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Gold and Silver in Stream Sediments from Reconnaissance
of $3 \times 10^5 \text{ km}^2$ of the Western United States

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ABSTRACT

As part of the National Uranium Resource Evaluation (NURE) Program, Lawrence Livermore National Laboratory analyzed about 30,000 stream sediment samples from selected areas of the western United States for numerous chemical elements. The analysis was performed by neutron activation. This report presents data for the concentrations of gold and silver for the samples in which they were detected. Gold was detected in 310 samples, and silver in 91. Latitudes and longitudes are given for the sites from which these samples were taken.

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Abstract

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GOLD AND SILVER IN STREAM SEDIMENTS FROM RECONNAISSANCE OF 3×10^5 KM² OF THE WESTERN UNITED STATES

I. Introduction.

The National Uranium Resource Evaluation (NURE) Program was established by the Atomic Energy Commission (later the Energy Research and Development Administration, now the Department of Energy) to evaluate domestic uranium resources in the continental United States and to identify areas favorable for uranium exploration. The Grand Junction, Colorado Office (GJO) of the Department of Energy (DOE) is responsible for administering and coordinating NURE program efforts. Lawrence Livermore National Laboratory (LLNL) was assigned responsibility for hydrogeochemical and stream sediment reconnaissance (HSSR) of 1.8 million square kilometers in ten western states. Other DOE laboratories were assigned responsibility for the rest of the continental United States including Alaska. The individual laboratories were made responsible for acquiring a proper set of field samples in their areas, processing and analyzing the materials, and compiling the data in report form. The resulting HSSR reports are made available to the public by DOE-GJO through simultaneous release at a number of sites in the U.S.

Lawrence Livermore National Laboratory's participation in the NURE program began in 1975 and was terminated in 1979 before the entire assigned region could be surveyed. Nevertheless, about 30,000 sediment samples were collected, processed, and analyzed from a considerable portion of this area. Five raw data reports on the orientation studies¹⁻⁵ in small regions and nine raw data reports on the National Topographic Map series quadrangles Tonopah⁶, Prescott⁷, Williams⁸, Lovelock⁹, Millett¹⁰, Las Vegas¹¹, Kingman¹², Winnemucca¹³, and Sand point¹⁴ were published. A large bank of data from other quadrangles remains unpublished as a result of funding termination. Quarterly progress reports¹⁵ were published from 1975 through early 1978.

As mentioned above, the purpose of the NURE program was to search for uranium. The sample processing and analysis were therefore tailored to optimize for location of uranium and associated pathfinder elements. Nevertheless, analysis was performed for many other chemical elements of economic significance. Among these were the precious metals gold, silver, rhenium, and the platinum group. Because of the importance of these metals in international economics and in industry, it seemed appropriate to us to sort out the significant observations of them in the entire area surveyed and to present the data for use by the public.

This report describes the area covered and the manner in which the samples were collected, processed, and analyzed, and presents a list of sites where detectable amounts of the precious metals were found.

II. Area Description

The regions from which samples were analyzed before termination of the LLNL participation in NURE are shown on the map in Figure 1. The shapes of these areas were determined by a combination of the initial LLNL decision to sample by geologic province and the later GJO direction to report results by NTMS quadrangle. The choice of regions was determined by priorities established by GJO. As can be seen, the area surveyed includes sizeable parts of the states of Nevada, Utah, Idaho, Arizona, Washington, and California.

III. Sample Site Selection and Collection

The proper selection of the sample site is fundamental in performing a valid reconnaissance survey. Sites were selected so that the samples would represent the sample acquisition areas, and contamination by environmental pollution (farms, bridges, mines, etc.) would be minimized.

Emphasis was placed on stream sampling along the range fronts. For relatively small drainages, a single sample was collected at the mouth of the canyon. In larger drainage canyons, samples were collected up the canyons and along tributaries to obtain representative coverage. Sampling on the fans was weighted to ground water samples with stream samples taken only along the most active streams.

The average sediment-site density overall was about one site per 10 km² although the actual site density varied between one per 8 km² and one per 18 km², because of differences in the scale of geological variability. Areas excluded from sampling or areas where the sampling density is lower include the playas and large alluvial valleys. A few rock samples were also taken.

Sites were selected by LLNL geologists, and sampling was done by contract geologists.

Aluminum or plastic shovels were used, and the samples were taken so as to avoid collapsed bank or wind deposited material. In each case, about 2 kg of material was taken, and placed in a double polyethylene bag. Dry samples were field sieved (stainless steel sieve) to remove the fragments larger than 6.35 mm (1/4 inch). At active stream sites, samples were collected from the stream bottom.

Lawrence Livermore National Laboratory observers occasionally accompanied the contract sampling crews. LLNL geologists resampled about 5% of the sites. More than 95% of the resampled sites were accurately located on available maps or photos. The remaining sites were plotted within 200 μm of the correct locations. Analytical replicates were run on about 10% of all samples. Comparison of the sediment replicate results with the original samples showed a 10% standard deviation in measured values.

