZ. MICROVEINLETS DEVOID OF CHLORITE, WHICH TERMINATE AT CLAST BOUNDARIES. • ONE IRREGULAR CLAST 20X10 MM CONSISTS OF CHL-SERICITE CLOTS EMBEDDED IN HEMATITE-RICH SUBMETALLIC MATRIX. THE HEMATITIC-ARGILLACEOUS SILTSTONE MATRIX OF THE BRECCIA IN THIS ENTIRE INTERVAL IS ITSELF SUBTLY BRECCIATED. THERE IS A SHEAR LAMINATION IN THE MATRIX WHICH FORMS AN ANGLE OF 10–80° WITH CORE AXIS -- THIS ANGLE CAN CHANGE FROM THE MAXIMUM TO THE MINIMUM WITHIN 10 CM ALONG THE CORE AXIS. BORDERS OF MANY OF THE CHERT AND SILICIF. SILTSTONE CLASTS ARE DARKENED BY AN INFUSION OF HEMATITE FROM THE MATRIX TO A DEPTH OF 1–3 MM.

(2726–2726.42'): CHERT, MULTIPLY FRACTURED & REHEALED W/CHL-QTZ-SER(?) & EARLIER CHL-CAL VNLTS. CHERT HAS PINKISH CAST DUE TO MINOR DISSEM. HEMATITE.

2727.6–2732.2': BRECCIA SIMILAR TO 2721–2727.6, EXCEPT BROWN NON-HEMATITIC DENSE MATRIX, AND ALSO THE MATRIX (& MANY CLASTS) ARE FINE-MEDIUM SAND RATHER THAN SLTST. & FINE SS. ALSO: THIS BX IS MUCH MORE CLAST-RICH THAN THE HEMATITIC BRECCIA ABOVE — IT PROB. CONTAINS AT LEAST 50% CLASTS. 90% OF THE CLASTS ARE LT. GREENISH-GRAY TO LT. BROWN, SILICIFIED & SPARSELY CHLTZD. SANDSTONE & SANDSTONE BRECCIA (BX WITHIN BRECCIA) — THEY RANGE IN SIZE FROM <1MM. TO AT LEAST 40 MM, AND IN SHAPE FROM ROUNDED TO ANGULAR (DOMINANTLY SUBROUNDED TO SUBANGULAR) — LT. BROWN SS & SS. BX CLASTS ARE IDENTICAL TO MATRIX. 5% OF THE CLASTS ARE CHERT, SAME AS 2726–2726.42' — • 1% OF CLASTS ARE DK. GRAY-GREEN CHLORITIC ARGILLITE, MOSTLY ANGULAR, SOME LATH-SHAPED, < 10 MM. MAX. DIMENSION. A FEW DK. GRAY-GREEN CRS. CHL. CLASTS < 1MM. DIA. LAST EPISODE OF BXN. MINRLZN. (CUTTING ABOVE) DARK GRAY GREEN BANDS UP TO 2 CM. WIDE COMPLETELY PULVERIZED AND ALTERED TO CHL(?)-QTZ-PHENGITE-PY-CAL. — CALCITE OCCURS AS DISS. PATCHES < 2MM. LENGTH OR DIAMETER — DITTO PYRITE & TEXTURALLY SIMILAR CHALCOPYRITE (SULFIDES 2% OF THESE LATE-STAGE VEINS). — NOTE: MATRIX OF BRECCIA BECOMES MORE CALCAREOUS AS LIMESTONE INTERVAL IS APPROACHED.

2728.85–2729.48 VEIN SEE SUPPLEMENT

2731.13–2731.30' (SEE SUPPL.)

2732.2–2736.37 (CONTACT @ ∠ TO CORE AXIS; DENSE, CRS-MED.-XLN. MARBLE BRECCIA, LT.-MED. GRAY CLAST SIZES AS IN BRECCIAS ABOVE

DAMN - NO SAMPLE
NOW HAVE ONE!

(2736-7)

2737–2741': BRECCIA, SIMILAR TO 2727.6–2732.2', EXCEPT THAT MATRIX IS VERY CALCAREOUS & ABOUT 50% OF THE CLASTS ARE CALCITE/LS. BX SIMILAR TO 2728.85 TO 2729.48', BUT WITHOUT SULFIDES & DARK OPAQUES — (MANY OF THESE ACTUALLY JUST F-M XLN. CALCITE). ~15% OF THE CLASTS ARE CHERT, AS ABOVE; REMAINDER ARE BRECCIA SAME AS 2727.6–2732.2' • – TR. LT. GREEN SILICIFIED & CHLTZD. SANDSTONE. LOCAL BANDS AT ALL ∠'S TO CORE AXIS ARE RELATIVELY IMPOVERISHED IN CLASTS & CUT OFF OLDER BX. THESE BANDS ARE UP TO 0.10' WIDE, UNDULATING, IRREGULAR. CALCITE CLASTS, PARTICULARLY SMALLER ONES, ARE PREFERENTIALLY ROUNDED. SOME OF THE LARGER CLASTS (CALCITIC) HAVE SCALLOPED & IRREGULAR BORDERS, INDICATING REACTION WITH MATRIX. ... APPEAR TO BE "STREAM LINES IN MATRIX.

CAREFULLY CHECK THIS INTERVAL IN GR. J.!

2741–2742.67 – LIMESTONE, SIMILAR TO 2732.2, BUT ONLY SUBTLY BRECCIATED
(IS THIS JUST A LARGE CLAST?)

2742.67–2744': LIMESTONE, F-M XLN., MASSIVE, CUT BY ABUNDANT CRS.-XLN. WHITE CALCITE VEINLETS UP TO 3 MM. WIDE WHICH LOCALLY COALESCE TO FORM ANGULAR, IRREG. CLOTS UP TO 50 X 30 MM — A FEW OF THESE HAVE OPEN SPACES UP TO 10 MM. WIDE LINED W/EUH. CALCITE XLS. (FINER-XLN., LT. BROWNISH WHITE IN CONTRAST TO PURE WHITE SUBSTRATE.

2744–2751' STYLOLITIC LS – SEE NEXT PAGE.

DRILL HOLE VC-1 (2700–2809' INTERVAL)
LOCATION VALLES CALDERA, NEW MEXICO
LOGGED BY J. HULEN AUG. 11, 12, 1985

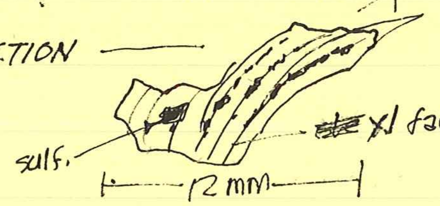
VC-1 LOG SUPPLEMENT

(357-5B)

2728.85-2729.48 -- VEIN(?)* → (* COULD ALSO BE A LARGE CLAST IN THE SURROUNDING BRECCIA) (SUSPECT THIS TO BE THE CASE – SEE 2731.13-2731.30) MINERALIZED. LT-MED. GRAY MOTTLED WITH WHITE. ACTUALLY A DENSE, FINE-XLN CALCITE-DOLOMITE BRECCIA*, SO COULD ACTUALLY BE A CLAST IN THE SANDSTONE BRECCIA DESCRIBED FOR 2727.6-2732.2'.

