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STEAMBOAT






WELL 21B-5R

GEOLOGY










STEAMBOAT (NV) WELL 21B-5R • SUMMARY GEOLOGIC LOG • J.B. Hulen & S.D. Johnson
 Oct. - Nov. 2004

Lithology

-  **HORNBLENDE-BIOTITE GRANITOID, MEDIUM-CRYSTALLINE**
-  **BIOTITE-HORNBLLENDE QUARTZ DIORITE, FINE-CRYSTALLINE**
-  **META-SEDIMENTARY ROCKS, INCLUDING META-QUARTZITE, QUARTZ META-SILTSTONE, BIOTITIC HORNFELSIC META-SILTSTONE & METASANDSTONE, BIOTITE & CALC-SILICATE HORNFELS.**
-  **PEBBLES, GRIT, & SAND, WELL-ROUNDED. MOSTLY "EXOTIC" ROCK TYPES (e.g. ANDESITE) CONFINED TO THE INTERVAL 2850-2860 FT.**
-  **SANDSTONE. CONFINED TO 2850-2860 FT. TWO TYPES: (1) QUARTZ-RICH, SILICA-CEMENTED; (2) ANDESITIC VOLCANICLASTIC, TUFFACEOUS, HEMATITIC, ARGILLIZED**

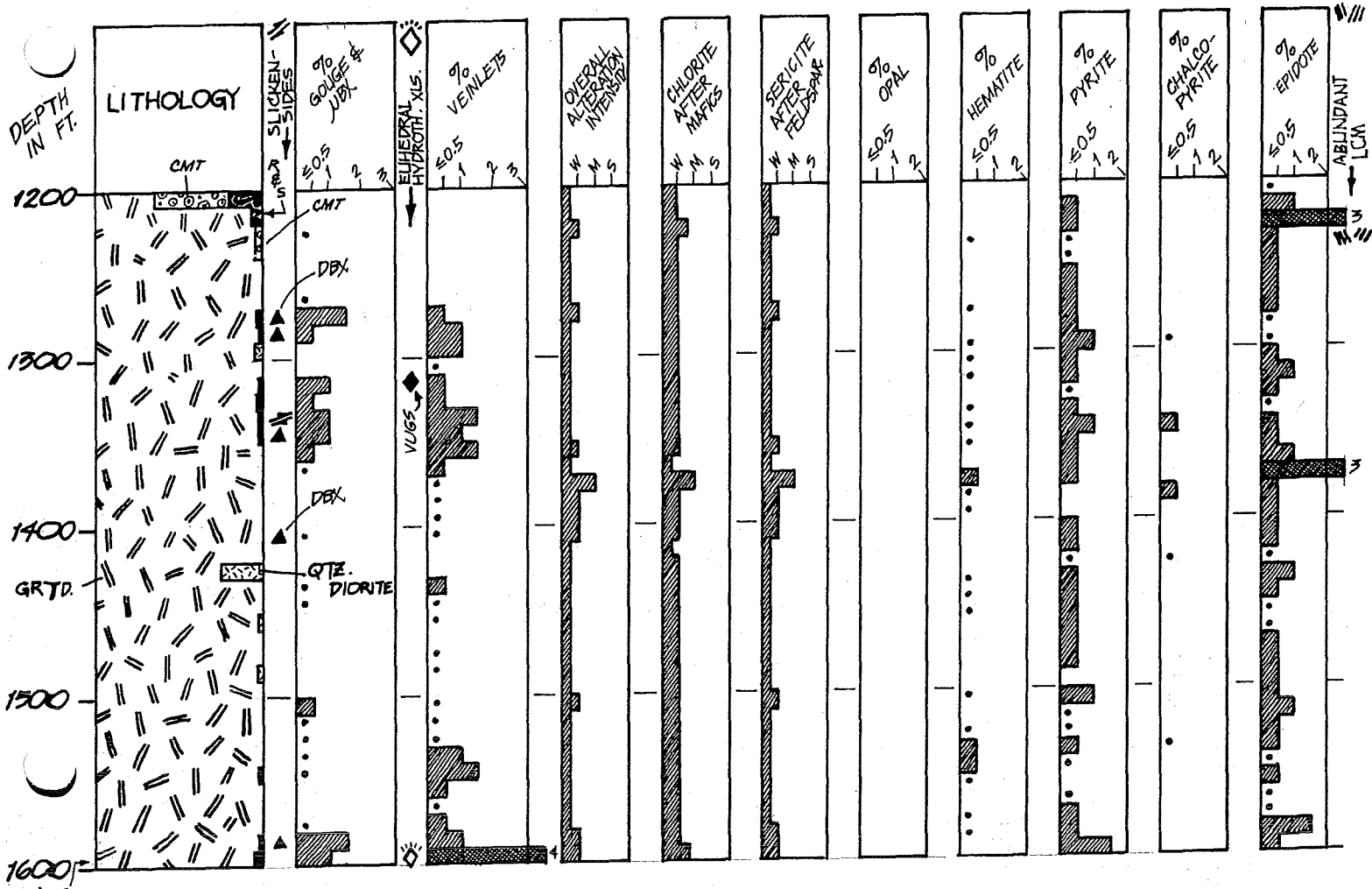
-  **PHYLLITE OR PHYLLOINITE**
-  **OPAL (± MINOR CALCITE), MASSIVE, CLEAR, COLORLESS. COMMONLY BOTRYOIDAL & CORALLINE WHERE UNBROKEN. RARE DEHYDRATION CRACKS. SUBTLY LAMINATED. TEXTURES REMINISCENT OF BOTH SINTER & GEOTHERMAL SCALE.**
-  **GOUGE, MICROBRECCIA & VEINLETS, UNDIVIDED (INDICATORS OF POTENTIAL MODERN HIGH PERMEABILITY)**
-  **CEMENT**
-  **RUST & STEEL, UNDIVIDED**

Symbols

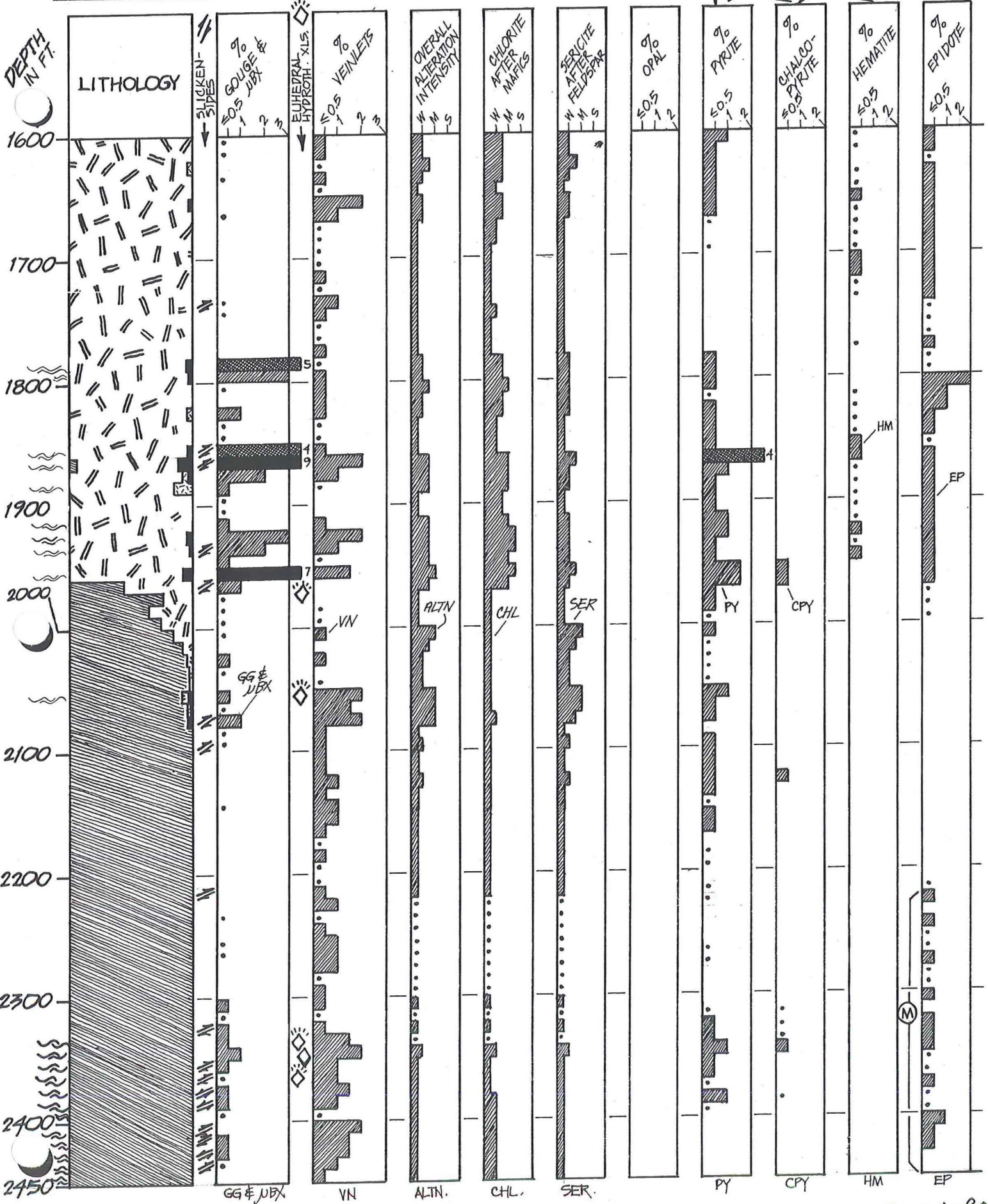
-  - EUHEDRAL HYDROTHERMAL CRYSTALS
-  - SLICKENSIDES
-  - SHEARING
-  - TRACE
-  - MOSTLY METAMORPHIC
-  - DILATIONAL MICROBRECCIA PRESENT
-  - ABUNDANT LCM
-  - AND
-  - VUGS

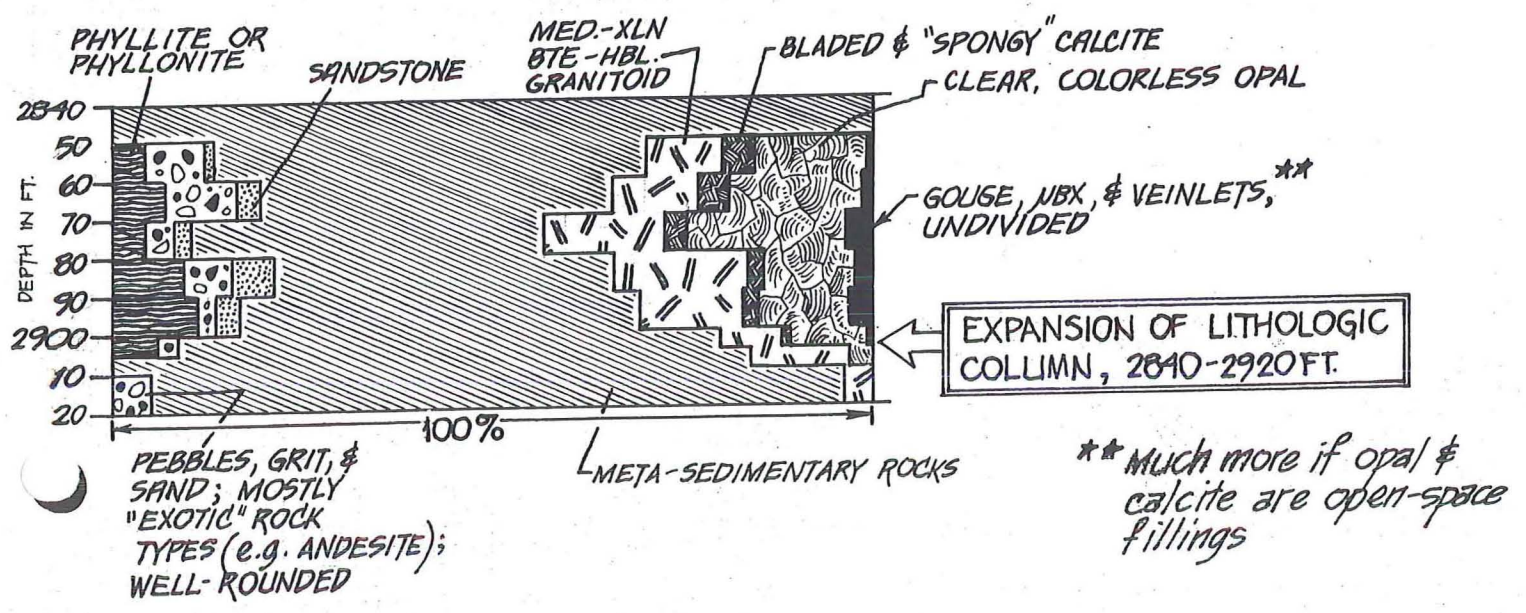
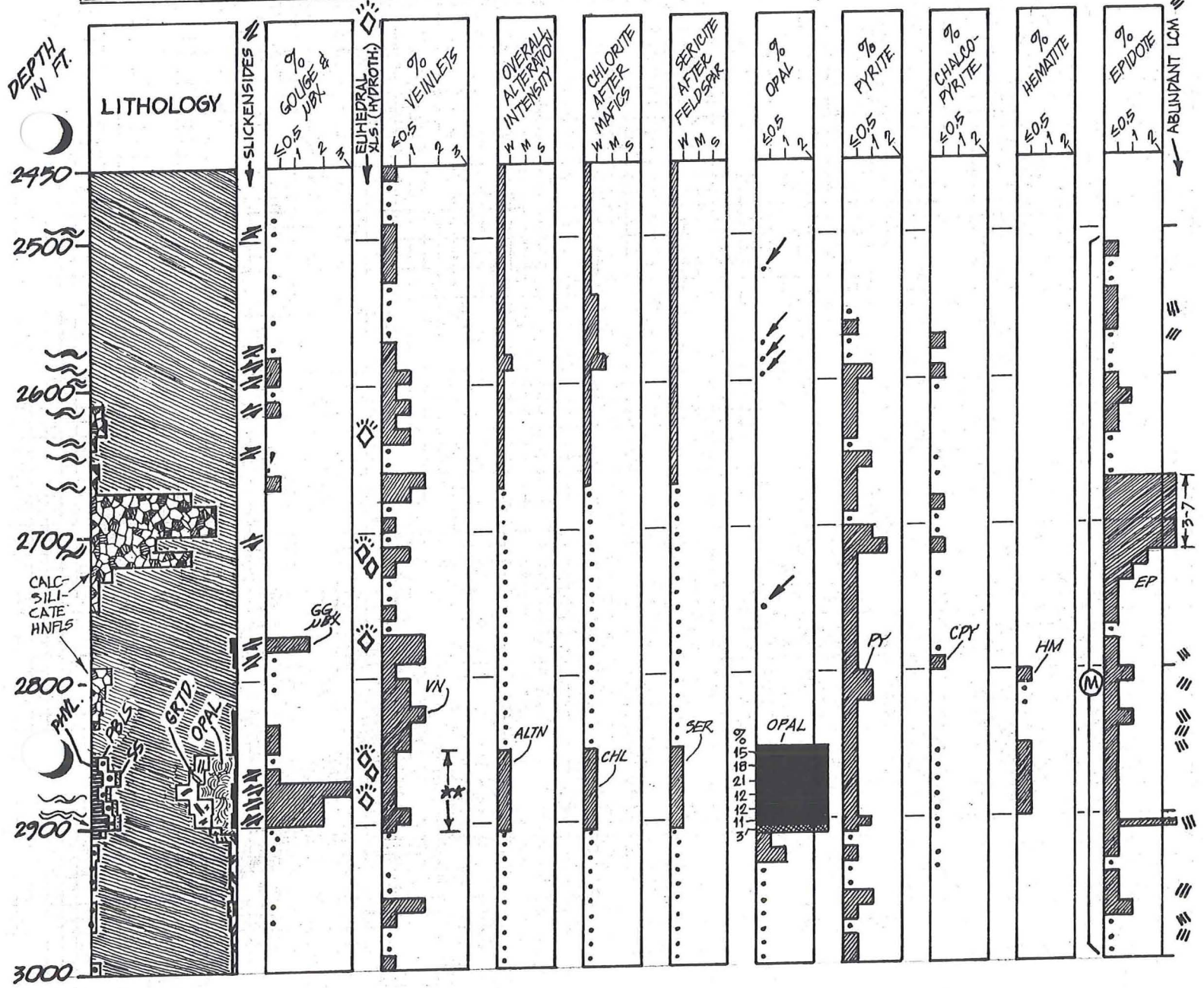
Abbreviations

- DBX - DILATIONAL MICROBRECCIA
- ALTN. - ALTERATION
- BTE. - BIOTITE
- CHL. - CHLORITE
- CPY. - CHALCOPYRITE
- e.g. - FOR EXAMPLE
- EP. - EPIDOTE
- FT. - FEET
- GG - GOUGE
- GRTD. - GRANITOID
- HBL. - HORNBLLENDE
- HM. - HEMATITE
- HYDROTH. - HYDROTHERMAL MATERIAL
- LCM - LOST-CIRCULATION MATERIAL
- M - MODERATE (INTENSITY)
- MED. - MEDIUM
- PBL - PEBBLES
- PHYL - PHYLITE OR PHYLLOINITE
- QZ - QUARTZ
- QD - QUARTZ DIORITE
- S - STRONG (INTENSITY)
- SER - SERICITE
- SS - SANDSTONE
- VN - VEINLETS
- W - WEAK (INTENSITY)
- XLN. - CRYSTALLINE
- XLS. - CRYSTALS
- DBX - MICROBRECCIA
- DBX - DILATIONAL MICROBRECCIA
- R & S - RUST & STEEL, UNDIVIDED
- CMT - CEMENT



STEAMBOAT WELL 21B-5R - SUMMARY GEOLOGIC LOG, cont'd





Lithology

- HORNBLENDE-BIOTITE GRANITOID, MEDIUM CRYSTALLINE**
- BIOTITE-HORNBLLENDE QUARTZ DIORITE, FINE-CRYSTALLINE**
- META-SEDIMENTARY ROCKS, INCLUDING META-QUARTZITE, QUARTZ META-SILTSTONE, BIOTITIC HORNFELSIC META-SILTSTONE & METASANDSTONE, BIOTITE & CALC-SILICATE HORNFELS.**
- PEBBLES, GRIT & SAND, WELL-ROUNDED, MOSTLY "EXOTIC" ROCK TYPES (e.g. ANDESITE) CONFINED TO THE INTERVAL 2850-2860 FT.**
- SANDSTONE. CONFINED TO 2850-2860 FT. TWO TYPES: (1) QUARTZ-RICH, SILICA-CEMENTED; (2) ANDESITIC VOLCANICLASTIC, TUFFACEOUS, HEMATITIC, ARGILLIZED**

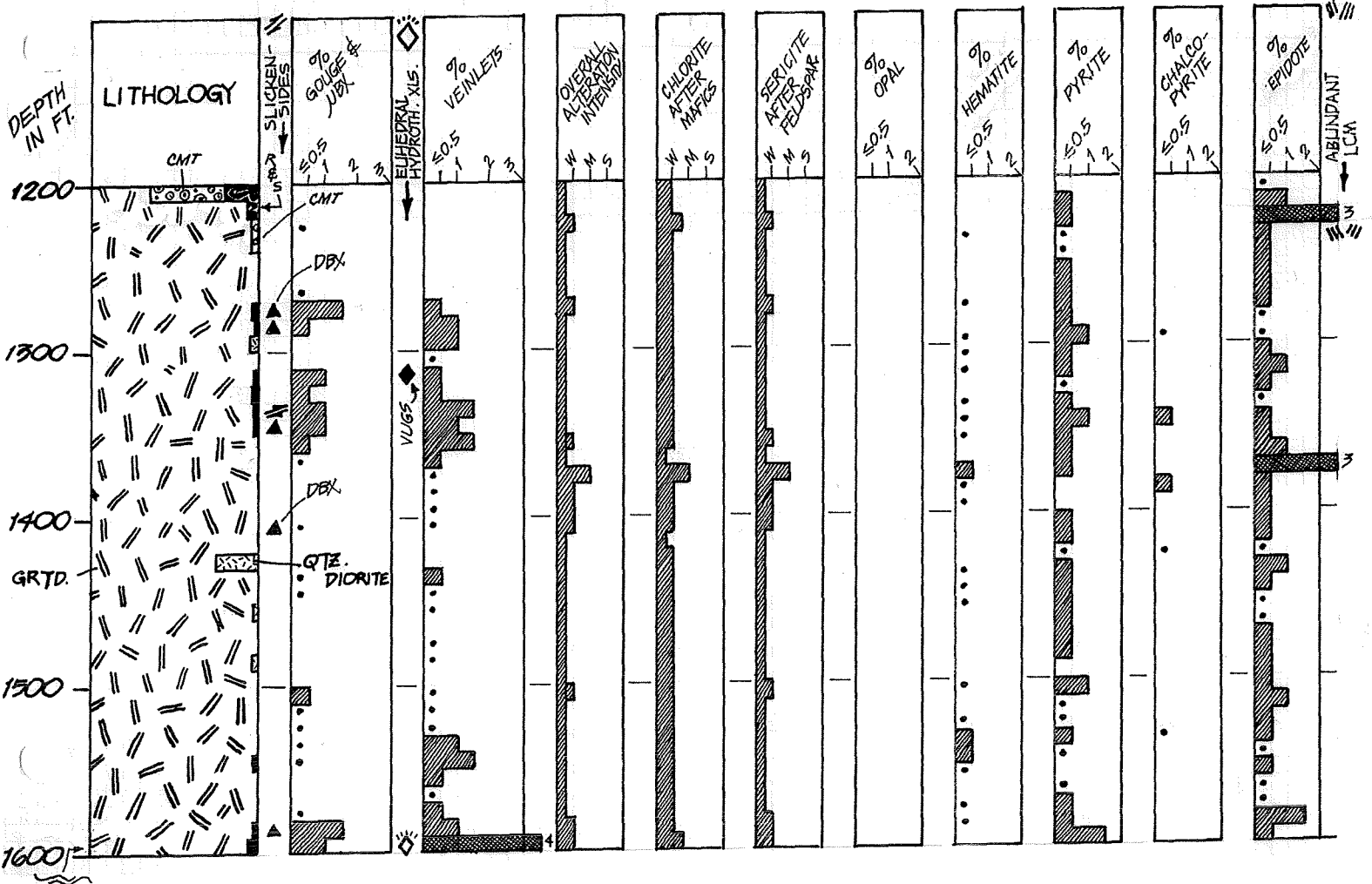
- PHYLLITE OR PHYLONITE**
- OPAL (± MINOR CALCITE), MASSIVE, CLEAR, COLORLESS. COMMONLY BOTRYOIDAL & CORALLINE WHERE UNBROKEN. RARE DEHYDRATION CRACKS. SUBTLY LAMINATED. TEXTURES REMINISCENT OF BOTH SINTER & GEOTHERMAL SCALE.**
- GOLGE, MICROBRECCIA & VEINLETS, UNDIVIDED. (INDICATORS OF POTENTIAL MODERN HIGH PERMEABILITY)**
- CEMENT**
- RUST & STEEL, UNDIVIDED**