IV. Sample Processing

The samples were processed by contract laboratories. The sediments were dried overnight at 110°C. They were split into two fractions and one was placed in archival storage. The other was sieved for 15 minutes, and for most regions, the portion passing a 1000 μm sieve, but retained on a 500 μm sieve was collected. This choice was made to eliminate fine, windblown material while still keeping enough grains to form a representative sample. In moist regions (Washington and Idaho), a finer size fraction was used. The sieved portion was placed in a polyethylene bottle and blended by tumbling about an axis at 45° to the axis of the bottle. Approximately 1-3 grams was weighed into a 1.85 cm³ (1/2-dram) polyethylene vial, which was heat-sealed by fusing the lid to the vial. This vial was then inserted into a 7.39 cm³ (2-dram) vial, centered between two polyethylene balls. After heat sealing, this vial was in turn inserted into a polyethylene "rabbit" and a lid was screwed in. Each rabbit carried a binary-coded number in the form of holes drilled into a band around its "waist." Prior to use, the polyethylene containers were soaked in reagent-grade methanol and nitric acid, and washed in an ultrasonic cleaner. Handling of clean containers was done with gloves. The rabbits were made of high purity linear polyethylene.

Rock samples were processed at LLNL. They were first dried, if necessary, under the same conditions as for sediments. The samples were broken into pieces small enough to fit into a jaw crusher, using a rock hammer or a small sledge and steel plate. The entire sample was passed through the crusher. If a sample was larger than about 2 kg, it was split using a Jones splitter, and one split was archived. The other split (less than 2 kg) was pulverized to -100 mesh (less than 150 μ m). The sample was then placed in a clean 250 ml wide-mouth polyethylene bottle and blended in the same way as were the sediments. Cleaning of equipment was performed with compressed air after each sample was processed. After uranium ores were processed, quartz material was passed through the equipment in order to clean it.

V. Sample Analysis

Neutron activation analysis was used for multi-element determinations in the sediment samples.¹⁶ Briefly, the method involved irradiating a sample with neutrons for a fixed period of time in the core of the Livermore Pool Type Reactor (LPTR*), counting delayed neutrons emitted from the sample a short time later to measure uranium concentration, and counting gamma rays at short and long decay times to analyze for other elements. A total of eight Ge(Li) gamma ray detectors were used in this work. The timing sequence used prior to January 1, 1979, is shown in Table 1.

TABLE 1. Timing Sequence Prior to January 1, 1979

STEP	OPERATION	ELAPSED TIME (sec)
1.	20-sec irradiation in thimble #1	20
2.	20-sec delay	40
3.	30-sec delayed neutron count	70
4.	18.4-min. delay	1170
5.	540-sec gamma count on one of four detectors, numbered 1 to 4	1710
6.	100-sec irradiation in thimble #1	1810 (30.2 min)
7.	1-week delay (approximately)	
8.	1800-sec gamma count (nights and week-ends, using detectors #1 to 4)	

Thimble #1 had a thermal neutron flux of about 3.1×10^{17} n/m²-sec, and an epithermal flux of about 1.2×10^{16} n/m²-sec. When the reactor was operating, a new sample entered the system every 3.48 min., giving a throughput of 17.2 samples per hour. After the last sample of the shift had entered the system, about 30 minutes had to elapse before this sample was ejected into the one-week storage bin, completing the first six steps. When the reactor was not operating, the system counted gammas from one-week-old samples.

At the end of 1978, the system was upgraded to include two thimbles in the reactor core instead of one, and eight Ge(Li) detectors rather than four. The new timing sequence is shown in Table 2.

* The LPTR was deactivated in 1980; the reactor and neutron activation system described here no longer exist.

TABLE 2. Timing Sequence After January 1, 1979

<u>STEP</u>	<u>OPERATION</u>	<u>ELAPSED TIME (sec)</u>
1.	20-sec irradiation in thimble #2	20
2.	20-sec delay	20
3.	30-sec delayed neutron count	70
4.	20.15-min. delay	1279
5.	562-sec gamma count on one of four detectors, numbered 1 to 4	1841
6.	120-sec irradiation in thimble #1	1981 (32.7 min)
7.	1-week delay	
8.	1800-sec gamma count usually using detectors #5 to 8	

Thimble #1 had a thermal neutron flux of about 3.3×10^{17} n/m²-sec, and an epithermal flux of 1.2×10^{16} n/m²-sec. Thimble #2 had fluxes of 2.6×10^{17} and 1.2×10^{16} n/m²-sec, respectively. When the reactor was operating, a new sample entered the system every 2.5 minutes, giving a throughput of 24 samples per hour. After the last sample of the shift had entered the system, about 33 minutes had to elapse before this sample was ejected into the one-week storage bin, completing the first six steps. Most of the second counts were performed by the separate counting system, which operated around the clock.

These timing sequences were arrived at by a compromise involving several factors:

1. High precision was desired for uranium and thorium detection.
2. Elements which would be helpful in elucidating the source and behavior of uranium had priority over other elements.
3. The throughput of samples had to be maximized to meet the program schedule.
4. The sequence chosen had to be amenable to continuous operation, allowing sufficient time for system maintenance.
5. The sequence had to be compatible with the reactor operation schedule.
6. The maximum number of detectable elements was desired, other requirements being satisfied.

It must be emphasized that these sequences were not optimized for detection of the precious metals. Rather, these metals were detected as a by-product of the search for uranium. Accordingly, the detection limits for some of them were not as low as they might have been, had precious metals been the primary goal.

The radionuclides which are pertinent to the detection of the precious metals are shown in Table 3. Note that nuclides having very short and very long half-lives and those producing few or no gamma rays, are omitted.