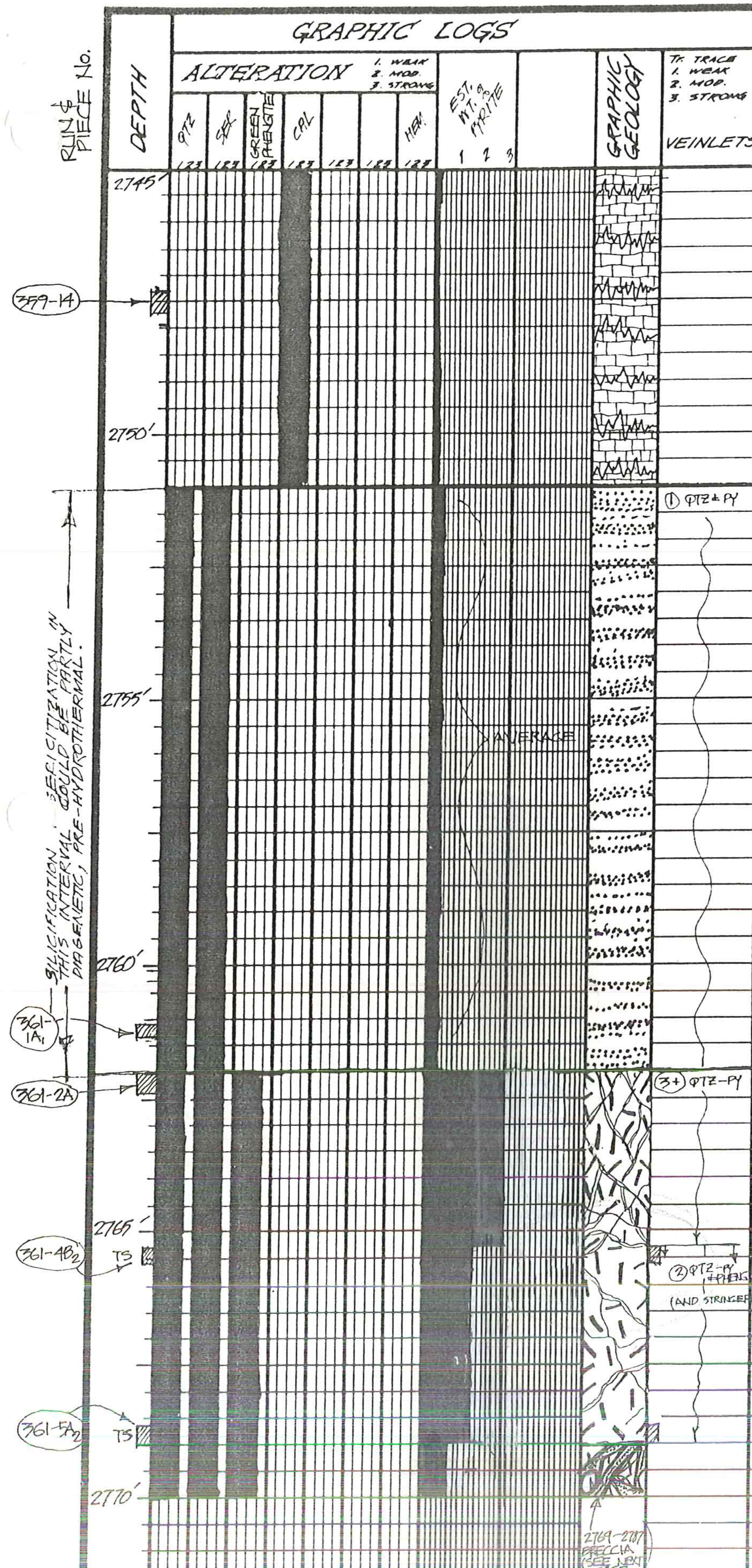
THE ROCK CONSISTS OF ROUNDED TO SUBANGULAR, OBVIOUS TO OBSCURE FXLN LS/DOL FRAGMENTS, UP TO AT LEAST 20 MM. IN DIAMETER, EMBEDDED IN AN IDENTICAL MATRIX. ABOUT 3% DISSEMINATED DARK OPAQUE MINERALS (XRD-MAGNETITE), AS IRREG. CLOTS FROM < 0.5-3 MM IN DIA., AND AS LOOSE AGGREGATES OF THESE CLOTS (ALSO IRREGULAR) UP TO 10 MM. IN DIAMETER → THIS DK. (SUBMETALLIC) MINERAL IS CONCENTRATED IN MATRIX. ALSO ~ 3% DISS. PYRITE, AND A TRACE OF CHALCOPYRITE, AS IRREGULAR GRAINS UP TO 2 MM DIA. (PY ONLY) (AVG. <0.5) (CPY <0.3 MM. GRAINS). 5% BARITE (XRD) ## AS SLIGHTLY PINKISH WHITE IRREGULAR CLOTS UP TO 30 MM. MAXIMUM DIMENSION, COMPOSED OF COLUMNAR CRYSTALS WITH PRONOUNCED CURVED HABIT & BASAL CLEAVAGE (NON-EFFERVESCENT) (INDIVIDUAL XLS. UP TO AT LEAST 10 MM. X 2 MM IN X-SECTION ——

SEVERAL OF THESE CLOTS CONTAIN SULFIDES CONCENTRATED ALONG CRYSTAL EDGES



(357-6C1)

2731.13 – 2731.30' → LARGE CLAST IN THE BRECCIA CONSISTING OF BRECCIA ITSELF — SPECIFICALLY CALCITE BRECCIA AS ABOVE (INCLUDING MINERALIZATION)



DESCRIPTIONS

2744-2751' STYLOLITIC FINE MED. XLN MARBLE, LT. MED GRAY WITH DK GRAY STYLOLITES COMPOSED OF AND CONCENTRATING SHALY (?) INSOLUBLE RESIDUES; OCCASIONAL IRREGULAR CLOTS OF SUCH RESIDUES UP TO 10 X 5 MM. — SOME OF THESE ARE LENS SHAPED. COMMONLY A SELVAGE EITHER SIDE OF THE STYLOLITE ZONE, UP TO 3 MM WIDE, W/ MUCH COARSER CALCITE THAN BULK OF ROCK (1-3 MM XLS. VS < 0.5 MM). — BEDDING AT ~ 70% TO CORE AXIS. ~ 0.1 % DISS. PY CONCENTRATED MOSTLY IN SCATTERED BANDS BETWEEN STYLOLITES.

2751-2762': SILICIFIED & SERITIZED, COARSE-GRAINED SS. V. LT. GRAY, OBVIOUS BEDDING @ ~ 80° TO CORE AXIS.; WELL-ROUNDED GRAINS, BIMODAL DISTRIBUTION — LARGER AVG. ~ 1 MM, ~ 50-60% OF ROCK, SMALLER, INTERSTITIAL, AVG. ~ 0.2 MM; ORIGINALLY ~ 5% FSP. GRAINS, NOW TOTALLY SERICITIZED — SERICITIZATION VERY POROUS, SPONGY-APPEARING. ~ 5% SERICITE PORE-FILLING. OVERALL ~ 0.5% DISSEMINATED PYRITE, IRREG. GRAINS UP TO 1 MM. DIA., AVG. ~ 0.1 MM. SPARSE, RANDOMLY-ORIENTED QTZ ± PY VNLTS, UP TO 5 MM. WIDE, WITH VAGUE, GRADATIONAL MARGINS. SOME OF THE FSP. GRAINS HAVE LEACHED APPEARANCE

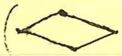
2762-2769' BRECCIATED QTZ-SERICITE-PHENGITE ROCK, INTENSELY ALTERED & QTZ-VEINED, SO THAT PARENT ROCK IS UNCERTAIN. HOWEVER IT LOOKS MOST LIKE A MED.-XLN. GRANITIC ROCK. LT. GREENISH-GRAY OVERALL. CONSISTS OF A NETWORK OF QTZ-PYRITE VEINLETS, SOME DELICATELY BANDED, FROM < 0.1 - 2 MM. WIDE, WHICH BREAK THE ROCK INTO "ISLANDS" FROM 1-5 MM. MAX. DIMENSION ("ISLANDS" ARE TRIANGULAR, CONSIST OF INTERLOCKING IRREGULAR TO EUHEDRAL-RECTANGULAR SERICITE AND ANHEDRAL CLEAR QUARTZ CLOTS). QTZ. CLOTS UP TO 5 MM. IN DIAMETER; SERICITE CLOTS UP TO 3 MM. DIA. MANY OF THE SERICITE CLOTS SHOW RELICT CLEAVAGE PLANES PARALLEL OR PERPENDICULAR TO XL. FACES — THESE CLEAVAGES COMMONLY MARKED BY QTZ. AND PYRITE ULTRA-MICROVEINLETS. ~10%-7% BRIGHT GRAYISH GREEN PHENGITE, SOME OF WHICH IS TEXTURALLY SIMILAR TO THE SERICITE AND SOME WHICH SEEMS TO FORM A MATRIX IN WHICH SER.-QTZ FRAGMENTS "FLOAT". SO: PHENGITE POST-DATES SERICITE & POST-DATES QTZ ± PY MICROVEINLETS IN SERICITE CLOTS — THEN, PHENGITE IS POST-DATED BY QUARTZ-PYRITE VEINLETS. THESE, IN TURN, ARE LOCALLY CUT BY BANDS OF OBVIOUS SILICIFIED BRECCIA WITH QUARTZ-ROCK FLOUR-PYRITE MATRIX AND CLASTS OF THE HOST & ITS COMPONENTS (MANY ROUNDED, SOME ANGULAR, UP TO 7 MM. DIA.). 0.5% DISSEMINATED, DARK OPAQUE MINERALS, AS IRREGULAR CLOTS, UP TO 2 MM (AVG. < 1 MM.) IN MAX. DIMENSION, SOME OF WHICH ARE INTERGROWN W/ MINOR AMOUNTS OF TEXTURALLY SIMILAR BUFF LEUCOXENE (?) AND PYRITE. PYRITE FORMS EST. 5% OF THE ROCK TO ABOUT 2765.2' — IT OCCURS AS SMALL (AVG. < 0.1 MM) GRAINS IN VEINLETS AND MORE RARELY AS DISSEMINATED GRAINS BETWEEN VEINLETS; ALSO AS SCATTERED "STRINGERS" IN THE QTZ-PY VEINLETS AND AS IRREG. CLOTS UP TO 3 MM. DIA. WHERE TWO OR MORE VEINLETS INTERSECT. BELOW 2765.3', INTRUSIVE IDENTITY OF ROCK BECOMES CLEAR (SOME RELICT FRESH FSP., LESS FRACTURING, LESS VEINING & ALTN

