U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES MAP
MF-2407-J
version 1.0

Map Showing Antimony Concentrations from Stream Sediments and Soils Throughout the Humboldt River Basin and Surrounding Areas, Northern Nevada

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The distribution of antimony in stream sediments and soils in the Humboldt River basin and surrounding area

In 1995, the Bureau of U.S. Land Management and the U.S. Geological Survey identified antimony along with 12 other elements to investigate within the Humboldt River basin located in northern Nevada. These elements are important because of their role as pathfinder elements for mineral deposits or as potential toxins in the environment. This report is one of the 13 separate published reports (MF-2407-A-M) that integrate the results of two geochemical studies conducted by the U.S. Geological Survey and that present geochemical maps created using computer models of stream-sediment and soil geochemistry. The other 12 reports present geochemical maps for Ag, As, Au, Ce, Co, Cu, Fe, Ni, Pb, Sc, Se, and Zn. These geochemical maps provide a visual aid to interpreting the trends and anomalies in element concentration when combined with information about the geology, topography, and mining districts in the Humboldt River basin.

The Humboldt River basin is a naturally occurring, internally draining river basin that covers approximately 43,700 km^2 (16,900 mi^2) and forms a substantial part of the larger Great Basin. The Humboldt River basin includes the upper reaches of the Little Humboldt River in Elko County, the Reese River in Lander County, and the main Humboldt River and its many tributaries that flow ultimately westward into the Humboldt Sink. Figure 1 shows the map area and the Humboldt River basin.

Stream-sediment and soil samples originally collected for the NURE (National Uranium Resource Evaluation) program were reanalyzed in 1994 for the Winnemucca-Surprise mineral resource assessment (3,524 samples; King and others, 1996) and in 1996 for the mineral and environmental assessment of the Humboldt River basin (3,626 samples; Folger, 2000) (fig. 2). An additional 206 stream-sediment samples were collected for the Winnemucca-Surprise mineral resource assessment by the USGS to fill gaps in the sample coverage. The combined sample coverage is generally spatially uniform with a sample density of one sample site per 17 km^2. Sample density is greatest along range fronts and sparsest along mountain ridges and broad valley bottoms.

Figure 2. Winnemucca-Surprise mineral resource assessment and Humboldt River basin mineral and environmental assessment sample localities in green and red, respectively.

Sample analysis

The -80 (<180 µm) and -100 (<150 µm) sieve mesh grain-size fractions of stream-sediment and soil samples were selected for reanalysis. The samples were prepared and analyzed using a weak acid digestion and organic extraction prior to analysis by inductively coupled plasma-atomic adsorption spectrometry (ICP-AES) (Motooka, 1996). This digestion method cannot dissolve complex silicates and therefore may underestimate the total antimony present in the sample. However, the method does permit measurement at low detection levels. There were 2,337 qualified values (below the limit of detection) in the Winnemucca-Surprise and none in the Humboldt River basin datasets. Prior to computing the statistics and subsequent grids, all qualified values were replaced with a value equal to 0.0475 ppm. Table 1 contains the statistical profiles and lower limits of determination (LLD) of the two datasets. Figure 3 shows the lognormal distribution of the data. The histograms illustrate the overwhelming effect of qualified values (tallest yellow bar on left) on the distribution statistics in the Winnemucca-Surprise study. To enhance the continuity of data, the two datasets were combined into a single dataset and plotted on the thematic map.

Table 1. Statistics for antimony. LLD, lower limit of determination; N, number; Dev, deviation.

	Winnemucca-Surprise		Humboldt River basin		Combined Data Sets	
	SB PPM	LOG SB	SB PPM	LOG SB	SB PPM	LOG SB
LLD	0.67		0.095			
N of cases	3730	3730	3626	3626	7356	7356
Minimum	0.048	-0.301	0.095	-1.022	0.0475	-1.323
Maximum	160	2.204	559	2.747	559	2.747
Range	159.95	2.505	558.91	3.77	558.95	4.071
Median	0.048	-0.301	1.145	0.059	0.975	-0.011
Mean	1.78	-0.045	2.428	0.109	2.096	-0.286
Standard Dev	7.22	0.405	13.36	0.326	10.70	0.768
Variance	52.10	0.164	178.53	0.106	114.49	0.590

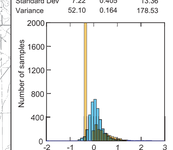

Figure 3. Overlapping histograms of log-transformed antimony values. Humboldt River basin in blue and Winnemucca-Surprise in yellow, and where there is overlap, the histograms are green.