TABLE 3. Pertinent Precious Metal Radionuclides

Element Indicated	Nuclide	Half-Life	Element Indicated	Nuclide	Half-Life
Gold	Au-198	2.7 days	Rhodium	Rh-104m	4.35 minutes
Silver	Ag-108	2.41 minutes	Osmium	Os-185	93.6 days
	Ag-110m	253 days		Os-191	13.0 days
Platinum	Pt-197	18.3 hours		Os-193	1.31 days
	Pt-199	30.8 minutes	Iridium	Ir-192	74 days
	Au-199	3.15 days		Ir-194	19.2 hours
Palladium	Pd-109	13.4 hours	Rhenium	Re-186	3.70 days
	Pd-109m	4.67 minutes		Re-188	17.0 hours
Ruthenium	Ru-97	2.89 days			
	Ru-103	39.6 days			
	Ru-105	4.44 hours			
	Rh-105	1.48 days			

The approximately 30,000 sediment samples were irradiated, and gamma ray spectrometry was performed. The data were analyzed using the GAMANAL program¹⁷, which performs a least squares fit to all the gamma ray peaks observed in the spectrum, using a library of known energies and branching intensities for radionuclides of interest. The library used was ACTAL 1076¹⁸, which included all the nuclides in Table 3, as well as many others for the other elements.

Standard samples containing weighed amounts of pure gold, silver, platinum, palladium, and ruthenium were also irradiated and counted on the same timing sequence, to determine which radionuclides were most prominent, and to calibrate the system. Blank rabbits and standard sediments were run periodically to check the operation of the analysis system.

The computer fitting parameters and calculated probable errors were then examined for several reported precious metal detections in sediments. As a result, it was found that most of the radionuclides were not useable either because the detection limits were too high, because there were interferences from other radionuclides, because detector gain or zero shifts led to frequent misassignment, or because they were also produced as fission products from uranium and the appropriate subtractions were not done properly. Eliminating the problem cases, we then reduced the list to gold, using Au-198, and silver, using Ag-110m. The results for some of the other precious metals could eventually be recovered if the data were properly corrected for uranium fission interference and detector gain and zero shifts, but funds for this effort are not currently available.

The GAMANAL output files for all the sediments and rocks were then searched for these radionuclides, and a separate list was compiled for each. The GAMANAL multi-element fitting parameters were examined for each reported detection of silver and a large fraction of the gold detections, and those resulting from zero or gain shifts, backgrounds in the detector shielding (in the case of Ag-110m) or other instrumental problems were eliminated from the lists. The chief problem with silver detection was interference with arsenic-76, which is still significant in some samples after a week. The resulting data were processed by the NURAB program^{19,20}, which applies flux, cross section, and sample weight data to the GAMANAL output in order to calculate elemental concentrations in parts per million or parts per thousand.

Using this analytical procedure, the minimum detection limit for gold was about 0.015 ppm, and for silver it was about 3 ppm. For comparison, the average crustal abundances of gold and silver are .005 and .05 ppm, respectively.²¹ Thus any valid measurement represents a site at which the gold or silver content is highly anomalous.

Absolute calibration of the system is believed to be accurate to within $\pm 20\%$ for gold and $\pm 25\%$ for silver.

VI. Results and Discussion

The final results, showing site number, latitude and longitude (in decimal form), detected concentration (ppm), and absolute detection error (ppm) are shown in Tables 4 and 5, arranged according to NTMS quadrangle. The rock samples are indicated by asterisks. Where more than one sample is shown for the same site number, they represent different sediment size fractions. Samples in which both gold and silver were detected are marked with & marks.

The total number of gold indications was 310, representing about 1% of the total number of samples analyzed. Silver was detected in 91 samples, or about 1/3% of the total analyzed. The maximum gold concentration detected was about 27 ppm, and the maximum silver concentration detected was over 40,000 ppm (in a rock sample). Highest silver content observed in a sediment was slightly over 2000 ppm.

The locations of the sites shown in Table 5 were compared with "The Principal Gold Producing Districts of the United States."²² In almost all cases the sites identified in this study are at or very near the location of known gold production. This is somewhat surprising since sampling sites were located well away from areas of potential contamination. It also shows that geochemical reconnaissance is a very powerful tool for location of areas of enrichment of gold and silver. Since the analytical method involves blended whole sediment analyses, the form or mineralogy of the occurrences does not affect the result. Finely disseminate arsenic-associated gold mineralization such as described by Joraleman²³ could be detected just as easily as could coarse "pannable" free gold.

Something can be said about the likelihood of a single "speck" of free gold causing the identification. As previously stated, the samples, except in Washington and Idaho, were sieve-sorted to 500-1000 μ m. The 1-3g (nominal 2g) sample would contain about 3300 particles of material, assuming an average density of 2.65. If just one were a particle of free gold, it would weigh about 4 milligrams and the analysis would show 2000 ppm. Since no analysis was greater than 27 ppm, we can safely conclude that no individual particle contained more than about one percent gold. The authors do not claim any rights over mineral deposits which may be discovered using these data. However, we would be interested in knowing if the data are useful, and would appreciate being notified by anyone who finds them so.

VII. Acknowledgments

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TABLE 4

SITES AT WHICH SILVER WAS FOUND THOSE SITES IDENTIFIED BY AN AMPERSAND (&) ALSO HAVE GOLD. SITES IDENTIFIED BY AN ASTERISK (*) ARE ROCK INSTEAD OF SEDIMENT SAMPLES. DUPLICATE SITE ANALYSES ARE FOR DIFFERENT SEDIMENT SIZE FRACTIONS.

