

Geochemical Analyses of Geologic Materials from Areas of Critical Environmental Concern, Clark and Nye Counties, Nevada

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Introduction

An assessment of known and undiscovered mineral resources of selected areas administered by the Bureau of Land Management (BLM) in Clark and Nye Counties, Nevada was conducted by the U.S. Geological Survey (USGS), Nevada Bureau of Mines and Geology (NBMG), and University of Nevada, Las Vegas (UNLV). The purpose of this work was to provide the BLM with information for use in their long-term planning process in southern Nevada so that they can make better-informed decisions. The results of the assessment are in Ludington (2006).

Existing information about the areas, including geology, geophysics, geochemistry, and mineral-deposit information was compiled, and field examinations of selected areas and mineral occurrences was conducted. This information was used to determine the geologic setting, metallogenic characteristics, and mineral potential of the areas.

Twenty-five Areas of Critical Environmental Concern (ACECs) were identified by BLM as the object of this study. They range from tiny (less than one km²) to large (more than 1,000 km²). The location of the study areas is shown on Figure 1. This report includes geochemical data for rock samples collected by staff of the USGS and NBMG in these ACECs and nearby areas. Samples have been analyzed from the Big Dune, Ash Meadows, Arden, Desert Tortoise Conservation Center, Coyote Springs Valley, Mormon Mesa, Virgin Mountains, Gold Butte A and B, Whitney Pockets, Rainbow Gardens, River Mountains, and Piute-Eldorado Valley ACECs.