Symbols

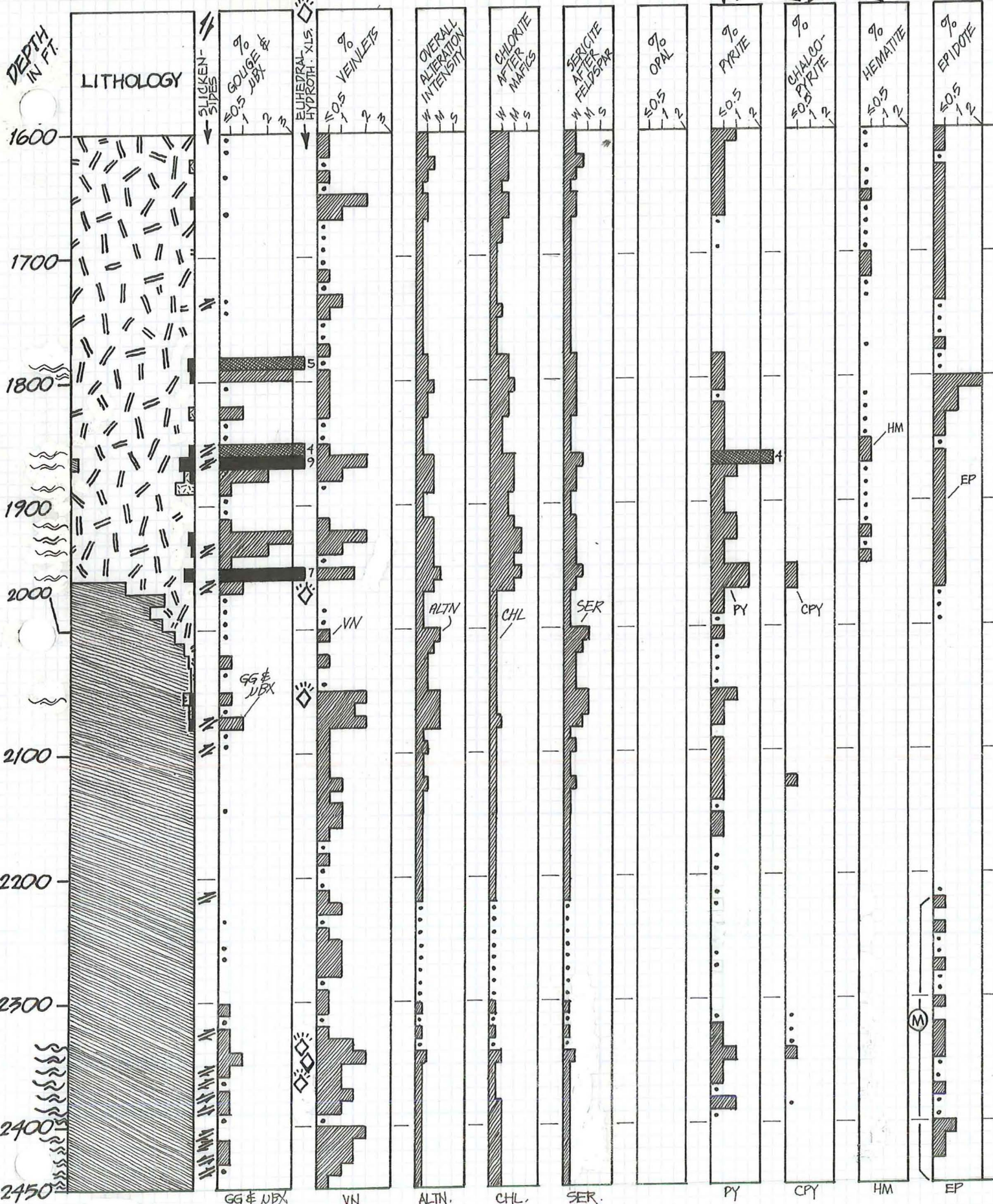
- EUHEDRAL HYDROTHERMAL CRYSTALS
- SLICKENSIDES
- SHEARING
- TRACE
- MOSTLY METAMORPHIC
- DILATIONAL MICROBRECCIA PRESENT
- ABUNDANT LCM
- PER CENT
- AND
- LESS THAN OR EQUAL TO
- VUGS

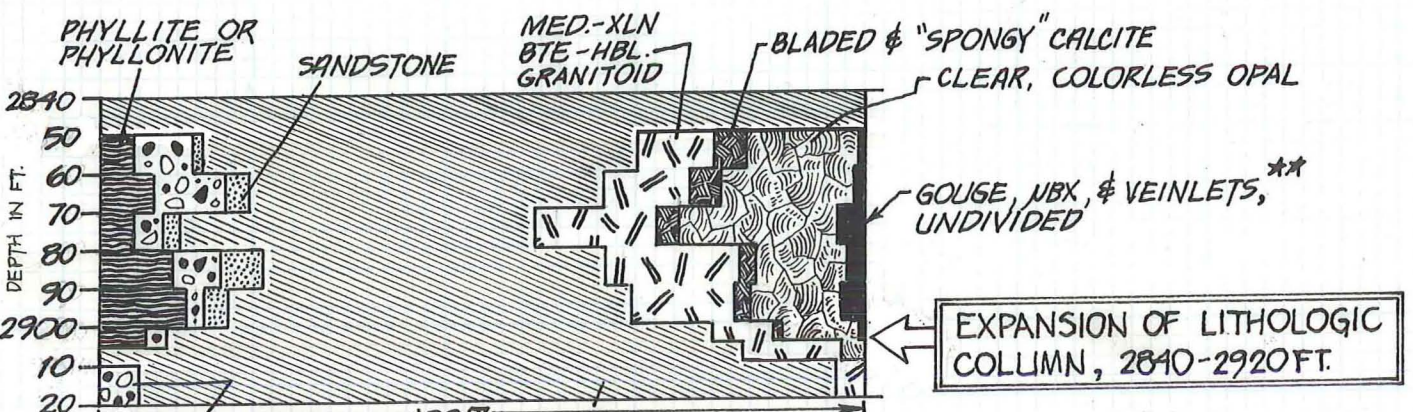
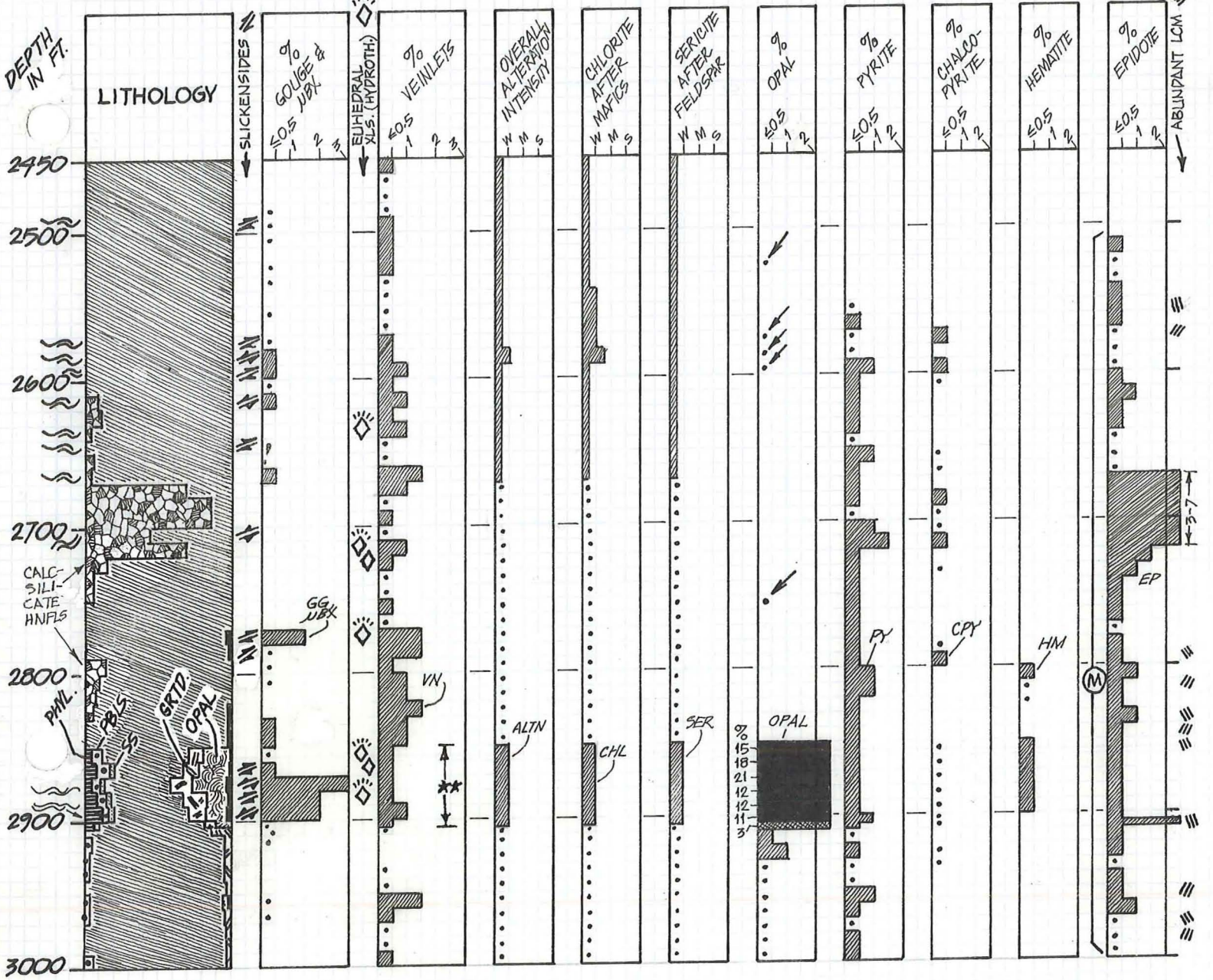
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- MED. - MEDIUM
- PBS - PEBBLES
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- R & S - RUST & STEEL, UNDIVIDED
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- PY - PYRITE
- QD - QUARTZ DIORITE
- S - STRONG (INTENSITY)
- SER - SERICITE
- SS - SANDSTONE
- VN - VEINLETS
- W - WEAK (INTENSITY)
- XLN. - CRYSTALLINE
- XLS. - CRYSTALS
- UBX - MICROBRECCIA
- DBX - DILATIONAL MICROBRECCIA



STEAMBOAT WELL 21B-5R - SUMMARY GEOLOGIC LOG, cont'd





EXPANSION OF LITHOLOGIC COLUMN, 2840-2920 FT.

PEBBLES, GRIT, & SAND; MOSTLY "EXOTIC" ROCK TYPES (e.g. ANDESITE); WELL-ROUNDED

META-SEDIMENTARY ROCKS

** Much more if opal & calcite are open-space fillings

WELL STEAMBOAT
21B-5R

Date Oct. 16-17, 2004 Examiners Hulen, Johnson

SAMPLE	LITHOLOGY, %										INTEGRATED ALTERATION INTENSITY		SELECTED SECONDARY MINERALS		FEATURES
	DEPTH	MXLN HBL - BTE GRANITOID	FYLN HBL - BTE QTZ DIORITE	GOUGE & CRUSH MICROBRECCIA	DILATIONAL MICROBRECCIA	VEINLETS	Chl / Mafics	Ep / Mafics	Ser / FSP	Cal / Mafics	Epidote %	Pyrite %	Hematite %		
1200'															
1210'	100			PLEASE REFER TO DETAILED LOGGING NOTES FOR ROCK TYPE DESCRIPTIONS				W	Tr	VW	W	Tr			
1220'	100									W	VW	VW	W	0.7	0.2
1230'	100				Tr	W-M	W-M	W	W	(3)	0.3				
1240'	100					W	VW	VW	W	0.3	Tr	Tr			
1250'	100					W	Tr	VW	W	0.2	Tr				
1260'	100	Tr				W	VW	VW	W	0.5	0.5				GOUGE, JBX DILATIONAL JBX
1270'	100				Tr	W	VW	VW	W	0.3	0.2				▲
1280'	97	1			(1.5)	0.5	W	W	W	W	0.5	0.2	Tr		▲
1290'	98.5				0.5	1	W	Tr	VW	VW	Tr	0.1			▲
1300'	94	5				1	W	Tr	VW	VW-W	Tr	0.7	Tr	Tr	Tr SPY
1310'	100	Tr				Tr	W	Tr	VW	VW	0.2	0.3	Tr		
1320'	98.5				1	0.5	W	W	W	VW	1	0.2	Tr		▲
1330'	99				0.5	0.5	W	VW	VW	VW	0.3	Tr			▲
1340'	97.5				1	(1.5)	W	VW	VW	VW	Tr	0.4	Tr		▲
1350'	98				0.5	0.5	1	W	VW	VW	0.3	1	Tr	Tr	0.1 SPY
1360'	98				0.5	(1.5)	W	VW	W	VW	0.3	0.2	Tr		▲
1370'	99.5				Tr	0.5	VW	Tr	VW	VW	0.7	0.3			▲
1380'	100				Tr	Tr	M	W	M	W	(2.5)	0.4	0.3	Tr	0.1 SPY
1390'	100				Tr	Tr	W	VW	W	VW	0.2		Tr		
1400'	100				Tr	Tr	W	VW	W	VW	0.4		Tr		
1410'	100				Tr	Tr	Tr	W	VW	W	VW	0.3	0.1		▲
1420'	75	25					VW	Tr	VW	VW	0.8	0.4			
1430'	100						W	Tr	VW	VW	Tr	Tr		Tr	SPY

STEAMBOAT
WELL 21B-5R

Date Oct 17, 18 2004 Examiner Hulen, Johnson

SAMPLE	LITHOLOGY										INTEGRATED ALTERATION INTENSITY		SELECTED SECONDARY MINERALS		FEATURES
	DEPTH	MXLN HBL-BTE GRANITOID	FYLN HBL-BTE QTE DIORITE	GOUGE & CRUSH MICROBRECCIA	DILATIONAL MICROBRECCIA	VEINLETS	Chl./Mafics	Ep./Mafics	Ser./FSP	Cal./Mafics	Epidote %	Pyrite %	Hematite %		
(P.2 of 9)															
1440'	99.5			Tr		0.5	W	VW	VW	VW	0.7	0.3	Tr	Δ	
1450'	100			Tr	Tr	Tr	W	VW	VW	VW	0.5	0.2	Tr	ΔΔ	
1460'	98 2					Tr	W	VW	VW	VW	Tr	0.3	Tr		
1470'	100						W	Tr	VW	VW	Tr	0.1			
1480'	100					Tr	W	VW	VW	VW	0.2	0.1			
1490'	97 3					Tr	W	VW	VW	VW	0.2	0.1			
1500'	100 Tr						W	VW	VW	VW	0.1				
1510'	99.5			0.5		Tr	W	VW	W	VW	0.3	0.7	Tr	Δ	
1520'	100			Tr		Tr	W	VW	VW	VW	0.7	Tr		Δ	
1530'	100			Tr		Tr	W	VW	VW	VW	0.2	Tr	Tr	Δ	
1540'	98.5 99			Tr		1.5	W	VW	VW	VW	0.1	0.2	0.1	Tr cpy Δ	
1550'	98.5			Tr		(1.5)	W	VW	VW	VW	Tr	Tr	0.1	Δ	
1560'	98.5 1					0.5	W	VW	VW	VW	0.5	Tr	Tr	Euh. HYDROTH. CRYSTALS	
1570'	100 Tr					Tr	W	VW	VW	VW	Tr	Tr			
1580'	99.5			Tr		0.5	V	VW	VW	VW	Tr	0.2	Tr	Δ	
1590'	96.5 1			(1.5)	Tr	1	W	W	W	W	(1.5)	0.3	Tr	ΔΔ	
1600'	95.5			1		(3.5)	W-M	W	W	W	0.5	(1.5)		Δ	
1610'	99.5			Tr		0.5	W-M	W	W	W	0.3	1	Tr	Δ	
1620'	99.5			Tr		0.5	W-M	W	W	W	0.3	0.3	Tr	Δ	
1630'	97 3					Tr	W-M	Tr	W-M	W	Tr	0.2			
1640'	99.5			Tr		0.5	W-M	VW	W	W	0.3	0.1	Tr	Δ	
1650'	100					Tr	W	VW	VW	W	0.2	0.2	Tr		
1660'	97 1					(2)	W-M	Tr	W	Tr	0.3	0.4	0.1		
1670'	99			Tr		1					0.5	0.2	Tr	Δ	

Euh. HYDROTH. CRYSTALS
↑
SHEAR-RING

SAMPLE	LITHOLOGY										INTEGRATED ALTERATION INTENSITY		SELECTED SECONDARY MINERALS		FEATURES
	DEPTH	MAX HBL-BTE GRANITOID	FXLY HBL-BTE BTE DIORITE	METR-SILTSTONE & METR-SANDSTONE	GOLGE & CRUSH MICROBRECCIA	DILATIONAL MICROBRECCIA	VEINLETS	Chl./Mafics	EP/Mafics	Ser./FSP	Cal./Mafics	Epidote %	Pyrite %	Hematite %	
1680'	100						Tr	W	VW	VW	W	0.3	Tr	Tr	
1690'	100						Tr	W	Tr	VW	VW	0.1		Tr	
1700'	100						Tr	VW	VW	VW	VW	0.3	Tr	Tr	
1710'	100						Tr	VW	VW	VW	VW	0.5		0.1	
1720'	99.5						0.5	VW	VW	VW	VW	0.2		0.1	SLICKEN-SIDES
1730'	100						Tr	VW	VW	VW	VW	0.2		Tr	
1740'	99				Tr	Tr	1	W	VW	VW	VW	0.2		Tr	△ (46)
1750'	99.5				Tr		0.5	VW	Tr	VW	VW	Tr			△
1760'	100	Tr					Tr	VW	Tr	VW	VW	Tr			
1770'	100	Tr					Tr	VW	Tr	VW	VW	Tr			
1780'	99.5						0.5	VW	VW	VW	VW	0.2		Tr	
1790'	95				(5)		Tr	W-M	Tr	W	VW	Tr	0.5		△
1800'	95	1.5			(3)		0.5	W-M	Tr	W	VW	Tr	0.2		△
1810'	99.5				Tr		0.5	(M)	W	W	W	(2)	0.1		△
1820'	99.5						0.5	W-M	VW	W	W	1	Tr	Tr	
1830'	96	2.5			1		0.5	W-M	VW	W	W	0.7	0.1	Tr	△
1840'	99	1			Tr		Tr?	W	VW	VW	VW	0.3	0.2	Tr	△
1850'	100	Tr			Tr		Tr	W	W	VW	VW	0.5	0.5	Tr	
1860'	96				(35)		(0.5)	W	Tr	VW	VW	Tr	0.1	0.2	△
1870'	85			4	(9)		(2)	(M)	VW	W-M	W	W-M SIL	(4)	0.1	△
1880'	90	5		2	(2)		*1	(M)	VW	W	W	Tr SIL	0.3	1	Tr
1890'	83.5	15		1	0.5		Tr	(M)	VW	W	W	"	0.5	0.5	Tr
1900'	100			Tr			W-M	VW	VW	W	W	0.5	0.3	Tr	△
1910'	100			Tr			W-M	VW	VW	W	W	0.3	0.1	Tr	△

STEAMBOAT
WELL 218-5R

Date 10/21-11/09/04 Examiner Hulen, Johnson

SAMPLE	LITHOLOGY								INTEGRATED ALTERATION INTENSITY				SELECTED SECONDARY MINERALS			FEATURES		
	DEPTH	MXLN HBL-BTE GRANITOID	FXLN HBL-BTE QTZ DIORITE	MS-1	MS-2	MS-3	MS-4	GOLGE & CRUSH MICROBRECCIA	DILATIONAL MICROBRECCIA	VEINLETS	Chl./Mafics	Ep./Mafics	Ser./FSP.	Cal./Mafics	Epidote %		Pyrite %	Hematite %
1920'	97	1.5						1	(1.5)	(M) VW	W	W		0.3	1	0.2		Δ
1930'	95							(3)	(2)	(M-5) VW	W	W		0.3	1	0.3		Δ
1940'	97							(2)	(1)	(M-5) VW	W	W		0.5	0.5	Tr		Δ
1950'	99.5							0.5	Tr	(M) VW	W	W		0.3	0.3	0.2		Δ
1960'	91.5							(7)	(1.5)	(M-5) VW	(M-5) W			0.1	(1.5)		0.1 cpy	Δ
1970'	56	Tr	43					1		(M) VW	W	W		0.2	(1.5)		0.1 cpy	Δ
1980'	28	Tr	74	3				Tr		VW	Tr	VW	Tr	Tr	0.1			Δ
1990'	35		62	3				Tr	Tr	VW	Tr	VW	Tr	Tr	0.2			Δ
2000'	25	1	69	5				Tr	Tr	VW	Tr	VW	Tr	Tr	Tr			Δ
2010'	14.5	1	75	9				Tr	0.5	VW	-	(M) -	-		0.2			Δ
2020'	9	Tr	80	11						VW	-	W-M	-		Tr			Δ
2030'	5	5	72	17				0.5	0.5	VW	-	W	-		Tr			Δ
2040'	3	5	5	77				Tr		VW	-	W	-		Tr			Δ
2050'	3	7	17	63				Tr	Tr	VW	-	W	-		Tr			Δ
2060'	5.5	4	19	68				0.5	(2)	VW	-	(M) -	-		1			Δ
2070'	2	3.5	17	76				Tr	(1.5)	VW	-	(M) -	-		0.3			Δ
2080'	1	5	20	72				1	(2)	VW	-	W-M	-		0.2			Δ
2090'	-	1.5	15	83				Tr	0.5	VW	-	VW	-		Tr			Δ
2100'	-	Tr	3.5	96				Tr	0.5	W	-	W	-		0.3			Δ
2110'		8	9.5	82				-	0.5	VW	-	VW	-		0.2			Δ
2120'		7	9.5	83				-	0.5	VW	-	VW	-		0.2			Δ
2130'		5	7	87				-	1	VW	-	W	-		0.1		0.2 cpy	Δ
2140'		7	5	81.5				-	0.5	VW	-	VW	-		0.2			Δ
2150'		3	5	91				Tr	1	VW	-	VW	-		Tr			Δ

