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

MISCELLANEOUS FIELD STUDIES MAP MF-2407-E version 1.0

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

By Douglas B. Yager and Helen W. Folger, 2003

NATIONAL VERTICAL GEODETIC DATUM OF 1929

CONTOUR INTERVAL 500 FEET

SCALE 1:500,000

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

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 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, Fe, Ni, Pb, Sb, 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 square kilometers (16,900 square miles) 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 square kilometers. Sample density is greatest along range fronts and sparsest along mountain ridges and broad valley bottoms.

Sample analysis

The -80 (<180 micrometers) or -100 (<150 micrometers) sieve 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 minimumcurvature 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

Briggs, Ian C., 1974, Machine contouring using minimum curvature: Geophysics, v. 39, no. 1, p. 39-48.

Briggs, P.H., 1996, Forty elements by inductively coupled plasma-atomic emission spectrometry, in Arbogast, B.F., ed., Analytical methods manual for the Mineral Resource Surveys

Program, U.S. Geological Survey: U.S. Geological Survey Open-File Report 96-525, p. 77-94.

Eisler, R., 1998, Copper hazards to fish, wildlife, and invertebrates: a synoptic review: U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR--1998-0002, 98p.

Folger, H.W., 2000, Analytical results and sample locations of reanalyzed NURE stream-sediment and soil samples for the Humboldt River basin Mineral-Environmental Resource Assessment, northern Nevada: U.S. Geological Survey Open-File Report 00-421, 491 p.

Kabata-Pendias, Alina, and Pendias, Henryk, 1992, Trace elements in soils and plants–Second edition: CRC Press, 365 p.

King, H.D., Fey, D.L., Matooka, J.M., Knight, R.J., Roushey, B.H., and McGuire, D.J., 1996, Analytical data and sample locality map of stream-sediment and soil samples from the Winnemucca-Surprise Resource Area, northwest Nevada and northeast California: U.S. Geological Survey Open-File Report 96-062-A (paper) and 96-062-B (diskette), 341 p.

Webring, Michael, 1981, MINC: A gridding program based on minimum curvature: U.S. Geological Survey Open-File Report 81-1224, 41 p.

Acknowledgments

We wish to thank Karen Kelley, Steven Smith, and Craig Brunstein (U.S. Geological Survey) for their reviews of this report.

Figures

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

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

Figure 4. Continuous surface model of Cu analyses.

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

Manuscript approved for publication September 23, 2002

For sale by U.S. Geological Survey Information Services
Box 25286, Federal Center, Denver, CO 80225

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