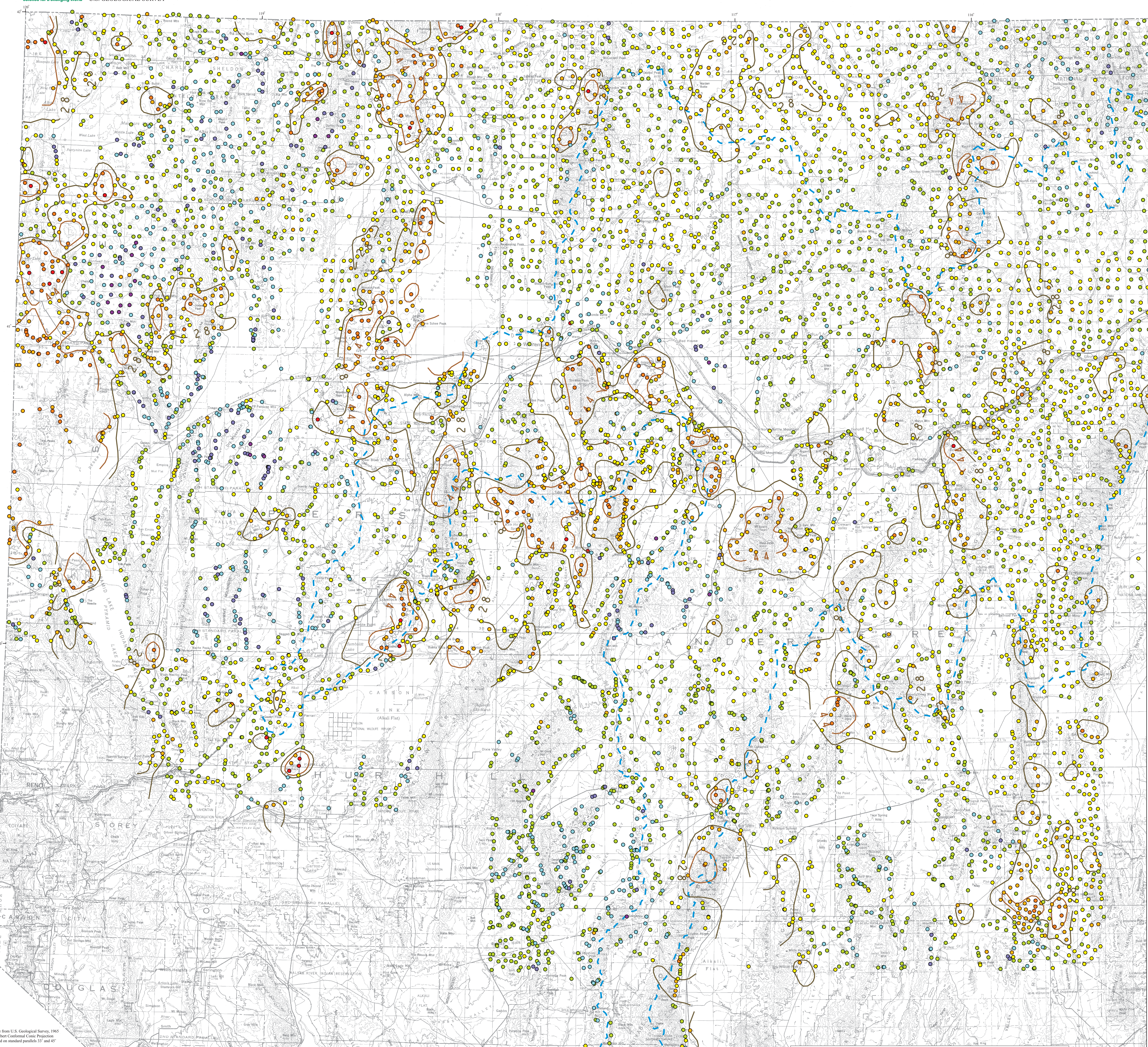
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES MAP
MF-2407-D
version 1.0



Base from U.S. Geological Survey, 1965
Lambert Conformal Conic Projection
based on standard parallels 33° and 45°

SCALE 1:500,000

CONTOUR INTERVAL 200 FEET
NATIONAL VERTICAL GEODETIC DATUM OF 1929

The distribution of nickel 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 nickel 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, 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 km^2 (16,900 mi^2) 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 (3,523 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 km^2. Sample density is greatest along range fronts and sparsest along mountain ridges and broad valley bottoms.

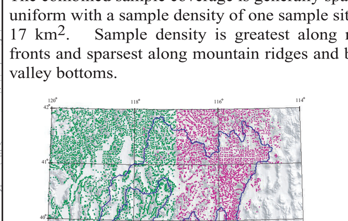


Figure 2. Winnemucca-Surprise mineral resource assessment and Humboldt River basin mineral and environmental assessment sample localities in green and red, respectively.

Sample analysis

The -80 (<180 µm) or -100 (<150 µm) 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, nickel may be underestimated in highly siliceous samples. There were 10 qualified values (below the limit of detection) in the Winnemucca-Surprise and none in the Humboldt River basin datasets. The qualified values were replaced by the value of 1 ppm. Table 1 contains the statistical profiles and lower limits of determination (LLD) of the two datasets. The histograms in figure 3 illustrate the lognormal distributions of analytical results for samples in the study area. To enhance the continuity of data, the two datasets were combined into a single dataset and plotted on the thematic map.