R26

WELL STEAMBOAT
21B-5R

Date 10/21-11/09/04

Examiner Hulen, Johnson

SAMPLE	LITHOLOGY										INTEGRATED ALTERATION INTENSITY		SELECTED SECONDARY MINERALS		FEATURES	
	DEPTH	MXLN HBL-BTE GRANITOID	FXLN HBL-BTE QTZ DIORITE	MS-1	MS-2	MS-3	MS-4	GOLGE & CRUSH VIBX DILATIONAL VIBX	VEINLETS	Chl./Mafics	Ep./Mafics	Ser./FSP	Cal./Mafics	Epidote %		Pyrite %
2160'	Tr	4-8	11	84				1	VV W	-	VV W	VV W	-	0.2		
2170'	Tr	4-8	7	88.5				0.5	VV W	-	VV W	VV W	-	0.1		
2180'		3	10	87				Tr	VV W	-	VV W	VV W	-	-		
2190'		2.5	10	87.5				0.5	VV W	-	VV W	VV W	-	Tr		
2200'		2-8	15	83				Tr	VV W	-	VV W	VV W	-	Tr		
2210'	1	2	17	80				Tr	VV W	-	VV W	VV W				
2220'	Tr	9.5	15	75				0.5	VV W	Tr	VV W	VV W	Tr	Tr		VA
2230'	Tr	10	10	79				1	-	-	-	-	0.1	Tr		
2240'	Tr	10	12	78	Tr			Tr	-	-	-	-				Δ
2250'	Tr	10	7	83				0.5	-	-	-	-	0.2	Tr		
2260'	Tr	7	15	77	Tr			1	-	-	-	-	Tr	Tr		Δ
2270'	Tr	7	10	82	Tr			1	-	-	-	-	Tr	Tr		Δ
2280'		5	15	79				1	-	-	-	-	0.2	Tr		
2290'		5	20	75				Tr	-	-	-	-	Tr			
2300'		11	17	71.5				0.5	-	-	-	-	Tr			
2310'		11	15	73	0.5			0.5	VV W	VV W	VV W	VV W	0.1			Δ
2320'	Tr	5	17	78	Tr			Tr	-	-	-	-	Tr		Tr	Tr
2330'		10	25	61	0.5			0.5	VV W	-	VV W	VV W	0.1	0.2		Tr
2340'		10	30	83.5	0.5			(1.5)	-	-	-	-	0.3	0.4		Tr
2350'		15	25	57	1			(2)	W	-	W	VW	0.3	0.7		Tr
2360'		12	25.5	61	0.5			1	VW	-	VW	VW	Tr	0.1		Tr
2370'		5	15	79	Tr			1	VW	-	VW	VW	Tr	0.1		Tr
2380'		2	10	86	0.5			(1.5)	VW	-	VW	VW	0.2	Tr		Tr
2390'		3	30	65.5	0.5			1	W	-	VW	VW	Tr	0.7		Tr

2150' 2 5.91 Tr 1 Tr 0.5

STEAM-
WELL BOAT 210-5R

Date 10/21-11/09/04

Examiner Hulen, Johnson

SAMPLE	LITHOLOGY										INTEGRATED ALTERATION INTENSITY		SELECTED SECONDARY MINERALS		FEATURES			
	DEPTH	MXLN HBL-BTE GRANITOID	FYLN HBL-BTE QTE DIORITE	MS-1 CONTINUED	MS-2 CONTINUED	MS-3 CONTINUED	MS-4 CONTINUED	GOUGE & CRUSH D/BX	DILATIONAL J/BX	VEINLETS	Chl./Mafics	Ep./Mafics	Ser./FSP	Cal./Mafics		Epidote %	Pyrite %	Hematite %
2400	2	5	45	48			Tr	Tr	W	VW	VV			Tr	Tr			Δ ~
2410	2	5	50	41				②	W	VW	VV			0.7				Δ ~
2420	Tr	3	50	45			0.5	①.5	W	VW	VV			0.2				Δ ~
2430	Tr	3	40	55			0.5	①.5	W	VW	VV			0.3				Δ ~
2440	1	5	35	68			Tr	1	W	VW	VV							Δ ~
2450	Tr	3.5	50	46				0.5	W	VW	VV							~
2460	Tr	1.5	55	43				0.5	VW	VV	VV							
2470	Tr	1	45	54				Tr	VW	VV	VV							
2480		2	40	58				Tr	VW	VV	VV							

SAMPLE	LITHOLOGY										INTEGRATED ALTERATION INTENSITY	SELECTED SECONDARY MINERALS			FEATURES			
	DEPTH	MXLN HBL-BTE GRANITOID	FXLN HBL-BTE QTZ DIORITE	MS-1	MS-2	MS-3	MS-4	OPAL	CALCITE	BOUGE & CRUSH JBOX		DILATIONAL JBOX VEINLETS	Chl./Mafics	Ep./Mafics		Ser./Fsp.	Cal./Mafics	Epidote %
P.7 of 9																		
2490'			2	35	63			Tr	Tr	VW		VV W	VV W					Δ
2500'			2.5	20	77			Tr	0.5	VW		VV W	VV W					Δ Δ ~
2510'			7.5	25	67			Tr	0.5	VW		VV W	VV W					Δ
2520'			9	2.5	25	63			0.5	VW		VV W	VV W	0.1				
2530'			5.5	15	79		(Tr)	Tr	0.5	VW		VV W	VV W	Tr.				Δ
2540'	1		5	15	79			Tr	Tr	XW		VW	VV W	Tr				Δ
2550'	1		7	1	20	71			Tr	W		VW	VV W	0.3				
2560'	1		6	2	10	81		Tr	Tr	W		W	VV W	0.3				Δ
2570'	0.5		20	1.5	10	68			Tr	W		VW	VV W	0.2	0.4			
2580'	0.5		15		15	69		(Tr)	Tr	0.5	W	VW	VV W	Tr	Tr	0.1	CPY	Δ ~
2590'	Tr		12	Tr	10	77		(Tr)	0.5	0.5	W-M	W	VV W	Tr	Tr			Δ ~
2600'	Tr		7.5		7	85		(Tr)	0.5	1	VW	VW	VV W	Tr	1	0.1	CPY	Δ ~
2610'	Tr		7	1.5	7	84		Tr	0.5	VW		VVW	VV W	0.1	0.3	Tr	CPY	Δ
2620'	Tr		25	9	5.5	59		0.5	1	VV W		VVW	VV W	1	0.3			Δ ~
2630'			30	10	7.5	52			0.5	VV W		VV W	VV W	0.5	0.5			
2640'			5	2	13	79			1	VV W		VV W	VV W	0.3	0.3			Δ
2650'			5	Tr	9	86		Tr	Tr	VV W		VV W	VV W	Tr	Tr			Δ ~
2660'			13	5	25	57			Tr	VV W		VV W	VV W	Tr.	1		Tr.	CPY
2670'			17	3	25	53		0.5	(1.5)	VV W		VV W	VV W	Tr	0.5		Tr	CPY
2680'			7	70	5	17			1					(4)	0.5			
2690'			5	87	1	7			Tr					(6)	0.1			0.1
2700'			5	87	1.5	6			(0.5)					(7)				Tr.
2710'			12	45	9	24		Tr						(5)	1			Tr.
2720'			10	69	13	7		1						(6)	(13)			0.2

meta-morphic

0.1 CPY
Tr.
CPY
Tr.
CPY
Tr.
CPY
0.2 CPY

WELL Steamboat 218-5R Date 10/21-11/09/04 Examiner Hulen, Johnson

SAMPLE	LITHOLOGY										INTEGRATED ALTERATION INTENSITY		SELECTED SECONDARY MINERALS		FEATURES																																																																																				
	MS-1	MS-2	MS-3	MS-4	MS-5	MS-6	MS-7	MS-8	MS-9	MS-10	MS-11	MS-12	MS-13	MS-14		MS-15	MS-16	MS-17	MS-18	MS-19	MS-20	MS-21	MS-22	MS-23	MS-24	MS-25	MS-26	MS-27	MS-28	MS-29	MS-30	MS-31	MS-32	MS-33	MS-34	MS-35	MS-36	MS-37	MS-38	MS-39	MS-40	MS-41	MS-42	MS-43	MS-44	MS-45	MS-46	MS-47	MS-48	MS-49	MS-50	MS-51	MS-52	MS-53	MS-54	MS-55	MS-56	MS-57	MS-58	MS-59	MS-60	MS-61	MS-62	MS-63	MS-64	MS-65	MS-66	MS-67	MS-68	MS-69	MS-70	MS-71	MS-72	MS-73	MS-74	MS-75	MS-76	MS-77	MS-78	MS-79	MS-80	MS-81	MS-82	MS-83	MS-84	MS-85	MS-86	MS-87	MS-88	MS-89	MS-90	MS-91	MS-92	MS-93	MS-94	MS-95	MS-96	MS-97	MS-98
P.8 99 DEPTH																																									INTEGRATED ALTERATION INTENSITY	SELECTED SECONDARY MINERALS		FEATURES																																																							
2730	1.5	15	15	65											0.5	(1.5)	0.5	Tr. cpy	□																																																																																
2740		5	3	92											Tr	0.7	0.1	Tr. cpy																																																																																	
2750		5	3	92											Tr	0.5	0.2																																																																																		
2760	2.5	3	7	87	(Tr)										0.5	0.2	0.3																																																																																		
2770	10	2	10	78											Tr	0.3	0.1																																																																																		
2780	21	3	7	66											(1.2)	(1.5)	0.3	Tr. cpy	⚡ □ Δ																																																																																
2790	27	2.5	5	68											Tr	(1.5)	0.1	0.3	⚡ Δ																																																																																
2800	46	13	3.5	37											Tr	0.5	0.1	cpy	Δ																																																																																
2810	55	9	3	32											Tr	1	0.7	0.2	Δ																																																																																
2820	69	7	2	21											Tr	1	0.5	1	Tr	Δ																																																																															
2830	76	5	3.5	14											(1.5)	Tr	0.5	Tr																																																																																	
2840	30	2.5	3	63											0.5	1	0.1	0.3	Tr. cpy	Δ																																																																															
2850	42	3.5		53											0.5	1	1	0.5		Δ																																																																															
2860	10	27	2.5	4	28	(7)	(2)	(15)	(4)	Tr	0.5											0.5				⚡ □ Δ																																																																									
2870	11	24	1	3	13	(7)	(9)	(3)	(18)	(4)	0.5	0.5											0.5				⚡ □ Δ																																																																								
2880	16	27	2.5	2	13	(4)	(3)	(2)	(2)	(3)	(3)	0.5	0.3	0.3											0.5				⚡ □ Δ																																																																						
2890	17	27	2.5	3	12	(9)	(6)	(5)	(12)	(3)	(2)	0.5											0.5				⚡ □ Δ																																																																								
2900	13	29	Tr	2	23	(11)	(2)	(3)	(11)	(3)	(2)	1											1				⚡ □ Δ																																																																								
2905	8	15	Tr	2.5	52	(6)	(2)	(1)	(10)	(3)	Tr	0.5	0.2	0.7	Tr. cpy	Δ																																																																																			
2910	13	15	4	30	35											(3)	Tr	0.5	Tr. cpy	Δ																																																																															
2920	4	5	Tr	3	82	(5)	(0.5)	(0.5)											0.2	Tr																																																																															
2930	4	2	Tr	3	87	(3)	(Tr)	(1)											Tr	0.2	Tr. cpy																																																																														
2940	4	4		2	87	(3)	(Tr)	(Tr)											Tr	Tr	Tr. cpy	⚡ Δ																																																																													
2950	3	5	*	23	89	(1)	(Tr)											Tr	0.5	Tr	Tr. cpy																																																																														
2960	35	3			90	(2)	(Tr)	Tr	1.5											0.3	1			⚡																																																																											

① and bslf

WELL STEAMBOAT 21B-5R Date 10/21-11/09/04 Examiner Hulen, Johnson

SAMPLE	LITHOLOGY										INTEGRATED ALTERATION INTENSITY		SELECTED SECONDARY MINERALS		FEATURES					
	MAX. IREL-BTE GRID EXLN	MS-1	MS-2	MS-3	MS-4	PHYLLITE OR PHYLLONITE	PEBBLES OR SAND	SANDSTONE, UNMETAMORPHIC	OPAL	CALCITE	GOUGE & CRUSH MFX	DILATIONAL JOINT VEINLETS	Chl. / Mafics	Ep. / Mafics		Ser. / FSP	Cal. / Mafics	Epidote %	Pyrite %	Hematite %
2970	5	3.5		89	(2)	(T)	(T)	T		0.9							0.7	0.3		4
2980	3	5		92		(T)				T							T	T		
2990	2	3		94	(1)	(T)	(T)			T							T	0.3		
3000	2			91.5	(6)	(T)				0.5							T	0.2		

249

DEPTH

TD

STEAMBOAT WELL 21B-5R

Geologic Logging Notes — Cuttings,
J. Hulen, S. Johnson 1200-
10/16/04 — 11/09/04 3000 ft. (TD)

- Symbol Explanation —→ (p. 78)
- Abbreviations —→ (p. 79-81)

• FEATURES OF PARTICULAR INTEREST

① 2850-2905' —→ (p. 57-72)

- ①a Relatively abundant contaminants (steel, rust, Cu-bearing grease, paint, plastic, cement, LCM)
- ①b Abundant opal w/minor, texturally affiliated calcite. Both phases are fresh; they occur principally as discrete chips, but also less commonly as veinlets in and crusts on other lithologies. Textures reminiscent of both hot-spring deposits and geothermal scales.
- ①c Moderately abundant "exotic" rock types (not present in samples from higher in the well). Rx include phyllite or phyllonite, tuffaceous sandstone, andesite, and scoria ash (of probable basaltic composition).
 - ~ 1/4 of these "exotic" rock types occur as rounded pebbles, grit, and coarse-sand grains, some of which are broken, sheared, and slickensided.
- ①d Sparse, <2 mm - L euhedral-prismatic quartz crystals.

● FEATURES OF PARTICULAR INTEREST, cont'd.

② Slickensides, shearing, and euhedral hydrothermal crystals (as well as gouge/microbreccia) common within and above the opal-bearing, 2850-2905' zone. Below the zone, these features are variously sparse or absent.

②a) Of the 171 total cuttings samples collected between 1200 ft and 2905':

● 31 samples (18%) contain chips w/ unambiguous slickensides

● 33 samples (19%) contain chips of rock that are sheared and granulated

● 13 samples (8%) contain euhedral hydrothermal crystals (mostly quartz)

* NOTE: THESE FEATURES ARE DISTINCT FROM CO-EXISTING BUT DRILLING-PRODUCED "BIT GOUGE"

③ Particularly abundant gouge, microbreccia, and shearing in granitoid between 1780' and the granitoid-horfels major contact at 1960' → (p. 25-31)

④ Particularly abundant hydrothermal vults (multiple types and ages), 1590-1600' → (p. 16-18)

KEY LITHOLOGIES

Medium-crystalline hornblende-biotite
and biotite-hornblende granitoid

DESCRIPTION ON:

(p. 1)

Fine-crystalline, mafic-rich, biotite-hornblende quartz diorite

(p. 3)

MS-1 (metasedimentary rock type 1):
Biotite-poor, commonly chloritic
metaquartzite and quartz meta-
siltstone

(p. 51)

MS-2 Quartz-chlorite-calc. silicate \pm
calcite hornfels

(p. 51)

MS-3 Quartz-plagioclase-biotite
(\pm hornblende) hornfels

(p. 51)

MS-4 Hornfelsic, biotite-rich
metasandstone and
metasiltstone. Gradational
to MS-3. Distinction be-
tween MS-3 and MS-4 some-
what arbitrary. Perhaps
should consider one rock type

(p. 51-52)

Pebbles, grit, & sand

(p. 58)

"Phyllite or Phyllonite"

(p. 59)

Sandstone (unmetamorphosed)

(p. 60)

Opal

(p. 60)

"spongy" & bladed calcite

(p. 61)

Logging Notes

STEARMBORT
21B-5R

J. Hulen Oct. 16, 2004
S. JOHNSON

FIRST
1200-
1210'
SAMPLE

20% RUSTED
STEEL
45% CEMENT
35% ~~INDG~~
INDIGENOUS
ROCK

~~35~~ 100%
MEDIUM-CRYSTALLINE (MXLN)
HORNBLENDE-BIOTITE (HBL-BTE)
GRANITOID.

Tr. EP

Hypidiomorphic-
granular. ~~35~~ Avg. grain
size ~ 2 mm, up to 4 mm.
5% mostly greenish-black * HBL.
10% bronze-black * BTE.

* where fresh.
20% clear, colorless quartz. 6%
glassy to transp. to transl. v. H-
lt. gray FELDSPAR (suspect PLAG > KFS)
Tr. lt. amber SPHENE. 1% black
MAGNETITE. (Latter two minerals
< 0.5 mm)

• Atn. Overall VW PROPYLITIC

w leucocr/ }
sphene } mafic }
w chl }
w cal }
tr. ep }
VW ser }
tr chl } fsp
tr. ep }

many xls. essentially fresh

1210-
1220'

Rusted
steel
CMT
paint

100 MXLN. HBL-BTE GRANITOID, aa

• Atn. Overall: W PROPYLITIC

~~0.1~~ PY 0.2
~~0.4~~ EP 0.7

w leucocr/ }
sphene* } mafic* }
w chl }
w cal }
VW ep }
VW ser }
tr chl } fsp* }
VW ep }

* Many XLS essentially fresh



1220-
1230

(Tr) GOUGE & MICROBRECCIA
(EG & UBX). qtz-saturated rock
flour)

~~X~~³ EP
0.3 py

1 copper
grease
1 bag fi-
bers (LCM?)
Tr metal-
lic green
paint
Tr. red
paint
Tr flat-
green
paint
5% cement
3% rusted
steel
90% indige-
nous

(100) MXLN HBL-BTE GRANITOID

aa
• Attn Overall
W-M PROPYLITIC

M-S leucx/spin*
W-M chl } / mafics*
W cal } / esp. hb)
W-M ep }
W ser } / FSP*
tr chl }
W ep }

1230-
1240

Incomplete Wash

(100) MXLN HBL-BTE GRANITOID.

0.3 EP
Tr. py
Tr. HM

2 rusted
steel
5 LCM
Tr. green
paint
5 cement
88 indige-
nous

aa
• Attn. Overall
VW PROPYLITIC
w leuc/spin*
w chl } / mafics
w cal } /
vw ep }
VW ser } / FSP*
tr. chl }
tr. ep }

* Many X's. essentially fresh

2

Logging Notes

STEAMBOAT
21B-5R

J. Hulen Oct. 16, 2004
S. Johnson

1240-1250

100% MXLN HBL-BTE GRANITOID, aa

0.2 EP
Tr. py

3.5" dia
2 cm
Tr. Cu-grease
95 indige-nous

• A/tn Overall: VW PROPYLITIC

w-vs leucos/sphn } w chl } mafics } *VWser }
w cal } tr. ep } tr. chl } FSP*
tr. ep }

1250-1260

Ⓣ FXLN, rel. mafic-rich (23-25%)
hbl-biotite qtz diorite

0.5 py
0.5 EP

avg grn. size 0.3-0.5 mm
- essentially fresh
- could be from xenoliths
or fine-x'n. enclaves
in the dominant coarser granitoid.

1 rusted steel
Tr green paint
cement

100 MXLN HBL-BTE GRANITOID, aa

• A/tn Overall: VW PROPYLITIC, all AA

1260-1270

Ⓣ GG qtz-serted rock flour

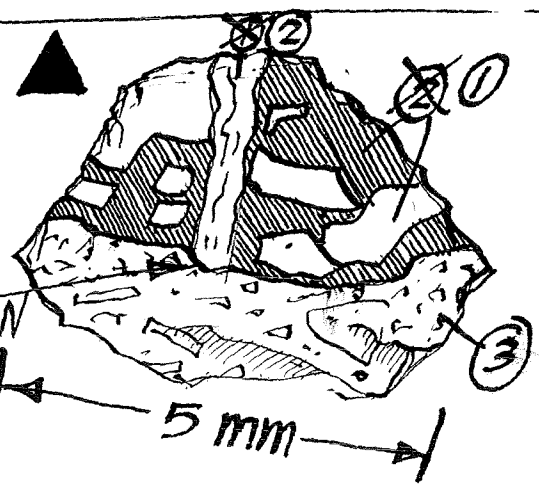
0.2 py
0.3 EP

100 MXLN HBL-BTE GRANITOID, aa

• A/tn Overall: VW PROPYLITIC, all AA

1 rusted steel

1270-1280



Veined HYDROTHERMAL MICROBRECCIA chip

- ① Earlier Older, coarser Hvx; granitoid-component elasts in qtz-ser. matrix
- ② pale-orange DOLOMITE VEINLET
- ③ younger, finer, buff-white Hvx with granitoid-component and tabular-veinlet fragments

* Many x's. essentially fresh

3

1270-1280
cont'd.

(1.5%) HBL - see sketch on previous page. — principally buff-white to v. H. yell. — gray — opaque
vxln qtz-ser matrix.

(0.5) VVF — ~~qtz-ser~~ qtz (vxln)-ser & dol — the latter, interbreccia in age; the former post-dating at least one gen. of dx

① FXLN HBL-BTE QTZ DIORITE
aa

⑨7 MXLN HBL-BTE GRANITOID, aa

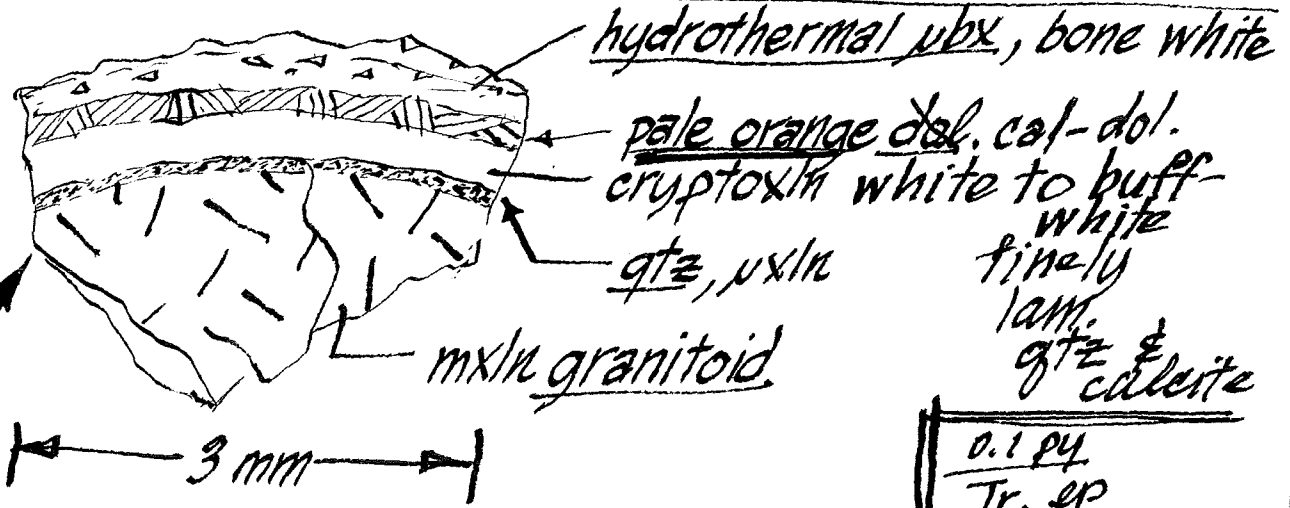
• Overall Atn: W PROPYLITIC

W-s leucx/spic W-H-ep } mafics * W-SER }
W-cal } Tr-chl } FSP*
W chl } VW-ep }

0.5 EP
0.2 py
Tr. HM

1280-1290

EPITHERMAL VEINLETS



0.1 py
Tr. ep

(0.5) HBL

① VVF
qtz, cal, dol.
(qtz, ser, chl)

(98.5) HBL-BTE GRANITOID, aa

• Atn. Overall:

VW PROPYLITIC

W leucx/spic * W chl } mafics * VW ser } FSP*
VW cal } Tr. chl }
* Tr. ep } Tr. ep }

Many x15. essentially fresh

~ 65% Anomalously large chips
(avg 7 mm - up to 12 mm)

Tr. CPU
0.7 PY
Tr. EP
Tr. HM

1290-1300

(25%)
⑤ Mafic-rich FXLN HBL-BIOTITE QTZ DIORITE
texture approaching EUHEDRAL-GRANULAR

fr xenoliths? • Altn. as below

also CAL-PY opal
also tr. HM.