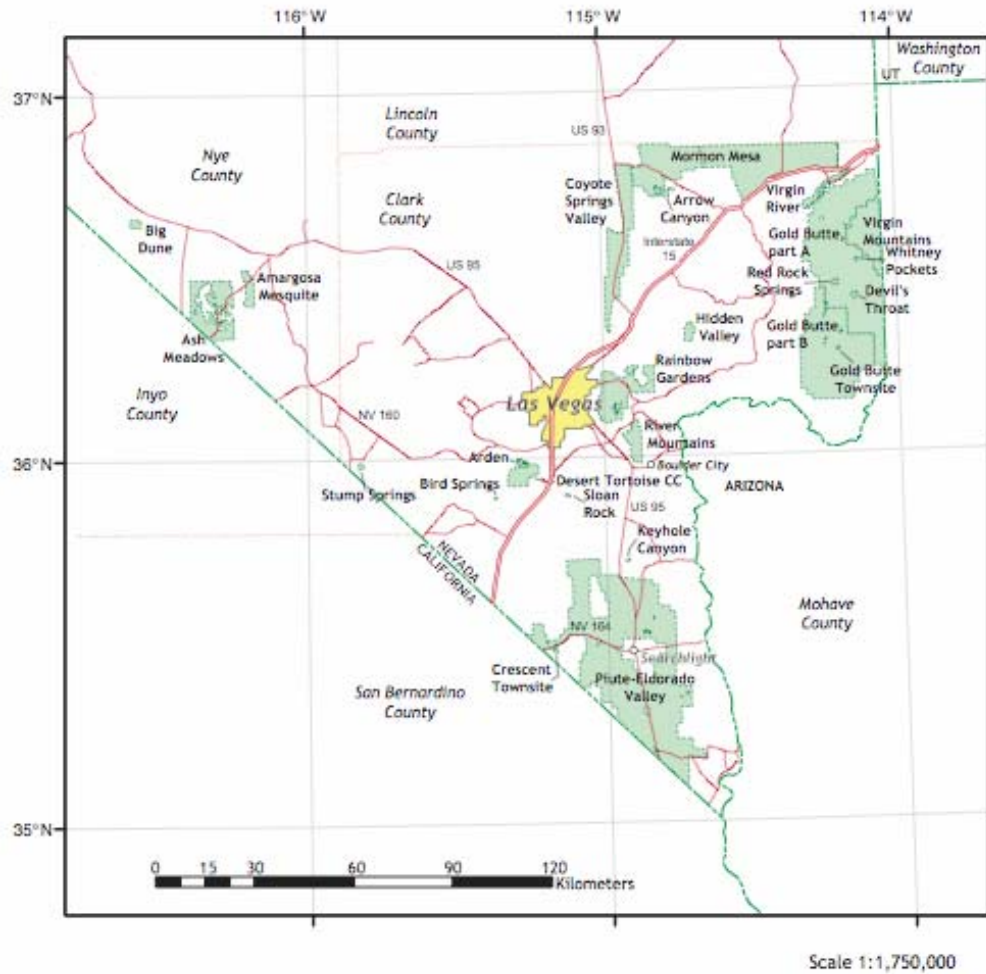


Figure 1. Map showing location of study areas (ACECs) in southern Nevada.

Explanation of Data Tables

The geographic coordinates and a simple description of the samples analyzed are in a table called *description*. Analytical results are in separate tables, one for each analysis type used. Further details on methods and detection limits for specific analysis types can be found in Taggart (2002), and at <http://www.acmelab.com/cfm/index.cfm>. In the tables, **■** means not analyzed, **■** means insufficient sample.

Description

Region, rock type, form, and lithology were delineated during field studies. Longitude and latitude were determined by GPS, and are referenced to the North American datum of 1983. Rightmost columns tabulate which tables contain analytical results for samples.

42ICP

Forty-two major, minor, and trace elements are determined by inductively coupled plasma-atomic emission spectrometry (ICP-AES) and inductively coupled plasma-mass spectrometry (ICP-MS). The samples are decomposed using a mixture of hydrochloric, nitric, perchloric, and hydrofluoric acids at low temperature. An aliquot of the digested sample is aspirated into the ICP-AES and the ICP-MS devices, and concentrations of the optimal elements are determined. Calibration of ICP-AES analyses is performed by standardizing with digested rock reference materials and a series of multi-element solution standards. ICP-MS analyses are calibrated with aqueous standards, and internal standards are used to compensate for matrix effects and internal drifts. Major elements are reported in weight percent; all other elements are reported in parts per million (ppm). Analyses were performed by XRAL Laboratories, a division of SGS Canada, under contract to the U.S. Geological Survey.

55ICP

Fifty-five major, minor, and trace elements (including rare earths) are determined by inductively coupled plasma-atomic emission spectrometry (ICP-AES) and inductively coupled plasma-mass spectrometry (ICP-MS). The samples are decomposed using a sodium peroxide sinter at 450° C. The resultant cake is leached with water and acidified with nitric acid. After an addition of tartaric acid, an aliquot of the digested sample is aspirated into the ICP-AES and the ICP-MS devices, and concentrations of the optimal elements are determined. Calibration of ICP-AES analyses is performed by standardizing with digested rock reference materials and a series of multi-element solution standards. ICP-MS analyses are calibrated with aqueous standards, and internal standards are used to compensate for matrix effects and internal drifts. Major elements are reported in weight percent; all other elements are reported in parts per million (ppm). Analyses were performed by XRAL Laboratories, a division of SGS Canada, under contract to the U.S. Geological Survey.

14ICP

Fourteen trace elements are determined by ICP-MS analysis. The samples are decomposed using a mixture of hydrochloric and nitric acids at 95 deg C. An aliquot of the digested sample is aspirated into the ICP-MS. The ICP-MS is calibrated with aqueous

standards, and internal standards are used to compensate for matrix effects and internal drifts. All values are reported in ppm. Analyses were performed by Acme Analytical Laboratories.

AuPtPd

Gold, platinum, and palladium are determined by ICP-MS after collection by fire assay. The lower reporting limits are 1 ppb for Au and Pd, and 0.5 ppb for Pt. The upper limit for all elements is 10,000 ppm. All values are reported in ppm. Analyses were performed by XRAL Laboratories, a division of SGS Canada, under contract to the U.S. Geological Survey.

