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

MISCELLANEOUS FIELD STUDIES MAP MF-2407-K version 1.0

Map Showing Cerium 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

NATIONAL VERTICAL GEODETIC DATUM OF 1929

CONTOUR INTERVAL 500 FEET

SCALE 1:500,000

The distribution of cerium 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 cerium 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 13 separate published reports (MF-2407-AM) 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, Co, Cu, Fe, 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.

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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 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 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, cerium 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.
Cerium (Ce), identified as an element of interest within the Humboldt River basin, is a lithophile element of the Lanthanide group, also known as light rare-earth metals or rare earth elements (REE). Cerium commonly exists in accessory minerals such as monazite $(Ce,La,Di)PO_4$, and bastnaesite $(CeF)CO_3$, cerite (a cerium silicate), and samarskite

(a niobate and tantalite of cerium and yttrium). Monazite, usually occurring in small quantities, is a common accessory mineral in granites, gneisses, aplites, and pegmatites.

Globally, the concentration of cerium is most enriched in acid volcanic rocks (45 to 250 ppm) and intermediate igneous rocks (60 to 160 ppm) (Kabata-Pendias and Pendias, 1992) and averages about 60 ppm for continental crustal rocks (Taylor, 1964). Cerium concentrations in the Humboldt River basin range from 4 to 945 ppm. Areas of anomalous concentrations of cerium may provide areas to explore for rare-earth deposits (Hedrick, 1999). The toxicity of cerium and its fate and transport in the environment are not well known.

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.

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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 cerium 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 Ce analyses.

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

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