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

	Winnemucca-Surprise		Humboldt River basin		Combined datasets	
	NI PPM	LOG NI	NI PPM	LOG NI	NI PPM	LOG NI
LLD	2		2			
N of cases	3729	3729	3712	3712	7441	7441
Minimum	1	0	2	0.301	1	0
Maximum	460	2.663	205	2.312	460	2.663
Range	459	2.663	203	2.011	459	2.663
Median	19	1.2788	18	1.255	19	1.279
Mean	24.4	1.274	20.8	1.261	22.6	1.267
Standard Dev	22.4	0.313	12.4	0.215	18.2	0.269
Variance	500.8	0.098	154.3	0.046	331.2	0.072

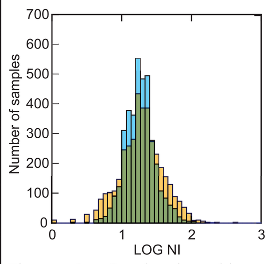


Figure 3. Overlapping histograms of log-transformed nickel values. Humboldt River basin in blue and Winnemucca-Surprise in yellow, and where there is overlap, the histograms are green.

Nickel (Ni), a heavy metal, is siderophilic with an affinity to form sulfide minerals and complex with metals of iron and cobalt. Pentlandite ($(Fe,Ni)_9S_8$) is its most common ore mineral; however, Ni occurs in trace amounts replacing iron in many sulfides and arsenides. The toxicity of nickel is a recognized health hazard stemming primarily from anthropogenic sources (Eisler, 1998).

Globally, the concentration of nickel is most enriched in ultramafic rocks (1,400 to 2,000 ppm) and mafic rocks (130 to 160 ppm) and ranges from 5 to 55 ppm for other igneous rock types. In sedimentary rocks, concentration ranges for argillaceous sediments and shale are 40 to 90 ppm, and 5 to 20 ppm for sandstone and carbonate rocks (Kabata-Pendias and Pendias, 1992). Nickel concentrations in the Humboldt River basin range from 2 to 460 ppm. Nickel forms minerals and occurs as a trace element in sulfides and arsenides and occurs in carbonates, phosphates, and silicates. Nickel is easily mobilized during weathering and then commonly precipitates with Fe-Mn oxides (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 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; 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.

Briggs, P.H., 1996, Forty elements by inductively coupled plasma-atomic emission 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. 77-94.

Eisler, R., 1998, Nickel hazards to fish, wildlife, and invertebrates: a synoptic review: U.S. Fish and Wildlife Service, Biological Science Report USGS/BRD/BSR-1998-0001, Contaminant Hazards Report No. 34.

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., 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.

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

Acknowledgments

We wish to thank Karen Kelley, Steven Smith, and Craig Brunstein (U.S. Geological Survey) for their reviews of this report.

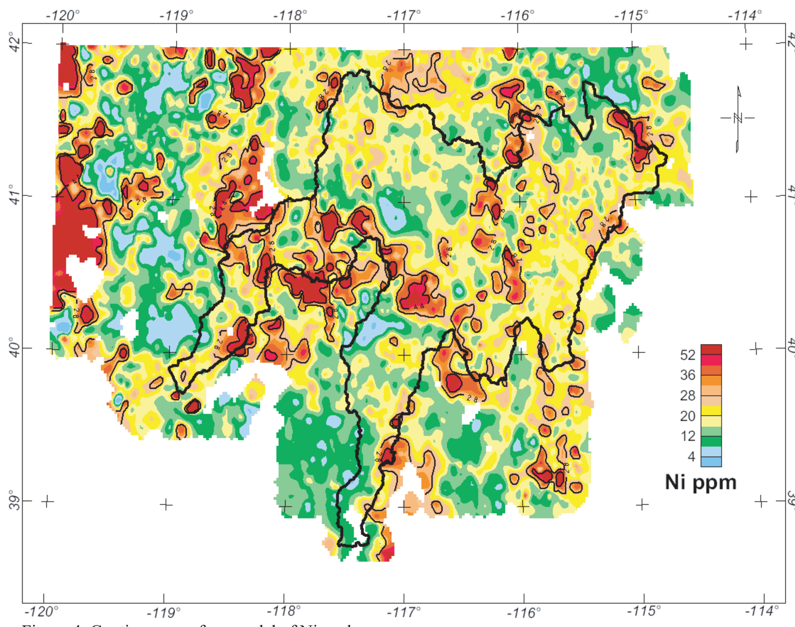


Figure 4. Continuous surface model of Ni analyses.

EXPLANATION

log value (ppm Ni)
Combined Winnemucca-Surprise and Humboldt River basin datasets
[Mean log value is 1.267; geometric mean ppm Ni is 18.5]

- 2.075 to 2.663 (>118.8)
- 1.806 to 2.075 (64.0 to 118.8)
- 1.536 to 1.806 (34.3 to 64.0)
- 1.267 to 1.536 (18.5 to 34.3)
- 0.998 to 1.267 (9.9 to 18.5)
- 0.729 to 0.998 (5.4 to 9.9)
- 0.46 to 0.729 (2.9 to 5.4)
- 0 to 0.46 (<2.9)
- Humboldt River basin boundary
- 28 (ppm Ni) contour interval
- 44 (ppm Ni) contour interval

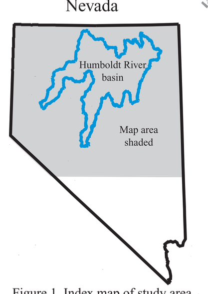


Figure 1. Index map of study area.

Manuscript approved for publication September 23, 2002

Any use of trade names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey

For sale by U.S. Geological Survey Information Services Box 25286, Federal Center, Denver, CO 80225

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

Map Showing Nickel 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