SITE#	LAT	LONG	CON (PPM)	ERROR	
NUGALES					
10060&	31.5230	110.7778	23.900	7.084	AG
10163&	31.6215	110.8929	40.920	7.549	AG
10182*&	31.6395	110.5030	126.600	12.290	AG
10024*&	31.7134	110.9249	1257.000	67.060	AG
10024&	31.7134	110.8248	44.420	7.982	AG
PRESCOTT					
2804&	34.4365	112.3649	27.610	6.538	AG
2278&	34.2969	113.1112	14.670	2.933	AG
SAN BERNARDINO					
51947	34.9545	116.8938	15.660	3.222	AG
LOS ANGELES					
60555	34.7986	118.6779	2.483	0.771	AG
WILLIAMS					
22160	35.6175	113.0713	29.590	8.602	AG
KINGMAN					
12969	35.8195	115.4779	13.980	2.876	AG
BAKERSFIELD					
5117&	35.0030	118.1704	23.840	2.059	AG
48105	35.0754	118.4260	12.100	3.647	AG
GRAND CANYON					
59353*	36.1975	113.4324	50.790	5.534	AG
59331*	36.2260	113.3164	45010.000	13190.000	AG
LAS VEGAS					
11979	36.1230	115.8488	11.050	1.523	AG

SITE#	LAT	LONG	CON(PPM)	ERROR	
LAS VEGAS (CONTINUED)					
12175	36.4446	115.9266	27.230	8.157	AG
DEATH VALLEY					
12149	36.4031	116.2740	4.678	1.438	AG
12870	36.8631	117.2042	6.430	1.920	AG
SALINA					
59480*	38.5577	110.8301	10.450	2.505	AG
59447	38.5377	110.8301	3.525	1.091	AG
RICHFIELD					
16429	38.8807	112.9298	6.459	1.561	AG
16906	38.9810	112.1726	12.870	3.794	AG
17409	38.2894	113.9350	6.067	1.355	AG
17646	38.5051	113.6543	5.075	1.440	AG
17035	38.4702	113.5676	4.744	1.314	AG
17088	38.5084	113.8613	3.022	0.902	AG
17054	38.5915	113.2791	6.421	1.896	AG
17532	38.7298	113.0366	4.669	1.126	AG
17140	38.8392	113.7812	4.565	1.300	AG
17148	38.8761	113.9279	5.577	1.720	AG
17060	38.8819	113.4013	5.255	1.214	AG
16729	38.9155	113.9399	4.828	1.399	AG
16292	38.9449	113.4888	5.012	1.275	AG
16652	38.9476	113.9146	5.470	1.408	AG
16648	38.9530	113.8814	4.166	1.223	AG
16214	38.9629	113.4491	5.780	1.111	AG
16230	38.9647	113.4884	4.180	1.194	AG
17037	38.9815	113.2973	3.681	1.140	AG
17036	38.9926	113.2250	4.199	1.134	AG
LUND					
16795	38.4#13	114.2361	4.748	1.240	AG
TODOPAH					
27654	38.1267	116.7319	13.700	3.257	AG
44369	38.9876	116.8857	2290.000	120.400	AG
44303	38.0257	117.5401	24.180	5.677	AG
191048	38.7227	117.120	7.488	7.488	AG
19814	38.5463	117.9731	19.100	4.020	AG
WALKER LAKE					
16204	38.9866	118.3162	10.290	3.113	AG

SITE#	LAT	LONG	CONFID	ERROR	
WALKER LAKE (CONTINUED)					
16511	38.5840	119.5119	6.030	1.741	AG
17611	38.6415	119.5208	9.361	2.052	AG
17233	38.9189	119.5225	4.936	1.916	AG
DELTA					
15990	39.2445	112.2932	4.856	1.231	AG
18162	39.3588	112.2199	4.226	1.270	AG
16147	39.4431	112.2597	4.705	1.059	AG
15993	39.6761	112.2931	7.794	2.387	AG
18082	39.9240	112.7611	13.900	4.301	AG
8943	39.0143	113.3111	8.984	2.682	AG
8944	39.0261	113.3554	8.789	2.290	AG
8905	39.0747	113.6113	4.033	1.216	AG
8896	39.0989	113.8099	4.593	1.359	AG
8873	39.1278	113.6132	5.320	1.260	AG
8871	39.1667	113.6031	7.946	1.657	AG
8864	39.1831	113.6373	5.095	1.586	AG
9023	39.2301	113.6224	7.111	2.228	AG
8366	39.2308	113.7712	6.285	1.839	AG
8692	39.3281	113.7158	7.146	1.804	AG
9002	39.4201	113.7891	8.063	2.471	AG
9088	39.4203	113.2397	6.603	1.667	AG
8686	39.4243	113.6870	5.656	1.558	AG
9036	39.4845	113.4905	4.363	1.212	AG
8767	39.5908	113.6550	5.590	1.691	AG
8626	39.7093	113.5125	3.450	1.014	AG
18092	39.8880	113.4127	14.580	2.942	AG
ELY					
16742	39.2632	114.0607	6.058	1.648	AG
16846	39.2903	114.0609	6.791	2.094	AG
16789	39.3787	114.0954	5.020	1.469	AG
17345	39.6174	114.1017	7.348	2.288	AG
17339	39.7346	114.1189	6.223	1.864	AG
MILLETT					
204578	39.2237	117.1344	27.270	5.136	AG
18311	39.4751	117.0721	10.480	3.180	AG
RENO					
15907	39.9133	118.4964	6.080	1.893	AG
79408	39.8973	119.4312	49.040	9.677	AG
TOOELE					
18207	40.0121	112.5899	15.290	4.609	AG

