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MISCELLANEOUS FIELD STUDIES MAP
MF-2407-E
version 1.0

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

In 1995, the U.S. Bureau of Land Management and U.S. Geological Survey identified copper 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 published 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, Fe, Na, Pb, Sc, Sc, 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 km² (16,900 mi²) 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 (3,523 samples; King and others, 1996) and in 1996 for the mineral and environmental assessment of the Humboldt River basin (3,712 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 km². Sample density is greatest along range fronts and sparsest along mountain ridges and broad valley bottoms.

Sample analysis

The –80 (<180 μm) or <100 (<150 μm) mesh grain-size fractions of stream-sediment and soil samples were selected for reanalysis. The samples were prepared using a sequence of strong acids, including hydrofluoric acid, and analyzed by Inductively-Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) (Briggs, 1996). This digestion method dissolves complex silicates, however, copper may be underestimated in highly siliceous samples. There were no qualified values (below the limit of detection) in the Winnemucca-Surprise and 1 qualified value in the Humboldt River basin datasets. The qualified value was replaced by the value of 1 ppm. Table 1 contains the statistical profile 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.

Copper (Cu) has been identified as a heavy metal of interest within the Humboldt River basin. It is highly chalcophilic with an affinity to form sulfide minerals and complex with metals. The chalcophile characteristics of copper 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, 1998).

Globally, the concentration of copper is most enriched in mafic rocks (60 to 120 ppm) and argillaceous sediments (40 to 60 ppm) and ranges from 2 to 80 ppm for other rock types (Kabata-Pendias and Pendias, 1992). Copper concentrations in the Humboldt River basin range from below detection limits (0.05 ppm) to 3,900 ppm. Copper commonly forms simple or complex sulfide minerals that are easily weathered, releasing copper into the environment. This is particularly true in acid environments (<4 pH); however, its mobility is controlled by adsorption by Fe 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 data set 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.

References

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

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

Figure 4. Continuous surface model of Cu analyses.

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

EXPLANATION
log value (ppm Cu)
Combined Winnemucca-Surprise and Humboldt River basin datasets
[Mean log value is 1.34;
geometric mean ppm Cu is 21.9]

- 2.106 to 3.58   (>127.6)
- 1.851 to 2.106   (71.0 to 127.6)
- 1.595 to 1.851   (39.3 to 71.0)
- 1.34 to 1.595   (21.9 to 39.3)
- 1.085 to 1.34   (12.2 to 21.9)
- 0.83 to 1.085   (6.8 to 12.2)
- 0.575 to 0.83   (3.8 to 6.8)
- 0 to 0.575   (<3.8)

--- - --- Humboldt River basin boundary

--- 32 (ppm Cu) contour interval

--- 48 (ppm Cu) contour interval

Nevada

Map area

Figure 1. Index map of study area.

SCALE 1:1,000,000

CONTOUR INTERVAL 300 FEET

NATIONAL VERTICAL GEODETIC DATUM OF 1929

Base from U.S. Geological Survey, 1963
Lambert Conformal Conic Projection
based on standard parallels 33° and 45°

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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/

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

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