— SEE SUPPLEMENT

DRILL HOLE VC-1 2700-2800' INTERVAL
LOCATION VALLES CALDERA, NEW MEXICO

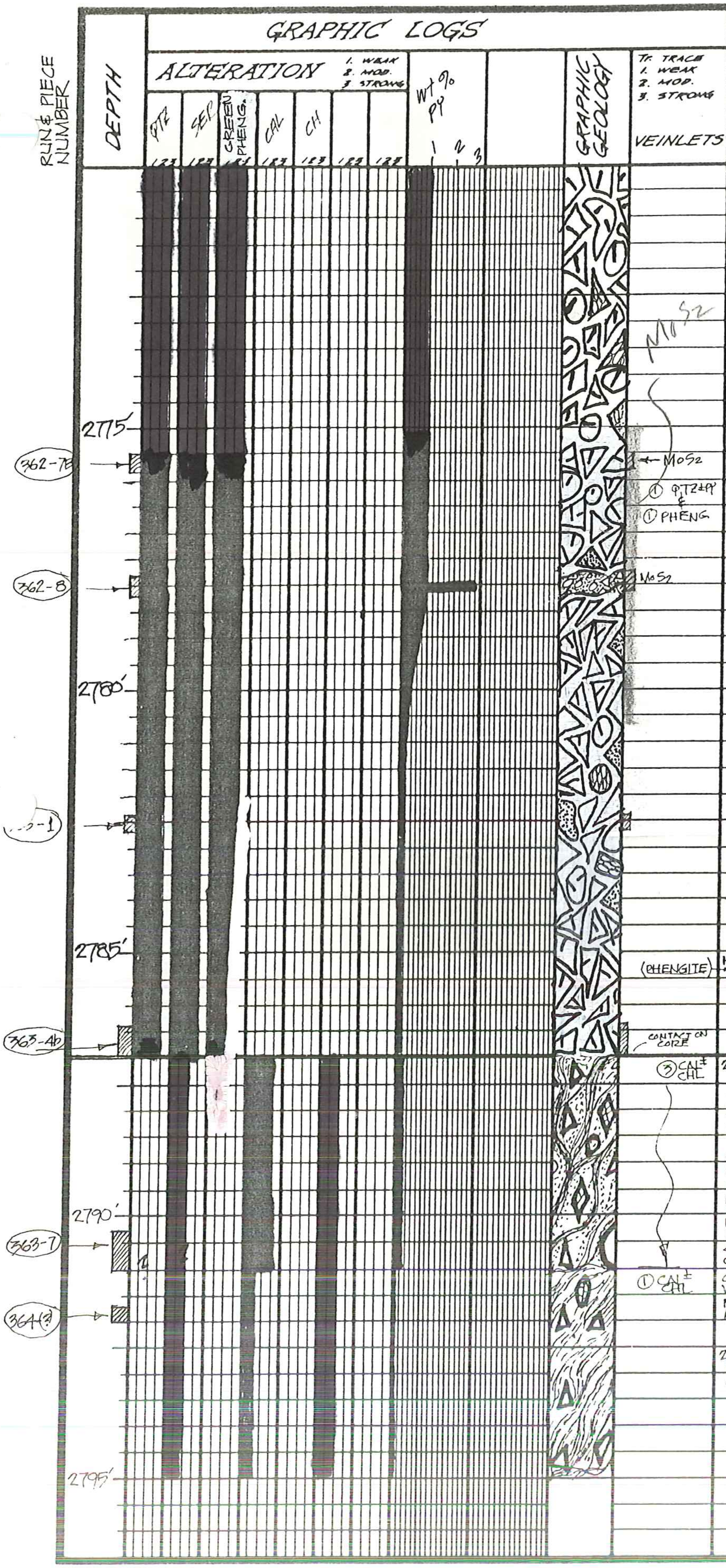
LOGGED BY J. HULEN AUG. 12, 1985

VC-1 LOG SUPPLEMENT

2765.3-2765.6: CLEARLY AN ALTERED MED.-XLN. GRANITIC ROCK (SEE LOG 2762-2765.3') — SOME FSP. REMAINS (NOT COMPLETELY SERICITIZED). IN THIS SMPL., GREEN PHENGITE FORMS NOT ONLY THE IRREGULAR CLOTS, BUT ALSO MICROVNLTS & VNLTS WITH & W/O PY & QTZ. — PHENGITE DOES POST-DATE WHITE SERICITE. THE EARLY QTZ. MICROVEINLETS ARE MORE RARE IN THIS INTERVAL, BUT PRESENT & DO PRE-DATE PHENGITE. DISS. LEUCOXENE (0.3%) AS ABOVE MOSTLY < 0.5 MM. DIA. & ANH., BUT A FEW EUH. XLS. () FORMING CLOTS UP TO 1.5 X 0.5 MM. (RARE). MUCH OF THE PHENGITE IS A BEAUTIFUL BRIGHT GRAY-GREEN.

2768.65-2769': AS ABOVE, BUT 1% DISS. DARK OPAQUES, IRREG., SAME DESCR. AS 2762- BUT SLIGHTLY COARSER. THIS INTERVAL ALSO: 0.5% DISS. SPHENE/LEUCOXENE, AS ABOVE, AND COMMONLY INTERGROWN WITH THE DARK OPAQUES.

BOTH THE ABOVE INTERVALS SHOW COMMON INCIPIENT(?) BRECCIATION.



DESCRIPTIONS

2769 - 2787'

HIGHLY-ALTERED BRECCIA, CONSISTING OF ANGULAR TO ROUNDED FRAGMENTS, UP TO 30 MM IN DIAMETER, THEMSELVES CONSISTING OF BRECCIATED QTZ-SER ROCK, EMBEDDED IN AN ESSENTIALLY IDENTICAL MATRIX, SO THAT DETERMINATION OF CLAST VS. MATRIX RATIO IS DIFFICULT. MATRIX, HOWEVER, IS ENRICHED IN BRIGHT GREEN PHENGITE, WHICH TYPICALLY FORMS IRREGULAR, SOMEWHAT ANGULAR CLOTS RANGING IN SIZE UP TO 10 MM MAX. DIAMETER, BUT AVGNG. <3 MM — THE LARGER PHENGITE CLOTS INCORPORATE SOME ROCK FLOUR & MICROCLASTS. PHENGITE ALSO OCCURRS AS WISPY, UNDULATING STRINGERS BETWEEN CLASTS.* THE PHENGITE PROBABLY ALSO INCORATES MICROXN. QTZ (CHECK THIN-SECTION). LOCALLY WITHIN THIS UNIT ARE IRREGULAR BRECCIA BANDS UP TO AT LEAST 10 MM. WIDE, WHICH CUT THE PHENGITE AND INCORPORATE PHENGITE-RICH CLASTS — MATRIX OF THIS BRECCIA IS V. CATACLASTIC-APPEARING, HIGHLY SILICIFIED, CONTAINS UP TO 3% DISS. PYRITE. OVERALL < 0.2% PY TEXTURALLY SIMILAR TO THAT BETWEEN 2765.3' AND 2769'.

* NOTE: PHENGITE ALSO OCCURRS AS DISCONTINUOUS VEINLETS AND AS THE PRINCIPAL CONSTITUENT OF THE MATRIX OF SCATTERED BANDS OF LATE BRECCIA, UP TO AT LEAST 50 MM WIDE, WHICH INCLUDES CLASTS OF THE EARLIER BRECCIA. — AT 2778' THE PHENGITE CONTAINS TRACES OF MOLYBDENITE. THE PHENGITIC LATE BX CONTAINS ABUNDANT HIGHLY ROUNDED CLASTS, AND SO IS PROBABLY A FLUIDIZED HYDROTHERMAL BX.

NOTE: THIS BRECCIA IS APPARENTLY DERIVED FROM BOTH MED-FXLN. GRANITIC ROCK AND MED-CRS. GRAINED SANDSTONE

HIGHLY ALTERED QTZ-SER-(CHL) BRECCIA, AS ABOVE, BUT CELADONITE IN THE MATRIX HAS DECREASED, AND THERE ARE SCATTERED, ROUNDED TO ANGULAR CHERT FRAGMENTS UP TO 10 MM. IN DIAMETER. THIS IS THE SAME CHERT THAT OCCURS 2726-2726.42', WITH RED TO PINK COLOR DUE TO ENTRAINED HEMATITE.

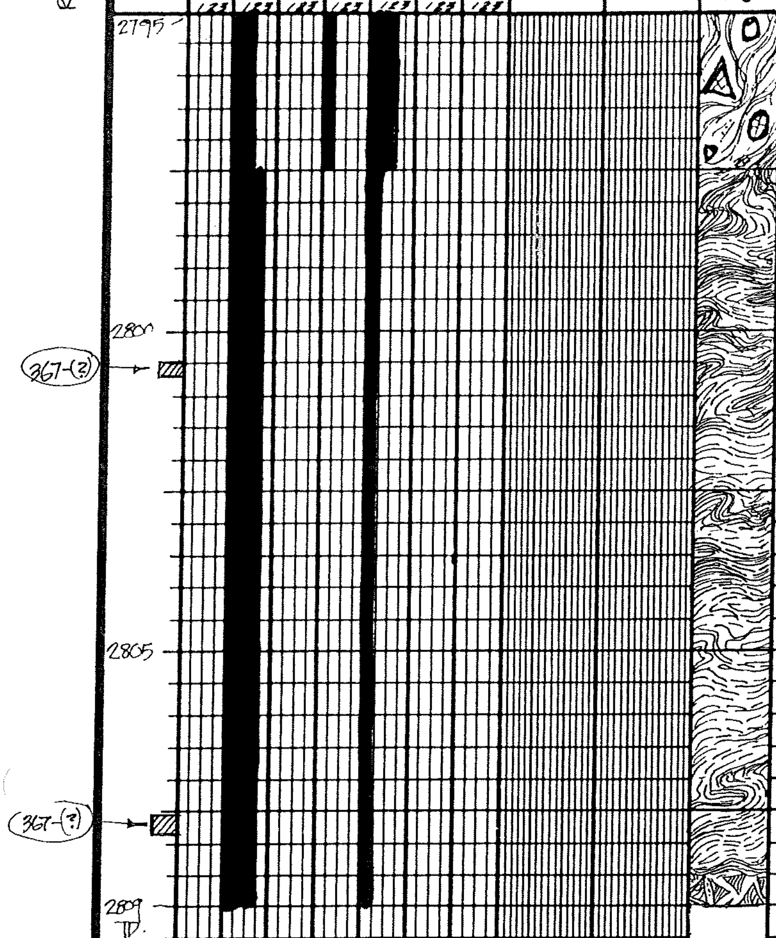
2787- 2791': CALCAREOUS, ARGILLACEOUS BRECCIA, DARK GRAY W/ A HETEROGENEOUS MIX OF ROUNDED TO ANGULAR CLASTS UP TO 25 MM. IN DIAMETER. ~7 % MED. SANDSTONE CLASTS, BUFF TO GREENISH & REDDISH (STAINED, INFUSED WITH CHLORITE & HEMATITE) PROBABLY SILICA-CEMENTED. IT'S POSSIBLE THAT → SOME OF THESE CLASTS ARE IGNEOUS. ROCK LIKE 2762-2769'. 1% HEMATITIC RED CHERT CLASTS (SEE 2726'). 5% - 7% F-MED. XLN. LS &/OR MARBLE CLASTS UP TO 25 MM. DIA. — THESE ARE VERY COMMONLY HIGHLY ROUNDED — MANY ARE MINERALIZED & APPEAR IDENTICAL TO THE "VEIN" AT 2728.83' (CONTAIN DISS. PY AND HEMATITE) — THE MINRLZ. IN THESE CLASTS DEFINITELY PRE-DATES DEVELOPMENT OF BRECCIA. MANY SMALLER CLASTS <1 MM. IN DIA APPARENTLY MONO- AND POLYCRYSTALLINE QUARTZ. ANASTAMOSING NETWORK OF CALCITE & CALCITE-CHLORITE VEINLET @ 0-25° TO CORE AXIS - SOME W/ CAL-CHL CENTERS & CAL SELVAGES — THESE VEINLETS MAKE UP ~ 5% OF ROCK — THEY BEAUTIFULLY DEFLECT AROUND CLASTS.

