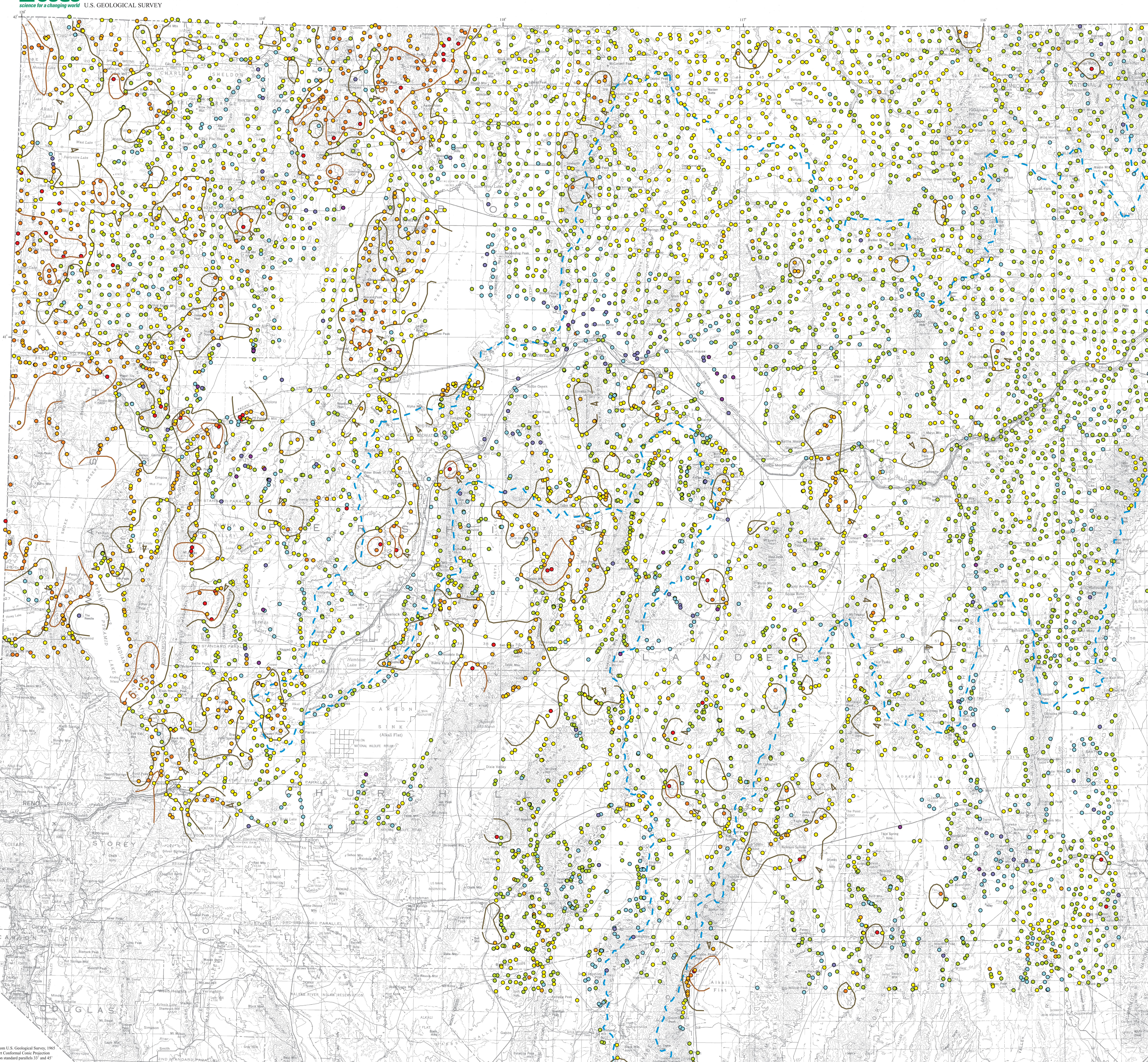
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES MAP
MF-2407-B
version 1.0



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

The distribution of iron 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 iron 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, 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 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.

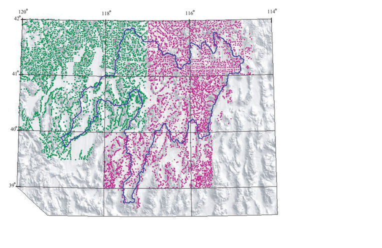


Figure 2. Winnemucca-Surprise mineral resource assessment and Humboldt River basin mineral and environmental assessment sample localities in green and red, respectively.

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, iron may be underestimated in highly siliceous samples. There were no qualified values (below the limit of detection) in the Winnemucca-Surprise and Humboldt River basin. Table 1 contains the statistical profile 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 iron. LLD, lower limit of determination; N, number; Dev, deviation.

