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

MISCELLANEOUS FIELD STUDIES MAP MF-2407-I version 1.0

Map Showing Silver 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 silver 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 silver 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 Au, As, Ce, Co, Cu, 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 (3,545 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 square kilometers. Sample density is greatest along range fronts and sparsest along mountain ridges and broad valley bottoms.

Sample analysis

The -80 (<180 micrometers) and -100 (<150 micrometers) 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 silver present in the sample. However, the method does permit measurement at low detection levels. Despite the better detection levels, there were 3,240 qualified values (below the limit of detection) in the Winnemucca-Surprise and 1 qualified value in the Humboldt River basin datasets. Prior to computing the statistics and subsequent grids, the qualified values were replaced with a value of 0.05 ppm (Winnemucca-Surprise) and 0.008 ppm (Humboldt River basin). Table 1 contains the statistical profile 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. Because of the significant differences between the dataset means and range of values, the two datasets are plotted separately side-by-side on the thematic map to enhance the resolution of the analyses.

Globally, silver concentrations range from 0.05 to 0.25 ppm in sedimentary rocks, 0.1 ppm in mafic rocks and 0.04 to 0.07 ppm for other igneous rocks (Kabata-Pendias and Pendias, 1992). Silver concentrations in the Humboldt River basin range from below detection limits (0.067 and 0.015 ppm) to 148 ppm. Silver exists in complex sulfosalts, tellurides, chlorides, and as native silver. Many sulfur-based minerals weather easily, potentially releasing trace quantities of silver into the environment. Once mobile, silver may be adsorbed onto humic material in soils or precipitated in reducing environments. Silver is a potential toxin to sensitive aquatic plants, invertebrates, and other aquatic biota (Eisler, 1996). High silver values in the Humboldt River basin are generally associated with old base-metal and precious-metal mines.

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 logtransformed 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.

References

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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 log-transformed silver 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 Ag analyses.

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

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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