2791'-2797.5 SHALY BRECCIA, AS ABOVE WITH, HOWEVER, ONLY ~ 5% CLASTS, & RELATIVELY FEWER LS. AND CHERT CLASTS.

DRILL HOLE VC-1 2700-2809' INTERVAL
LOCATION VALLES CALDERA, NEW MEXICO

LOGGED BY J. HULEN
AUG. 13, 1985

RUN & PIECE No.	DEPTH	GRAPHIC LOGS: ALTERATION (1. WEAK 2. MOD. 3. STRONG) — QTZ, SER, CPY, CH	GRAPHIC GEOLOGY	VEINLETS (Tr. TRACE 1. WEAK 2. MOD. 3. STRONG)	DESCRIPTIONS



SHALY BRECCIA AS IMMEDIATELY ABOVE.

2797.5-2808.5': HIGHLY CONTORTED & FRACTURED SHALE, LT. TO MED. GRAY, MOTTLED & SWIRL-TEXTURED. APPEARS TO HAVE BEEN BROKEN APART MANY TIMES AND SIMPLY SMASHED BACK TOGETHER UNDER PRESSURE

2808.5-2809' FAULT BX DERIVED FROM THE SHALE DESCRIBED ABOVE.

DRILL HOLE VC-1 2700-2809' INTERVAL

LOCATION VALLES CALDERA, NEW MEXICO

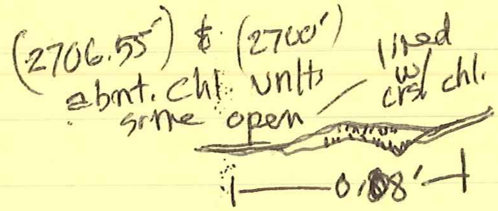
LOGGED BY J. HULEN

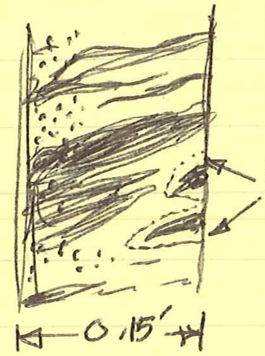
AUG. 13, 1985

VC-1 LOG

00 - 2700.94' calc? sltst., massive, v. lt. greenish-gray, tr. hairline chl. vnlts. : poss. v. subtly bxtd.

2700.94' - 2706.53' calc? siltstone, v. lt. greenish-gray & med. purplish gray, mottled, sparse chl. vnlts. ; locally speckled w/ rndled hem. clots up to 2 mm. dia., (probably a partially bleached redbed) (Abo?





2706.55 - 2708 ; intbd. v. lt. greenish gray mudstone & siltstone only tr. hematite, v.v. rare tr. chl. vvnts

2708 - 2710 ; finely lam. greenish-grey, purplish-gray mudst. highly contorted slickensided // to bedding? planes talcose texture

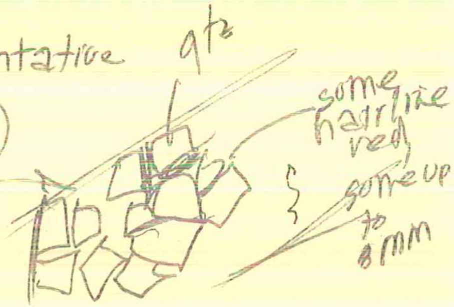
2710' - 2711' ; silicified bx, chltzd, euh. qtz. xls. in flattened to ⊥ cavities

2711 - 2721' : breccia ~ see 2715.55 - 2716.56' (totally representative dark red, hematitic

2721 - 2727.6' → as above, but much coarser clasts; up to at lst. 0.2' dia, mostly angular

356.6 is representative

bxtd. qtz. vein, 2721.47 - 2722'
red, hematitic matrix



note 2726 – 2726.42' — quartz vein, broken, rehealed w/chl.? + silica (see 357-1)

2727.6 – 2732.2'(?) — bx, as above, except matrix not brick-red to maroon hem, but lt. grey to brownish-gray
25–30% larger (> 2 mm) ∠ frags – look to be qtz vn fragments (dominantly) some chloritic, some ls(?) frags
1 – 2% diss. py, some rare cpy ± sp, ∆
2728.85 – 2729.48' – quartz vein (see 357-5b)

2732.2 – (2737' 2736') ∠ to core contact

coarse-xline, med. grey ls. or marble breccia
2734.46 – 2734.72 – silcfd. zone, dense, tr py

2737 – 2741 – bx, as 2727.6 – 2732.2' (see 358-18A [represent.]
diss py <1% overall locally 2%

2741 – 2742.67' – ls bx(?) same as 2732.2 – 2737'
obvious stylolites (bx texture pretty subtle – better ls?)

2742.67 – 2744' – fairly massive fxln mxln. lt. grey ls. disrupted by calcite vnlts which locally coalesce to form ∠ clots up to 30x30 mm poss. minor local silicifc.

2744 – 2751 — (see 359-14)

2751 – 2762' massive crs-med lt. grey ss, obvious bedding <0.1% diss. py
qtz. sand, well-rounded
~~v.~~ sparse healed fractures bedding ∠80° to core axis

@ 2763.6 – 2764 0.06' silicfd zone 66° to core axis

@ ~ 2760.5 – 2761 – open spaces up to 10 cm x 0.5

2762 – 2781′ — qtz – plag – ser. – sulf. bx – clastic-derived.

more sheared below 2769′

2781 – 2791′ — Tectonic bx / int. rx black shale/mudstone w/ silicf. clasts of poss
similar to above
clasts do contain py
closely spaced network of fracs @ 70° to core axis
go around & do not penetrate clasts
fracs poss. sl. chloritic

2791 – 2797.5 bx fractured // to core axis — more intensely chlted. – possibly talcose (?) – black shale matrix, less clasts, smaller clasts

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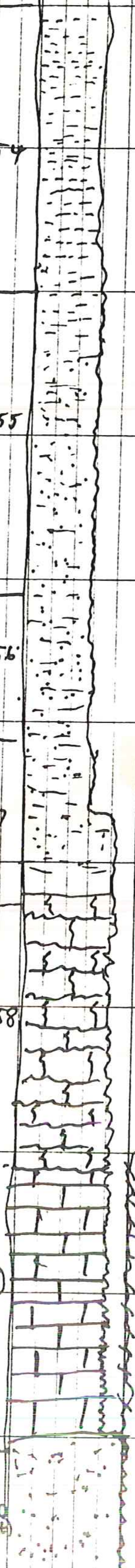
@ 2797.5 – 2808.5 — mostly ar rubble of crumbled core

lt. gray (to lt. greenish-gray) illitic shale, not bx –
shale is fractured // to core axis sustains open fracs
possibly talcose

2808.5 – 2809 – fault gouge & bx – disaggregated shale, as above
minor porosity (perm?)