SITE#	LAT	LONG	CON (PPM)	ERROR	
TOOELE	(CONTINUED)				
ELKO					
7401	40.8183	115.7763	10.210	2.647	AG
WINNEMCCA					
7234	40.5936	117.3581	17.120	5.111	AG
LOVELOCK					
28672	40.2447	118.1980	20.090	4.152	AG
6658	40.0513	118.1242	9.368	2.935	AG
MCDERMITT					
5508	41.0965	116.1558	11.600	2.814	AG
59176	41.8912	117.9245	8.324	2.592	AG
HAILEY					
18703	43.6632	115.6179	44.500	12.930	AG
THANAGAIT					
46444	48.0409	118.0921	25.310	5.009	AG
45648	48.9225	118.8073	5.868	1.150	AG

TABLE 5

SITES AT WHICH GOLD WAS FOUND THOSE SITES IDENTIFIED BY AN AMPERSAND (&) ALSO HAVE SILVER SITES IDENTIFIED BY AN ASTERISK (*) ARE ROCK INSTEAD OF SEDIMENT SAMPLES. DUPLICATE SITE ANALYSES ARE FOR DIFFERENT SEDIMENT SIZE FRACTIONS.

SITE#	LAT	LONG	CON (PPM)	ERROR	
NOGALES					
10179	31.5167	110.7841	0.021	0.010	AU
10060&	31.5230	110.7778	0.122	0.030	AU
10153	31.5962	110.8303	0.164	0.022	AU
10034	31.5971	110.8925	0.254	0.027	AU
10154	31.5969	110.8303	0.065	0.017	AU
10033	31.5969	110.8453	0.076	0.018	AU
10032	31.6016	110.8662	0.465	0.153	AU
10031	31.6043	110.8830	0.015	0.006	AU
10031	31.6043	110.8830	0.258	0.036	AU
10030	31.6061	110.8788	0.068	0.020	AU
10030	31.6061	110.8788	0.097	0.040	AU
10157	31.6070	110.8630	23.340	1.245	AU
10157	31.6070	110.8630	7.379	0.432	AU
10156	31.6070	110.8672	0.078	0.023	AU
10158	31.6097	110.8566	26.920	1.480	AU
10155	31.6097	110.8714	1.134	0.126	AU
10155	31.6097	110.8714	0.879	0.146	AU
10190	31.6167	110.8060	0.253	0.030	AU
10188	31.6205	110.8287	0.133	0.038	AU
10163&	31.6215	110.8629	0.242	0.032	AU
10182* &	31.6395	110.9030	0.248	0.029	AU
10024* &	31.7134	110.8248	0.652	0.065	AU
MESA					
10359	33.8397	110.8606	0.072	0.023	AU
PRESCOTT					
39683	34.0300	112.4255	0.057	0.014	AU
39905	34.0607	112.8929	0.072	0.015	AU
40064	34.1129	112.7150	0.039	0.013	AU
22825	34.2278	112.8674	0.059	0.019	AU
39669	34.2494	112.2533	0.107	0.015	AU
14388	34.2550	112.2077	0.020	0.011	AU
22327	34.2822	112.7893	0.101	0.017	AU
14400	34.3062	112.2323	0.053	0.015	AU
26171	34.3366	112.7696	0.089	0.012	AU

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SITE#	LAT	LONG	CON(PPM)	ERROR	
PRESCOTT (CONTINUED)					
39780	34. 3378	112. 3382	0. 414	0. 028	AU
14327	34. 3475	112. 4165	0. 044	0. 018	AU
14381	34. 3555	112. 3505	0. 451	0. 031	AU
14311	34. 3918	112. 4849	0. 603	0. 041	AU
14324	34. 3935	112. 1164	0. 017	0. 008	AU
14319	34. 4283	112. 4278	0. 040	0. 014	AU
200448	34. 4365	112. 3649	23. 650	1. 247	AU
14339	34. 4432	112. 3290	0. 063	0. 010	AU
14299	34. 4531	112. 4859	1. 121	0. 064	AU
14315	34. 4725	112. 4254	0. 171	0. 019	AU
14342	34. 4763	112. 2597	1. 282	0. 035	AU
14368	34. 4772	112. 1733	0. 221	0. 043	AU
14337	34. 4906	112. 3614	0. 039	0. 024	AU
22285	34. 4929	112. 6859	0. 056	0. 017	AU
38850	34. 5282	112. 3838	0. 040	0. 011	AU
39125	34. 5299	112. 2258	0. 232	0. 023	AU
9971	34. 3078	113. 6622	0. 329	0. 094	AU
9891	34. 3130	113. 7135	0. 035	0. 010	AU
9974	34. 3158	113. 6690	0. 029	0. 007	AU
10092*	34. 3432	113. 5242	0. 048	0. 017	AU
9912*	34. 3589	113. 6214	0. 150	0. 026	AU
38951	34. 4344	113. 1385	0. 652	0. 039	AU
39241	34. 4435	113. 2586	0. 065	0. 018	AU
22901	34. 4563	113. 7562	0. 037	0. 012	AU
20859	34. 7498	113. 8096	0. 067	0. 032	AU
SAN BERNARDINO					
60787	34. 3241	116. 9054	0. 014	0. 004	AU
53070	34. 3484	116. 8554	0. 032	0. 004	AU
53074	34. 3537	116. 7978	0. 014	0. 004	AU
53075	34. 3546	116. 7890	0. 016	0. 005	AU
51345	34. 7138	116. 8198	0. 041	0. 010	AU
52270	34. 8597	117. 5129	0. 012	0. 006	AU
52268	34. 8638	117. 5038	0. 010	0. 006	AU
52575	34. 8605	117. 5142	0. 007	0. 003	AU
LOS ANGELES					
60241	34. 6751	118. 3808	0. 034	0. 012	AU
51459	34. 8779	118. 2332	0. 056	0. 006	AU
52471	34. 9533	118. 2682	0. 089	0. 021	AU
52469	34. 9559	118. 2825	0. 076	0. 017	AU
52472	34. 9632	118. 2706	0. 021	0. 008	AU
60689	34. 9647	118. 4601	0. 016	0. 007	AU
51447	34. 9875	118. 1800	0. 013	0. 004	AU
WILLIAMS					
21327	35. 4000	113. 5094	0. 038	0. 013	AU