MAJORS

This table contains determinations by several different methods, each of which is described briefly below. Analyses were performed by XRAL Laboratories, a division of SGS Canada, under contract to the U.S. Geological Survey.

WDXRF—Eleven major elements (SiO_2 , Al_2O_3 , Fe_2O_3 , MgO , MnO , CaO , Na_2O , K_2O , TiO_2 , Cr_2O_3 , P_2O_5 ; and *LOI* at 925 deg C) are determined by wavelength dispersive X-ray fluorescence spectrometry (*WDXRF*). The sample is fused with 50/50 lithium metaborate lithium tetraborate flux. In addition to 10 major elements, the method provides a gravimetric loss on ignition. Calibration curves for each element are derived from a variety (about 40) of international reference materials (*NIST*, *USGS*, *CANMET*, *NIM*) and a number of synthetic standards to extend the range for certain elements. Detection limits for all elements including *LOI* is 0.01%. These results are reported in weight percent.

Total_H2O—Essential water is determined by drying the sample for 1 hour at 105 ± 5 deg C to remove H_2O – (hygroscopic water). The sample is then heated to 950 deg C by using a tube furnace. The H_2O^+ is absorbed by magnesium perchlorate. From its gain of weight the amount of combined water is calculated. Non-essential water is determined by drying the sample for 2 hours at 105 ± 5 deg C. From the loss in weight, non-essential water is calculated. The lower reporting limit is 0.05% for both forms of water. This value is reported in weight percent.

FeO—A 0.5 gram sample is digested using a mixture of sulfuric, hydrofluoric, and hydrochloric acids. The solution is titrated with potassium dichromate using sodium diphenylamine sulphonate indicator. The lower reporting limit is 0.01% *FeO*. This value is reported in weight percent.

F, Cl—Fluoride and chloride are determined by ion selective electrode. Samples are fused and dissolved before analysis. These values are reported in ppm.

S—Total sulfur is determined by using an automated sulfur analyzer. Sulfur is oxidized to sulfur dioxide, and this gas is then measured with an infrared detector. The reporting range for total sulfur is from 0.05% to about 35%. Sulfur is reported in weight percent.

C—Total carbon is determined by the use of an automated carbon analyzer. A weighed sample is combusted in an oxygen atmosphere at 1370° C. to oxidize carbon to carbon dioxide. Moisture and dust are removed and the carbon dioxide gas is measured by a solid state infrared detector.

ICP10

Ten elements are analyzed by ICP-AES. The sample is leached with a hydrochloric acid-hydrogen peroxide mixture to solubilize metals not tightly bound in the silicate lattice of rocks, soils, and stream sediments. The metals are extracted by a 10% Aliquat 336-diisobutylketone (*DIBK*) solution as organic halides. This liquid is aspirated into a multichannel *ICP* instrument where the concentrations of the extracted metals (Ag, As, Au, Bi, Cd, Cu, Mo, Pb, Sb, and Zn) are determined. It is important to note that this procedure is a partial digestion and depending on element availability, results may be biased low compared to other methods of analysis. Results are reported as ppm. Analyses were performed by XRAL Laboratories, a division of SGS Canada, under contract to the U.S. Geological Survey.

MAJTRICP

Eleven major oxides and two trace elements are determined by ICP-AES, and thirty-one minor and trace elements are determined by ICP-MS analyses. An aliquot of the sample is fused with lithium metaborate and then dissolved in dilute nitric acid. This solution is aspirated into the ICP-AES and concentrations of the elements are determined. SiO₂, Al₂O₃, Fe₂O₃, MgO, MnO, CaO, Na₂O, K₂O, TiO₂, Cr₂O₃, P₂O₅, LOI, C, and S are reported in weight percent; other elements are reported in ppm. An aliquot of the solution is analyzed by ICP-MS and trace and minor element results are reported in ppm. Total carbon and sulfur are measured with Leco combustion analysis, and loss on ignition (LOI) is measured by weight difference after ignition at 1000 deg C. Some of the samples in this table were not analyzed for major oxides. Analyses were performed by Acme Analytical Laboratories.