Depth	Box	Run / Rec.	Lithology	Recovery	Porosity	fracturing	Alteration	sulfides
2700			↑		low	med		
2705	395	354		Not Avail			chlorite, hematite celadonite in frac. cavities	v. minor py
2710			mottled ^ Greenish grey siltstone w/ varing amts. of carbonate					
2711.5	396		- - - - - - - -	- - -		- - -	- - - - - -	
2715 / 16		355	Dark-red shaley SS with white angular silica(?) fragments	Not Avail	med-hi	low	lightly Altered	NO sulfs in red unit
2720	397a	356		Not Avail			No	
2725	397b							NO
2728		357	Reddish gray shaley SS w/ angular silica(?) clasts	6.0	hi	Low		
2730 / 2730.5 / 32			- - - - - - - -	- - -				
2735	398	358	L.S. is brecciated all the way to the top.	9.0	little	low	~	minor py finely disser.
2740			At 2746 L.S. is brecciated "in situ" and fine grain Along stylolites pyrite develope (in soluble residue?) L.S. is recrystalized. stylolites, Larg spary Calcite along stylolites	9.3				
2745	399	359					No	
2746			Gray Limestone with dark clay and some quartz(?)		little	some		
2750 / 2751	400		- - - - - - - -					
2755	401	360 (cont)	Gray coarse sandstone with "cross bedding"??			(cont)		

2684 2C92 A-well[illegible]

Feet	Box	Run	Picture	Lithology	Recovery ft	Porosity	Fracturing	Alteration	Sulfides
2755	401	360		gray coarse sandstone	9.5	~~high~~ little	medium	No	No
2760									
2765	402	361		the green chlorite? is typical.	10				
2770									
2775	403	362		large pieces of breccia seem to be "in place" seperated by vaines					
2780				with Green Brecciated Sandstone ~~w~~ some calcite (secondary)		medium	minor	Yes	Y
2785	404	363							
				–2787 Poorly sorted dark gray sandstone, with angular fragments of mixed lithologies. Rock cut by thin vaines		little	minor		Y
2790				–2791					
	405	364		Brecciated and Sheard Shale		none	high		Y
2795	406	365		Sheared and/or brecciated shale (mainly brecciated)		none	high		Y
2800.0		366							
2805.0	407			Sheared and/or brecciated shale with some calcite		none	[illegible], high		Y
		367							
2809.0									
2810									

Moly somewhere in this interval

6/7/[illegible]

357-2A 2726.71- 2727.04'

(Matrix) - mostly quartz, cht, volc. rx grains avg. 0.1 mm. dia or length: variably-shaped, from angular ~~and elongate~~ to rarely rounded & equant to elongate, but dominantly subangular and subequant. Many of the grains have rounded to angular cores with well-defined quartz overgrowths — clearly derived from clastic sediment. ~3% of the fragments are chert, 1% are VRF's; <1% are commonly deformed, lath-shaped to lenticular ser-chl-qtz (probable shale) fragments. ~1% are angular to subangular hydrothermal quartz fragments with clearly-defined growth zones. other grains in traces - muscovite, zircon. The small grains dominating the matrix are embedded in a mat of sericite-chlorite ± cryptoxln quartz (v.v. f.gr) ± hematite. The micaceous component of the matrix is locally well-foliated in bands — in which quartz grains are much more elongate, are oriented with long axes parallel to foliation, and appear to have been crushed and "strung out"

Hematitic ~~BCTAE~~ Matrix is locally separated by undulating bands up to 15 mm. wide, in which foliation is much better developed, and hematite is weak to absent.

OPINION — NOT REDUCED AREAS, BUT POST-BRECCIA, TECTONICALLY MIXED OXIDIZED & REDUCED AREAS.

rarely subrounded

FRAGMENTS — size → up to at least 40 mm. maximum dimension — multilithologic — dom. angular to subangular (rarely subrounded) chert fragments w/ typical "salt & pepper" texture & 5-10% v.v. fxln (<<0.01 mm) disseminated chl, & local tr. diss. hematite — subequal to cht. frags. are rel. crs-xln. hydrothermal quartz clasts, which consist of mosaic aggregates of interlocking xls. from 0.02-0.5 mm. dia; The larger xls. commonly show well-developed multiple euhedral growth zones; in many of the clasts, coarser xls. are concentrated toward the margins, giving a vug-like appearance, heightened by subh.-euh. xls projecting into the matrix; however, these euh. xl. projections are commonly rounded off/abraded, and a few have well-defined overgrowths w/ hematitic "dust rings"

NOTE: foliation in matrix flows, (where present) around these "pseudovugs" — showing they are clasts

Subordinate fragments

(1) v.v. fxln — ser-chl-qtz. argillite? shale? mudstone?, angular, up to 10 mm. long slightly deformed & elongated // to foliation.

(2) opaque - semi-opaque reddish chloritic-hematitic mudstone

Rocky Mtn. Corrosion Control.

357-3b

SANDSTONE BRECCIA — see binoc. description!
sandstone bx clasts are not discernible from sandstone bx matrix!

MATRIX — angular to subrounded small (avg n 0.1 mm dia) clasts of quartz in turn embedded in matrix of fibrous v. fxln. pale green chlorite w/ v. minor sericite and silt(-) size quartz.
—— many of the quartz grains are lightly-stained with hematite, and many have well-defined quartz overgrowths and were clearly derived from a clastic source. —— There is a distinct lack of the fine-grained, commonly micaceous foliation present in 357-2A
—— 1-2% of the small matrix quartz clasts are angular hydrothermal quartz w/well-defined growth zones. 1% are chert

LARGE CLASTS — same character & composition as 357-2a, —and in addition; about 25% of the clasts are subangular to subrounded chlorite clots, v. fxln. (< 0.01 mm), around some of which the matrix has developed flow-lamination

SEE BINOC DESCR. for clasts not discernible in thin-section

many hydrothermal quartz clasts - see 357-2A

MINRLZ/ALTN — about 1/3 of the slide occupied by hydrothermal quartz-chlorite (± py ± calcite) aggregate — not sure yet if vein or clast — ambiguous.

may be some adularia in this vein(?) get a Preml Tool.

vein(?) consists of randomly scattered masses of almost diabasic or decussate — appearing intergrowths of (mostly) lath-shaped, (also irregular) quartz (+ adularia??) x/s avg ~ 0.03 m. x 0.01 mm intergrown w chlorite fibers, randomly oriented, < 0.01 mm length — scattered in this qtz-chl. material are irregular clots of essentially chlorite-free subh-euh. qtz. xl. aggregates — these x/s are much larger than those in the decussate masses — avg ~ 0.15 mm — reaching 0.3 mm — In the quartz clots, which reach 5 mm. maximum dia are commonly centrally-located open spaces up to 1 mm dia, into which project euhedral qtz. x/s. — a few of these cavities are filled w/ calcite.

Tr epidote(??) intergrown w/ the coarse quartz.

PYRITE occurs as diss. subh.-euh x/s & xl clots up to 1.5 mm. in diameter both in bx matrix & in vein — larger clots commonly incorporate clastic fragments

BARELY DISCERNIBLE FOLIATION

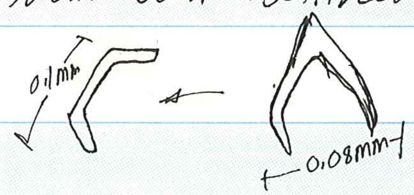
357-6C1

Rock is cut by a few irreg. discontinuous calcite veinlets.

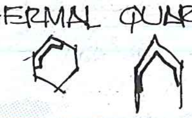
MATRIX — angular to rounded grains averaging about 0.08 mm. in dia., in turn embedded in a sub-matrix of <0.01 mm (qtz (minor)) chl and calcite. The ~~quartz~~ grains are dominantly quartz w/ lesser calcite, ~~shale~~ (?) traces of shale (?) (ser-chl-i'l rock) and minor chert. The calcite fragments ~~are~~ (in the matrix) are commonly more irregular & tend to have corroded-appearing borders — they also blend into sub-matrix carbonate and are often difficult to distinguish from it.

In the sub-matrix: chlorite and calcite are irregularly distributed & occur in all proportions. The chlorite is a v. f. x/n (< 0.01 mm) fibrous pale green variety in which ultra-fine (< 0.02 mm) quartz grains may be embedded.

NOTE: abundant quartz overgrowths on small matrix grains attest to clastic origin but perhaps 2-3% of these matrix quartz grains are definite hydrothermal qtz w/ subh.-euh. outlines & well-defined growth zones.



← ... THOUGHT THESE WERE SHARDS BUT THEY APPEAR TO BE DETACHED GROWTH ZONES FROM HYDROTHERMAL QUARTZ CRYSTALS.



HOWEVER, THEY ARE VERY DELICATE, AND SUPPORT ORIGIN OF THE BRECCIA BY FLUIDIZATION (SHEARING WOULD TEND TO BREAK THEM)

There

FRAGMENTS up to at least ___ mm dia:

minor: subrounded chlorite clasts consisting of fibrous <0.01 mm. flakes randomly-oriented

THESE CLASTS ARE NOT DEFORMED

dominant, subequal → angular to subangular CHERT (some spicular) - x/s usu. < 0.01 mm, but up to 0.1 mm in the aggregates.

& fine-~~med~~ x/n. marble (?) or limestone — aggregates of irregular, randomly oriented x/s. avg 0.05—0.1 mm max. dimension. in a few of these the ~~clasts~~ x/s. in the clasts avg 0.5 mm. max. dim. The ls. clasts tend to be sub-r to well rounded.

minor well x/zd, zoned, hydrothermal quartz crystal aggregates (or rarely, broken but obviously euhedral individual quartz crystals. (see 357-2A)

minor subang-rnded crs-x/n. quartz grains up to 1 mm. dia

358-18A NOTE

NOTE: The large marble breccia clast has inclusions of the high-relief, low birefringence columnar mineral* present in the large, so-called marble "vein" * BARITE (XRD) WITH MAGNETITE & HEMATITE

361-2a 2762. - 2762.

FRACTURED, BRECCIATED, ALTERED & MINERALIZED GRANITE

ESTIMATE ABT. 70% CLASTS, 30% SERICITIZED ROCK FLOUR

361-4b2

FRACTURED, BRECCIATED & ALTERED GRANITE

consists principally of equant to highly irregular "islands" (up to at least 10 mm. max. dimension) of mostly polycrystalline quartz and minor, partly sericitized, potassium feldspar (both microcline and orthoclase), totally sericitized plagioclase and a tr. crs-xln muscovite embedded in a fine xln sericite/phengite/quartz matrix.