SITE#	LAT	LONG	CON. (PPM)	ERROR	
WILLIAMS	(CONTINUED)				
KINGMAN					
11230	35.0257	114.4374	0.129	0.019	AU
7372	35.0769	114.4281	0.095	0.015	AU
15230	35.3283	114.1419	0.103	0.026	AU
14921	35.3363	114.0614	0.047	0.012	AU
42588	35.3837	114.2786	2.309	0.133	AU
20679	35.8161	114.1876	0.375	0.027	AU
21253	35.9111	114.2031	0.021	0.013	AU
3747	35.9190	114.8139	0.059	0.018	AU
21277	35.9856	114.0430	0.101	0.022	AU
7390	35.1588	115.6472	0.259	0.028	AU
10569	35.2018	115.0797	0.059	0.016	AU
TRONA					
52668	35.0595	116.6271	0.685	0.028	AU
60335	35.2914	117.5422	0.049	0.009	AU
60347	35.2333	117.6525	0.017	0.007	AU
60364	35.3611	117.9508	0.065	0.011	AU
60305	35.3865	117.6518	0.019	0.010	AU
60351	35.4099	117.8084	0.014	0.007	AU
60350	35.4192	117.7798	0.038	0.008	AU
55291	35.5612	117.6918	0.022	0.011	AU
52035	35.5623	117.6554	0.016	0.006	AU
BAKERSFIELD					
511728	35.0030	118.1704	0.564	0.032	AU
51171	35.0046	118.3578	0.117	0.008	AU
51173	35.0047	118.1748	0.017	0.005	AU
51471	35.0084	118.1705	0.035	0.009	AU
61160	35.4925	118.1267	0.015	0.006	AU
42461	35.3610	119.3443	1.755	0.105	AU
MARBLE CANYON					
59266	36.7335	111.7235	0.019	0.007	AU
GRAND CANYON					
59232	36.7773	112.6932	0.012	0.006	AU
59257	36.7773	112.6932	0.014	0.006	AU
59248	36.7773	112.6932	0.016	0.006	AU
59231	36.7773	112.6932	0.024	0.006	AU
59257	36.7773	112.6932	0.054	0.006	AU
59257	36.7773	112.6932	0.056	0.019	AU
59257	36.7773	112.6932	0.058	0.010	AU

SITE#	LAT	LONG	CON (PPM)	ERROR	
(CONTINUED)					
GRAND CANYON					
59237	36.7773	112.6932	0.058	0.007	AU
59257	36.7773	112.6932	0.075	0.015	AU
LAS VEGA :					
21256	36.0119	114.1208	0.038	0.013	AU
15134	36.2767	114.1978	0.088	0.012	AU
15141	36.5246	114.0805	0.093	0.023	AU
15110	36.1579	115.0374	0.062	0.014	AU
13549	36.3978	115.4377	0.018	0.006	AU
12729	36.4121	115.7319	0.054	0.007	AU
DEATH VALLEY					
12238	36.0457	116.6863	0.076	0.022	AU
12577	36.1083	116.4545	0.026	0.008	AU
13329	36.4334	116.5839	0.017	0.003	AU
13689	36.4205	117.1216	0.654	0.040	AU
12401	36.5106	117.2053	0.172	0.014	AU
12514	36.8384	117.3421	0.012	0.005	AU
MARKUSA					
30349	37.7516	119.5470	0.110	0.016	AU
30353	37.8190	119.8556	0.143	0.028	AU
30393	37.8130	119.8556	0.046	0.015	AU
30318	37.8307	119.8554	0.149	0.021	AU
30324	37.8607	119.8554	0.020	0.009	AU
RICHFIELD					
16694	38.5279	113.2566	0.026	0.008	AU
16535	38.8416	113.0071	0.021	0.008	AU
TONGPAH					
27581	38.4105	116.2773	0.035	0.012	AU
44159	38.5902	116.6829	0.040	0.010	AU
44366	38.8947	116.8086	0.129	0.027	AU
44308	38.0485	117.4764	0.057	0.012	AU
191048	38.0727	117.2086	0.962	0.062	AU
20095	38.4274	117.5923	0.034	0.013	AU
44177	38.3116	117.0218	0.507	0.032	AU
26771	38.3254	117.0218	0.031	0.012	AU
29242	38.5423	117.2249	0.075	0.029	AU
19893	38.7727	117.7252	0.036	0.010	AU
29408	38.9018	117.8349	0.041	0.010	AU
WALKER LAKE					
30345	36.5550	119.7235	0.028	0.011	AU

