UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

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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

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	EPIDOTE	CLINOPTILOL.	TALIMONTITE			
KCF 82-15:																						
FILL BENEATH SHOE	M			m		m			TR?	m		m			m							
ITA-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

SUMMARY OF X-RAY DIFFRACTION ANALYSIS

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* POSSIBLY MICA
* MAY INCLUDE KAOLIN

BULK XRD

17A-6

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.	ALUNITE	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

SUMMARY OF X-RAY DIFFRACTION ANALYSIS

UNIVERSITY OF UTAH RESEARCH INSTITUTE , EARTH SCIENCE LABORATORY

SEMI-QUANTITATIVE MINERALOGIC ANALYSIS BY X-RAY DIFFRACTION

-Methods and Procedures-

Bulk Analysis: Representative one-gram splits of bulk samples are ground in acetone in an agate mortar to <325 mesh (< 45 μ) then scanned at 2°2θ per minute from 2-65°2θ. Diagnostic peaks of minerals identified on resulting diffractograms are re-scanned on duplicate samples. Approximate weight percentages of the minerals are determined by comparing diagnostic peak intensities with those generated by standard pure phases mixed in various known proportions.

Clay Analysis: Bulk samples, at least 35 grams if possible, are sonically disaggregated in deionized water, allowed to settle sufficiently to yield the desired particle size fraction (generally < 2 μ or < 5 μ), decanted and centrifuged. The resulting slurries are smeared on glass slides and X-rayed at 1°2θ per minute following air-drying (2-37°), vapor glycolation for 24 hours at 60°C (2-22°), heating to 250°C for one hour (2-15°) and heating to 550°C for one hour (2-15°). Approximate weight percentages of the layer silicates identified on diffractograms corresponding to these treatments are determined by comparison of diagnostic peak intensities with those generated by pure reference clays in appropriate mixtures.