	Winnemucca-Surprise		Humboldt River basin		Combined datasets	
	FE PCT	LOG FE	FE PCT	LOG FE	FE PCT	LOG FE
LLD	0.01		0.01			
N of cases	3729	3729	3712	3712	7441	7441
Minimum	0.21	-0.6778	0.38	-0.42	0.21	-0.678
Maximum	31	1.4914	26.74	1.427	31	1.491
Range	30.79	2.1692	26.36	1.847	30.79	2.169
Median	3.3	0.5185	2.77	0.442	2.99	0.476
Mean	3.79	0.533	2.95	0.446	3.37	0.49
Standard Dev	2.10	0.193	1.26	0.132	1.79	0.171
Variance	4.43	0.037	1.58	0.017	3.19	0.029

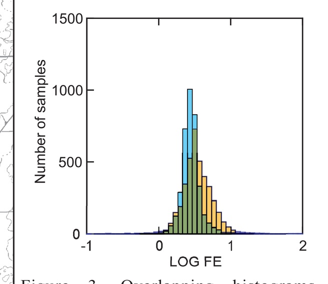


Figure 3. Overlapping histograms of log-transformed iron values. Humboldt River basin in blue and Winnemucca-Surprise in yellow, and where there is overlap, the histograms are green.

Iron (Fe), a transition metal, is one of the most abundant elements in the lithosphere and an element of interest within the Humboldt River basin. Iron commonly occurs in mineral form as sulfides, oxides, and hydroxide compounds in soils and sediments. They are readily weathered and areas of Fe-enrichment usually reflect the elemental contribution from several of these forms. It is iron's association with trace elements and ore metals such as As, Cu, Cd, Ag, Pb, Zn, and Au that that make it a useful pathfinder element.

Globally, the concentration of iron is most enriched in ultramafic rocks (9.4 to 10 %) and mafic rocks (5.6 to 8.7 %) and ranges from 1.4 to 3.7 % for other igneous rock types (Kabata-Pendias and Pendias, 1992). Iron concentration in sedimentary rocks ranges from 3.3 to 4.8 % in shale and argillaceous sediments and 0.4 to 3.0 % in sandstone and carbonate rocks. Iron concentrations in the Humboldt River basin range from 0.21 to 31 %. The geochemistry of Fe is very complex and is in general governed by the Eh-pH system of the surrounding environment. It can be generalized that Fe is mobilized in acid and reducing environments and precipitates in oxidizing and alkaline environments (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.

References

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Acknowledgments

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

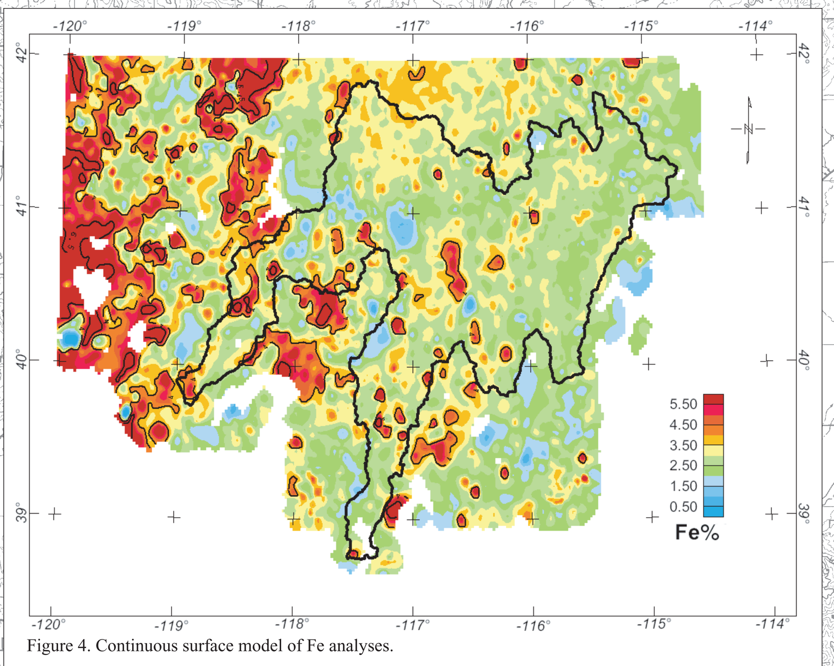

Figure 4. Continuous surface model of Fe analyses.

EXPLANATION

log value (percent Fe)
Combined Winnemucca-Surprise and Humboldt River basin Datasets
[Mean log value is 0.49; geometric mean percent Fe is 3.1]

- 1.003 to 1.491 (>10.1)
- 0.832 to 1.003 (6.8 to 10.1)
- 0.661 to 0.832 (4.6 to 6.8)
- 0.49 to 0.661 (3.1 to 4.6)
- 0.319 to 0.49 (2.1 to 3.1)
- 0.148 to 0.319 (1.41 to 2.1)
- -0.023 to 0.148 (0.95 to 1.41)
- -0.678 to -0.023 (< 0.95)
- Humboldt River basin boundary
- 4 (percent Fe) contour interval
- 6.5 (percent Fe) contour interval

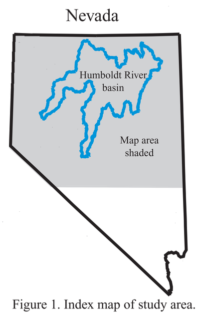

Figure 1. Index map of study area.

SCALE 1:500,000

10 0 10 20 30 40 MILES

10 0 10 20 30 40 50 KILOMETERS

CONTOUR INTERVAL 500 FEET

NATIONAL VERTICAL GEODETIC DATUM OF 1929

Map Showing Iron 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

Manuscript approved for publication September 23, 2002

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

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