INAA

Four major and twenty-nine minor and trace elements are determined by instrumental neutron activation (abbreviated count) methods. Samples are weighed (0.3 - 1.0 g) into appropriate containers and irradiated for 6.5 to 8 hours in a uniform neutron flux ($2.4 \times 10^{12} \text{ ns}^{-1} \text{ cm}^{-2}$). Data is acquired with a calibrated multichannel analyzer adjusted for 0.1 keV/channel for low energy detectors and 0.5 keV/channel for high energy detectors. These data are processed with in-house data reduction programs to determine concentration values based on peak areas. The data are reported in ppm, except for Au, which is reported in ppb. Analyses were performed by U.S. Geological Survey laboratories.

ICPREE

Thirteen rare earth elements (REE) are determined by inductively coupled plasma-mass spectrometry (Taggart, 2002). The REE are made soluble in the sample material by sintering with sodium peroxide, leaching with water, and acidifying with nitric acid. Lutetium is added as an internal standard for oxide correction. Rhodium and Iridium are added on line as internal standards to correct for matrix effects and instrument instability. Calibration for each element is made by using the average intensity of blanks taken through the entire procedure and the intensities acquired on a solution of rock standards containing known concentrations. The data are reported in ppm. Analyses were performed by U.S. Geological Survey laboratories.

References

- Acme Analytical Laboratories Ltd., 2005, Geochemical – Whole Rock Analyses, Year 2005 Price Brochure, p. 12 [<http://www.acmelab.com/cfm/index.cfm>].
- Ludington, Steve, (editor), 2006, Mineral Resource Assessment of Selected Areas in Clark and Nye Counties, Nevada: U.S. Geological Survey, Scientific Investigations Report 2006-5197, [<http://pubs.usgs.gov/sir/2006/5197/>].
- Taggart, J.E., 2002, Analytical methods for chemical analysis of geologic and other materials, U.S. Geological Survey, v. 5.0: U.S. Geological Survey Open-file Report 02-223 [<http://pubs.usgs.gov/of/2002/ofr-02-0223/>].

Downloadable Tables

Excel

- <http://pubs.usgs.gov/of/2005/1450/xls/42ICP.xls>
- <http://pubs.usgs.gov/of/2005/1450/xls/55ICP.xls>
- <http://pubs.usgs.gov/of/2005/1450/xls/14ICP.xls>
- <http://pubs.usgs.gov/of/2005/1450/xls/AuPtPd.xls>
- <http://pubs.usgs.gov/of/2005/1450/xls/MAJORS.xls>
- <http://pubs.usgs.gov/of/2005/1450/xls/10ICP.xls>
- <http://pubs.usgs.gov/of/2005/1450/xls/MAJTRICP.xls>
- <http://pubs.usgs.gov/of/2005/1450/xls/INAA.xls>
- <http://pubs.usgs.gov/of/2005/1450/xls/ICPREE.xls>
- <http://pubs.usgs.gov/of/2005/1450/xls/DESCRIPTION.xls>

ASCII text

- <http://pubs.usgs.gov/of/2005/1450/txt/42ICP.txt>
- <http://pubs.usgs.gov/of/2005/1450/txt/55ICP.txt>
- <http://pubs.usgs.gov/of/2005/1450/txt/14ICP.txt>
- <http://pubs.usgs.gov/of/2005/1450/txt/AuPtPd.txt>
- <http://pubs.usgs.gov/of/2005/1450/txt/MAJORS.txt>
- <http://pubs.usgs.gov/of/2005/1450/txt/10ICP.txt>
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- <http://pubs.usgs.gov/of/2005/1450/txt/DESCRIPTION.txt>