The "islands" vary in shape from equant-subrounded & subangular to angular to highly irregular forms — some are clearly clasts others seem too irregular to be so. Many examples of feldspar-rich clasts just barely disrupted & rotated in the sericitic matrix. —— The polycrystalline quartz aggregates in the islands, consist of aggs of irreg. xls up to 0.5 mm. in diameter with mostly irregular sutured boundaries between xls —— the xls' extinction varies from straight to undulatory, and many of the larger qtz. xls. show sub// (within grains) healed microfractures. —— The quartz rexlzd aggregate locally show excellent polygonal rexlzn. —— mortar texture locally developed between qtz. grains in the polycrystalline quartz clasts —— K-feldspar in the "islands" occurs as subhedral xls, up to at least 3 mm. in dia., intergrown with the polyxln. quartz aggregates described above, or a single monomineral clasts in the qtz-ser. matrix. —— The K-spar is partially sericitized (and locally calcite-altered), along cleavage planes, irregular microfractures and probably original perthitic albite lamellae. —— Many K-spar clasts are disrupted and individual pieces partially rotated (but just barely)

~0.3% of this brecciated granite is relatively coarse muscovite, avg ~ 0.3 mm. in length, up to 0.7 mm, mostly intergrown with quartz and feldspar in the clasts & islands described above, but also rarely detached and "floating" in the quartz-sericite matrix — xls in clasts have irregular, ragged borders

— Former plagioclase in the clasts/"islands" is totally sericitized these sericite patches however, by contrast with matrix, tend to extinguish en-masse
→ up to 1 mm. maximum dimension

LEUCOXENE → as <0.1% DISS. irregular clots up to 0.5 mm (avg <0.1 mm) dia, commonly near or intergrown with sulfides and as irregular grains <0.01-0.03 mm. in diameter invariably intergrown with coarse muscovite and as ~~sulfide~~ <0.01-~~0.03~~ mm grains irregularly diss. in matrix — commonly defining a crude foliation

THE MATRIX IS A DENSE MAT OF (INTERGROWN,) V. FXLN. FIBROUS TO FLAKY SERICITE (& MICROXLN QUARTZ) IN WHICH ARE EMBEDDED (SPARSELY) ANGULAR QUARTZ MICROCLASTS (MOST <0.02 MM. DIA. & SULFIDES (TO BE DISCUSSED). MATRIX IS LOCALLY REPLACED BY HIGHLY IRREGULAR & IRREGULARLY DISTRIBUTED PATCHES OF FINE XLN. CALCITE (IND. XLS. 0.1-0.2 MM DIAMETER)

CORE RUN & PIECE No.	DEPTH	BULK XRD: QUARTZ	K-FELDSPAR	ALBITE	CALCITE	DOLOMITE	BARITE	MAGNETITE	HEMATITE	PYRITE	MIXED-LAYER ILLITE-SMEC.	ILLITE	CHLORITE	(<5 μ) CLAY FRACTION: ML ILLITE-SMEC	ILLITE	CHLOR.	ILLITE CRY. IND.	
354-1 →	2700-2700.38	44			–	–					54		2	98		2	(1.18)	(85-90)
354-11a	2706.55-2706.78'	70			–	–					19		11	90		10	(1.20)	(85-90)
354-X →	2708.9-2709.1'	27			–	–					70		3	99		1	(0.82)	(85-90)
355-1b →	2710.52 - 2711.0'	71			1	–					17		11	75		25	(0.88)	(85-90)
355-X →	2715.55- 2716.56'	43			–	–			14			36	7		95	5	(0.66)	
356-1 →	2720.74 - 2721.0'	48			–	–	TR		15			32	5		95	5	(0.66)	
356-6 →	2723.15 - 2723.64'	52			TR	–			11			34	3		95	5	(0.60)	
357-1 →	2726.0 - 2726.42'	91		5	1	–			—				3	NO CLAY FRAC.				
357-2a	2726.71 - 2727.04'	66			–	–			7			25	2		97	3	(0.52)	
357-X →	2728.48 - 2728.78'	80			–	–				3		3	14		25	75	(0.48)	
357-X 3b →	2728.48 - 2728.78 CHL-QTZ "VEIN" OR CLAST	70			–	–				2		—	28	NO CLAY FRAC. —				
357-5b →	2729.05 - 2729.48	2			34	60	1	1	TR	2		3	—	—	—	—	—	
357-5b →	2729.05 - 2729.48' INSOLUBLE RESIDUE	25			—	—	21	16	TR	35			3	NO CLAY FRAC.				
357-6C1 →	2731.03 - 2731.27	45			39	5				3			8			100	—	
358-18a →	2741.22 - 2741.57	70			10	7				2			8			100	—	
359-7a →	2743.72 - 2744.04'	5			92	2				–			1	NO CLAY FRACTION				
359-14 →	2747.93 - 2748.22'	4			95	1				—		—	—	NO CLAY				
361-1a1 →	2761.10 - 2761.30'	90			—	—				2		8	—		99	1	(0.63)	
361-2a →	2762.0 - 2762.40'	55			4	–				3		37	1		99	1	(0.80)	
361-4b2 →	2765.30' - 2765.60'	45	7		10	–				2		33	2		99	1	(0.66)	
361-5a2 →	2768.65 - 2769.0'	54			11	–						32	3		98	2	(0.65)	
362-7b →	2775.50 - 2775.80'	63			3	–				2		27	5		90	10	(0.50)	
362-8 →	2777.90 - 2778.10'	53			TR	–				1		38	8		95	5	(0.52)	
363-1 →	2782.40 - 2782.65'	65			2	–						28	5		95	5	(0.51)	
363-4b →	2786.40 - 2787.0'	61			8	–				1		20	10		60	40	(0.50)	
363-7 →	2790.30 - 2791.0'	45			40	1				1		5	8		50	50	(0.63)	
367-X →	2800.50 - 2800.70'	35			—	—				1		56	8		95	5	(0.60)	
	2733.50 - 2734.50'	6			94									NO CLAY				
	2639.0 - 2639.4'	65			11						15		8					1 APATITE
	2642.0'	65									12		23					
	2646.6 BRN	17			27				6		37		13					
	2646.6 WH.	3			97													
	2668.5	35			63								2					
	2683.0	61		2	1	TR			–		17		19					

BOREHOLE VC-1 2700'-TD XRD RESULTS

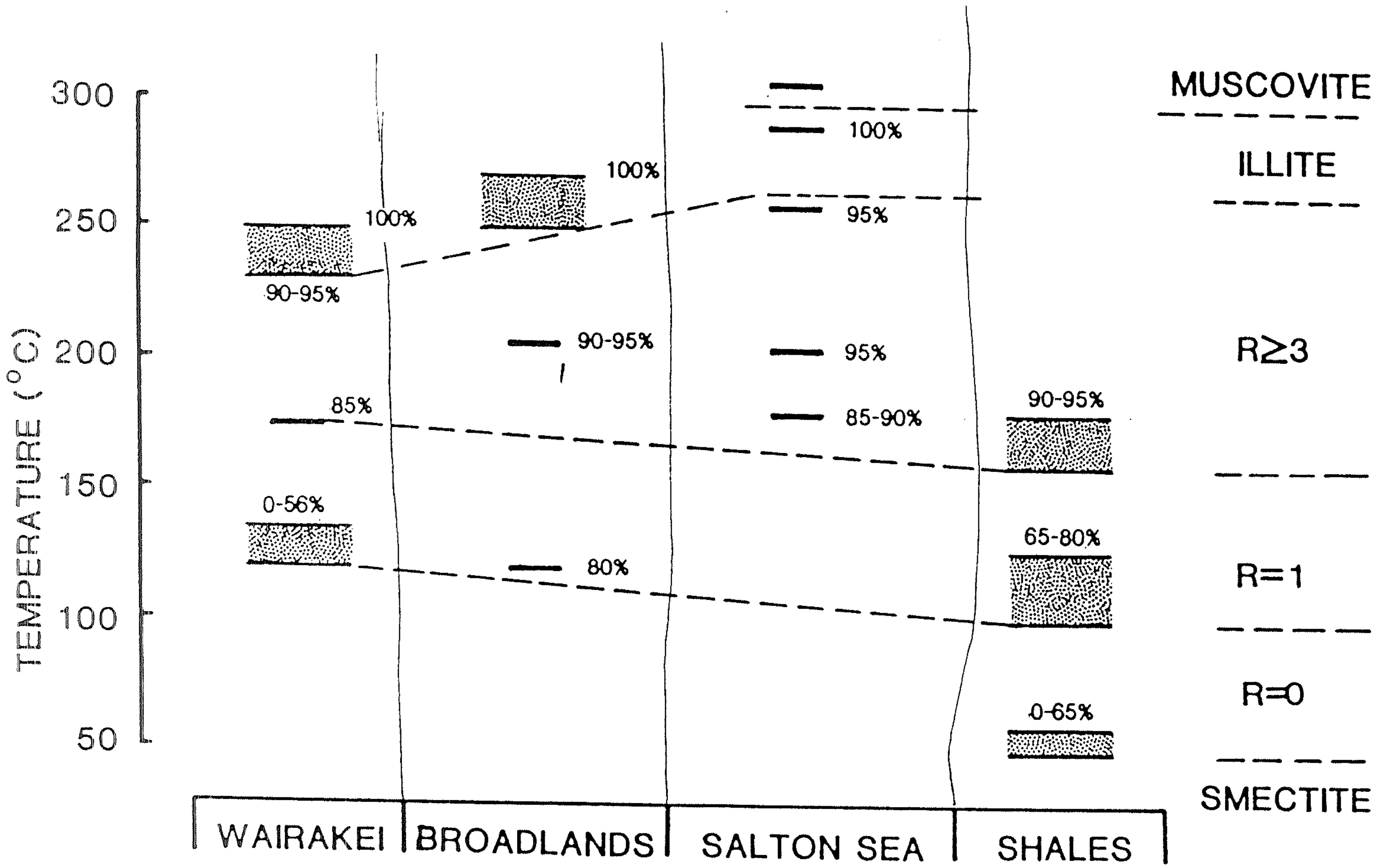


Figure 6. A summary of the temperature dependence of I/S composition from active geothermal areas and deeply buried shales. See text for explanation. (Hower, pers. comm.).

