

INTER OFFICE MEMORANDUM

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Date: February 18, 1975

From: Frank Dellechaie

Subject: Preliminary report on the thermal feature of the  
Beulah Reservoir area, Oregon

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Thermal Features

Eighteen water samples were collected in the vicinity of Beulah reservoir, Oregon, during July and August, 1974. Water temperatures vary from 12°C at Main Cold Spring to 72°C at Beulah Hot Spring. The background temperature is about 14°C. The Beulah reservoir spring issues out of Miocene and Pliocene vitric tuffs on the north east shore of Beulah reservoir. The springs have deposited large quantities of siliceous sinter and continue to do so. Hot springs also issue from the north fork of the Malheur River 3 miles WNW of the Beulah Hot Springs and one mile north of Juntura. Spring or well names, temperature and flow rates are listed in Table 1.

Table 1. Thermal features of the Beulah Reservoir area.

Name	T°C	Discharge gpm
Beulah Hot Spring #1	72	10
Beulah Hot Spring #2	72	50
Section 29 Warm Spring	44.5	15
Bath House Hot Spring	35	6
Butler Warm Well	25	50
De Armond Warm Spring	20.5	10

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### Chemistry

Thermal waters in the Beulah reservoir area are of the sodium-sulfate-bicarbonate variety (see Table 2). Chloride concentrations are inordinately low for a hot water system and approaches the 10 mg/l chloride boundary that separates hot water and dry steam systems. White, et al (1971) report springs associated with vapor-dominated systems that have near neutral pH, high sodium and bicarbonate and low chloride. Cl/F ratios range from 2.2 to 7.4, unusually low for a hot water system. Cl/SO<sub>4</sub> ratios are very low and consistently show more SO<sub>4</sub> than Cl. B, Li, NH<sub>3</sub> and H<sub>2</sub>S are all volatile and are found in favorably high levels in the Beulah Hot Springs water.

Silica thermometry corrected for amorphous silica yields temperatures of about 125°C. Na/K temperatures show unreasonably low temperatures i.e. less than 68°C. Na-K-Ca temperatures correlate well with silica temperatures. The water from Beulah Hot Spring appears to have equilibrated at about 125°C.

Two interpretations are offered to explain the chemistry of Beulah Hot Springs. First, the chemistry may be interpreted as representing a rather luke-warm hot water system that would not offer temperature in excess of 125°C. Secondly, the chemistry may represent a hot water system on the periphery of a dry steam system. The second interpretation is based on the favorable concentrations of volatile elements and the conspicuous dearth of chloride. An analysis of a sample from the deepest wells of the Carboli hot water field located on the southern border of the Larderello steam field by Cataldi et al (1969) is included in Table 2 for comparison.

  
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Table 2. A chemical comparison of a typical cold spring and hot springs from the Beulah Reservoir Area, Oregon, and a hot well from Carboli, Italy. Concentration units are mg/l unless otherwise noted.

	<u>Castle Rock Cold Spring</u>	<u>Malheur River Hot Spring</u>	<u>Beulah Hot Spring #1</u>	<u>Section 29 Warm Spring</u>	<u>Italy Cataldi et al 1969</u>
pH	8.10	8.50	7.60	9.6	≈ 7
Cl	3.6	20	51	11	42.6
Z	0.2	4.8	4.8	0.8	---
HCO <sub>3</sub>	90	100	160	50	89.7
CO <sub>3</sub>	0	40	0	48	---
SO <sub>4</sub>	4	70	290	38	137.4
SiO <sub>2</sub>	70	82	194	70	---
Na	12	120	220	72	56.6
K	3.8	1.6	5.8	0.7	32
Ca	16	3	18	1	---
Mg	7	0.1	0.3	<0.1	5
Li	<0.1	0.21	0.24	<0.1	---
B	<1.0	1.1	4.6	<1.0	13.9
Cu	<0.1	0.1	0.1	<0.1	---
Mo (ug/l)	<1	15	30	8	---
Zn	0.1	0.1	0.1	0.2	---
Fe	<0.1	<0.1	<0.1	<0.1	---
NH <sub>3</sub>	---	0.49	1.3	---	19
H <sub>2</sub> S	---	---	0.78	---	---
TDS	208	444	952	293	---
T°C	16.5	58	72	44.5	300
Flow gpm	50	50	10	15	---
TSiO <sub>2</sub> (Total) °C	118.2	126.4	177.9	118.2	
TSiO <sub>2</sub> (Amorphous) °C	2.9	4.4	52.4	-2.9	
TSiO <sub>2</sub> (Quartz) °C	118.2	122.0	125.5	118.2	
TNa/K °C	374.2*	28.5	67.7	13.2	
TNa-K-Ca °C	51.6	100.1	122.8	89.3	
Cl/SO <sub>4</sub>	2.4	0.77	0.48	0.78	
Cl/F	9.6	2.2	5.7	7.4	

\* Does not reflect subsurface equilibrium.