SITE#	LAT	LONG	CON. PPM	ERROR	
WALKER LAKE (CONTINUED)					
30332	38.7950	119.9994	0.121	0.014	AU
30332	38.7950	119.9994	0.068	0.019	AU
DELTA					
16020	39.8299	112.3953	0.082	0.010	AU
18184	39.8323	112.1803	0.054	0.015	AU
18070	39.8433	112.4797	0.014	0.006	AU
18088	39.8637	112.6232	0.018	0.003	AU
18201	39.9925	112.7497	0.033	0.011	AU
8619	39.8537	113.4594	0.017	0.006	AU
18323	39.9102	113.8252	0.201	0.022	AU
8717	39.9598	113.1975	0.042	0.004	AU
ELY					
28834	39.4373	115.9751	0.043	0.013	AU
19548	39.4723	115.9572	0.054	0.016	AU
28791	39.4724	115.9686	0.149	0.023	AU
19571	39.4957	115.9533	0.030	0.011	AU
7404	39.9503	115.5769	0.071	0.012	AU
MILLETT					
28797	39.4166	116.0811	0.087	0.032	AU
20573	39.8493	116.5815	0.051	0.012	AU
28918	39.0739	117.1364	0.066	0.015	AU
20489	39.1227	117.1805	0.045	0.011	AU
204676	39.2237	117.1344	0.653	0.043	AU
6354	39.3461	117.2112	0.021	0.007	AU
6358	39.4977	117.0954	0.035	0.017	AU
28942	39.5582	117.4307	0.212	0.024	AU
20396	39.5696	117.4948	0.718	0.047	AU
6333	39.8508	117.1625	0.028	0.011	AU
RELM					
73408	39.8973	119.4312	0.048	0.014	AU
ELKO					
19496	40.0246	115.8598	0.093	0.030	AU
5400	40.5339	115.9869	0.035	0.011	AU
WINNEMUCCA					
20542	40.0414	116.8577	0.032	0.010	AU
6985	40.4184	116.8232	0.196	0.015	AU
7935	40.2815	117.9175	3.388	0.168	AU

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SITE#	LAT	LONG	CON PPM)	ERROR	
WINNEMUCCA (CONTINUED)					
LOVELOCK					
7869	40.2189	118.0753	0.022	0.009	AU
5909	40.2910	118.3388	0.029	0.008	AU
7143	40.3858	118.7837	0.049	0.010	AU
6716	40.4279	118.8001	0.047	0.017	AU
7852	40.4416	118.1508	0.027	0.011	AU
6714	40.4419	118.7675	0.047	0.009	AU
7562	40.4473	118.6509	0.406	0.026	AU
5868	40.5713	118.2393	0.115	0.015	AU
5843	40.6869	118.0260	0.022	0.009	AU
5858	40.7151	118.3544	0.011	0.005	AU
35504	40.8335	118.4718	0.035	0.013	AU
7533	40.8588	118.1438	0.040	0.012	AU
29823	40.0142	119.9525	0.036	0.010	AU
6854	40.0156	119.0532	0.025	0.011	AU
6745	40.2973	119.0190	0.031	0.010	AU
36609	40.8222	119.2269	1.185	0.068	AU
WELLS					
5612	41.1325	114.9926	0.066	0.011	AU
5049	41.5313	115.1161	0.017	0.003	AU
MCDERMITT					
6398	41.2047	116.7555	0.045	0.019	AU
6399	41.2201	116.7662	0.022	0.013	AU
7056	41.1986	117.1646	0.060	0.013	AU
6516	41.5679	117.4689	0.208	0.030	AU
57763	41.8599	117.6313	0.097	0.017	AU
VYA					
37679	41.0873	118.3394	0.332	0.022	AU
37679	41.0873	118.3394	0.073	0.023	AU
37740	41.3495	118.3292	0.028	0.013	AU
58773	41.5213	118.8097	0.019	0.007	AU
50290	41.7061	118.2608	0.235	0.016	AU
50340	41.7626	118.2900	0.025	0.009	AU
58839	41.8232	118.7015	0.261	0.020	AU
50357	41.8956	118.4574	0.058	0.012	AU
50471	41.1863	119.4395	0.051	0.013	AU
36876	41.6546	119.4006	0.104	0.021	AU
HAILEY					
18826	43.5758	115.6751	0.042	0.025	AU

SITE#	LAT	LONG	CON (PPM)	ERROR	
HAILEY (CONTINUED)					
18718	43 7253	115 6008	0 050	0 018	AU
DUBOIS					
44621	44 9509	113 6139	0 212	0 025	AU
44621	44 9509	113 6139	0 051	0 017	AU
44621	44 9509	113 6139	0 065	0 017	AU
44621	44 9509	113 6139	0 077	0 017	AU
44606	44 9657	113 4739	0 071	0 014	AU
44605	44 9728	113 4792	0 134	0 018	AU
44641	44 9728	113 4792	1 824	0 101	AU
44605	44 9728	113 4792	0 218	0 027	AU
44641	44 9728	113 4792	0 237	0 016	AU
44641	44 9728	113 4792	0 240	0 023	AU
44605	44 9728	113 4792	0 262	0 034	AU
44605	44 9728	113 4792	0 326	0 039	AU
44605	44 9728	113 4792	0 344	0 030	AU
44641	44 9728	113 4792	0 419	0 037	AU
44641	44 9728	113 4792	0 045	0 023	AU
44605	44 9728	113 4792	2.887	0 315	AU
44605	44 9728	113 4792	0 695	0 041	AU
44601	44 9757	113 5098	0 101	0 014	AU
44601	44 9757	113 5098	0 015	0 007	AU
44603	44 9777	113 5010	0 640	0 037	AU
DILLON					
44635	45 0790	113 8993	0 036	0 014	AU
44634	45 4876	113 9727	0 107	0 019	AU
44634	45 4876	113 9727	0 013	0 007	AU
44634	45 4876	113 9727	0 027	0 010	AU
44630	45 4878	113 9304	0 058	0 007	AU
44633	45 5045	113 9467	0 103	0 015	AU
44633	45 5045	113 9467	0 305	0 032	AU
44633	45 5045	113 9467	0 050	0 011	AU
WALLACE					
43348	47 2101	115 9806	0 028	0 010	AU
SPOKANE					
43376	47 2164	116 2116	3 205E-02	1.074E-02	AU
RITZVILLE					
8033	47 9497	118 1183	0 151	0 031	AU

