3:30 PM Yu, Jae-Young

FATE OF THE POLLUTANTS FROM THE ABANDONED COAL MINE DRAINAGES ALONG IMGOK CREEK IN GANGDONG-MYEON, KANGREUNG, KOREA AND MEANING OF FE VERSUS AL COMPOUND PRECIPITATION

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Numerous abandoned coal mines in the study area are draining acid waters into the Imgok creek. The principal pollutants from the mine drainages are not only dissolved H, Fe and SO4, but also numerous other major and minor elements, whose concentration levels are up to thousands times higher than those of unpolluted water in the area.

Examining the field measurement data and chemical compositions of the Imgok creek reveals that the geological system of the study area already lost most of its acid neutralizing capacity. Only the dilution by freshwater from the tributaries appears to be significant in buffering the acids and lowering the pollutant concentration levels from the coal mine drainage. The precipitation of Fe and Al compounds are accelerated by pH increase due to influx of the fresh water and quickly removes Fe, Al and other trace metals from the water. Most trace metals show similar patterns of the concentration level variation to that of Fe along the pathway of Imgok creek, but equilibrium calculation indicates the creek water is undersaturated with most of the trace compounds at every sampling site. It indicates that significant fraction of the trace pollutants is removed from the water by their adsorption to or coprecipitation with the Fe and Al precipitates.

Chemical, thermal and spectral analyses of the yellowish brown and white precipitates suggest they are Fe and Al hydroxysulfate, respectively. However, equilibrium calculation indicates that Fe oxyhydroxide and Al hydroxide may precipitate, too. Field observation of the study area since October, 1995 indicates that Al precipitate replaces or covers already formed Fe precipitate and its amount increases as time passes. Stability relations among Fe and Al compounds indicate that it is the sign of the acid generation in waning stage or increased fresh water recharge from the atmospheric precipitation.

3:45 PM Shanks, W. C. III

TRACE ELEMENT AND STABLE ISOTOPE GEOCHEMISTRY OF ENVIRONMENTAL MINERALS AND ACID ROCK DRAINAGE: PATAGONIA MOUNTAINS, ARIZONA

SHANKS, W.C. III and LICHTE, F.E., U.S. Geological Survey, 973 Denver Federal Center, Denver, CO 80225 (pshanks@helios.cr.usgs.gov)

As a first phase study of the abandoned mines in the Patagonia Mountains, mine drainage water, secondary salts, and mineralized samples from mine dumps were analyzed chemically and for sulfur isotope values. Water flows from many of the mine adits year round whereas leaching from the mine dumps occurs primarily during the high rainfall seasons.

Primary and secondary minerals containing Fe, Cu, Zn, Pb, & Mn were analyzed by laser ablation ICP-MS. Arsenic in sphalerite and pyrite ranges up to 8 wt.%, and Se and Te in galena are as high as 800 ppm. Waters from the mine adits range from: 15-80ppm Cu; 10-200ppm Fe; 1-40ppm Zn; 6-50ppb I; 40-250ppm Ca; 0.1-12ppb Pb; 10-120ppb Cd; 0.2-7ppb As; and 10-140ppm Mn, suggesting potentially significant contributions of toxic elements to regional groundwater systems.

Sulfur isotope values of primary sulfide mineralization from Cu-Pb-Ag- Au deposits range from -5.4 to 0.4 permil. Sulfur isotope studies at the 3R Mine indicate that sulfate in mine drainage (-3.7) and in secondary salts on tailings (-2.8,-3.2) have identical sulfur isotope values to primary pyrite (-3.9 to -1.2). Similarly, sulfate in 4 Metals mine drainage (-1.1) is identical to primary pyrite (-0.8 to -1.3). The lack of sulfur isotope fractionation during sulfide mineral oxidation makes this technique a particularly useful tracer for the source of sulfate in acid drainage.

4:00 PM McComb, Mark B.

USING NET CARBONATE VALUE (NCV) ASSAY METHODS AND SEMIQUANTITATIVE XRD-XRF ANALYSIS TO PREDICT POTENTIAL ACID MINE DRAINAGE

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Net Carbonate Value (NCV) assay methods and Semiquantitative XRD-XRF analysis are commonly used at Newmont Metallurgical Services to predict potential acid mine drainage problems in prospective mine sites. NCV methods are used on drill hole assay pulps to determine the acid generating potential (AGP) and acid neutralizing potential (ANP) of each sample. Semiquantitative XRD-XRF analysis identifies the mineralogy and alteration type associated with acid generating and acid neutralizing rock. Data generated from these techniques is used for modeling potential acid generating areas of the deposit, selecting material for test work, and ultimately designing waste dumps.

4:15 PM Lechner, Mike J.