* most discussions of cataclastic rocks deal only with cataclasis of competent rocks
what happens when shales or mudstones are involved in faulting?

Faulting alone can mix formerly separate rock units into heterolithologic ~~fault~~ breccias

e.g. in the San Andreas fault zone near San Francisco are found breccias consisting of clasts of serpentine, sandstone, siltstone, altered basalt or diabase, quartzite, calcareous rx, qtz. diorite and diorite in a laminated mylonitic matrix (Waters and Campbell, 1935)

- in thin-section, however, the mylonite shows evidence of strain, crushing, shearing, and granulation (strain shadows, "mortar-structured" crush powder between larger grains, microscopic shears in individual mineral grains, "rolled" "ROUNDED" grains, "trails" of crushed particles in the strain shadows of large porphyroclasts.

can high-level faulting produce these textures?

The NE-trending ~~Jemez~~ Santa Clara fault zone, which defines the Jemez lineament NE of the Valles caldera, ~~has developed~~ shows evidence of development partially in response to significant compression — ~~slickensid~~ ~~the~~ faults of the Santa Clara zone is ~~are~~ oblique-slip dominated by the strike-slip component. (The motion has been fundamentally strike-slip) [Aldrich, 1985]

— "sections of strata have been ~~remove~~ removed and tectonically added elsewhere along the fault (exotic slices of older material are surrounded by younger along the fault)

beds steeply-dipping ~~and~~ to overturned; broken by conjugate shears.

- (tectonic mixing again)

"CHIMNEY" ORE DEPOSITS (of the Silverton caldera region) are confined ~~to th~~ principally to the caldera's ring fracture zone (actually the NW sector of this zone), in an area also rich in "volcanic pipes"

—Burbank and Luedke, 1968—

some of the chimney deposits are on the rims of, or within "volcanic pipes"

" the cauldron rim zones are perforated by large numbers of [felsic] subvolcanic pipes and by (BRECCIA PIPES)

The Jemez fault zone near Soda Dam has a braided aspect (see Goff and Kron, 1980) reminiscent of the patterns developed by recurrent strike-slip faulting (see Higgins, 1971 fig. 31)

newer ? → Goff et al., 1979

↳ describe "spectacular displays of dragfolds, gouge and breccia zones and chaotic bedding" along Jemez fault zone NE & SW of Soda Dam

— in Soda dam slice – Sandia Fm. vertical to horizontal – are the vertical attitudes due to dragfolding?

Although the Jemez fault zone may be down-to-the-east now, it may, like the Santa Clara segment to the NE of the Valles caldera, have originated as a strike-slip ~~zone~~ fault under influence of an older stress-regime —

this, I believe, implies a certain amount of compression — thus, brecciation, perhaps mylonitization, & tectonic rock type mixing may have been feasible.

CATACLASITE IS EQUIVENT TO FAULT BRECCIA EXCEPT THAT IT HAS A PRIMARY COHERENCE. (Higgins, 1971). FAULT BX., IF COHERENT, HAS BEEN SECONDARILY CEMENTED

I THINK IT MIGHT COMMONLY BE DIFFICULT TO TELL ONE FROM THE OTHER,

E.G. WHAT ABOUT ULTRA FINE-XLN 2nd QUARTZ CEMENTING A FAULT BX? COULD THIS BE DISTINGUISHED FROM FINELY PULVERIZED BUT PRIMARILY COHERENT QTZ??

ENVIRONMENT & ASSOCIATED BX MIGHT HELP — IF METAMORPHIC WALL ROCKS, POSSIBLY CATACLASITE.???

WISE ET AL. (1984) SAY CATACLASITES ARE BRITTLE-ZONE GENERATED. (I WOULD AGREE)

SIBSON, 1977 p. 209: "FORMATION OF INCOHESIVE GOUGE AND BRECCIA IS PROBABLY RESTRICTED TO RELATIVELY NEAR-SURFACE CONDITIONS" (p. 209) p. 208 figure 8 shows 1-4 km as conceptual depth for this process

CORE SAMPLE SHEET

Core Hole Number VC-1

Box #	Run #	Depth Interval	Sample Size (length or width)	Piece #	Type of Sample	Unit	Requestor/ Organization	Purpose Taken	Date Taken	Date Returned	Comments
120	178	676.35-676.5'	0.15'		CORE	Band. Tuff	UURI/ESL J. HULEN, D. NIELSON	STRATIGRAPHIC, STRUCTURAL, ALTERATION RESEARCH	06/24/85		
165	167	965.95-966.5'	0.55'	(from) 8	"	"	"		"		
167	169	984.5-984.8'	0.3'	9	"	"	"	"	"		
395	354	2706.55-2706.78'	0.23'	11A	"	Sandia Fm	"	"	"	———	8/24.92-824.99 M
396	354	~2709'	0.21'	—	"	"	"	"	"		
396	354	2700-2700.38'	0.38'	1	"	"	"	"	"	———	822.92-823.04 M
396	355	2710.52-2711.0'	0.48'	1b	"	"	"	"	"	———	826.13-826.28 M
397a	355	2715.55-2716.56	1.01' (½ CORE LONGITUDINALLY)	X	"	"	"	"	"	———	827.66-827.97M
397a	356	2720.74-2721.0'	0.26'	#1	"	"	"	"	"	———	829.24-829.32M
397a	356	2723.15-2723.64'	0.49'	6	"	"	"	"	"	———	829.98-830.13M
397b	357	2726-2726.42'	0.42'	1	"	"	"	"	"	———	830.84-830.97M
397b	357	2729.05-2729.48	0.43	5b ✓	"	"	"	"	"	———	831.77-831.90 M

Date Rev. 10/84

Curator S. Graff

6

CORE SAMPLE SHEET

Core Hole Number VC-1

Box #	Run #	Depth Interval	Sample Size (length or width)	Piece #	Type of Sample	Unit	Requestor/ Organization	Purpose Taken	Date Taken	Date Returned	Comments
397b	357	2726.71-2727.04'	0.33'	23	CORE	SANDIA FM	J. HULEN/D. NIELSON	STRATIGRAPHIC, STRUCTURAL, ALTERATION RESEARCH	06/24/85	———	831.06-831.16M
397b	357	2728.48-2728.78'	0.30'	5b	"	"	"		"	———	831.6 - 831.7 M
397b	357	2731.03-2731.27	0.24'	6C1	"	"	"	"	"		
398	358	2741.22-2741.57	0.35'	18A	"	"	"	"	"		
399	359	2743.72-2744.04'	0.32'	7	"	"	"	"	"	———	836.25-836.34M
400	359	2747.93-2748.22'	0.29'	14	"	"	"	"	"		
401	361	2761.1-2761.3'	0.20'	1A1	"	"	"	"	"		
401	361	2762(?)-2762.4'	0.40'	2A	"	"	"	"	"		
402	361	2765.3-2765.6'	0.30'	4B2	"	"	"	"	"	———	842.8-842.9 M
402	361	2768.65-2769'	0.35'	5A2	"	"	"	"	"		

Date Rev. 10/84

Curator S. Goff

CORE SAMPLE SHEET

Core Hole Number VC-1

Box #	Run #	Depth Interval	Sample Size (length or width)	Piece #	Type of Sample	Unit	Requestor/ Organization	Purpose Taken	Date Taken	Date Returned	Comments
403	362	2785.5-2785.8'	0.30'	7b	CORE	SANDIA FM	LLLRI/ESL J. HULEN, D. NIELSON	STRATIGRAPHIC, STRUCTURAL, ALTERATION RESEARCH	06/24/85		
404	363	2782.4-2782.65'	0.25	bottom end of 363-1	″	″	″	″	″		
404	363	2786.4-2787'	0.60'	4b	″	″	″	″	″		
405	363	2790.3-2791'	0.70'	7	″	″	″	″	″		
405	364	2792.7-2793'	0.30'	—	″	″	″	″	″		850.44 – 850.66 M
407	367	2800.5-2800.7'	0.20' (several pieces)	—	″	″	″	″	″		
407	367	2807.55-2807.85'	0.30'	—	″	″	″	″	″		
?	362	2777.9-2778.1	0.20'	8	″	″	″	″	10/84		846.66 - 846.72M

