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EARTH SCIENCE LABORATORY
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January 23, 1985

Richard Gunderson, Geologist
Union Oil Company of California
Union Geothermal Division
2099 Range Avenue
Santa Rosa, CA 95406

Dear Richard:

    The 31 Geysers area cuttings samples you recently submitted to our lab
have been mineralogically analyzed by qualitative X-ray diffraction (XRD).
Results of the analyses, a summary of methods by which the analyses were
obtained, and all corresponding diffractograms accompany this letter.

    Well 17A-6, from which 30 of the samples were obtained, is shown by XRD
to be distinctly zoned mineralogically. Smectite is confined to the interval
between 1400 and 4330 feet (depth). Four samples in this interval contain
trace to minor clinoptilolite. The lower part of the smectite zone overlaps a
chlorite zone which extends from 3940' to the deepest sample at 9590'.
Epidote accompanies chlorite between 4750' and 7720'. Amphibole appears at
4750' and persists to the deepest sample. Mica (probably mostly biotite) is
prominent below 7550'.

    The upper part of well 17A-6 apparently penetrates interlayered basic and
felsic volcanic rocks; the former mostly plagioclase, the latter composed
principally of sanidine and cristobalite. These volcanics overlie probable
metasedimentary rocks, in turn intruded by mica-amphibole quartz diorite(?).
Much of the mineralogic zoning revealed by XRD, therefore, reflects rock type
rather than alteration. Smectite, chlorite and epidote, however, are clearly
secondary, as is the minor pyrite between 4750' and 6920'. Petrographic
examination and clay-fraction XRD might reveal additional alteration phases.

    Thank you for submitting these cuttings, and please call if I can clarify
any aspect of their XRD mineralogy.

Sincerely,

Jeffrey B. Hulen
Geologist

JBH/jp

SUMMARY OF X-RAY DIFFRACTION ANALYSIS
UNIVERSITY OF UTAH RESEARCH INSTITUTE, EARTH SCIENCE LABORATORY

MINERALOGY, APPROX. WT.% ☐ (or) RELATIVE ABUNDANCE ☑

SAMPLE NO.	Quartz ✓	Cristobal.	Tridymite	Plagiocl. ✓	K-Feldsp. ✓	Calcite ✓	Hematite ✓	Ilmenite	Pyrite ✓	Illite ✓	Mica ✓	Chlorite ✓	Smectite ✓	Mixed-Layer Illite-Smec. ✓	Mixed-Layer Chl.-Smec. ✓	Amphibole	Epidote	Clinoptilol.	Laumontite	Notes
KCF 82-15: Fill beneath shoe	M			m	m				Tr?	m		m	m							
17A-6:																				
200-230′				M			Tr?	m												
620-650′	m	M	m?	Tr?	M		Tr													
950-980′				M			Tr	m												
1400-1430′	m			M			Tr	m?					m				m			GLASS (M)
1600-1630′				M			Tr	m?					m				Tr			GLASS (M)
1800-1830′	Tr	M	m?	m	M			Tr?					m							
2100-2130′	Tr	M		m	M		Tr						m							
2400-2430′				M									Tr							GLASS (M)
2750-2780′				M			Tr						m				Tr			
3040-3070′	m			M			Tr	Tr?					M	m			Tr			
3400-3430′	M			M				m					m							
3940-3970′	m			M			Tr	m				Tr*	m							
4300-4330′	m			M			Tr?	m?				Tr*	m							
4750-4780′	m			M						Tr			m*			Tr				
5070-5100′	m			M						Tr			m	m	m	m				
5400-5430′	m			M	Tr	m	Tr						m			m	m			
5950-5980′	m			M	Tr		Tr			Tr			m			m	Tr			
6300-6330′	m			M	m		Tr			Tr			m			m				
6600-6630′	M			M	m		Tr			Tr	m*		m			m	Tr			
6900-6930′	M			M	m					Tr	m*		m			m	Tr			

MM = PREDOMINANT   M = MAJOR   m = MINOR   Tr = TRACE   ? = TENTATIVE IDENTIFICATION

† POSSIBLY MICA
* MAY INCLUDE KAOLIN

BULK XRD

MINERALOGY, APPROX. WT.% ☐ (or) RELATIVE ABUNDANCE ☑

SAMPLE NO.	Quartz	Cristobal.	Tridymite	Plagiocl.	K-Feldsp.	Calcite	Hematite	Ilmenite	Pyrite	Illite	Mica*	Chlorite	Smectite	Mixed-layer Illite-Smec.	Mixed-layer Chl.-Smec.	Amphibole	Clinoptil.	Xalimontite	Epidote
7200-7230'	M			M	m	Tr?					m					m	m?		
7550-7580'	m			M	Tr	Tr?				m	m					m	m?		
7710-7720'	M			M	m	Tr?				m	m					m		Tr	
7800-7830'	M			M	m	Tr?				m	m					m			
8100-8130'	M			M	m					m	m					m			
8400-8430'	M			M	m					m	m					m			
8700-8730'	M			M	m					m	m					m			
9000-9030'	M			M	m					m	m					m			
9300-9320'	M			M	m					m	m					m			
9590-9620'	M			M	m					m	m					m			

*MAY INCLUDE MINOR ILLITE.

MM = PREDOMINANT   M = MAJOR   m = MINOR   Tr = TRACE   ? = TENTATIVE IDENTIFICATION

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