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

MISCELLANEOUS FIELD STUDIES MAP
MF-2407-F
version 1.0

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

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

In 1995, the U.S. Bureau of Land Management and the U.S. Geological Survey identified zinc 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, Sb, Sc, and Sr. 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.

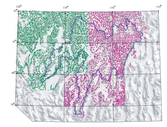

Figure 2. Winnemucca-Surprise mineral resource assessment and Humboldt River basin mineral and environmental assessment sample localities in green and red, respectively.

Sample analysis

The -80 (<180 µm) or -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 zinc present in the sample. However, the method does permit measurement at low detection levels. There was one qualified value (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 0.025 ppm. Table 1 contains the statistical profiles and lower limits of determination (LLD) of the two datasets. The histograms in figure 3 illustrate the lognormal distributions of analytical results for samples in the study area. 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 zinc. LLD, lower limit of determination; N, number; Dev, deviation.

	Winnemucca-Surprise		Humboldt River basin		Combined datasets	
	ZN PPM	LOG ZN	ZN PPM	LOG ZN	ZN PPM	LOG ZN
LLD	0.05		1			
N of cases	3730	3730	3626	3626	7356	7356
Minimum	0.85	-0.071	9.25	0.966	0.85	-0.071
Maximum	20000	4.301	10754	4.032	20000	4.301
Range	19999	4.372	10744.8	3.066	19999.2	4.372
Median	58	1.763	60.9	1.785	59.9	1.777
Mean	77.3	1.761	80.0	1.819	78.6	1.789
Standard Dev	417.3	0.222	193.0	0.213	326.5	0.222
Variance	174109.8	0.049	37253.1	0.046	106613.6	0.049

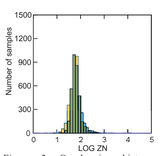

Figure 3. Overlapping histograms of log-transformed zinc values. Humboldt River basin in blue and Winnemucca-Surprise in yellow, and where there is overlap, the histograms are green.

Zinc (Zn), a trace element and heavy metal, is highly chalcophilic with an affinity to form sulfide minerals; however, it also occurs commonly in carbonates, silicates, and oxides. The chalcophile characteristics of zinc make it a useful "pathfinder" element in the exploration for mineral deposits. It is considered an essential nutrient; however, deficiencies and excesses can cause adverse health affects in humans, wildlife, plants, and especially freshwater biota (Eisler, 1993).

Globally, the concentration of zinc in magmatic rocks ranges from 40 to 120 ppm with zinc being slightly more enriched in the mafic rocks. In sedimentary rocks, argillaceous sediments and shale are enriched (80 to 120 ppm) compared to sandstone and carbonate rocks (10 to 30 ppm) (Kabata-Pendias and Pendias, 1992). Common zinc ore-minerals include sphalerite (ZnS), smithsonite ($ZnCO_3$), calamine (H_2ZnSiO_3), and zincite (ZnO). Zinc concentrations in the Humboldt River basin range from below detection limits (0.05 ppm) to 14,000 ppm. Zinc is moderately mobile in the environment and tends to be absorbed by organic material and Mn-oxides.

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.

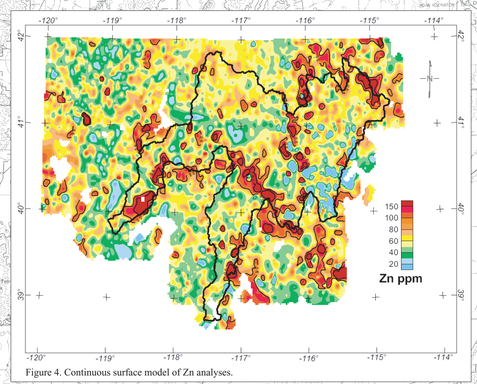

Figure 4. Continuous surface model of Zn analyses.

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Figure 1. Index map of study area.

EXPLANATION
log value (ppm Zn)
Combined Winnemucca-Surprise and Humboldt River basin datasets
[Mean log value is 1.789; geometric mean ppm Zn is 61.5]

- 2.456 to 4.301 (>285.8)
- 2.234 to 2.456 (171.4 to 285.8)
- 2.012 to 2.234 (102.8 to 171.4)
- 1.789 to 2.012 (61.5 to 102.8)
- 1.567 to 1.789 (36.9 to 61.5)
- 1.345 to 1.567 (22.1 to 36.9)
- 1.123 to 1.345 (13.3 to 22.1)
- -0.071 to 1.123 (<13.3)
- Humboldt River basin boundary
- 90 (ppm Zn) contour interval
- 150 (ppm Zn) contour interval

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

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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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