Date Rev. 10/84

Curator S. Goff

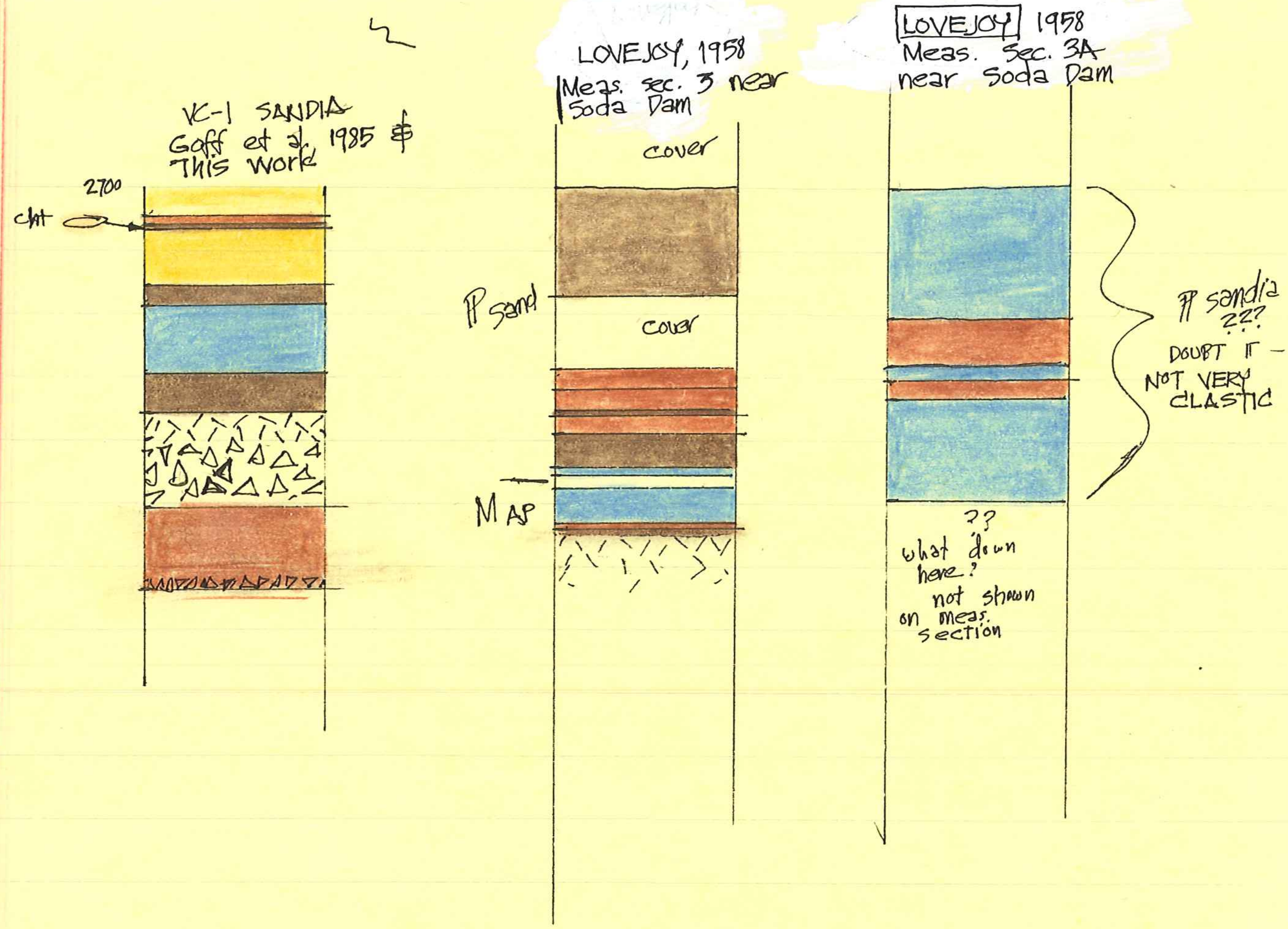
CORE SAMPLE SHEET

Core Hole Number VC-1

Box #	Run #	Depth Interval	Sample Size (length or ~~width~~) Weight	Piece #	Type of Sample	Unit	Requestor/ Organization	Purpose Taken	Date Taken	D Ret
370	332	2498.0-2498.45'	0.45'	9b	core	Madera	Hulen UURI/ESL	Detailed Petrographic Work	11/04/85	
377	339	2557.0-2557.4	0.4	1	"	"	"	"	"	
378	339	2563.8-2564.3'	0.5'	17b	"	"	"	"	"	
387	347	2639-2639.4	0.4'	8	"	"	"	"	"	
388	348	2642-2642.1	0.1'	—	"	"	"	"	"	
389	349	2655-55.7	0.7	8	"	"	"	"	"	
389	349	2658.6-2658.8	0.2	24	"	"	"	"	"	
391	350	2668.5-268.9	0.4	13	"	"	"	"	"	
392	351	2677.7-2678	0.3	14	"	"	"	"	"	
404	363	2787.-2787.3	0.3	5b2	"	SANDIA	"	"	"	
[illegible]	362	2781-2781.5	0.5	13	"	"	"	"	"	Curat

Data Rev. 10/84

2


VC-1 SANDIA
Goff et al. 1985 &
This work
2700
cht
LOVEJOY, 1958
Meas. sec. 3 near
Soda Dam
cover
IP sand
cover
M AP
LOVEJOY 1958
Meas. Sec. 3A
near Soda Dam
IP sandia
???
DOUBT IT —
NOT VERY
CLASTIC
??
what down
here?
not shown
on meas.
section

J-ff

3 VC-1 361-2A

ELEMENT		CONCENTRATION		
NA	% OX.		0.085	
K	% OX.		4.15	
CA	% OX.		2.87	
MG	% OX.		1.16	
FE	% OX.		2.67	
AL	% OX.		13.54	
SI	% OX.	<	1.60	
TI	% OX.		0.262	
P	% OX.		0.029	
SR	PPM		35	
BA	% OX.		0.054	
V	PPM	<	250	
CR	PPM		15	
MN	% OX.		0.027	
CO	PPM		16	
NI	PPM		22	
CU	PPM		23	
MO	PPM	<	50.0	
PB	PPM		61	
ZN	PPM		27	
CD	PPM	<	5.00	
AG	PPM		3	3, 3.8
AU	PPM	<	4.00	<0.1
AS	PPM	<	25.0	
SB	PPM	<	30.0	
BI	PPM	<	100	
U	PPM	<	2500	
TE	PPM	<	50.0	
SN	PPM		5	
W	PPM	<	1200	
LI	PPM		37	
BE	PPM		2.5	
B	PPM	<	400	
ZR	PPM		46	
LA	PPM		86	
CE	PPM		194	
TH	PPM	<	150	
	TOTAL		26.440	

4 VC-1 361-4B2

ELEMENT			CONCENTRATION	
NA	% OX.		0.103	
K	% OX.		4.85	
CA	% OX.		4.09	
MG	% OX.		0.976	
FE	% OX.		2.11	
AL	% OX.		11.69	
SI	% OX.	<	1.60	
TI	% OX.		0.106	
P	% OX.		0.014	
SR	PPM		89	
BA	% OX.		0.097	
V	PPM	<	250	
CR	PPM		11	
MN	% OX.		0.038	
CO	PPM		2	
NI	PPM		10	
CU	PPM		19	
MO	PPM	<	50.0	
PB	PPM		22	
ZN	PPM		26	
CD	PPM	<	5.00	
AG	PPM	<	2.00	1.4
AU	PPM	<	4.00	<0.1
AS	PPM	<	25.0	
SB	PPM	<	30.0	
BI	PPM	<	100	
U	PPM	<	2500	
TE	PPM	<	50.0	
SN	PPM		7	
W	PPM	<	1200	
LI	PPM		32	
BE	PPM		1.5	
B	PPM	<	400	
ZR	PPM		29	
LA	PPM		46	
CE	PPM		96	
TH	PPM	<	150	
	TOTAL		25.680	

– bar × 0.1 = MPa

Grain			T_h(L) (°C)	T_m (°C)	% eq. NaCl (weight %)
1			174.0	–.6	1.0
			192	–.6	1.0
			188.1		
			181.6		
			182.7		
				–.6	1.0
			179.0		
2			166	–.5	.9
			184.3	–.5	.9
3			180.5		
			185		

probable max. correction for pressure increase (pressure correction) for 1000 m lithostatic load ≈ 20°C

aver. 181°C (+20°C) = 200°C (max. trapping temp.)

all inclusions are primary, range in size from 10 × 4 um to .5 × 1 μm

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Fault-Controlled Thermal Stresses as a Fracturing Mechanism in Hydrothermal Systems

M Lee Allison (Univ. of Utah Research Inst., Salt Lake City, UT 84108)

Hydrothermal fluids circulating along open faults or fractures in high temperature geothermal systems will produce thermal stresses large enough to fracture the adjacent rock. Assuming a uniform elastic semi-infinite half-space a thermal stress will develop proportional to the temperature difference between the hydrothermal fluid and the cool rock/fluid beyond the system. The vertical stress σ_{zz} is assumed to be based on the thermal gradient. In contrast to studies on oceanic ridges however, the maximum stress σ_{xx} is normal to the fluid-hosting fault. Stress along the fracture, σ_{yy}, is assumed to be zero because the convecting fluid will equalize temperatures quickly after entering the system. The model is a steady-state system in which hydrothermal fluids continue to replace those that cool and pass out of the system. Thus, neither adjacent rocks nor the source cool as in the cases of oceanic lithosphere or dike injection. For typical rock values the thermal stress is from 1 to 2 kbars for each ΔT of 100°C across the field. Typical continental deviatoric stresses are 0.1 to 1 kbar.

In an extensional environment (σ_1 vertical) faults develop ideally in the direction of σ_2 and perpendicular to σ_3. When later hydrothermal fluids are injected along the faults the new thermal stress results in a reorientation of the total stress field. Stress normal to the fault changes from σ_3 to σ_1. Stress along the fault changes from σ_2 to σ_3. New fractures and faults will form at a high angle to the pre-existing ones. This may help account for complex fracture patterns in hydrothermal systems.

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