U.S. DEPARTMENT OF THE INTERIOR
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MISCELLANEOUS FIELD STUDIES MAP MF-2407-H version 1.0

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

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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 selenium in stream sediments and soils in the Humboldt River basin and surrounding area

In 1995, the U.S. Bureau of Land Management identified selenium 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 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 1996 for the mineral and environmental assessment of the Humboldt River basin (4,336 samples; Folger, 2000) (fig. 2). An additional 73 stream-sediment samples originally collected for the Winnemucca-Surprise mineral resource assessment (King and others, 1996) were reanalyzed by Folger (2000) for total selenium. 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 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 selenium present in the sample. However, the method does permit measurement at low detection levels.

Samples in the western part of the Humboldt River basin (green symbols in fig. 2) were analyzed by hydride-generation atomic adsorption (Hageman and Welsch, 1996). There were 681 and 769 qualified values (below the limit of detection) in the western Humboldt River basin (green) and the eastern Humboldt River basin (red), respectively. The Humboldt River basin-west dataset is a subset of Winnemucca-Surprise samples that were reanalyzed for selenium and thallium concentrations during the Humboldt River basin study (Folger, 2000). Prior to computing the statistics and subsequent grids, all qualified values were replaced with a value equal to 0.0001. 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. To enhance the continuity of data, the two datasets were combined into a single dataset and plotted on the thematic map.

Selenium (Se) has been identified as an element of interest because of its association as a pathfinder element for ore deposits and for potential toxicity to wildlife within the Humboldt River basin. It is considered an essential nutrient; however, deficiencies and excesses can cause adverse health effects in humans, wildlife, plants, and especially freshwater biota (Eisler, 1985).

Globally, the concentration of selenium in magmatic rocks range from 0.01 to 0.05 ppm, and are highest in shale and argillaceous sediments (0.4 to 0.6 ppm) and sandstone and carbonate (0.03 to 0.1 ppm) rocks. Selenium concentrations in the Humboldt River basin range from <0.001 to 60.5 ppm. Selenium forms selenides (Se^{2-}), selenates (SeO_4), and selenites (SeO_3) when oxidized and may substitute for small quantities of sulfur in sulfide minerals. Selenium tends to occur in trace amounts with As, Sb, Cu, Ag, and Au in sulfide deposits, black shale, and carbonaceous sandstone (Neal, 1995).

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

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Figures
Figure 2. Sample localities of NURE samples reanalyzed by ICP-AES (red) and HAAS (green) methods for the Humboldt River basin mineral and environmental assessment.
Figure 3. Overlapping histograms of logtransformed selenium 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 Se analyses.

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

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