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

MISCELLANEOUS FIELD STUDIES MAP MF-2407-C version 1.0

Map Showing Cobalt 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 cobalt 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 cobalt 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 streamsediment and soil geochemistry. The other 12 reports present geochemical maps for Ag, As, Au, Ce, 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 (3,549 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 ∝m) or -100 (<150 ∝m) 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, cobalt may be underestimated in highly siliceous samples. There were no qualified values (below the limit of detection) in the Winnemucca-Surprise and 22 qualified values in the Humboldt River basin datasets. Qualified values were substituted with the value of 1.4 ppm. 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. Because of the significant differences between the datasets' 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.

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

Cobalt (Co), a transition metal, occurs as a trace element in Cu-Ni-sulfide ores and forms minerals of complex sulfarsenides and sulfantimonides. It is considered an essential nutrient for plants; however, unusually high Co contents in soils may be toxic. (Kabata-Pendias and Pendias, 1992).

Globally, the concentration of cobalt is most enriched in ultramafic rocks (100 to 200 ppm) and mafic rocks (35 to 50 ppm) and ranges from 1 to 15 ppm for other igneous rock types. In sedimentary rocks, concentration ranges for argillaceous sediments and shale are 11 to 20 ppm, and 0.4 to 3 ppm for sandstone and carbonate rocks (Kabata-Pendias and Pendias, 1992). Cobalt concentrations in the Humboldt River basin range from < 2 to 210 ppm. The distribution of Co in the soils and sediments is strongly determined by the Mn-oxide phase present. Cobalt tends to be more mobile in soils that are oxidizing and acidic; however, the Fe and Mn-oxides adsorb mobilized Co before it can migrate far (Kabata-Pendias and Pendias, 1992).

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.

References

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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.

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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 cobalt values. Humboldt River basin in blue and Winnemucca-Surprise in yellow, and where there is overlap, the histograms are green.

Table 1. Statistics for cobalt. 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