①
②

VVF cal-dol ± hm ± qtz pale orange
carbonate veinlet has ≥ 3 mm selvage of intense sericitization.

* NOTE: 0.2 mm-wide

⑨ MXLN HBL-BTE GRANITOID, aa (very fresh-looking)

Overall Altn: VVW PROPYLITIC (aa)

w leuc/sph* w chl } / mafics* VW-W SER } / FSP*
vw cal } Tr CHL }
tr ep } Tr EP }

1300-1310

⑦ VVF ~~aa~~ cal-dol-ser
⑧ FXLN QTD DIORITE aa
⑩ MXLN HBL-BTE GRANITOID, aa
Very Fresh-Looking

0.3 PY
0.2 EP
Tr. HM

Overall Altn VVW PROPYLITIC

w leuc/sph* w chl } / mafics* VW-SER } / FSP*
vw cal } Tr. CHL }
tr ep } Tr EP }

* ^{Most} Many xls. essentially fresh

1310-1320

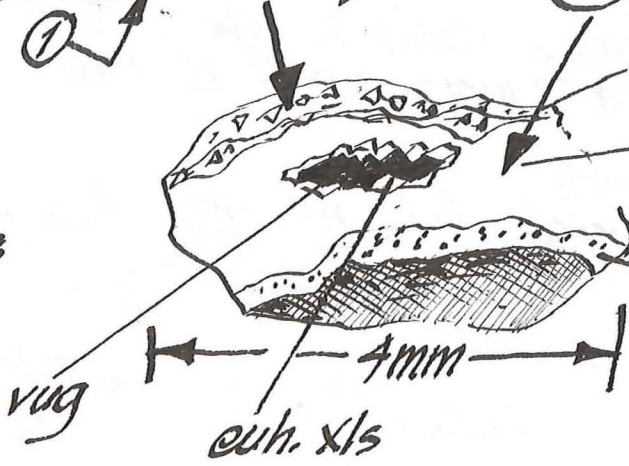
~~0.5~~ Aitd. Crush jbx

0.5 VVF

qtz-chl-ser;
cal, dol, qtz

Tr, in vmlts

Tr, in vmlts



buff-white crush jbx (cal-dol-qtz)
transl. lt. gray jbxln CAL

lt. gray buff jbxln cryptoxln
CAL ± dol

1 EP
0.2 py
Tr. HM

~~98~~ MXLN HBL-BTE GRANITOID, aa

98.5 overall altn: W PROPYLITIC

w-s leucocrn / spn*

w-M ep }
w chl } mafics*
vw cal } (esp. hbl.)

w ser }
tr chl } FSP*
vw ep }

1320-1330

0.5 CRUSH jbx

0.5 VVF, aa

transl. pale orange

transl. pink

crush jbx buff white w/ granitoid clasts

jbxln cal + dol



granitoid

Tr py
0.3 ep

Tr RFS
Tr LEM

99 MXLN. HBL-BTE GRANITOID, aa

overall altn: YW PROPYLITIC

w leucocrn / spn*

w chl }
vw cal } mafics*
vw ep }

vw ser }
tr chl } FSP*
vw ep }

* Many xls. essentially fresh

6

GRTD mafic content increases to ~ 20%

1330-
1340

Tr. Cu
grease



(14) Tr

~~GG~~ ^{GG} crush, vbx
(1.5) VVF — mostly pale-med orange
nxln-fxn dol-cal

Tr. HM
0.4 py
(diss.)
Tr. EP



- ① bone-white crush, vbx
- ② crushed bte
- ③ ~~of~~ transp. transp white-lt. gray calcite
- ④ pale-med orange cal ± dol. (nxln)

97.5
~~98~~ MXLN HBL-BTE GRNTD

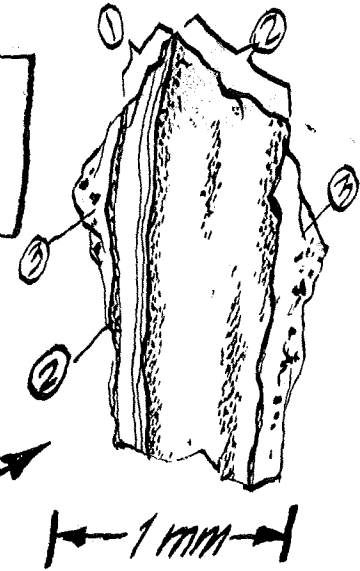
Overall Alt: VW PROPYLITIC ALTN
(aa) (see previous page)

1340-
1350

Tr. steel

Less Mafic Again
(HEX) silicified, Puritized, Hydrothermal
Microbreccia Present

1340-
1350'
cont'd.



- Transl. lt. gray # CAL
- ① Delicately laminated uxln silica
 - ② Transl. sl. bluish-gray uxln silica w/ uxln (1-5 μ?) + CAL
 - ③ lt. gray, opaque-transl. qtz-ser (uxln) w/ sl. coarser qtz-ser miss. py + CAL

- ① 0.5 HUBX
- ① 0.5 GG & crush ubx
- ① VVF
 - qtz-cal-py (see above)
 - pale orange cal ± dol.

1 py
0.1 cpy
0.3 ep
Tr. HM

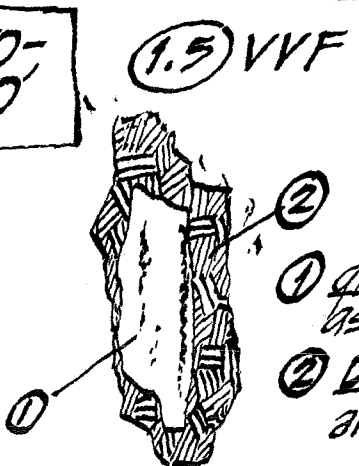
① 98 MXLN HBL-BTE GRD. aa

R/tn. Overall: VW Propylitic

<u>W-S/leucoxn</u>	<u>W chl</u>	<u>VW ser</u>
<u>spn*</u>	<u>VW cal</u>	<u>tr. ep</u>
	<u>VW ep</u>	<u>tr. chl</u>
	} mafics*	} FSP*

1350-
1360'

5 LCM
Tr steel
CMT



- ① 1.5 VVF
 - ① 0.5 GG & crush ubx aa
 - ① 98 MXLN HBL-BTE GRD, aa
- R/tn. Overall: VW PROPYLITIC (aa)
w/ local S-SERICITIC

0.3 EP	0.2 py
Tr HM	

- ① qtz-ca-py as above
- ② DOL-CA, fxl, speckled red-orange and white

SUSPECT HEM stain but
 CANNOT rule out
 Sb. or As compounds

* Many x/s. essentially fresh

1360-1370

Logging Notes Steamboat ~~SR~~ 218-5R

J. Hulen Oct. 17, 2004
S. Johnson

Tr. steel
Tr LEM

(05) VVF cal-dol (oring)
aa

(70) GG & cubx
aa

(99.5) MXLN HEL-BTE GRD.
aa.

Attr. Overall: VW PROPYLITIC

W-VS (W)
leucx
spk*

0-S (VW) CHL
0-W (VW) CAL
0-M (VW) EP
0-M (O) SER

MAFICS*

0-S (VW) SER
Tr CHL
0-VW (O) EP
0-VW (O) KFSP
(pinkish)

FSP

0.7 EP
0.3 py

1370-1380

Attr. Increases

(Tr. VVF)
aa

(100) MXLN. HEL-BTE GRD.
aa

Overall Attr.:
W-M PROPYLITIC

0.1 CPU
0.4 py
EP 2.5
0.3 HM

3/4 of chips; attr aa (W PROP)
1/4 of chips pale "salmon" color & (M PROP.)

M-VS (S) leucx
spk

W-VS (M) chl
W → cal
0-S (W) ep
0-M (VW) ser

M-S (M) ser
Tr chl
0-M (W) ep
0-W (VW) cal

MAFICS

FSP

Alt. Decreases

1380-1390'

Tr steel
1 LCM
Fr. ppytc andesite
2
CVD

(Tr) VVF cal-dol (pale orange)

(100) MXLN HBL-BTE BRD.
Overall Alt.:
VW PROPYLITIC aa

0.2 EP
Tr. HM

Tr. paint

1390-1400'

Tr steel

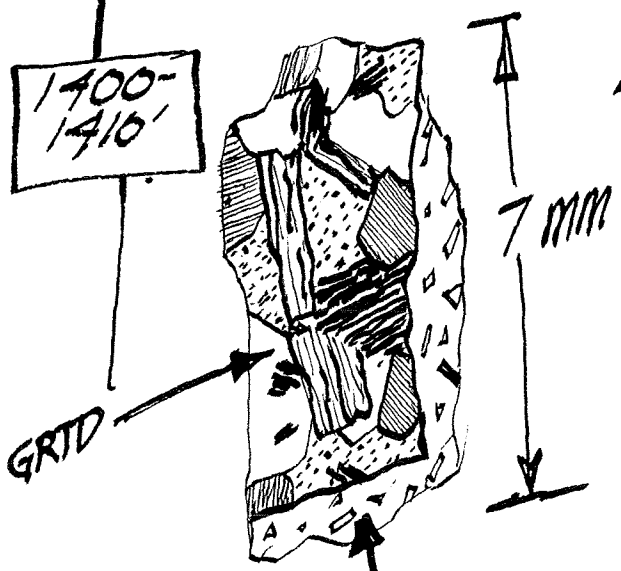
(Tr) VVF aa

(100) MXLN HBL-BTE GRD.
VW PROPYLITIC alt.
smp. appears essentially fresh.

0.4 EP
Tr. HM

(VFL)

1400-1410'



(Tr) VVF cal-dol
(Tr) HBX (HUBX - see sketch)
(Tr) GG & CVX
(100) MXLN HBL-BTE GRANITOID
• VW PROPYLITIC Alt.
(VFL)

0.1 py
0.3 ep

HUBX, buff white
alt. to gtz-ser-dol

Logging Notes

STEAMBOAT
21B-5R

J. Hulien
S. Johnson

Oct. 17, 2004

1410-
1420'

0.5 R&S

(25%) FXLN, Malic-Rich (30-33%),
HBL-BTE ~~GRD~~ ~~GRD~~ DRT

"salt-and-pepper" aspect.

Avg. grain size 0.3-0.5 mm.

Altn same as below (VFL)

(75%) MXLN. HBL-BTE GRD. VW Propyl. Altn, aa
~~FL~~ (VFL)

0.4 py
0.1 ep

1420-
1430'

1 R&S

(100) MXLN. HBL-BTE GRD, aa. VW
Propyl. Altn. aa
(VFL)

Tr. py
Tr. ep
Tr. ep

1430-
1440'

Tr. CM

(T) GG & CUBX

(0.5) VVF-pale-med orange, fxln. cal-dol.

(99.5) MXLN HBL-BTE GRD. aa - also EP

VW Propyl. Altn.

(FL)

0.7 EP
0.3 py
Tr. HM

1440-
1450'

teel
r. LEM

(T) HUBX - buff-white, grt-cal-ser

(T) CUBX - aa, no ^{altn}

(T) VVF aa

(100) MXLN HBL-BTE GRD, aa

VW Propyl. Altn

(FL)

0.5 EP
0.2 py
Tr. HM

1450-1460'

② FXLN Mafic-Rich HBL-BTE DTE DIORITE, aa
altm. as below (VFL)

Tr. EP
0.3 py
Tr. HM

5 LCM

(Tr) VVF aa

(98) MXLN HBL-BTE GRD.
VW Propyl. AltM aa (VFL)

1460-1470'

(100) MXLN HBL-BTE GRD, aa
• VW Propylitic AltM.
(VFL)

0.1 py
Tr. EP

Tr. RES
2 LCM

1470-1480'

(Tr) VVF, aa (100) MXLN HBL-BTE GRD, aa
• VW Propyl. AltM.
(VFL)

0.2 EP
0.1 py

3 LCM

1480-1490'

Incomplete Work

③ FXLN Mafic-Rich HBL-BTE DTE DRT. AltM as below (VFL)

0.2 EP
0.1 py

(Tr) VVF — MXLN Qtz-cal (buff-white) w/ Qtz-ser-chl selvage

(97) MXLN HBL-BTE GRD, aa
• VW Propyl. AltM aa (VFL)

2 LCM

Logging Notes

STEAMBOAT
21B-5R

J. Hulen 10/17/04
S. Johnson

1490-
1500'

(TR) FXLN Mafic-rich HBL-BTE QTZ. DIORITE
aa (VFL) altn. as below

0.1 EP

(100) MXLN HBL BTE GRTD. aa

2 LCM
Tr. R&S

1500-
1510'

(0.5) GG & CUOX, ALTN. INCREASES
pyritized (TR) VVF

(99.5) MXLN HBL-BTE GRTD.

0.3 EP
0.7 PY
Tr. HM

W-S (M) / CUOX /
SPN

O-VS (TW) CHL
O-W (VW) CAL
O-W (F) SER
O-VW (FF) EP

MAFICS
Tr-S (TW) SER
Tr CHL
Tr CAL
O-VW (TR) EP / FSP

Altn. overall: W Propylitic w/ 5% of
chips ~~3~~ having ~~PL~~ FSP
strongly SERCTED (white, opaque,
VX/PL) & mafics mod CHLZ
M-S CHLTZ

Note: A few GRTD. CHIPS W/ KLY SHEARED

(TR) VVE cal

(TR) GG & CUOX
calcite - emtd

0.7 EP
Tr PY

(100) MXLN HBL-BTE GRTD aa

W Propyl. Altn w/ 3-5% of
chips having S-VS SERCTEN / FSP
& O-S CHLTEN. OF MAFIC

A few chips

1520-1530

Tr LCM

(1) GG & CUBX, calcite-cmtd

(2) VVF — pale-med. ornq. calcite

(100) MXLN HBL-BTE GRD., aa

• W propyl. Altk w/ 3% of chips having s-vf ser/fsp

(FL) much fresh glassy fsp

0.2 EP

Tr. py

Tr. HM

1530-1540

(1) VVF: lt-med orange DOL & buff-white to lt. salmon calcite

(2) GG & CUBX, aa

(100) MXLN HBL-BTE GRD., aa

(99) • W propylitic Altk

(FL)

0.1 EP

0.1 HM

0.2 py

Tr. cpy

1540-1550

Tr. LCM

(1.5) VVF, aa

(0.5) GG (Tr) aa

(98.5) MXLN HBL-BTE GRD., aa

• VW propylitic Altk

(VFL) much fresh glassy fsp.

Tr. EP

Tr. py

0.1 HM

1550-1560

R. black rubber
Tr LCM

(0.5) VVF, aa

(1) FXLN maf.-rich HBL-BTE Qtz Dior, aa Altn as below

(98.5) MXLN HBL.-BTE GRD., aa

• VW Propyl. Altk

(VFL)

0.5 EP

Tr. HM

Logging Notes

STEAMBOAT 21B-5R

J. Hulén
Oct. 18 '04
S. Johnson

Tr. EP
Tr. PJ

1560-1570

⊗ (100) MXLN HBL-BTE GRD, aa;
• VVW Propylitic AltH

(VFL) (Very fresh-looking w/abund. unaltered mafics & glassy fsp.)

(T) FXLN HBL-BTE QTZ DRT aa Ⓟ VVF
d_{AltH} same as GRD

Tr. steel

1570-1580

⊗ VVF pale-med. orange f_{xtl} cal-dot (2)
• (0.5)

(T) CVEX - buff-white to pale orange, cal - crtd

(99.5) MXLN HBL BTE GRD, aa
• VVW Propylitic AltH (VFL)

Tr. EP
0.2 PJ
Tr. HM

Tr. steel

1580-1590

▲ Alteration Increases

(1) FXLN HBL-BTE QTZ DIORITE, mafic-rich
• AltH. as below

(1.5) GG & cubx — many chips distinctly sheared-appearing. Intensely altd. Various comb. of opaque buff-white, transl. lt. gray to lt. grnsh-gray, pale orange (trans-opq). ~~tab~~ vnit-like, up to at least & 2 mm. wide

(Tr) HUBX — sub₂ rx & vn. clasts < 0.1 mm suspended in chl-bearing vxn Qtz. matrix — occurs in VVF

1.5 EP
0.3 PJ
Tr. HM

1580-1590, cont'd

① VVF: cal
 qtz-chl
 qtz-ser

⑨ 96.5 MXLN HBL-BTE GRTD., aa

↳ 4% of chips S chl-ser altv

M-S (<u>S</u>) leuc	W-S (<u>M</u>) chl	M-VS (<u>S</u>) ser
sphn	M-VS (<u>S</u>)	TR chl
	O-M (<u>W</u>) EP	TR-W cal
	W cal	TR EP
	W ser	FSP

matrics, esp. hbl

↳ 96% of chips W Propyl. Altn

O-S (<u>W</u>) leuc/sphn	O-M (<u>VW</u>) chl	VW-M (<u>W</u>) ser
	O-S (<u>VW</u>) EP	TR chl
	W cal	TR-W (<u>TR</u>) EP
	O-M (<u>VW</u>) ser	TR-W (<u>VW</u>) cal

matrics (esp. hbl) FSP

1590-1600

Tr. black rubber



Stronger Alteration & Veining

① GG & cubx: crushed, sheared, granulated, and altered GRTD; ~~contn~~ Variouslly transl. lt-med. gray, v. lt.-lt grnsh-gray, opaque buff-white to v. lt. gray. Variouslly silicified, sericitized, chloritized, & pyritized to a greater or lesser extent

(1.5 PY) *
 0.5 EP

1590-
1600'
cont'd.

(3.5) VEINLETS & VEINLET FRAGMENTS
(VVF), up to at least 2.5 mm wide

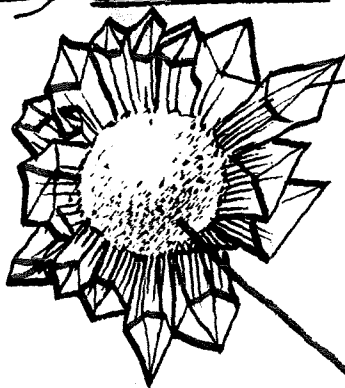
3 types:

(V1) ~~Q~~ cal-dol (?) pale-med. orange,
transl., fxltn (Tr)

(V2) ~~Q~~ 3% → pxln silica-pyrite. Transl.-
opaque v. lt-lt. gray w/ pale brassy
sulfide. Some chips crudely lam.
contain minor ser & chl

(V3) 0.5% → chloritic pxln silica-pyrite
aa but grnsh-gray

☐ (V4) Tr. → Free Euhedral xls. — mostly
quartz — one ser (?) qtz.
Very unusual



Radially-
arranged
euhedral
qtz. xls

Nearly spherical
ball of white
pxln sericite

← 2 mm →

1590-1600'
cont'd.

~~99.1~~ ~~99.5~~!

95.5 MXLN HBL-BTE GRTD, aa, but more intensely altered.

- ~5% of chips intensely sericitized

M-VS(5)	V-VS(5) chl	M-VS(5) SER	
leucx	W-M(W) cal	TR CHL	FSP
SPK	W-S(M) ser	TR CAL	
	O-M(W) ep	TR EP	

} mafics

- ~95% of chips W-M Propyl. Altn

O-S(W)	O-M(W) chl	VW-M(VW) SER	
leucx	O-W(W) cal	TR CHL	FSP*
SPK*	O-M(VW) ep	TR CAL	
	O-M(VW) ser	O-VW(O) EP	

} mafics* esp. hbl.

1600-1610'

77 GG & CUBX, aa
0.5 VVF, aa (same types & proportions)

99.5 MXLN (BTE HBL) GRTD., aa
• 97% W Propyl. Altn. aa
• 3% S Chl-Sercten, aa

1 PY
TR. HM
0.3 EP

TR black rubber

→ some chips

1610-1620'

All aa exc. less. PY

0.3 PY
0.3 EP
TR. HM

* Many x's. essentially fresh

1620-
1630'

2 LCM
(vol)

smp. essentially fresh

Tr. EP
0.2 py

3% FXLN Hornblende-Biotite Qtz. Diorite

fine-crystalline, hypidiomorphic-granular. Avg. \approx 0.4 mm \times size. Rel. mafic-rich. w/ hbl. w/ bte. ¹⁵

- Plag. fresh to "clouded" (transl., prob. wkly sericitized \pm chl.)
- Bte. bronze-black & fresh mostly scd. xls partially altd. to med. gray-green chl.
- Hbl. greenish-black & fresh mostly scd. xls. partially altd. to chl.

OVERALL ALTN.
VW - chitzn of mafics
Tr-VW - sericitzn of FSP

► This rx type similar to but much-finer- \times ln and more mafic-rich than the prevailing med.- \times ln. granitoid (see below). Could represent simply finer- \times ln enclaves, or could be xenoliths

97% MXLN HBL-BTE GRANITOID; Avg. grain size

\approx 2 mm — up to 4 mm; 5% mostly fresh grnsh-black HBL; 10% mostly fresh bronze-black BTE; 20% QUARTZ; 65% mostly fresh, glassy, transp. - transl., lt.-med. gray FSP (suspect PLAG > KFS); Tr. lt. amber, transp. - transl. SPHENE

- scd. FSP "clouded" to wkly-mod. SERICITIZED \pm minor CHL; local Tr. EP
- ~~X~~ scd. MAFICS wkly-mod. CHLTZD
- SPHENE locally ptly. altd. to LEUCOXENE

Tr VVF
-qtz
-chl
-ser
-py

1630-
1640

(Tr) GG

0.5

(Tr) VVF

- ~~cal~~ CAL
- CAL-(hm)
- QTZ-CHL-
- ser-(py)
- QTZ-SER

(99.5)
100%

MXLN. HBL-BTE
GRANITOID
aa

0.3
Tr. ep
0.1 py
Tr. H ⁺

- W-M chltzn/mafics
- W serctzn of fsp (\neq tr. chl)
- W cal/mafics
- tr. cal/fsp

2 LCM

3 mm



Qtz-ser
(buff-white)

Many mafics essentially unaltered

cryptoxln to pxln. qtz.
(transl. lt.-med. sl. brnsh & grnsh-gray)

1640-
1650

(Tr) VVF

- CAL-(hm)
- QTZ-ch-ser-(hm)

(100) MXLN. HBL-BTE
GRANITOID
aa

0.2 py
0.2 ep
Tr. HM

- W chltzn } after mafics
- W cal } after mafics
- VW serctzn } after fsp
- tr. chltzn } after fsp
- tr. cal } after fsp

both sheared-looking and w/ apparent porosity (ϕ)

fsps. commonly "clouded" to transl. grnsh-gray, but still rel. fresh

1650-
1660

GO TO NEXT PAGE

Logging Notes

STEAMBOAT
21B-5R

J. Hulen Oct. 16, 2004
S. JOHNSON

1650-
1660'

TR
R#5

② VVF — mostly v. it to med. salmon to orange w/ minor white CALCITE & probable DOLOMITE with tr-minor HM

- also tr QTZ-SER. PY
- vnit. chips up to 4mm in dia
- also QTZ-CHL-PY-(ser)

0.3 EP
0.4 PY
0.1 HM

① FXLN HBL-BTE QTZ-DIORITE, aa

⑨7 MXLN HBL-BTE GRANITOID, aa
& W-MX CHL } after mafics
tr. ep W cal

W SER } after plag
tr cal
tr. ep → tr 2nd KF

many xls
essentially
fresh.