Antimony (Sb) is a trace element and heavy metal of interest within the Humboldt River basin, where it exists as a trace element in many sulfide minerals associated with base-metal or precious-metal deposits. The environmental consequences of antimony enrichment or contamination are unknown; however, Sb uptake has been noted in plants (Edwards and other, 1995).

Globally, the concentration of antimony is most enriched in argillaceous sediments (1.2 to 2 ppm) and shales (0.8 to 1.5 ppm) and ranges from 0.05 to 0.3 ppm for other sedimentary rock types (Kabata-Pendias and Pendias, 1992). Igneous rocks tend to contain minute quantities that range between 0 and 1.0 ppm. Antimony concentrations in the Humboldt River basin range from below detection limits (0.06 ppm) to 559 ppm. Stibnite (Sb_2S_3) is the most common antimony mineral; however, it's occurrence is rare. Elevated concentrations of Sb have been associated with chemical fertilizers, sewage sludge, coal fly-ash, Pb-Zn smelters, and mine wastes (Edwards and others, 1995). Regardless of the source, the fate and transport of Sb in the environment is not well known.

Construction of thematic maps

The thematic map is a useful format for representing the regional variation in geochemical concentration between samples. The approach used for each dataset was to (a) transform every concentration to the logarithm of the concentration for the element and (b) calculate the mean and standard deviation of the log-transformed data. Element concentrations are now expressed as a logarithm and are classified by standard deviations above or below the mean. The standard deviation category for each sample is indicated by a color symbol. Samples with standard deviations below the mean were assigned the "cool" hues of blues and greens, and samples with standard deviations above the mean were assigned the "warm" hues of gold, orange, and red.

A small geochemistry map (fig. 4) was generated from the data using a Geosoft software version of the minimum-curvature algorithm. The minimum-curvature algorithm (Briggs, 1974; Webring, 1981) is useful in fitting a surface to closely spaced and gradually varying data while interpolating smoothly between widely spaced data. Data gaps, while conservatively interpolated, may occasionally allow the surface to overshoot or undershoot. Contour intervals on the thematic map are calculated from the minimum curvature grid values and provide an indicator of the generalized spatial continuity of geochemical trends. Contour lines (in brown) left unclosed reflect the sparseness of data available in these areas.

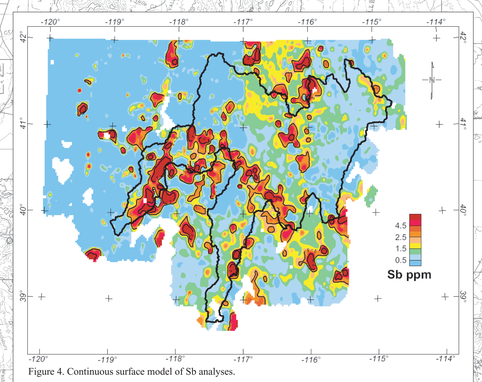

Figure 4. Continuous surface model of Sb analyses.

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Base from U.S. Geological Survey, 1965
Lambert Conformal Conic Projection
based on standard parallels 33° and 45°

EXPLANATION
log value (ppm Sb)
Combined Winnemucca-Surprise
and Humboldt River basin datasets
[Mean log value is -0.286;
geometric mean ppm Sb is 0.5176]

2.018 to 2.747	(>104.23)
1.25 to 2.018	(17.78 to 104.23)
0.482 to 1.25	(3.03 to 17.78)
-0.286 to 0.482	(0.5176 to 3.03)
-1.054 to -0.286	(0.088 to 0.5176)
-1.882 to -1.054	(<0.088)

Humboldt River basin boundary
2.5 (ppm Sb) contour interval
7 (ppm Sb) contour interval

Figure 1. Index map of study area.

SCALE 1:500,000
10 0 10 20 30 40 MILES
10 0 10 20 30 40 50 KILOMETERS
CONTOUR INTERVAL 500 FEET
NATIONAL VERTICAL GEODETIC DATUM OF 1929

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For sale by U.S. Geological Survey Information Services
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This map was produced on request, directly from digital files, on an electronic plotter. It is also available as a PDF file at http://geology.cr.usgs.gov