

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, Cd, Co, Cr, Fe, Ni, Pb, Sb, Se, Si, 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 km² (16,900 mi²) 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 not uniform with a sample density of one sample site per 17 km². Sample density is greatest along range fronts and sparsest along mountain ridges and broad valley bottoms.

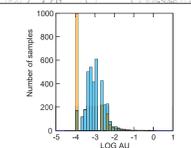


Figure 3. Overlapping histograms of log-transformed gold values, Humboldt River basin in blue and Winnemucca-Surprise in yellow, and where there is overlap, the histograms are green.

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 Au-enriched soils has been observed (Edwards and others, 1995).

Globally, Au concentrations are 0.002 to 0.007 ppm in sedimentary rocks, 0.005 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 minimum-curvature algorithm (Briggs, 1974; Wehring, 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 were 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.

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

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

	Winnemucca-Surprise	Humboldt River basin	Combined Data Set
	AU PPM	LOG AU	AU PPM
LLD	0.002	0.002	0.002
N of cases	3721	3626	7347
Minimum	4	4	4
Maximum	4.4	6.63	4.68
Range	4.4	6.63	4.68
Mean	0.0051	0.005	0.0051
Standard Dev.	0.077	0.084	0.083
Variance	0.006	0.011	0.007

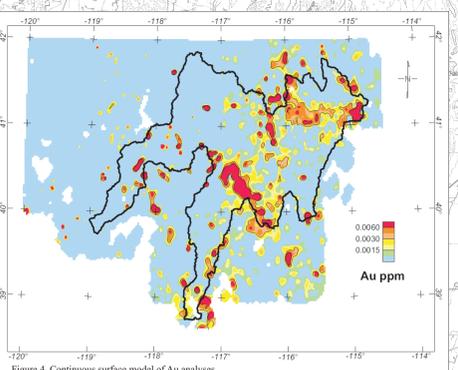


Figure 4. Continuous surface model of Au analyses.

Base from U.S. Geological Survey, 1963
 Lambert Conformal Conic Projection
 based on standard parallels 37° and 41°

- EXPLANATION**
 log value (ppm Au)
 Combined Winnemucca-Surprise and Humboldt River basin datasets
 [Mean log value is -3.536;
 geometric mean ppm Au is 0.0003]
- -1.138 to 0.67 (0.0728)
 - -1.937 to -1.138 (0.0116 to 0.0728)
 - -2.737 to -1.937 (0.0018 to 0.0116)
 - -3.536 to -2.737 (0.0003 to 0.0018)
 - -4.335 to -3.536 (0.0003)
- Humboldt River basin boundary
 --- 0.003 (ppm Au) contour interval
 --- 0.006 (ppm Au) contour interval



Figure 1. Index map of study area.

SCALE 1:500,000
 0 10 20 30 40 50 MILES
 0 10 20 30 40 50 KILOMETERS
 CONTOUR INTERVAL: ONE FOOT
 NATIONAL VERTICAL GEODETIC DATUM OF 1983

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

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