SITE#	LAT	LONG	CON (PPM)	ERROR	
(CONTINUED)					
RITZVILLE					
46480	47.9528	118.1627	0.045	0.011	AU
46455	47.9732	118.2311	0.17	0.096	AU
49318	47.9368	119.9243	0.063	0.011	AU
KALISPELL					
46105	48.0404	114.3369	0.029	0.012	AU
46558	48.1451	114.1660	0.026	0.009	AU
45680	48.1817	114.1170	0.058	0.013	AU
45683	48.1900	114.1596	0.044	0.017	AU
45684	48.1936	114.1607	0.051	0.012	AU
45674	48.2135	114.2134	0.020	0.012	AU
46183	48.2559	114.1667	0.038	0.016	AU
46073	48.4621	114.5570	0.058	0.016	AU
43307	48.4628	114.5570	0.059	0.018	AU
46089	48.5661	114.4693	0.055	0.012	AU
46054	48.5862	114.0961	0.043	0.013	AU
43303	48.5974	114.5844	0.073	0.015	AU
46053	48.6165	114.1961	0.020	0.007	AU
46052	48.6205	114.0650	0.020	0.009	AU
46027	48.6713	114.3432	0.044	0.014	AU
46003	48.7475	114.2929	0.039	0.011	AU
SANDPOINT					
24606	48.0874	116.8577	0.112	0.019	AU
23992	48.1021	116.6145	0.064	0.023	AU
24062	48.2235	116.1195	0.074	0.028	AU
23989	48.3273	116.7329	0.110	0.027	AU
23945	48.7523	116.5184	0.055	0.014	AU
23968	48.7595	116.9905	0.052	0.014	AU
24664	48.7811	116.9937	0.051	0.015	AU
23594	48.8136	116.4116	0.021	0.022	AU
24119	48.8509	116.2926	0.067	0.026	AU
24013	48.8612	116.0920	0.085	0.019	AU
23920	48.8952	116.9532	0.042	0.013	AU
24008	48.9000	116.0026	0.066	0.034	AU
23922	48.9133	116.9713	0.093	0.030	AU
24648	48.9151	117.1131	0.172	0.019	AU
24672	48.9327	117.3488	3.653	0.587	AU
25267	48.9541	117.3657	0.074	0.021	AU
25232	48.9688	117.5363	0.107	0.019	AU
25251	48.9803	117.3626	0.061	0.016	AU
24417	48.3032	117.6688	0.070	0.021	AU
24412	48.3431	117.6113	0.477	0.033	AU
24222	48.4903	117.6899	0.253	0.026	AU
23959	48.6206	117.0736	0.049	0.020	AU
24684	48.8357	117.2208	0.082	0.017	AU
24622	48.9315	117.6089	0.076	0.021	AU

SITE#	LAT	LONG	CON(PPM)	ERROR	
SANDPOINT	(CONTINUED)				
24669	48 9509	117 2144	0 081	0 017	AU
24825	48 9786	117 5371	0 089	0 026	AU
OKANAGAN					
45934	48 3615	118 8941	0 029	0 014	AU
45926	48 3846	118 8625	0 552	0 037	AU
45720	48 4015	118 3619	0 020	0 009	AU
45956	48 4511	118 8653	0 032	0 012	AU
45060	48 5187	118 7386	0 024	0 013	AU
45599	48 5500	118 9783	0 302	0 023	AU
45059	48 6734	118 6843	0 021	0 006	AU
45056	48 6938	118 6442	0 027	0 012	AU
45643	48 7319	118 4745	0 150	0 021	AU
45652	48 9074	118 8518	0 029	0 013	AU
48644	48 9347	118 1333	0 064	0 015	AU
46850	48 9479	118 1663	0 037	0 009	AU
44996	48 9835	118 5902	0 050	0 015	AU
45519	48 0376	119 0399	0 031	0 011	AU
45078	48 1627	119 0992	0 9	0 035	AU
45253	48 3050	119 1415	0 086	0 018	AU
45172	48 3432	119 1215	0 115	0 018	AU
44983	48 4809	119 4486	0 454	0 188	AU
45185	48 4390	119 0984	0 085	0 008	AU
45428	48 6191	119 2768	0 100	0 030	AU
44915	48 7427	119 0702	0 045	0 015	AU
45397	48 6867	119 6257	0 094	0 011	AU
46242	48 8969	119 5446	0 047	0 009	AU
46230	48 8980	119 5351	0 039	0 014	AU
46244	48 9096	119 7381	0 105	0 012	AU
46217	48 9143	119 6247	0 274	0 018	AU
46216	48 9417	119 7108	0 321	0 006	AU

■ INDICATES ROCK SAMPLE