1660-
1670'

① VVF cal-DOL-(hm) aa (salmon/orange)

⑨7 GG Qtz-chl-ser-cal-py

⑨9 MXLN HBL-BTE GRANITOID, aa

W-M chl } after mafics
W cal
vw ep

vw chl } after fsp
W ser
tr. ep
tr. hm
tr 2nd KF

0.5 EP
0.2 PY
Tr. HM

many many
xls. essentially
fresh

1670-1680'

Tr LCM

(Tr) VVF - orange cal-DOL-(hm) aa
(100) MXLN. HBL-BTE GRANITOID, aa
Aith. overall: VW propylitic

0.3 EP
Tr. HM
Tr. py

W chltz } after mafics VW ser } after fsp
W cal } tr. chl }
VW ep } tr. ep }
tr. 2nd KE }

many xls. essentially fresh.

1680-1690'

1 LCM

Finer Cuttings

(Tr) VVF - orange cal-DOL-(hm) aa
(100) MXLN HBL-BTE GRANITOID aa
Aith overall: VW propylitic

0.1 EP
Tr. HM

W chl } after mafics VW ser } after fsp
VW cal } tr. chl }
Tr. ep } tr. ep }
tr. 2nd KE } W leucox/syn

many xls. essentially fresh.

1690-1700'

Finer Cuttings

(Tr) VVF - orange cal-DOL-(hm), aa
(100) MXLN HBL-BTE GRANITOID, aa
Aiteration Overall:
VVW PROPYLITIC

0.3 EP
Tr. py
Tr. hm

W leucox. } after sphene VW chl } / mafics VW ser } / feldspar
VW cal } tr. ep } tr. chl }
tr. ep } tr. 2nd KE }

many xls. essentially fresh

1700-1710'

(74) VVF — pink to orng. cal-dol (hm)
(100) MXLN HBL-BTE GRD, aa

0.5 EP
0.1 HM

TR R&S

Overall
VW
Propyl.

0-5 (VW) leukxn*
SPN
0-5 (VW) chl
VW cal
0-VW (VW) ep
0-W (VW) ser } mafics*

FL

0-W (VW) ser }
tr
0-W (VW) ser }
tr
0-VW (VW) } fsp*

TR CNT
TR. PAINT
TR R&S

1710-1720'

(0.5) VVF — aa to red-orng. &
as narrow as 50u. A few
obvious fracture surfaces
sparsely coated w/ earthy brick-red
hm.

0.1 HM
0.2 EP

Overall
VW
Propyl

(99.5) MXLN HBL-BTE GRD, aa (all) (FL)
sl. "cloudy" in appearance.

1720-1730'

(74) VVF, aa
(100) MXLN. HBL BTE GRD

0.2 EP
TR. HM

1 LCM

• WK Propyl. Altk
in 3% of chips
5-15 ser/fsp & chl/mafics

1730-1740'

~~(0.5) VVF bone-white dk uxn cal~~
(1) possibly cementing/replacing QUOX
in part

(74) QUOX — GRD protolith
& GG

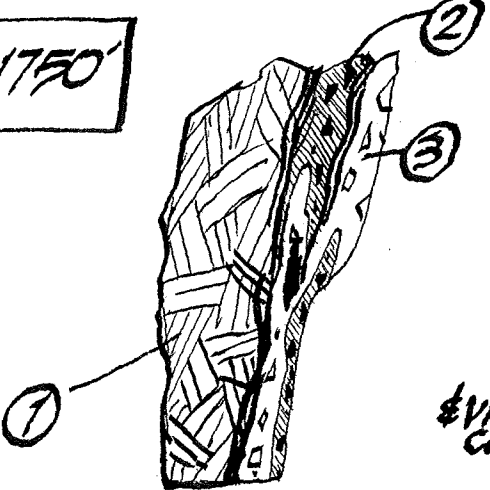
(74) HVBX —
chltz. clsts,
calcite matrix

1 LCM

(74) TR — on HVBX frag.
(99.5) MXLN HBL. BTE GRD, aa
W. Propyl. Altk.

1740-1750'

Tr LCN
Tr R&S



2mm

COMPOSITE
VNLT/HYBX CHIP

"clean"
① fxln, transp-transl., white to lt. gray calcite (earliest)

② ^CHYBX frags of grtd., incl. bte, embedded in cryptoxln, transl., lt., sl. bluish-gray SILICA

③ ^CHYBX, aa, but matrix is 'cryptoxln' silica + calcite

Tr. EP

① 0.5 VVF (see above)

② ^CHYBX (see above)

may be hybrid
CVBX = HYBX

③ 99.5 MXLN HBL-BTE GRTD, aa

• Tr-VVW propyl. altn.

VFL

1750-1760'

① VVF pale-med. orng. cal-dol

② 100 MXLN HBL-BTE GRTD, aa

• VVW Propyl. Altn., aa

Tr. ep

③ Tr FXLN HBL-BTE QTE DRT, mafic-rich, aa

Altn. AA

VFL

1760-1770'

— All AA —

Tr ep

Logging Notes

STEAMBOAT
212 ER

J. Hulen; Oct. 20, 2004
S. Johnson

1770-
1780

(0.5) VVF — CAL — (ch, hm, ser)

INHERITED?

0.2
PY EP
Tr. HM

(99.5) MXLN HBL-BTE GRD, aa

(VFL) Much glassy fsp.

VVW propyl. alt. — most xls. essentially fresh.

1780-
1790

(5) GG & CRUSH VEX, mottled buff-white and lt-med. grnsh-gray to olive-gray, comm. w/ anom. lg. clear colorless quartz clasts. Avg. clast size ~ 175 μ; larger Qtz. clasts up to 1 mm. "Nubby" appearance overall. No obvious shearing. VS CHL-SER ALTN.

some chips

(7) FXLN HBL-BTE QTZ. DIOR. aa mafic-rich. Alt. as below

(0.5) PY

L in GG & CRUSH

Tr. EP

(95) MXLN. HBL. BTE GRD., aa

• WK PROPYLITIC ALTN, aa ("cloudy" fsp)

1790-
1800

(0.5) VVF — (ch) — CAL (banded)

(3) GG & CRUSH aa VS CHL-SER. ALTN

(1.5) FXLN HBL-BTE QTZ DRT aa (incl. alt.)

(95) MXLN HBL-BTE GRD, aa (incl. alt.)

some chips

0.2 PY

Tr. EP

1800-1810

RX BECOMES COARSER-XLN.

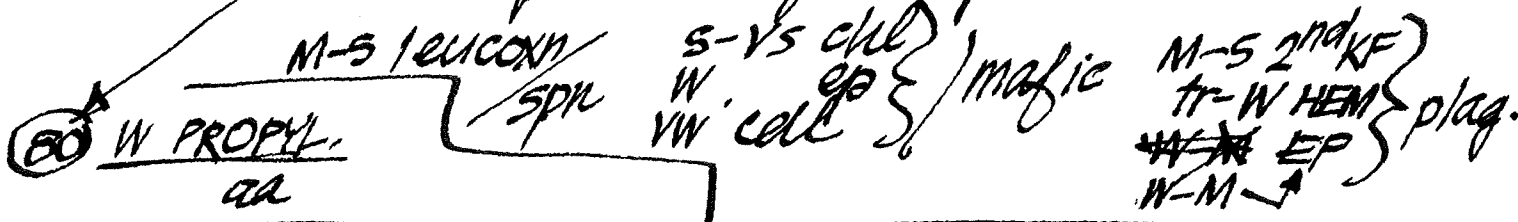
& MORE EPIDOTE-RICH

2

- 0.5 VVE — Mostly EP (∴ older; pre-geothermal)
- Tr GG & UBL — aa
- 99.5 MXLN HBL-BTE & GRD., aa

2.5 EP
0.1 py

→ 15.5 S Propylitic Alter: Mostly salmon or pale orange chips within which:



1810-1820

0.5 VVE Ep; cal(NX/N)

- 99.5 MXLN HBL-BTE GRD. } aa
- 4.5 S Propylitic } aa
- ~~95~~ 95 W Propylitic } aa

1 EP
Tr. py
Tr. HM

1820-1830

0.5 VVE
 — Bone-white calcite
 — pale orange cal-dol

- 1 GG & CUFX, aa but more ser & less chl.
- 2.5 FXLN Mafic-Rich HBL-BTE QTE. DIORITE, aa (incl. alter)
- 96 MXLN HBL-BTE GRD., aa
 — 3 S Propylitic
 — 93 W Propylitic

0.7 EP
Tr. HM
0.1 py

1830-
1840

(Tr) vfxln chl-cal rock. May. could be
a nondescript vein fragment
-conceivably could be marble??

0.3 EP
0.2 PY
Tr-HM

Tr
LCM

(need T.S.)

(Tr) quex, aa

(1) FXLN mafic-rich hbl.-bte qtz dior. aa

(9) MXLN HBL-BTE GRTD, aa W Propylitic aa
(VFL)

1840-
1850

(Tr) quex aa

(Tr) FXLN mafic-rich hbl.-bte qtz dior. aa

(100) MXLN HBL-BTE GRTD, aa

- 3 S Propylitic

- 97 W Propylitic w/ "clouded"
plag & Kfs

0.5 EP
0.5 PY
Tr HM

1850-
1860

(0.5) sheared gouge

lt-med grnsh-gray - obvious
granitoid protolith (larger clasts)

0.2 HM
0.1 PY
Tr-EP

Tr LCM

(1)

in GG

(3) quex, aa, chl-ser-ald.

(0.5) VVF, mostly HM-SER-chl

(96) MXLN HBL-BTE GRTD, aa

W Propylitic Alt aa

1860-
1870

Huge Increase in GG, CUBX, and
pyrite —



9% CRUSH MICROBRECCIA, clearly from
a granitoid protolith; Intensely
qtz-ser-py (\pm kaolin? need XRD) altered;
Mottled white, lt-med. gray, & pale
brass; a few larger & clasts
of ~~the~~ clear colorless quartzo —
chips commonly sheared-appearing;
" " contain up to
at least 20% pyrite (diss. grains
mostly < 50 μ dia).

A) ~~B~~ meta-siltstone^(?) and vtg. metasandstone^(?)
Intensely pyritized, sericitized
and locally silicified. Generally
lt. gray and comm. pale brass —
distinguished by UNIFORMITY OF
CLAST SIZE, i.e. GOOD SORTING.

* Alternatively, these clasts chips
conceivably could be ~~be~~ gravitationally-sorted
hydrothermal microbreccia (i.e.,
settling in ~~fract.~~ open & fractures
following hydrothermal explosion
✓ THIN SECTION

Logging Notes

STEAMBOAT
21B-5R

10/21/04

J. Hulen
S. Johnson

1860-1870 cont'd

~~1~~ VVF • qtz-chl-heml
② • qtz-ser-py mostly

④ py
0.3 EP
0.1 HM

⑧5 MXLN HBL-BTE GRD.

Overall Mod. Propyl.

M chl (W-VS) }
W cal } mafics }
VW ep } VV ep } Fsp
Tr ser } W ch }

1870-1880

⑤ FXLN Maf-Rich HBL-BTE QTZ DRT aa; altn as below

② Int. qtz-ser-py altd. ~~DR~~ CUBX, aa

① VVF - qtz-ser-py, aa

~~1~~ ② Metasiltstone & Meta-ss, aa
int. qtz-ser-py altered

⑨0 MXLN HBL-BTE QTZ DRT GRD, aa
W-M Propyl. Altn, aa

1 py
0.3 EP
Tr. HM

1880-1890

①5 FXLN Maf-Rich HBL-BTE QTZ DRT aa
altn. as below

②5 CUBX qtz-ser-py aa

⑦ VVF aa

① Metasilt & meta-ss, aa

~~83.5~~ ⑧3.5 MXLN HBL-BTE GRD, aa
W-M Propyl. Altn, aa

0.5 py
0.5 EP
Tr. HM

1890-1900

⑩ MXLN HBL-BTE GRD, aa
• W-M Propylitic Alt.

0.3 py
0.5 HM
0.3 EP

Tr LCM

⑦ Meta slts, heavily pyrited

1900-1910

All aa

0.3 EP
0.1 py
Tr. HM

1910-1920

- ① CUBX - ^{int.}qtz-ser-py, aa
- ② VVF - qtz-py; qtz-ser-py
- ③ FXLN Magic-rich
HBL-BTE qtz-DRT, aa
- ④ MXLN HBL-BTE GRD, aa
• W-M Propyl. Alt.

1 py
0.3 EP
Tr HM

some chips

1920-1930

- ③ CUBX int. altd. variously
to qtz-ser-py & qtz-chl-hm-(py/ser)
- ② VVF - mostly qtz-chl-hm(-ser/py)
• also qtz-ser-py
• & qtz py

1 py
0.3 HM
0.3 EP

Tr R & S

⑤ MXLN HBL-BTE GRD
• Mod Propyl. Alt.
chip comm.


Logging
Notes

STEAMBOAT
21B-5R

J. HULEN
S. JOHNSON

10/21/02

1935-
1940

- ② CUBX, aa
- ① VVE, aa
- ⑦ MXLN HBL-BTE GRD, aa, COMM. sheared 
- Mod. Propyl. Altn

0.5 EP
0.5 PY
TY


1940-
1950

- ①.5 CUBX, aa
- TY VVF ⑨.5 MXLN HBL-BTE GRD. 5

0.2 HM
0.3 PY
0.3 EP

• Mod Propyl. Altn w/ greater intensity of chl, plg fsp - giving the rock a trans gray-green color & appearance.

1950-
1960

- ③ CUBX, aa ⑦
- ①.5 VVF - dom qtz-ser-py
- ⑨.5 MXLN HBL-BTE GRD, aa, COMM. sheared 
- Mod Propyl. Altn (strong)

1.5 PY
0.1 CPY
0.1 EP

1960-
1970

CHANGE

④ QTZ-PLAG-BTE HORNfels, HNfLS. [43 MS-A] ³

avg. grain size \approx 100 μ , and very uniform. Med-dark brown, mottled intergrown with trans-subopaque lt gray. overall at least 35% bte, locally much more

1960-1970 cont'd.

• HNFLS is essentially unaltered. local wk - mod. chl/bte.

① CUBX - aa chl-ser-gtz ± py

① * cubic py
X/S. up to 1mm;
clusters up to 2mm.

15 py
0.1 cpy
~~ep~~ ep (0.2)

⑤⑥ MXLN HBL-BTE GRTD, aa
• W-M Propyl. Altn

1970-1980

⑦⑧ CUBX - aa

②③ MXLN HBL-BTE GRTD, aa incl. altn.

⑦⑦ BTE HNFLS, aa ess. unalt.
[3-MS-~~3~~; 7-MS-~~4~~]

0.3 py
Tr ep

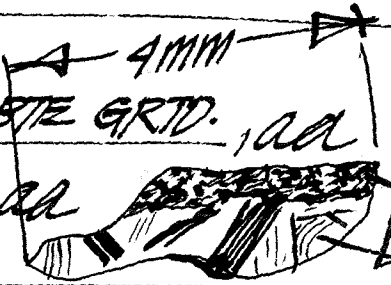
Tr LCM

1980-1990

⑦⑧ CUBX - aa

③⑤ MXLN HBL-BTE GRTD, aa

⑥⑤ BTE HNFLS, aa
[3-MS-~~3~~; 62-MS-~~4~~]



0.2 py
Tr ep
HNFLS
GRD

CONTACT LIKE INTRUSY.

1990-2000

⑦ Metasits & vfg Metasandstone
lt.-med. brownish-gray & grayish-brown; minor lt.-med. greenish-gray; bte-rich comm. Locally partly rexed. to HNFLS. Also locally interlaminate w/ HNFLS.

②⑤ MXLN-HBL-BTE GRTD aa • Wk Propyl. Altn

⑥⑧ BTE HNFLS aa -

ess. unaltered

1-MS-1
5-MS-~~2~~
69-MS-~~3~~

32

Tr EP
Tr PY

Logging Notes

STEAMBOAT
21B-5R

Oct. 21, 2004 J. Hulken
S. Johnson

2000-
2010

(11)

on knifls.
\$

~~(6) Meta-sls / Meta-ss, aa~~

~~(8) MXLN, HBL-BTE GRD, aa, but more leucocratic~~

(145) • WK. Propyl. Rltr

0.2 py

(0.5) VVF
(ser, in knifls)

1 MS-1
9 MS-3
75 MS-4

~~(10) BTE HNFELS, aa, UXLN~~

Nil chltz of bte, but:
M-S serctzn of plaq

tr. pale
rose-colored
GARNET

2010-
2020

Tr. LCM

~~(7) Meta-sls / Meta-ss, aa~~

(9) MXLN HBL-BTE GRD, aa
• W Propyl. Rltr

~~(84) BTE HNFELS, aa~~

• W-M serctzn of plaq.

0.1 py

Tr MS-1
11 MS-3
80 MS-4

2020-
2030

(5) MXLN HBL-BTE GRD, aa

~~(17) Meta-ss / Meta slts, aa, exc~~
in 5% pale-med. grayish-gray
& calcareous

Tr.
py

(0.5) VVF • ser
• gtz-ser-py

(0.5) CUBX, aa • gtz-ser-chl=py

~~(77) BTE HORNFELS, aa~~

5 MS-1
17 MS-3
72 MS-4

2030-2040'

③ MXLN HBL-BTE GRTO, aa

Tr. py

~~②⑤ Meta slts / Meta ss~~

7- transl. grnsh-gray to gray to graysh-olive, commonly calcareous

18- lt-med. brownish-gray & grayish-brown - ble-rich - comm. transitional to HNFLS

~~⑦ CUBX~~ ~~⑩ BTE HNFLS, aa~~

5 MS-1
77 MS

2040-2050'

③ MXLN HBL-BTE GRTO, aa

Tr. py

~~②⑤ Meta slts / Meta ss~~

7- grnsh-gray ②⑧ brnsh-gray

~~⑦ VVF -cal -ser~~

~~⑩ BTE HNFLS, aa~~

7 MS-1
17 MS-3
63 MS-4

2050-2060'

~~⑤ VVF. cal ± ser & py~~
② cal-gtz & py

1 py

①⑤ CUBX gtz-ser-ch-cal ± py

⑤.5 ~~③~~ MXLN HBL-BTE GRTO

~~②⑤ ? Meta. slts / Meta-ss~~

~~⑩ BTE HNFLS, aa~~

4 MS-1
19 MS-3
68 MS-4

cal + gtz (< 1 mm. max. dimension)

M ser/plaq

Logging Notes

STEAMBOAT
21B-5R

J. Hulek 10/21/04
S. JOHNSON

2060-2070'

Tr ep
0.3 py

Tr R&S

- 1.5 VVF - aa
- Tr CUBX - aa

2 MXLN HBL-BTE ~~QTZ~~
GRD, aa

~~25 BTE HNFLS, aa~~

~~71.5 Meta-silt & Meta-ss, hornfelsic~~
in part w/ abundant metamorphic bde (brown)

45% is lt. grnsh-gray & comm. calcareous

3.5 MS-1
17 MS-3
76 MS-4

2070-2080'

0.2 py

2 VVF cal ± chl, ser, Qtz, py
comm

1 CUBX, aa

~~60 Meta-silt & Meta-ss~~

Tr

~~25 BTE HNFLS, aa~~

aa - Distinction between this & HNFLS gradational and somewhat subjective

5 MS-1
20 MS-3
72 MS-4

1 MXLN HBL-BTE GRD, aa

2080-2090'

0.3 py

~~35 BTE HNFLS, aa~~

Tr CUBX, aa

0.5 VVF, aa

~~64.5 HNFLS Meta-silt, and Meta-ss, aa~~

Tr

1.5 MS-1
15 MS-3
83 MS-4

35

2090-2100'

Likely considerable caving

0.5 VVF-cal, ser, chl, (py)

Tr ~~cp~~

3.5 MS-3
96 MS-4

100 HNFIC meta-sls & meta-ss

99.5 • VW-W section of plag
• VW-chlitz. of bte.

0.3 py

2100-2110'

0.5 VVF, aa

0.2 py

99.5 ~~HNFIC META SLS & META SS~~

8 MS-1 82 MS-4
9.5 MS-3

Tr LCM

(MS-1) (HFL) • trans it. grayish-gray (calc.)
(MS-2) (HFL) • trans. - semi-opaque, lt-med. grayish-brn & grayish-gray
(MS-3) •
• VVW: chlitz of mafics ser of fsp

2110-2120'

~~All aa~~

7 MS-1
9.5 MS-3
83 MS-4

0.2 py

2120-2130'

1 VVF, aa

0.2 cpy
0.1 py

99 ~~HNFIC META SLS & META SS, aa~~

• Alt. aa

5 MS-1
7 MS-3
87 MS-4

2130-2140'

0.5 VVF, aa

0.2 py

99.5 MS

7 MS-1

Alt. aa

5 MS-3

87.5 MS-4



* see 2700-2710'

Logging Notes

STEAMBOAT
21B-5R

10/21/04

J. Hulien
S. Johnson

2140-
2150

① VVF CAL ≠ ser, chl, py

* (TP) CUBX alt to grt, ser, chl.

(TP) MXLN HBL-BTE GRD, aa

(99) HNFLSC Metasites & vfg Meta-ss (MS)

5-MS1: transl. H= med. gray-green
(chlc. in part)

97-MS2: wkly transl. - subopaque
lt-med grayish-brown &
brnsh gray - bte-rich

Tr. py

Tr. paint
Tr. RFS
Tr. LCM

2150-
2160

① VVF, aa

(TP) GRD, aa

~~(99) MS1 (7)~~

~~& MS2 (92)~~

0.2 py

4 MS-1 MS-4
11 MS-3 84

VWV chl/m VWV ser/p

2160-
2170

(0.5) VVF, aa

(TR) GRD, aa

~~(99.5) MS1 (5)~~

~~& MS2 (94.5)~~

0.1 py

4 MS-1 88.5 MS-4
7 MS-3

VWV chl/m VWV ser/p

2170-
2180

(TP) VVF, aa

~~(100) MS-1 (3)~~

~~& MS2 (97)~~

alt. aa

3 MS-1 87
10 MS-3 MS-4

(0.5) VVF, aa

(99.5) MS-1 (2) 2.5

~~& MS2 (97.5) 87.5~~

MS-3 - 10

Tr py

2180-
2190

2190-2200'

(T) VVF aa

(100) MS-1 ~~(97)~~ 2
* ~~MS-2~~ 83

Tr. py

• altn aa \rightarrow MS-3:15

2200-2210'

(T) VVF aa

(1) GRD aa

(99) MS-1 (2) 80
* MS-2 ~~(78)~~

• altn aa \rightarrow MS-3:17

2210-2220'

(0.5) VVF aa
chl-cal

(T) GRD aa

~~(99.5) MS-1 (16)~~
MS-2 ~~(88)~~ 75

• altn aa

Tr. py
Tr. ep

\rightarrow MS-3:15

(1) Tr

- GO TO 2100'

RESUMED 10/28/04

2220-2230'

(1) VVF
chl-cal

(T) HDL-BTE
GRD, aa

0.1 EP (metm.)

Tr. py

(many of these are flat, and clearly not "frozen" to the wallrock)

(10) MS-1

~~(79) MS-2~~

(10) MS-3

Essentially Unaltered

2230-2240'

(1) VVF

(1) CHX

(T) GRD, aa

(10) MS-1

~~(78) MS-2~~ 4*

(12) MS-3

\rightarrow Ess. Unaltd.

