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Appendix L

METAL ION CONCENTRATIONS  
(New Mexico State University)

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## Salton Sea Scientific Drilling Project

Well State 2-14

June 3-5, 1988

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Title: Measurement of Metal Ion Concentrations in  
Geothermal Brines.

**E**  
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On June 3, 4, and 5 brine samples were taken from the two-phase flowline near the wellhead. An additional sample was taken from the weirbox on June 5. **N**

The weirbox sample was obtained by dipping a container into the active flow stream. Some of that fluid was then suction filtered and an aliquot placed into a sample bottle. The sample was clearly not complete since suspended solids, mostly related to silica precipitation, were visibly abundant and provided the main motive for filtering. Solid sodium chloride was abundant in the weirbox as a consequence of steam losses which resulted in its supersaturation. Additional sodium chloride precipitated from the sample while filtering. **D**

**R**  
Samples from the flowline were taken with a teflon lined probe/cooling coil assembly. Access was through a gate valve on the flowline about 40 feet from the wellhead. The probe, 1/4-inch O.D. stainless steel, was inserted into the flow space of the flowline through an access valve assembly located at a 3-o'clock position on the horizontal flowline. Flowline temperatures at the sampling point were essentially those of the wellhead, and near 492°F.

Although the flowline carried a mixture of steam and brine, it was intended to locate the tip of the probe near the pipe wall where a continuous liquid phase might be encountered. Cooled brine

discharging from the coil end was directed into a pre-weighed sample container containing dilute nitric acid.

At the time of flowline sampling the attempt to obtain steam-free brine appeared successful. It was possible to adjust the probe tip position so that no gas bubbles (effervescence) were associated with the discharge from the sampling assembly. Success is further indicated by the essential identity of apparent in situ concentrations for the brine samples collected on successive days (1). Additionally, the relative difference in salt contents of the flowline and weirbox samples (after adjustment for precipitation) are in good correspondence to what would be expected from steam release between the two locations. Scale deposition in the probe/coil sampling equipment appeared minor and is not considered further.

All samples were sent to a commercial laboratory for neutron activation analysis for precious metals. The samples, contained in scintillation vials with a volume of 17.3 ml, plus comparator standards, were irradiated for 30 minutes in a TRIGA Mark I Nuclear Reactor at a flux of  $1.8 \times 10^{12}$  n/cm<sup>2</sup>-sec. After a decay of one day, the samples for gold, platinum and palladium were wet-ashed in the presence of gold and palladium carriers. Palladium was separated using dimethylglyoxime. Gold was separated as the metal using sulfur dioxide. The separated samples were then counted on a Ge(Li) detector coupled to a multi-channel gamma-ray spectrometer. The elements gold, platinum and palladium produce Au-198, Au-199 and Pd-109 with half-lives of 2.75 days, 3.15 days and 13.5 hours respectively. The samples for silver and iridium were allowed to decay for several weeks to remove the Na-24 activity. They were then counted as above. The elements silver and iridium produce Ag-110 m, Ir-192 with half-lives of 245 days and 74 days respectively. The results are tabulated in Table 1.

The analytical data shown in Table 1 are particularly confusing for silver. None of the flowline samples indicated silver above the detection limits which ranged from 140-540 ppb. On the other hand the weirbox sample showed the presence of nearly 1 ppm (890 ppb) silver. The weirbox sample had considerable precipitate which was removed prior to collection of the sample. Data provided elsewhere in this report (1), indicates that the precipitate contained iron, silica, lead, arsenic, cadmium and copper. Iron is suspected of being co-deposited with silica, but the severe loss of copper, arsenic and cadmium suggests losses due to sulfide formation, and hence silver

and gold would also be expected to be lost as sulfides (1). (In support of this hypothesis, the gold content in the weirbox sample ranges from 20-80 percent of that found in the flowline sample). Nevertheless, the weirbox sample was the only one which showed silver above detection limits.

Gold concentrations in the flowline samples were uniformly low and ranged from 0.0325 to 0.120 ppb. Platinum, on the other hand was detected at the 5 ppb level in two of the flowline samples, but it was below the detection limit in the other four flowline samples.

Considering that the platinum detection limit for these four samples ranged from 4-16 ppb, these data are not inconsistent. Iridium and palladium were not observed above detection limits in the two samples analyzed.

The variation of detection limits for various samples for the same element deserves some comment. Neutron activation analysis detection limits vary with the size of the sample irradiated, with the irradiation time, with the time elapsed between irradiation and counting, with the time of counting and with the carrier recovery. Thus unless all these factors are constant throughout the analysis, the detection limit will vary for even duplicate samples.

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## Reference

1. Appendix E, Well Test Engineering Report on Testing of Kennecott State 2-14, June 1-25, 1988, Salton Sea Scientific Drilling Project, prepared by Mesquite Group Inc. for Bechtel International.

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TABLE 1. Neutron Activation Analysis of Precious Metals  
in Salton Sea Geothermal Water: Well State 2-14

Sample	Metal Concentration (PPB)*					Comments
	Ag	Au	Pt	Ir	Pd	
DMA 05	ND < 540.	0.0717±0.0122	ND < 16	-	-	Sample from flowline collected 6/8/88 after 500 ml passed through sampler.
DMA 08	ND < 290.	-	-	-	-	Sample from flowline collected in dilute nitric acid immediately after collection of DMA 05.
DMA 02	-	0.0586±0.0047	5.25±1.47	-	-	Sample from flowline (unacidified) collected immediately after DMA 08.
DMA 03	-	0.0683±0.0057	4.80±1.10	-	-	Sample from flowline (unacidified) collected 6/4/88 after 1000 ml passed through sampler.
DMA 06	ND < 500.	-	-	-	-	Sample from flowline (acidified) collected immediately after DMA 03
DMA 01	890.±134	0.0756±0.0054	ND < 12.	-	-	Sample collected 6/5/88 at Weirbox after geothermal water exposed to atmosphere. Sample was filtered through 0.45µ filter prior to collection.
DMA 07	ND < 140.	-	-	ND < 0.8	-	Sample from flowline collected 6/5/88 and acidified.
DMA 04	-	0.0325±0.0036	ND < 4.	-	ND > 6.5	Sample from flowline (unacidified) collected immediately after DMA 07.
179	ND < 140	0.120±0.008	ND < 8.4	-	-	Sample from flowline (acidified) collected immediately after DMA 04

\* ND - Not Detected below limit of detection