GEOCHEMICAL MODELING AT TWIN CREEKS MINE, HUMBOLDT CO., NV

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Eight geochemical constituents are modeled at Santa Fe Pacific Gold's Twin Creek Mine located in Humboldt County, Nevada. Geochemical model estimates are used for scheduling refractory ores, waste rock characterization, predicting pit lake geochemistry and assessing future environmental issues. The following items are modeled: arsenic, mercury, antimony, iron, total sulfur, sulfide sulfur, carbonate and organic carbon. In addition to these elements, two ratios are also calculated, ANP/AGP (acid neutralizing/generating potential) and Fe/As+Sb.

The underlying data support for modeling these items consists of approximately 8,200 bench composite analyses. The actual modeling procedure involves three separate steps: (1) calculate geochemical means by structural domain and load to the block model (2) calculate geochemical means by rock type and load to the block model and (3) inverse distance estimation of each element using different powers determined by the relative distribution of each element (i.e., normal or lognormal). Each step also utilizes 5 gold indicators, since predictable relationships exist between gold mineralization and each constituent. Block model geochemical data for various material types such as sulfide mill ore, sulfide subgrade ore and sulfide waste are compared to composite sample data as an initial validation procedure. Routine reconciliation studies comparing blasthole geochemistry to model data are conducted on a monthly basis to gauge model performance. Appropriate adjustments can be made to the model based upon these studies to improve future predictions.

Sulfide waste rock is differentiated into acid neutralizing or acid generating material in reserve statements and mine planning schedules by using the ANP/AGP ratio calculated in the block model. Actual material classification during mining operations is based upon blasthole geochemical results and geologic mapping. Geochemical data for blocks exposed in the ultimate pit in conjunction with groundwater models are used by hydrologic consultants for predicting pit lake geochemistry. Future environmental risks associated with mine dumps and tailings dams are easier to assess

4:30 PM Leventhal, J.

GEOCHEMICAL FORMS OF ARSENIC AND OTHER ELEMENTS ASSOCIATED WITH CARLIN-TYPE GOLD DEPOSIT MILL TAILINGS FROM 1930s THRU 1960s, NEVADA, USA

LEVENTHAL, J., U.S Geological Survey, Federal Center MS 973, Denver, CO 80225, jleventh@usgs.gov ; RAINES, Gary, USGS, Reno, NV; MOTOOKA, J., DAWS, T., USGS, Denver; DUNN, Victor, Bureau of Land Management, Winnemucca, NV.

From a color-ratio-composite Thematic Mapper image, an anomalous black area was observed in the Potosi mining district in Humboldt County, Nevada. Based on the spectral properties of the image the most likely explanation of the anomaly is carbon. The black area corresponds to mill-roaster tailings from a sediment hosted, Carlin-type disseminated gold deposit that were disposed of prior to 1970 at the Getchell Mine. Some tailings had been transported by wind and water since then and are visible as an extension (plume) of the black area. The tailings impoundments were abandoned until 1990 when reclamation was begun.

The top few cm of soil were sampled (5 locations) to determine if geochemical data could help confirm the source of the plume and to understand its environmental chemistry; a deeper sample (10 cm) and 4 samples out of the visible plume served as background. Rock-eval analysis of organic matter showed 0.1 to 0.5 % TOC (total organic carbon) that was refractory-graphitic as is typical of carbon associated with Carlin-type deposits, but not with recent soils. This amount of refractory carbon is sufficient to impart a dark color in the sample.

Routine chemical analyses showed anomalous arsenic concentrations for plume samples compared to samples outside the plume area. Sequential chemical extraction was used to determine the leachability and chemical form of As and associated elements. The results of this geochemical study are of interest for baseline and environmental purposes. These tailings and associated impoundments are being reclaimed by the current mine operator under State of Nevada permits and BLM oversight.

4:45 PM Swayze, Gregg A.

MAPPING ACID-GENERATING MINERALS AT THE CALIFORNIA GULCH SUPERFUND SITE IN LEADVILLE, COLORADO USING IMAGING SPECTROSCOPY

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The Leadville mining district, located in the Central Colorado Rockies, has tailings rich in pyrite and other sulfides that releasing toxic trace metals into snowmelt and thunderstorm runoff which contaminates the nearby Arkansas River. Secondary minerals such as jarosite, goethite, and hematite formed by sulfide oxidation can be mapped using AVIRIS (Airborne Visible/Infrared Imaging Spectrometer) data. This NASA/JPL instrument collects 7000 radiance measurements per second in 224 spectral channels from 0.4-2.5 microns for 17m x 17m pixels from an ER-2 aircraft at 20km altitude. AVIRIS data acquired in July, 1995 were corrected to surface reflectance and then mapped for mineral identity using the USGS Tricorder algorithm. Mineral maps show tailings piles having bull'seye patterns composed of a central jarosite zone surrounded by a jarosite-goethite zone, in turn surrounded by goethite or hematite zones. Since jarosite is one of the first weathering product of pyrite, areas at the center of the bull'seyes have a high acid generating capacity and are surface sources for acid water and heavy metals. These mineral maps have cut costs ($500,000) and accelerated (by 1 year) the cleanup by pin-pointing the worst acid generating areas.