Tr. py
0.2 EP (metm.)

2240-2250'

(0.5) VVF
- chl
- chl-cal
- cal

~~(1) MS-1~~

~~(99.5) MS-2~~ 4*

(82.5)

(7) MS-3

Essentially unaltered

Tr. py
0.2 EP (metm.)



* SEE 2700-2710'

2250-
2260'

To Reiterate, as per 2700-2710':

Tr. py
Tr. EP (metm.)

⑦ MS-1, i.e., sparsely to strongly chloritic vfg meta-quartzite & quartz meta-silts, lt.-med., comm. grnsh-gray, matte to sl. translucent. Many chips contain acicular, crudely aligned, silky calc-silicate crystals and crystal bundles, probably tremolite. unaltered.

⑪ ~~MS-4~~ MS-4, i.e., Bte-Bearing, Hornfelsic Metaquartzite & Quartz Meta-siltstone, transitional to bona-fide bte. hornfels. Mostly lt.-med. grayish-brn. to brnsh-gray & grnsh-gray-brown. Tr. rose-colored euhedral garnet.

⑮ MS-3
[HNLs]

① VVF — CAL; chl-CAL; chl

Tr. cubx

Tr. GRTP, aa

2260-
2270'

— All aa —

exc. ⑩ MS-3
⑫ MS-4

39

Tr. py
Tr. epy
0.1 EP (metm.)

Tr. py
0.2 EP (metm.)

2270-2280'

① VVF, aa

* ⑤ MS-1

~~④ MS-4~~
⑦⑨

Ess. unaltd.

⑮ MS-3

Tr. LOM

2280-2290'

⑮ VVF
.CAL

* ⑤ MS-1

~~⑦⑤ MS-4~~

Ess. unaltd. ⑳ MS-4

Tr EP (metm.)

2290-2300'

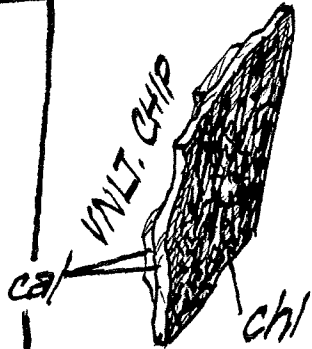
①⑤ VVF
.chl-CAL

* ⑪ MS-1

~~⑧⑤ MS-4~~ ⑦⑮

Ess. unaltered

Tr. EP (metm.)



Vnlt. chips comm. broken entirely free of the host rock, to which the vnlt's. clearly were not "frozen."
∴ These are hydrothermal vnlt's, not metamorphic.

↪ & ⑰ MS-3

2300-2310'

①⑤ cubx, grnsh-white, distinct from "bit gouge"

①⑤ VVF, CAL, chl-CAL

* ⑪ MS-1

⑮ ~~⑧③ MS-4~~

~~⑦③ MS-4~~

1% strongly chl-sericitized = cal (buff-white to grnsh-white)

otherwise essentially unaltd.

0.1 EP (metm.)

2310-2320'

⑦ cubx
aa

⑦ VVFa
.cal

⑦ GRD aa

Tr. py
Tr. Cpy

⑤ MS-1*

~~⑦⑤ MS-4~~
⑦⑧

Ess. unaltered

& ⑰ MS-3

40

* see 2250-60' & 2700-10'

Tr R&S
obv. Cvd.

Logging Notes

STEAMBOAT
21B-5R

Oct. 28, 2004
S. JOHNSON

J. HULLER

2720-
2770

11
Tr

0.5 VVF
• cal
• chl-cal
• cal-chl-ser

0.5 cubx ~~~~~
buff-white
to grayish-white

Tr. cpy
0.2 py
0.1 EP (metm)

10 MS-1*

25 MS-3*, QTZ-FSP-BTE HORNFELS, vfxln,
speckled brown, brnsh-gray, & transl.
lt-med. gray. 20-30% bte. comm.
crudely foliated. Essentially unaltdx

6A MS-4, aa

• ~ 1% of these rx. intense
altd. to chl. & ser. in various
combinations

2770-
2790

qtz

1.5 VVF
• cal

10 MS-1*

11
Tr

30 MS-3*
• qtz
• cal-chl-ser

0.5 cubx ~~~~~

58.5 MS-4*

0.4 py
Tr. cpy
0.3 EP (metm)

2340-
2350

qtz

2 VVF
aa & qtz-ser-py

15 MS-1*

25 MS-3*

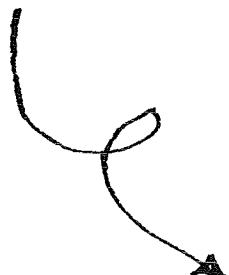
57 MS-4*

1 cubx, aa

0.7 py
0.1 cpy
0.3 EP (metm)

ALTN = W-X OK
SER/PI = W-X'
CHL/ML = W

* see 2700-2710'



November 8, 2004

2350-2360'

(1) Tr

(1) VVF aa
(0.5) cubx

(12) MS-1
(25.5) MS-3
(6) MS-4

see 2700-2710'

0.1 py
Tr. ep
(MTM)

alth = W ser = W chl = W

2360-2370'

(1) Tr

0.5 LCM



(1) VVF aa

incl. one 5x3x2 mm vuggy gtz-ser-(py) chunk

(5) MS-1
(15) MS-2
(7) MS-3

see 2700-2710'

0.1 py
Tr. ep

(1) cubx

alth = W-VW
ser = W-VW
chl = VW

but str. chl-ser ± gtz alth adjacent to vnlts

2370-2380'

(1) Tr

(1.5) VVF — up to 3 mm. wide
mostly tight ser-cal-(chl)



also pure cal.

(0.5) cubx

- A. Distinctly fibrous-appearing semi-transl. white calcite
- B. Sheared, but coarser-grained w/ly transl. white cal.
- C. chl-ser-gtz-altered cubx — sheared.

(2) MS-1
(10) MS-2
(86) MS-3

see 2700-2710'

alth AA

42

Tr. py 0.2
EP
(MTM)

2380-
2390

④ TR

① VVF aa } see
② 0.5 cubx } 2700-
③ MS-1 } 2710'
④ MS-2 }
⑤ 65.5 MS-4 }

0.7 py
TR. Epy
TR. ep (MTM)

ser / fsp - VW } but M-S adj. to units.
chl / mfc - W } (affects ~ 2% of TRV)

finer cuttings

2390-
2400

TR. LCM
* R#5
TR. paint
* CU-
grease

① TR VVF aa } see
② TR cubx, aa } 2700-
③ 5 MS-1 } 2710'
④ 45 MS-2 }
⑤ 60 MS-4 }
⑥ 48 }

TR. py
TR. EP

ALTN 22 ② HBL-BTE-MXLN GRTD

2400-
2410

① TR

② VVF aa } see
③ 5 MS-1 } 2700-
④ 50 MS-3 } 2710'
⑤ 40 MS-4 }

② GRTD, aa

0.7 EP

ALTN aa

1-R#5
TR - "mud"
TR - CU grease
TR - LCM or
bag fiber

2410-
2420

④ TR

① 1.5 VVF aa } see
② 0.5 cubx } 2700-
③ MS-1 } 2710'
④ 50 MS-3 }
⑤ TR GRTD, aa } 45 MS-4 }

0.2 EP

altn aa
i.e., VW-W

1-R#5
1-CU grease
TR - paint
TR - LCM
TR - "mud"

2420-2430'

Tr-LCM
0.5-Cu grs
Tr-"mud"
1-R&S

(1A)

(1.5) VVF aa

many (most) are
loose flakes/plates
w/one or both flat
surfaces polished
& slickensided

(7) GRTD, aa

(3) MS-1 } ?

(40) MS-2 } see
(55) MS-3 } 2700-2710'

← def. post-
metamorphic

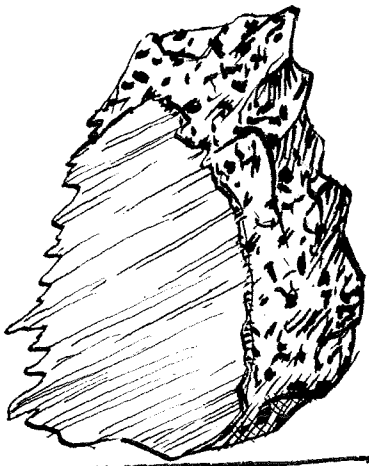
0.3 EP

(0.5) cubx

W ser/asp
W chl/mfcs

2430-2440

0.5
Cu-grease
Tr. LCM
Tr. paint
0.5 R&S



EXAMPLE OF A COMMON OCCURENCE

0.1 EP

Biotite Hornfels chip with
"scab" of ~~the~~ wklu trans-
lucent white calcite/seri-
cite that is prominently
stickensided!

(1A) → see
above

(1) VVF, aa

(7) cubx, aa

(5) MS-1

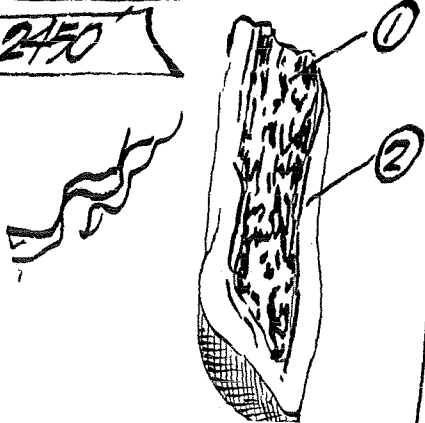
(1) clear colorless
quartz (not opal)
chips - from GRTD

(35) MS-2

(68) MS-4

see 2700-2710'

2440-2450



(1) sheared bte knifs, 2 fr. shear
(2) ser-cal "sheath" } zone

(0.5) VVF aa

(3) MS-1 } see
(50) MS-3 } 2700-10'
(46.5) MS-4 }

(7) GRTD

VW altu.

44

Logging Notes

STEAMBOAT 21B-5R

J. Hulert 11/08/04
S. Johnson

2450-2460

- 0.5 VVF, aa
- 1.5 MS-1
- 55 MS-3
- 43 MS-4

"fresh"

TF GRD

VW altn
VW ser / fsp
VW chl / mfs

2460-2470

- TF VVF, aa
 - 1 MS-1
 - 45 MS-3
 - 54 MS-4
 - Altn. aa
- "freshen" TF GRD
see 2700-10

2470-2480

- TF VVF, aa
- 2 MS-1
- 40 MS-3
- 58 MS-4
- Altn. aa

2480-2490

- TF CU BX
- 2 MS-1
- 35 MS-3
- 63 MS-4
- TF VVF, aa
- Altn. aa

2490-2500

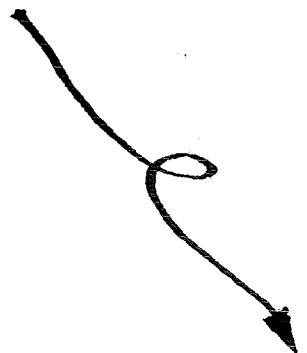
- TF VVF, aa
 - 0.5
 - 2 MS-1
 - 20 MS-3
 - 77.5 MS-4
- see 2700-2710'

JA TF

TF CU BX

Altn VVW, aa

45



2500-2510'

- (0.5) VVF, aa
- (7) MS-1
- (T) CUBX, aa
- (29.5) MS-3
- (67) MS-4

see 2700-2710'

Alteration VVW

(VFL)

Tr. R&S

2510-2520'

- (0.5) VVF, aa
- (9) MS-1
- (CAL-ch) ser
- (2) MS-2
- (25.5) MS-3
- (63) MS-4

see 2700-2710'

Altn. VVW

(VFL)

Tr. paint

0.1 EP (MTNL.)

2520-2530'

** Tr. PROBABLE OPAL appears

Tr. EP (MTNL.)



colorless, clear, "crackled" conchoidally fractured OPAL

chl-ser-ald, sheared CUBX

sl. grnsh-yellowish white

- (0.5) VVF, aa, &
- (5) MS-1
- (T) CUBX, aa
- (15) MS-3
- (79.5) MS-4

altn. AA

(VFL)

2530-2540'

- (T) VVF
- (5) MS-1
- (T) CUBX, aa
- (15) MS-3
- (1) GRD
- (79) MS-4

see 2700-2710'

(VFL)

Tr. EP

(VFL altn)

Tr. R&S

2540-2550'

- (T) VVF
- (7) MS-1
- (1) GRD
- (1) MS-2
- (20) MS-3
- (71) MS-4

see 2700-2710'

(VFL)

Tr. py 0.5 EP

(VFL altn aa)

46

Appearance of abundant LCM

0.3 EP
(mtm.)

2550-
2560'

- (Tr) VVF CAL-ser-(chl)
- (Tr) CUBX [qtz-sercted]
- (1) ~~(Tr) GRTD~~
- (2) MS-2
- (6) MS-1
- (10) MS-3
- (8) MS-4

VFL

altm
aa } VW

10-LCM

2560-
2570'

* 1 x 1.5 x 1 mm PY-ser chip

0.4 PY
0.9 EP
(mtm.)

- (0.5) GRTD
- (Tr) VVF
aa
- (20) MS-1
- (1) MS-2 (w/tr. garnet)
- (10) MS-3
- (68.5) MS-4
- (FL)

w chl/mfcs.
VW ser/fsp

see
2700-
2710'

3-LCM

(** Tr OPAL) [only one chip found]

Tr. cpy (0.1)
Tr. py
Tr. ep

2570-
2580'

- (0.5) GRTD
- (0.5) VVF
aa
- (Tr) CUBX aa
- (15) MS-1
- (15) MS-3
- (69) MS-4

see
2700-10'

ww altm
aa

(4)
Tr.
on vult.

6-LCM

2580-
2590'

- (Tr) GRTD
- (0.5) VVF
- (0.5) CUBX
- (** Tr OPAL)
- (12) MS-1
- (Tr) MS-2
- (10) MS-3
- (77) MS-4

see
2700-
2710'

Tr. py
Tr. ep

w altm (w ser/fsp)
(w-m chl/mfcs.)

(1) aa

1-LCM

2590-2600
1 LCM
① TR
on visit

★★ Tr. OPAL

① TR GRTD

① VVF & . grt-ser-py
• CAL
• CAL-SER-CHL (chl)
• ser-chl

① MS-1

① MS-3

⑧ MS-4

0.1 ep
Tr. BN
① ~~TR~~ py

①.5 CUBX, aa

vw ser/fsp
vw chl/mfc } vw

2600-2610
2 LCM

①.5 VVF
① TR CMBX
aa

① TR GRTD

① MS-1

①.5 MS-2

① MS-3

⑧ MS-4
vw altn
aa

see
2700-
2710

0.3 py
Tr. ep
0.1 EP (mtm)

2610-2620
3 LCM

★★ Appearance of orange & brnsh-
yellow & grnsh-gray mottled hornfels,
prob. calc-silicate — distinct from
all other rock types.

① TR

①.5 CMBX

① VVF, aa

① TR GRTD, ② MS-1

⑤ MS-3, ⑧ MS-4

vw altn, aa (ser & chl)

0.3 py
1 EP
3 GNT } mtm

⑨ MS-2 calc-silicate
hornfels — contains
brnsh- & grnsh-yell.
epidote & transparent
pale orange garnet (gros-
sular?). Rx is v, 3x
as coarse-grained as
co-existing bte. hmfels.
Garnets up to at 1st.
1 mm. major axis, and may
be porphyroblasts.

Logging Notes

STEAMBOAT 21B-FR

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2620-2630'

(0.5) VVF
aa

(30) MS-1
(10) MS-2
(7) MS-3
(52.5) MS-4

see above
\$ 2700-2710'

0.5 py
0.5 EP
2 GNT

(FL)

1 LCM

vw ser/fsp.
vw chl/mfc.
to Tr.

2630-2640'

(1) VVF
aa &
qtz (py)

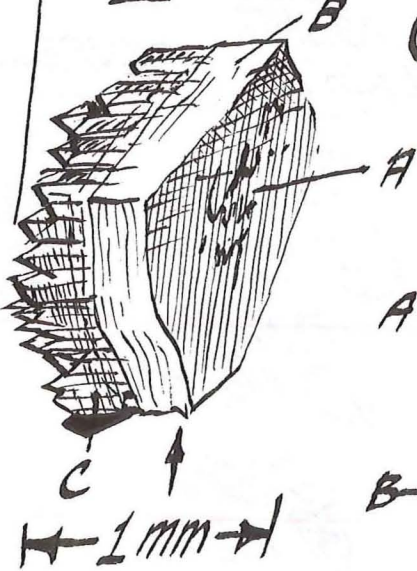
(5) MS-1
(2) MS-2
(13) MS-3
(79) MS-4

0.3 py
~~0.5~~ EP
0.5 GNT

(alt. aa)

3 LCM

qtz



A - Flat vein base
w/ scabs of
hem. & chl
B - Massive cryptocr.
silica, transl. white
C - Euh. prismatic qtz.,
clear, colorless.

(FL)

2640-2650'

(Tr) VVF
• CAL - (ser, chl)
• CHL - SER - (cal)

(5) MS-1
(Tr) MS-2
(9) MS-3
(86) MS-4

Tr. py
Tr. ep
Tr. gnt

(vw alt. aa)

2 LCM

Tr
Tr

2650-2660' (17) VVF, aa (13) MS-1 1 PY

2 LCM

Tr - VVW
VW alt'n
aa

(5) MS-2

(25) MS-3

(57) MS-4

see 2700-2710'

Tr. CPY
Tr. EP
Tr. GNT

2660-2670' (4) Tr (0.5) CMEX (17) MS-1 0.5 PY

(1.5) VVF

aa

some ff

(3?) MS-2

(25) MS-3

(53) MS-4

see 2700-10'

Tr. CPY
Tr. EP

VW alt'n aa

2670-2680' ** CHANGE TO ABUND. CALC-SILICATE HORNFELS 4 EP metm.

(1) VVF

CAL ≠ (ser, chl)

(7) MS-1

(70) MS-2

(5) MS-3

(17) MS-4

clear, pale-med. orange

7 GNT

0.5 PY

Ess. unaltered

2680-2690' (17) VVF (5) MS-1 0.1 CPY

aa

(87) MS-2

(1) MS-3

(7) MS-4

metm

0.1 PY

6 EP

5 GNT

Ess. unaltered

2690-2700' (0.5) VVF (5) MS-1 7 EP

aa

(87.5) MS-2

(1) MS-3

(6) MS-4

metm

4 GNT

Tr. CPY

Ess. unaltered

Detail first, consolidate later

in part calcareous, uncommonly contains tremolite

2700-2710'

2 LCM

(12)

(MS-1)

to grnsh-gray
QUARTZ METASILTSTONE & VFG METAQUARTZITE
v. lt-med. matte to sl. vitreous/transl. gray; Dense, hard, "flinty" ^{chlorite} in part

Transitional to MS-2

(45)

(MS-2)

^{CHL-} QTZ-CALC-SILICATE ± CAL HORNFELS, vfxln matte to translucent v. lt-med. (lt) grnsh-gray, grayish-green, & grayish yellowish gray-green (variously);

MS-2 contains ~4% pale-med. clear orange garnet-11/09/04

Need thin section & XRD for full mineral I.D. but this rock type contains at least epidote, chlorite, quartz & muscovite, and appears to contain plagioclase, tremolite, and garnet; Near-fully recrystallized, but scattered relict Qtz grains belie a sedimentary protolith.

some transp. orange to red-orange

(9)

(MS-3)

QTZ-PLAG-BTE HNFs & QTZ-PLAG-HBL-BTE HORNFELS, mottled transl. lt. gray, med. brown, & med-dk. gray-green, vfxln (avg. n 100v); pronounced granoblastic texture

(24)

(MS-4)

BTE-BEARING, HORNFELSIC META-SANDSTONE (vfg) & METASILTSTONE. Lt-med (rarely dk) grnsh-brn to brnsh-gray. Transitional to BTE Hnf's, above.

& grnsh-brn. to brnsh-green.

2700-2710

cont'd

Apparently negligible hydrothermal alteration or mineral exc. for diss. sulfides

* SEE ADDENDUM ON FOLLOWING PAGE.

1.5 EP (metm.)
1 PY
Tr. cpy

2710-2720



Tr. qtz.

10 MS-1*

69 MS-2

1 VVF
• (met? ep, mostly)
• Tr HYDR. QTZ

13 MS-3

7 MS-4

1.6 EP (metm.)
1.3 PY
0.2 cpy

2720-2730



Tr. qtz

4 MS-1*

15 MS-2

0.5 VVF
• (metm. EP)
• Hydr. QTZ-PY

15 MS-3

65.5 MS-4

LOST MOST MS-3 BY HERE

1.5 EP (metm.)
0.5 PY / Tr. cpy

2730-2740

— MS-1*

5 MS-2

Tr VVF

0.4 PY

3 MS-3

92 MS-4

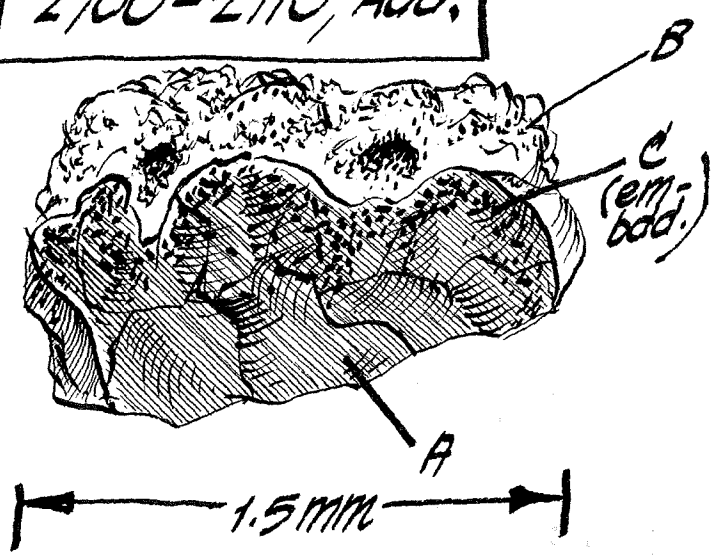
Tr. cpy

0.7 EP (metm.)

Protolith more calcareous — RX contains conspicuous & mod. abundant tremolite needles

* See 2700-10 for detailed lith descriptions

2700-2710, Add.



