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

Map Showing Gold 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

The distribution of gold 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 gold 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, Ce, Co, Cu, Fe, Ni, Pb, Sb, Sc, Se, and Zn and are available in this MF series. 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 (3,515 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) or -100 (<150 micrometers) sieve mesh grain-size fractions of stream-sediment and soil samples were selected for reanalysis. Prior to analysis stream-sediment and soil samples are roasted in a graphite furnace at 700oC to oxidize sulfides and organic material. Samples were digested in solutions of hydrobromic acid and bromine to dissolve the gold, followed by an organic extraction and analysis in an atomic absorption spectrophotometer (GFAA) (O'Leary and Meier, 1996). The lower limit of detection is 0.0005 ppm for the Humboldt River basin and 0.002 ppm for the Winnemucca-Surprise samples. There were 3,240 qualified values (below the limit of detection) in the Winnemucca-Surprise and 170 qualified values in the Humboldt River basin datasets. Prior to computing the statistics and subsequent grids, qualified values in the Winnemucca-Surprise datasets were replaced with a value of 0.0001. Qualified values in the Humboldt River basin dataset were replaced by a value of 0.00005 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. 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.

Gold (Au) is a rare element that exists as native gold and as a trace element in sulfides, tellurides, selenides, and organometallic compounds. It may be concentrated in rich seams, placers, or disseminated in low-grade deposits. In stream sediments and soils

Au tends to exist as discrete flakes and particles and is generally not uniformly distributed throughout the sample media. The toxicity of gold is unknown; however, uptake of Au in plants grown in Auenriched soils has been observed (Edwards and others, 1995)..

Globally, Au concentrations are 0.002 to 0.007 ppm in sedimentary rocks, 0.0005 to 0.003 ppm in mafic rocks, 0.005 ppm (average) in ultramafic rocks (Kabata-Pendias and Pendias, 1992). Gold concentration in the Humboldt River basin, ranges from below detection limits (0.002 and 0.0005 ppm) to 4.68 ppm. The weathering of Au-bearing sulfides, sulfosalts, and tellurides can release aqueous and particulate gold into the stream environment (Edwards and others, 1995), which can be redistributed mechanically and geochemically. Gold is relatively immobile in soils; however, particulate gold can be readily transported and concentrated in a stream environment.

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 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.

Edwards, R., Lepp, N.W., and Jones, K.C., 1995, Other less abundant elements of potential environmental significance, in Alloway, B.J., ed., Heavy metals in soils, Second edition, Blackie Academic and Professional, p. 306 - 310.

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

O'Leary, R.M., and Meier, A.L., 1996, Gold by flame or graphite furnace atomic absorption 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. 31-36.

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

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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 logtransformed gold 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 Au analyses.

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

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