- (just one)
- FOUND A COMPOSITE
OPAL-CALCITE CHIP
- A—clear, colorless,
"crackle-textured"
opal
- B—"spongy" matrix,
buff-white calcite
- C— $< 2\mu$, dk. gray
metallic flakes
embedded in opal

ALSO: (1) Tr
\$
~~~~~

\$ more copy (4 0.39)

\$ 5% orange garnet

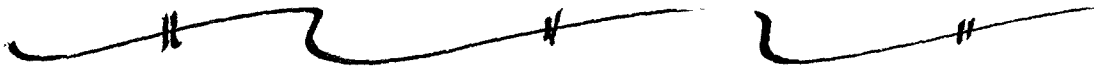
2710-2720, Add.

~~1~~  
2 LCM  
Tr. insect  
parts

- \$ 13 orange garnet
- \$ Tr diss. bornite
- \$ Tr colorless clear opal  
[2 small broken chips]

2720-  
2730'  
Addendum

‡ ~ 1% orange garnet



2840-2850 Add'm

‡ Tr. clear, colorless opal.

‡ 0.1 brick-red to maroon  
hematite

Logging Notes

STEAMBOAT  
218-5R

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2740-  
2750'

2 LCM

Tr. black rubber

- MS-1\*
- ⑤ MS-2
- ③ MS-3
- ~~95~~ MS-4
- ~~92~~
- ⑦ VVF
- ser
- cal

|                |
|----------------|
| 0.2 py         |
| 0.5 EP (metm.) |

Ess. unaltered VFL

2750-  
2760'

1 LCM



1 mm

ONE chip consists of an aggregation of thin-walled, white to pale orange, hollow oolitic spheroids.

|              |        |
|--------------|--------|
| ①.5 VVF      | 0.3 py |
| - qtz        | 0.2 EP |
| - qtz-ser-py |        |
| - cal        |        |

- ②.5 MS-1\*
- ③ MS-2
- ⑦ MS-3
- ⑧ MS-4

• RX Ess. unaltered

2760-  
2770'

- ⑩ MS-1\*
- ② MS-2
- ⑩ MS-3
- ⑦ MS-4
- ⑦ VVF
- cal

|        |
|--------|
| 0.1 py |
| 0.3 EP |

• Ess. unaltered

2770-  
2780'

- ② MS-1\*
- ③ MS-2\*
- ⑦ MS-3
- ⑥ MS-4\*
- ①.5 VVF
- cal
- qtz

|         |
|---------|
| 0.3 py  |
| Tr. cpy |

①.5 GG & CBX - opaque, mottled bone white & lt. gray-green w/ Tr- 2% diss. pyrite

① Tr.

Tr. cal, qtz.

55

2780-2790'

VA  
Tr

(23) MS-1\* (2) MS-2  
(5) MS-3 (68.5) MS-4

(1.5) VVF  
Tr  
0.3 PY  
0.1 EP

2790-2800'

5 LCM  
Tr R&S

(46.5) MS-1\* (13) MS-2 (0.5) VVF  
-cal -gtz  
(3) MS-3 (37) MS-4 (Tr) CUBX

0.1 CPY  
0.5 PY  
2 EP (med)

2800-2810'

3 LCM  
Tr R&S

(57) MS-1\* (9) MS-2 (1) VVF  
-cal -hm  
(3) MS-3 (32) MS-4 (Tr) CUBX

0.2 HM  
0.7 PY  
1 EP (med)

2810-2820'

5 LCM  
Tr R&S

Finer-X/L

(69) MS-1\* (7) MS-2 (1) VVF  
-cal -PY  
(2) MS-3 (21) MS-4 (Tr) CUBX

1 PY  
Tr HM  
0.5 EP

2820-2830'

2 LCM  
Tr R&S

(16.5) MS-1 (5) MS-2  
(3) MS-3 (14) MS-4

(1.5) VVF  
-ser-cal-py (gray 5")  
Tr EP | 0.5 PY | Tr HM  
Tr. gray 5"

Essentially unaltered

56

S. Johnson

All RX ESS. Unaltd.

2830-2840'

- (30) MS-1\*
- (2) MS-2\*
- (3) MS-3\*
- (69.5) MS-4\*
- (1) VWF. qtz, cal, chl, py
- (0.5) CUBX aa

SEE 2700-2710'

0.3 PY  
0.1 EP  
Tr CPY

15 LCM  
Tr R&S

2840-2850'

- (42) MS-1\*
- (3) MS-2\*
- (53.5) MS-4\*
- (1) VWF, aa
- (0.5) CUBX (qtz-ser chl-py)

SEE 2700-2710'

1 EP  
0.5 PY

7 LCM  
Tr. R&S  
Tr. CU grease

Rocks are essentially unaltered

2850-2860'

\*\*\* RADICAL CHANGES \*\*\*

- \*\*1. Big increase in unambiguous contaminant (steel, rust, paint, etc.
- \*\*2. 1/4 of sample consists of rock types not present higher in this re-drill.
- \*\*3. Opal appears. Mostly fresh, clear, and colorless. Textures reminiscent of both SINTER and SCALE. Minor accompanying "spongy" tufa-like calcite
- \*\*4. 1/4 of these "exotic" rock types occur as subrounded to rounded sand & grit grains and pebbles.

CONTAMINANTS

3 R&S  
1 paint (grn)  
0.5 CU-grease

Tr. qtz

7 LCM  
drill-produced dust  
minutated cuttings  
dk. green plastic

also 5% silt & clay-sized drilling-produced "fines" clumped & dried

CEMENT  
magnetic FeO flakes of un-

clumps of un- I.

2870-  
2860  
cont'd.

(7%) SAND TO GRIT GRAINS & PEBBLES

(and broken pieces thereof).

Most grains 0.5-2 mm dia., but a few pebbles up to 7mm.

Whole grains are equant to stubby-elongate, subrounded to well-rounded. Grain fragments are identified on the basis of one or more rounded or abraded surfaces. Grains comprise, in decreasing order of volumetric abundance:

- [4%] Metaquartzite & Quartz Metasiltstone, mostly lt.-med. grayish- & brnsh-gray & grayish-brn. Possibly hornfelsic. contain bte & chl. some relict bddng. apparent.

- [2%] Med.-Xtl. Ste-Hbl. Qtz. Drt., similar to the granitoid higher in the re-drill, but generally more leucocratic, & with ~~&~~ seemingly much higher hbl:bte ratio

- [1%] Altered Andesite & ~~Porphyritic~~ Porphyritic Andesite. opaque med. grayish-green or grayish-olive. seemingly strong propylitic alteration. [58]

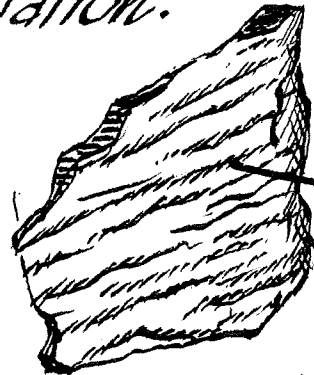
2850-  
2860,  
cont'd.

SAND TO GRIT GRAINS & PEBBLES, cont'd.

- [Tr] PHYLLITE (or PHYLLONITE?)

opaque, slightly bluish medium gray. "Glittery" micaceous, ~~ss~~ strongly lineated // to foliation.

\*\* NOTE:  
Pebbles comm. partially coated w/ earthy goethite/ hematite (could be either indigenous or rust from drill steel).



PHYLLITE-PEBBLE CHIP  
Lineations ("normal" for phyl-  
lite)  
Rounded, abraded

2mm

- [Tr] Andesitic Volcaniclastic ss, x  
poorly-sorted. Intense Propylitic Alter.

(15%) chips of "Exotic" Rock Types, x, i.e., not encountered higher in the re-drill. In decreasing abundance:

(NOT "EXOTIC" 11/20/04) - [10%] Med.-xln Bte-Hbl. Qtz. Diorite & individual crystal constituents thereof. (same rx type forming pebbles — see above).

- [4%] Phyllite, aa

59

2850-  
2860'  
cont'd

"EXOTIC" Rock Types, cont'd.

[1%] Brick-red, argillized, tuffaceous sandstone & siltstone  
Suffused with earthy hematite.  
poorly-sorted. Sand grains appear to be mostly andesitic or basaltic lithic fragments, entirely clay-altered.

[Tr] ss, argill., vfg (rarely up to mg),  
poorly sorted, buff-white to lt. gray-buff. ~~X~~ appears to be volcaniclastic & tuffaceous  
— Not metamorphosed = Cenozoic rock

(15%) OPAL chips. Dominantly colorless and transparent ("water-clear"). Locally translucent to semi-opaque white ("milky") in irregular to distinctly globular domains gen. < 1 mm max. dimension. "crackled" texture, reminiscent of perlite. Commonly contain tr-0.2% disseminated, opaque, < 1-50 $\mu$  wide (avg < 10 $\mu$ ), reddish-gray to black metallic-appearing flakes. 5-10% of these chips have one or more delicately botryoidal to globular surfaces.

- A few of the botryoidal surfaces are clearly desiccation-cracked possibly indicating dehydration in air.

[60]



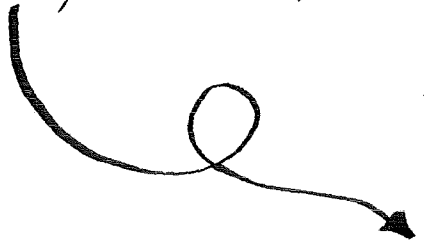
2850-  
2860  
cont'd.

Microgranular,  
3% "Spongy" textured CALCITE chips. Buff-white to slightly yellowish- or orange-white. Many chips ~~are~~ are reminiscent of pumice, ~~but~~ but are wholly calcareous.

Ti "Bladed" CALCITE CHIPS, in which blades of reddish-brown to brnsh-yellow calcite have grown sub-perpendicularly ~~to~~ outward from a flat, 5-10u-thick, opaque <sup>med. orange-</sup> dark brown substrate <sub>brn to</sub>

3% COMPOSITE OPAL-CALCITE CHIPS; Opal >> Calcite. Typically a thin (<0.5mm) calcite layer adjoining a thicker (up to at least 5mm) opal layer.

• Calcite layer ranges from "spongy" (aa) to relatively dense buff-white cryptocrystalline. The latter ~~is~~ invariably incorporates ~~flat lying~~ thin, randomly-oriented calcite blades ~~x~~ 0.2-0.7 mm wide & 20-40u thick (lesser measurement // to chip surface) (<sup>7</sup><0.5)



2850-  
2860  
cont'd

(Ti) CUBX, aa

(0.5) VFL cal, chl, ser, qtz (□)

(56.5) chips of other rock types,  
as follows:

[27.5] MS-1

[2] MS-2

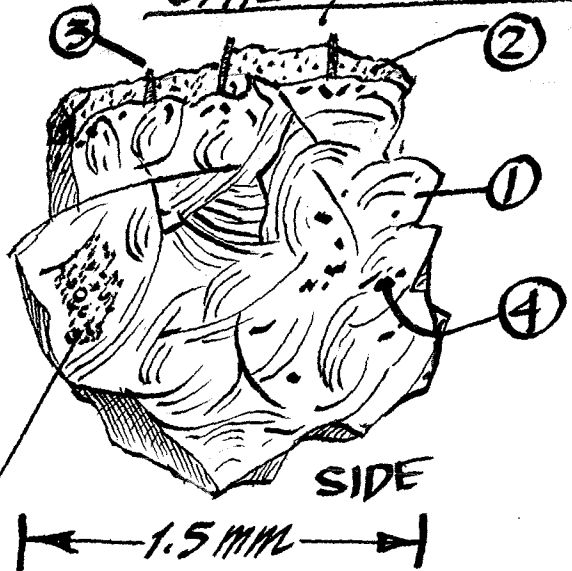
[4] MS-3

[28] MS-4

} see 2700-  
2710 for  
rock  
descrip-  
tions

\* All of these  
essentially (VFL  
unaltered

\*\* SKETCHES OF REPRESENTATIVE  
OPAL & CALCITE CHIPS



① "crackled" water-clear  
opal (hyalite)

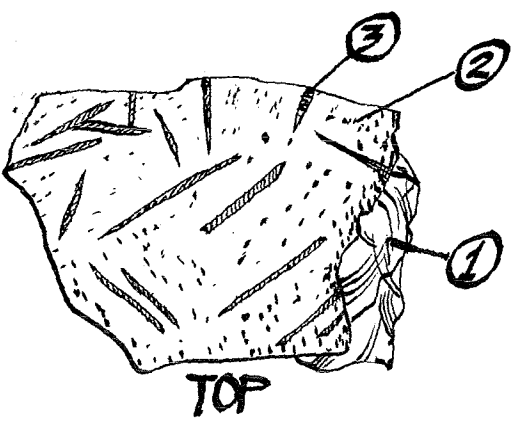
② "spongy" - textured  
buff- to sl. orange-white  
n granular calcite

③ bladed calcite, probably  
broken at top

NONMAGNETIC

④ opaque reddish-gray  
& black metallic flakes  
(embedded in opal)

⑤ Apparent inclusion of  
arkosic (3) silt (need  
to v thin section

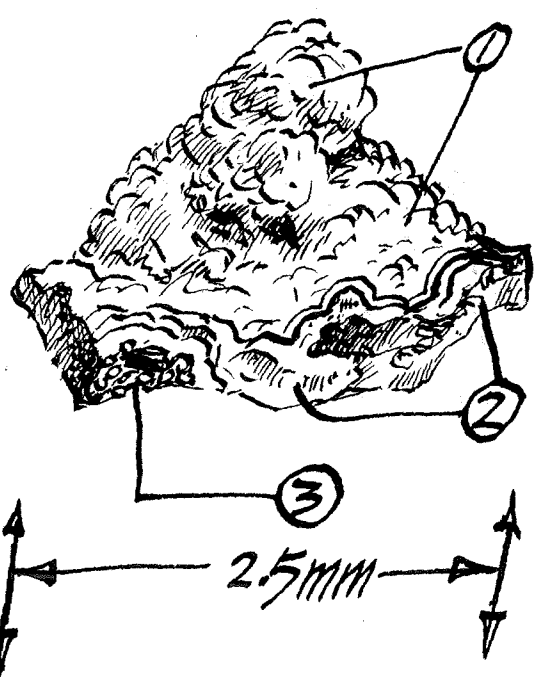
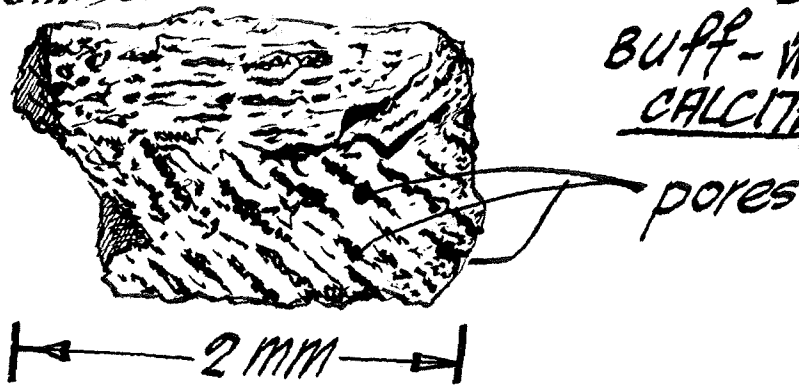


J. Miller  
10/24/04  
S. Johnson

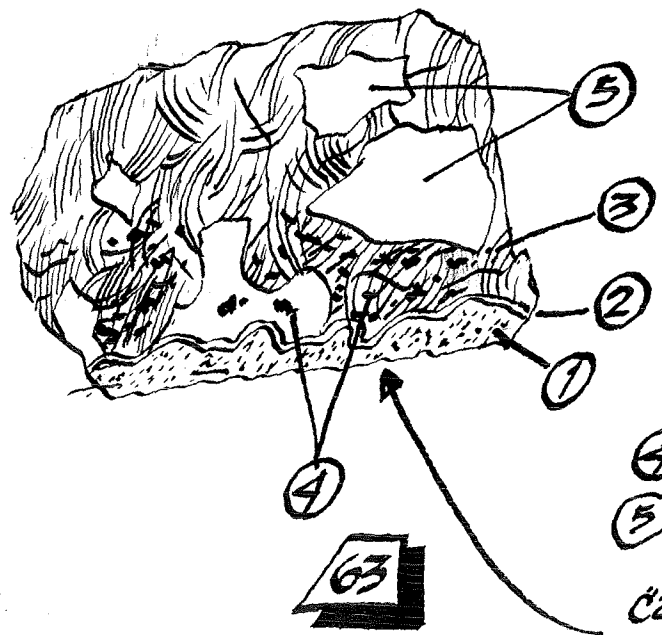
STEAMBOAT  
21B-5R

2850-  
2860 cont'd

"Spongy"  
Buff-white granular  
CALCITE



- ① opaque white to w/ly translucent lt. gray "fluffy" opal
- ② transparent-translucent
- ③ fg sand loosely cemented & overgrown with opal



- ③ — see below
- ~~③~~ "crackled" colorless to lt. gray transparent opal
- ② sl. brownish clear opal.
- ~~①~~ lt. gray-buff granular calcite
- ④ PURE WHITE CLAY (likely kaolin)
- ⑤ black metallic flakes (↓)
- calcite blades (see drawing A2) underneath

2850-2860' cont'd.

\*\*\*\*  
 "phyllite" cut by calcite veinlets and by veinlets of euh. quartz poss. intergrown w/ opal(?) V petrographically

2860-2870

Tr. CNT  
 0.5 cu grease  
 4 R & S  
 Tr. grn paint  
 2 LCM  
 Tr. grn plastic



⑨ SAND, GRIT, & PEBBLES, aa, but the latter up to at least 13 mm max. dimension.

③ Basaltic or Andesitic pebbly coarse-gr. ~~ss~~ VOLCANICLASTIC SS mottled lt-med. gray-green and lt-med. reddish to purplish-gray through grayish red and grayish-purple.

- ② Brick-red slts & ss
  - ② Qtz. Diorite
  - ① Phyllite
  - ① Andesite
- } same as 2850-2860

⑳ "EXOTIC" ROCK TYPES NOT "EXOTIC"

- ⑦ Phyllite
- ⑩ Qtz Diorite
- ① Basaltic or Andesitic volc. ss, aa
- ③ Brick-Red ss and slts
- ⑦ basaltic ss
- ① Andesite
- ①① Qtz-rich sericitized ss

commonly sheared & slicken-sided.



- ⑬ OPAL, aa
- ④ "spongy" cal, aa
- ⑦ bladed calcite
- ⑤ VVF
- ①⑤ CUPEX, aa
- ②④ MS-1
- ① MS-2
- ③ MS-3
- ⑬ MS-4



Logging Notes

STEAMBOAT  
21B-5R

J. HULEK 10/24/04  
S. JOHNSON

2570-2600

11

3 sand, Grit Grains & Pebbles, aa  
[ ] Meta-Qtz, Phyllite, and  
Qtz. Drt, aa

0.5 py  
0.3 EP

23 "EXOTIC" ROCK TYPES, aa

NOT "EXOTIC" IN 11/09/04

[ ] Qtz Drt. [ ] Phyllite  
[ ] Brick-red ss & slts - COMM  
[ ] Andesite [ ] Basalt

Tr. cement  
0.5 cu grease  
4 R&S  
Tr. gm. pnt  
Tr. dk green plastic  
2 LCM

\* 21 OPAL, aa    22 OPAL-CAL, aa  
3 "SPONGY" CAL, aa    (Tr) BLADED cal., aa.  
NB. some pcs rounded one pc. calcite on 55!

3 CUBX, COMM. strongly chrtad. ± 2nd ser, qtz, py

0.5 VVF, aa    44/5 "OTHER"    14 } see 2700-2710  
46/5    [ ] NS-2    [ ] NS-4    [ ] NS-1  
[ ] NS-3    [ ] NS-1

2680-2690

11 Tr.

6 Sand, Grit, & Pebbles, aa

[ ] ~~2~~ Meta-Qtz, aa (one pink chip)

[ ] 3 Brick-red ss & slts, probably suffaceous. Soft intensely argillized - could easily have been rounded in transit to the rig floor from depth

[ ] 1 ~~1~~ Qtz. Drt, aa  
[ ] Ppytc Andesite aa

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3 R&S  
Tr LCM  
Feox mgntc. of un-known origin  
TR

Tr qtz.

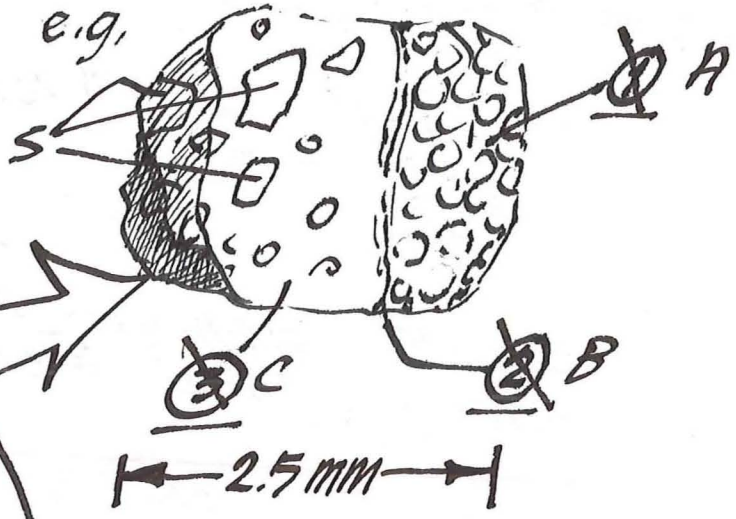
2880-2890  
CONT'D.

92 → "EXOTIC" ROCK FRAGMENTS, aa

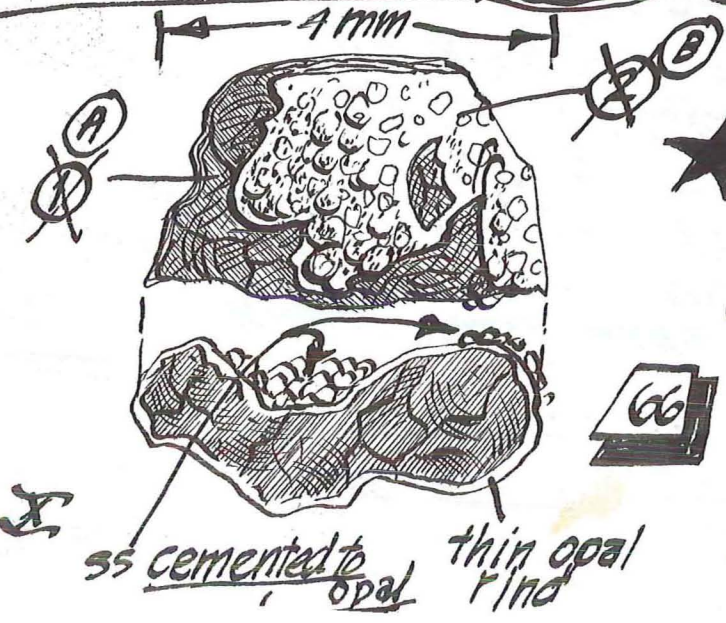
NOT "EXOTIC"  
JH 11/09/04

- [17] Bte-Hbl Qtz Dtr, aa
- [3] Brick-red argill slts & ss, aa
- [9] Phyllite, aa
- [2] SANDSTONE, in part volcaniclastic; in part silicified, but not metamorphosed.

A transl. lt. gray  
 dense, intensely silicified  
 quartz-rich ss  
 diffuse, grayish-orange  
 band  
 silicified & sericitized (w/tr. chl. & py) immature f-cg ss or nbx of unknown origin  
 "s" = pure white sericite

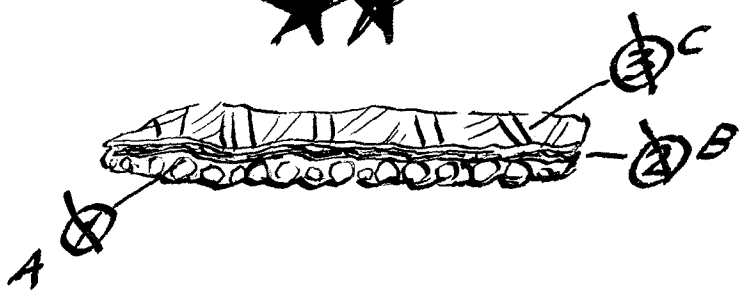


- [1] Andesite, aa
- [Tr] Banded chalcidony



- ★★ (A) Transparent, sl. brownish lt. gray, "crackled" opal
- (B) sandstone → vfg-fg; subf to subrm, subsequent quartz grains embedded in a white clay (kaolin?) matrix.

2880-2890 cont'd.



- A. vfg-fg qtz-rich ss, silicified
- B. thin, multiple laminae of opaque orange-white to transl. yellowish to brnsh-gray calcite (cryptoxln.)
- C. translucent white - lt. gray vfxln calcite.

⑫ OPAL, aa

② OPAL-cal, aa

② "spongy" cal, aa

⑦ bladed calcite, aa

② cnbx, aa

①.5 VVF, cal qtz, chl, ser, (py)

④.5 OTHER RX TYPES

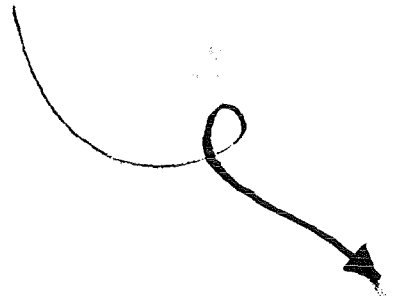
265 MS-1

2 MS-2

7 MS-3

12 MS-4

} see 2700-2710'



~~2890-2900~~

~~NO SAMPLE~~

~~2900-2905~~

Found it. (out of place)

2890-2900

THE ROSETTA STONE?

★★

- ⚡
- Tr. cement
- 2 R&S
- 2 FeOx (magnetic) part
- of unknown origin
- 1 LCM



|              |
|--------------|
| Whole sample |
| 0.3 PU       |
| Tr. CPU      |
| 0.3 EP       |

① PHYLLITE or PHYLLONITE, speckled lt.-med. translucent gray and opaque med.-dk. gray (shiny, "sparkling"); quartz, plag., & bte. Rock is apparently unaltered.

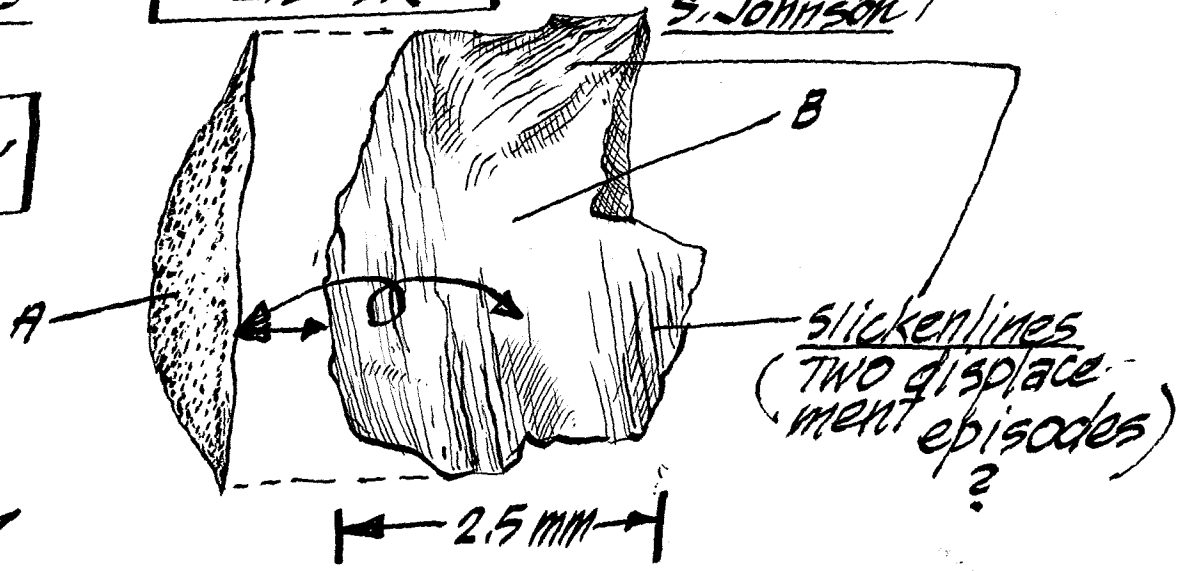
② vitreous, transparent, colorless, fresh OPAL. Does not seem to contain the micron-size metallic(?) flakes characteristic of most of the opal in this and overlying samples.

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More (Next page) →



2890-  
2900'



\*\* Broken volcaniclastic sandstone pebble sheared and slickensided on the broken surface.  
 A — Rounded, smoothed, abraded surface  
 B — Polished & slickensided surface.



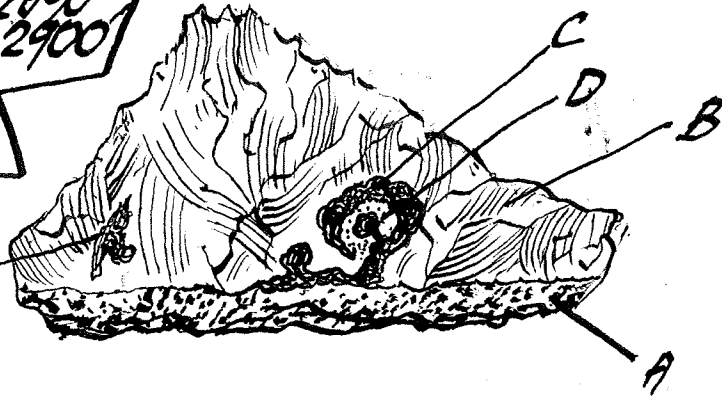
A — SANDSTONE, vfg-fg, overall buff-white to v. lf. gray-buff, 5% darker "speckles". cemented with opal. Grains mostly quartz (& fsp?) w/ minor reddish-gray & grayish-red volcanic rock fragments and biotite.

B — OPAL, aa                      D — Bte grain  
 C — Fragment of iron-stained, uxn calcite.

~~2800-2900~~  
cont'd

2800-2900

C  
(embed.)



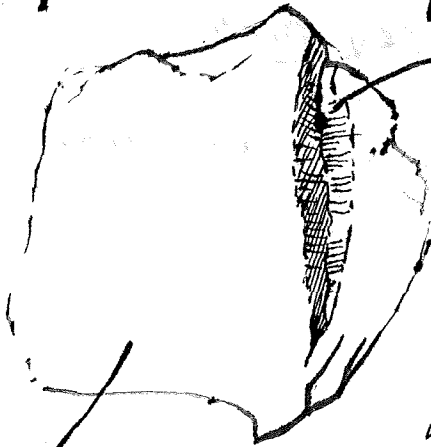
A. Orange-white, granular calcite

B. clear, colorless "crackled" opal

C. Translucent deep brownish-orange (somewhat resinous) to opaque submetallic brownish-black FeOx

D. (Lighter-colored ring). | Transl. -  
| Opaque lt. greenish-gray  
microcrystalline, unknown aggregate.  
Possibly clay (smectite?) - opal mixture

2.5 mm



vegetation impression??

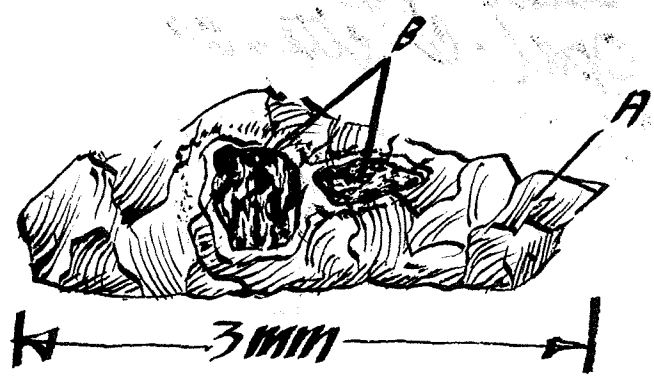
very ambiguous but  
should check using  
SEM

strongly  
doubt  
it 11/10/04  
JH

opal, aa,  
enclosing  
abundant fine-sand grains

70

2890-  
2900  
CONT'D.



A - Clear Opal,  $\frac{2}{3}$   
B - Hornfelsic  
Meta-quartzite  
grayish-brown.  
bte-bearing

Sample Composition

2

Sand, Grit, & Pebbles

1.5 - Metagrt, aa

0.5 - Qtz. DIT, mxln, aa

Tr - Andesite, volc. ss, aa

~~Tr - Andesitic v~~

Andesitic

27 - "EXOTIC" Rock Types, aa

Andesitic  
Volcaniclastic

2 - Brick-red argill. ss & slts, aa

in (s. argillic)

1 - vfg quartz ~~ss~~, aa, comm.

silicified & w/ white clay or ser.

(s silicif  
s ser)

11 - Gray Phyllite, aa (unalt.) (local tr. chl)

13 - MXLN Qtz. DIT, aa (vwv propyl.)

Tr - Basaltic SCORIA dk gray & grayish-red to grayish maroon. (unalt.)

Tr - Bright grayish-red chert

NOT  
"EXOTIC"  
JH 11/09/04

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2890-2900

~~2890-2890'~~  
2890'  
cont'd

- ⑪ Clear Opal, aa
- ① Opal-Calcite, aa
- ② "Spongy" Calcite, aa
- ⑩ Bladed Calcite, aa

② CUBX comm. (JN)

① VVF cal qtz

⑤⑦ OTHER CHIP-ROCK TYPES

~~①~~ MS-1      Tr-MS-2 } see 2700-2710'  
 ② MS-3      ③ MS-4 }

2900-2905

(sample Envelope labeled "2905" & [faintly] "TD")

② pebbles, grit, sand & fragments thereof

Tr-Andst.      ①.5 Metagrt aa  
                  ①.5 MXLN Qtz. Dior. aa

0.7 py  
 Tr. cpy  
 0.2 ep.

⑮ "EXOTIC" ROCK FRAGMENTS

- \* ~~⑧~~ MXLN Qtz. diorite aa
- \* ~~⑥~~ Phyllite, aa (Phyllite) (or phyllonite)
- \* ~~①~~ Brick-red volc. slts & ss, aa
- \* ~~Tr~~ Basaltic scoria, aa
- \* ~~Tr~~ Qtz-rich ss, aa
- \* ~~Tr~~ Andesite, aa

⑩ OPAL, aa

① 69.5 "OTHER"

② OPAL-CAL, aa

① MS-1 Tr-MS-2

① "SPONGY" CAL aa

② MS-3 ③ MS-4

see 2700-2710'

①.5 VVF ORL

(qtz, chi)

all essentially unaltered

Tr CUBX aa

72

1 FeOx of origin  
2 RES  
LCM

XVI

Opal, phyllite, ss, volc's variously disappear or dramatically diminish.

2905-2910

2 RFS  
1 LCM  
Tr unkn.  
FeOX

- ③ OPAL, dom. & clear & colorless, aa
- Tr "spongy" CALCITE, aa.
- Tr CUFX, aa
- Tr VVF chl, cal
- ⑬ BTE-HBL GRANITOID, mxln, aa

Tr. epv  
0.5 py  
3 EP  
(metm.)

Overall  
VW PROPYL.  
or DELITERIA  
ALTN.

(- w-m chl  
tr. ser  
10-w tr. ep  
0-5 (m) chl  
w. cal  
0-wf

Mafics

0-w (Tr) ser  
tr. cal  
0-tr. ep } fsp

No grtd. chips strongly altered

⑮ MS-1

④ MS-2

~~⑮~~ ⑳ MS-3

~~④~~ MS-4

⑳

SEE  
2700-  
2710'

all essentially unaltered.

2910-2920

PEBBLES (?) return

consider  
milling during  
in the drilling sys.

③ Sand, Grit, & Pebbles & fragments thereof, mostly greenish metagrt, distinct from the prevailing biotitic lnfisc. meta-ss.

CAVED ?

4.5 lt. gray-green metagrt  
0.5 ss, vfg, lt. gray-buff & buff

XVII

12

1 RFS

2910-2920' cont'd

~~A~~ 1

0.2 EP  
Tr. py

④ MXLN BTE HBL GRTD, aa  
W-M propyl. altn. aa

No grtd. chips  
\* Intensely altd.

0-5 (M) chl } mafics  
0-W (Fr) ep } asp altn  
W cal } aa  
0-tr (Fr) ser }

① OPAL, aa

⑦ CUEX (fr. grtd. intense ser)

② BRICK-RED SLTS/SS (argill.), aa

⑤ MS-1

⑦ MS-2

} see 2700-2710'

③ MS-3

⑧ MS-4

all ess. unaltered

2920-2930

2 RES  
Tr. LCM

③ SAND, GRIT, & PEBBLES & fragments thereof  
all lt greenish-gray METACRET, aa  
highly anomalous in this simpl.

evd? - ⑦ Brick-red ss, aa (drill-milled? doubt it.)

① OPAL, aa

④ MXLN HBL-BTE GRTD, aa  
W-M Propyl. Altn

Tr. CU  
0.2 py  
Tr. EP

→ 0.5% intensely altd (chl-ser-cal)

② MS-1

⑦ MS-2

③ MS-3

⑧ MS-4

} all essentially unaltered

} see 2700-2710'

74

2930-2940

Tr. CMT  
R&S  
Tr. LCM  
Tr. UNKN.  
FeOx

11

(Drill-milled?)  
③ SAND, GRIT, & PEBBLES, & fragments thereof. Lithologies anomalous for simpl. Mostly grayish-gray metagrtz; minor biotitic hornfels, biotitic hornfelsic metaslts/meta-ss.

- Tr Brick-red argill. slts/ss, aa
- Tr Laminated, fxln. white calcite
- ④ MXLN BTE-HBL GRTD, aa

Wk. Propyl. Altn, aa

No chips intensely altered

Tr VVF chl-cal

- ① MS-1
- ~~MS-2~~
- ② MS-3
- ⑧ MS-4

all essentially <sup>unaltd.</sup> altd.: see 2700-2710

2940-2950

Tr. cmt  
R&S  
green paint  
Tr. LCM

① PEBBLES; ANOMALOUS lith; HNFLS, metagrtz, biotitic metaslts.

③ MXLN BTE-HBL GRTD & Tr. FXLN HBL-BTE GRTD, aa  
W-M Propyl. Altn

~~0.5%~~ 0.3% Intensely Altd. (Chl-Ep-Cal-Ser)

Tr OPAL Tr ~~VVF~~ chl-cal

- ⑤ MS-1
  - ② MS-3
  - ⑧ MS-4
- } BSS, unaltd. } see 2700-2710

0.5 EP  
Tr. PY

75

2950-2960

5 LCM (vol.)  
Tr. CMT  
1 R&S

★  
④ on chl-cal vint. surface

② SAND, GRIT, & PEBBLES & fragments thereof, aa mostly grish-gray metaqtz.

VVF • qtz - ser - py  
• chl - cal • py

1 py  
0.3 EP

⑦ OPAL, aa

⑦ CUBX, aa

③ MS-1 } Ess. unalt. } see 2700-2710  
② MS-1 }

③ MXLN HBL-BTE ~~ERTD~~, aa - WK PROPYL No intense attr.

2960-2970

Tr. cement  
1 R&S  
Tr. LCM

② PEBBLES, etc., aa

⑦ OPAL-CALCITE, aa

0.7 EP  
0.3 py

⑤ GRTD, aa W-M Propyl, no intense attr

⑦ CUBX \* ⑤ VVF • chl-cal • py ± chl

③ MS-1 ⑧ MS-1 } both ess. unalt. see 2700-2710

2970-2980

5 LCM

⑤ MS-1, incl. likely grish-gray meta-qtz pebble frags (by comparison w/above). Ess. unaltered.

⑦ VVF chl-cal

③ GRTD, all aa

⑦ OPAL

② MS-1, aa, Ess. unaltd.

Tr. py  
Tr. ep.

XXI

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2980-2990'

Logging Notes

STEAMBOAT 21B-5R

J. Hulen 10/27/04  
S. JOHNSON

4 LCM  
Tr. CNT  
2 RFS

(Tr) Brick-red argill volc. ss/slt, aa  
① Pebbles, etc., aa - Mostly metagrtzt.

(Tr) Opal, aa

② GRTD, all aa

(Tr) VVF

-py -chl-cal

0.3 py  
Tr. ep

③ MS-1, unaltd.

④ MS-1, ess. unaltd., } see 2700-2710

2990-3000'

Tr. CNT  
Tr. Black Rubber  
1 RFS  
Tr. LCM

⑥ ~~DBB~~ Pebbles, etc, aa: In decreasing order of volumetric abundance:

Grnsh-gray meta-grtzt., grt. & ser.-rich ss, knifsc, meta-sandstone, basalt (1 chip)

(Tr) Opal, aa

(0.5) VVF

0.2 py

② GRTD, all aa

chl-cal

Tr. ep

(91.5) MS-1 sl. more bte-rich than above but still essentially unaltd

T. D.

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XXII



# ABBREVIATIONS

(A)

AA - as above  
ABUND. - abundant  
ADD'M. - addendum  
ALTD. - altered  
ALTN. - alteration  
ANDST. - andesite  
ANOM. - anomalous (ly)  
ARGILL. - argillized  
AVG. - average

(B)

BDDNG. - bedding  
BN. - bornite  
BRN. - brown  
BRNSH. - brownish  
BTE. - biotite  
BX. - breccia

(C)

C - coarse  
CA - calcite  
CAL - calcite

(C), cont'd

CG. - coarse-grained  
CH. - chlorite  
CHL. - chlorite  
CHLTC. - chloritic  
CHLTZD. - chloritized  
CLST. - claystone  
CMT. - cement  
CMTD. - cemented  
CMBX } crush  
CUBX } microbreccia  
CPY - chalcopyrite  
COMB. - combinations  
COMM. - common (ly)  
CONT'D. - continued  
CRYPTOXLN. - crypto-crystalline  
CU - copper  
CVD - caved

(D)

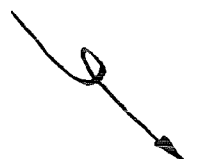
DIA. - diameter  
DIOR. - diorite  
DISS. - disseminated  
DK. - dark  
DOM. - dominant (ly)  
DOL. - dolomite  
DRT. - diorite

(E)

E.G. - for example  
EMBDD. - embedded  
EP. - epidote  
ESP. - especially  
ESS. - essentially  
EUH. - euohedral  
EXC. - except

(F)

F. - fine [size]  
FGR. - fine-grained  
FeOx - iron oxide  
FL. - "fresh-looking"  
FRAG. - fragment  
FR. - from  
FSP. - feldspar  
FXLN - fine-crystalline



# ABBREVIATIONS cont'd

(G)

GEN. - generally (or) generation, depending on context

GG. - gouge

GNT. - garnet

GRD. - granodiorite

GRN. - green (or) grain, depending on context

GRNSH - greenish

GRNTD - granitoid

GRTD - granitoid

GRYSH - grayish

(H)

HGX. - hydrothermal breccia

HBL. - hornblende

HEM. - hematite

HGX. - hydrothermal microbreccia

HM. - hematite

HNFLS. - hornfels

HYDR. - hydrothermal

HYDROTH. - hydrothermal

(I)

I.D. - identify (or) identification, depending on context.

I.E. - that is, ...

INCL. - including

INT. - intense (ly)

INTRSV. - intrusive

(J)

(K)

KF } potassium  
KFSP } feldspar  
KSP }

(L)

L - LONG

LAM - laminated

LCM - lost-circulation material

LEUC - leucoxene

(L)

cont'd.

LEUCOX } leu-  
LEUCOXN } coxene  
LEUCX }

LG. - large

LITH. - lithology (or) lithologic, depending on context

LT. - light (colored)

(M)

M. - moderate (intensity)

MAF. - mafic

MAX. - maximum

MED. - medium

METAQTZT - meta-quartzite

META-SS - meta-sandstone

MFC. - mafic

MG. - medium-grained

MGNTC. - magnetic

MM - millimeter

MSV - massive

MXLN - medium-crystalline

MTM. } meta-  
METM. } morphic

MXLN - micro-crystalline

**ABBREVIATIONS,**  
*cont'd*

(N)

OBV — obvious(ly)  
OPQ — opaque  
ORNG — orange

(O)

(P)

PC(s) — pieces  
PLAG. — plagioclase  
PPYTD. — porphyritic  
POSS. — possibly  
PROP. } propylitic  
PROPYL. }  
PY — pyrite  
PYRTED. — pyritized

(Q)

QTZ. — quartz  
QTZT. — quartzite

(R)

R&S — rust & steel  
REL. — relatively  
REXLED. — recrystallized  
RX — rocks

(S)

S — strong (intensity)  
S<sup>2</sup> — sulfide  
SCTD. — scattered  
SER. — sericite  
SERCTED — sericitized  
SERCTEN — sericiti-  
zation  
SL. — slightly  
SLTS. — siltstone  
SMPL. — sample  
SPN } sphene  
SPHN }  
SS — sandstone

(T)

T.D. — total depth  
T.R.V — total rock  
volume  
T.S. — thin section  
TRANSL. — translucent  
TRANSP. — transparent  
TR. — trace

(U)

UNALT. } unaltered  
UNALTD. }  
UNKN. — unknown

(V)

V — very  
VV — very, very  
VFL — "very fresh-looking"

(V) cont'd.

VFG — very fine-grained  
VFXLN — very fine crystalline  
VN — veinlet(s)  
VNLT — veinlet  
VVF — veinlets & veinlet fragments  
VOLC — volcanic (or) volcaniclastic, depending on context  
VOL. — volume

(W)

w — weak (intensity)  
w/ — with  
wo/ — without  
wkly — weakly

(XYZ)

XL(s) — crystal(s)  
X — cross (section)  
XLN — crystalline  
XRD — X-ray diffraction

# SYMBOLS

- < — less than
- > — greater than
- ≤ — less than or equal to
- >> — much greater than
- ± — plus or minus;  
with or without
- μ — micron
- & — and
- ≈ — approximately
- ≡ — implies
- ∴ — therefore
- // — parallel to
- / — after (replacing)  
e.g. chlorite/biotite
- $\bar{x}$  — average quantity or  
intensity, depending  
on context
- % — per cent
- x — times (multiple of)
- ✓ — investigate further
- 2<sup>nd</sup> — secondary (mineral)
- ∠ — angular
- ⊥ — perpendicular
- ◊ — euhedral  
hydrothermal  
crystal(s)
- ◆ — vug, in fracture  
or veinlet
- Δ — gouge and/or  
crush micro-  
breccia
- ▲ — dilational  
microbreccia
- // — slickensides
- ≈ — prominent  
shearing
- φ — porosity
- ≡ — lost-circulation  
material