USGS Mineral Resources External Research Program - 2006
Selected Research Topics

Long-term goal 1: Ensure availability of up-to-date quantitative assessments of potential for undiscovered mineral deposits

- **Gold in Tertiary volcanic rocks, Alaska Peninsula and south-central Alaska** - In south-central Alaska from the Alaska Range east of Cook Inlet to the southwestern end of the Alaska Peninsula, epithermal gold mineralization and deposits are known to occur in association with Tertiary volcanic rocks. In a few cases, these deposits have been highly productive (Apollo and Sitka mines) and in other cases highly prospective (Shumagin prospect, 25 Gold, and others). Copper-gold porphyry systems are also present. As a result of AMRAP studies in the 1970's and 1980's, USGS scientists collected a large suite of volcanic rock samples and completed a wide variety of chemical analyses. Inferences were made during the resource assessment process about the correlation of gold mineralization with certain chemical signatures in the volcanic rocks, however no systematic study was ever made to confirm or deny the hypotheses. Proposals are solicited to test various hypotheses that might relate the gold mineralization to these chemical signatures and phases of the volcanism. This work would be useful in developing and testing hypotheses to explain the volcanic rock and mineralization association and could provide a prospecting guide for the region. Contact: Ric Wilson, U.S. Geological Survey, 4200 University Drive, Anchorage, AK, 99508-4667; fwilson@usgs.gov; 907-786-7448.
- **Magnetite in the redbed-associated stratabound copper mineralizing system in the Middle Proterozoic Belt Supergroup** - The "Metallogenesis of Proterozoic Basins" project solicits proposals aimed at characterizing magnetite formed in redbed-associated stratabound copper mineralizing systems. In the redbed copper system in the Middle Proterozoic Ravalli Group, Belt Supergroup, magnetite occurs (1) regionally in former redbeds at biotite grade of greenschist facies (pure burial) metamorphism not associated with the Cu deposits, (2) in Cu-depleted, albite-rich rocks of the Albite alteration zone which is interpreted as being distantly associated with the Cu deposits as the source rocks of the metal, and (3) in a narrow part of the ore mineral zonation, together with chalcocite, digenite, bornite, ferromagnesian dolomite, barite, and authigenic K-feldspar. There is good evidence that each of these other authigenic minerals within ore originated as a sandstone cement during diagenesis. Three types of magnetite studies would enhance the "Metallogenesis of Proterozoic Basins" project: (1) mapping and semiquantitative interpretation of aeromagnetic data focused on the various magnetite occurrences in the Ravalli Group rocks; (2) magnetite geochemistry studies employing laser-ablation ICPMS and comparisons with magnetite from ordinary igneous and other environments; and (3) establishment of temperatures of magnetite precipitation in the different occurrences using microsampling and oxygen isotope studies. Contacts: Steve Box, U.S. Geological Survey, West 904 Riverside Ave., Spokane, WA, 99201;

sbox@usgs.gov; 509-368-3106; Tim Hayes, U.S. Geological Survey, E.N.R. Bldg., 520 N. Park Ave., Tucson, AZ, 85719-5035; thayes@usgs.gov; 520-670-5024.

- **Neoproterozoic glaciation and genesis of sediment rock-hosted ores** - Proposals are solicited for field- and laboratory-based research to address potential links between Neoproterozoic glaciation and genesis of sediment rock hosted ores. Such links are likely in certain areas of current interest for USGS mineral resource studies (e.g., east-central Alaska, West African craton, and Kalahari craton) and may also apply in other Neoproterozoic basins that have a record of Neoproterozoic glaciations (e.g., Idaho, Utah, California). Deposit types of interest include redbed copper, banded iron, sedimentary manganese, and barite. Possible approaches might include regional stratigraphy, stable-isotope chemostratigraphy, geochronology, or detailed ore-deposit studies. Contact: Dwight Bradley; U.S. Geological Survey, 4200 University Drive, Anchorage, AK, 99508; dbradley@usgs.gov; 907-786-7434.
- **Phosphorite genesis and exhalative metal deposits** - Ancient sedimentary basins host some of the largest and economically important metal deposits on Earth. Single sedimentary basins often are host to different types of syngenetic metal deposits in correlative strata; for example, sedex Zn-Pb-Ag-Ba, Au-Ba, Ni-PGE-Mo-Au-V-P, and phosphate deposits, and metalliferous black shales are all commonly hosted in correlative strata of the same sedimentary basin. An outgrowth of the research under the "Metals and Basinal Brines and Petroleum" project has been a pilot study to assess the relationship of phosphate deposits in this spectrum. New Rb-Sr analyses from the Phosporia Formation and the giant phosphorite of Tunisia show the presence of radiogenic Sr in these phosphate deposits and suggest a hydrothermal link, in contrast to an upwelling process. A series of high-resolution samples have been collected from Cambrian deposits of south China and Cambrian Georgina Basin in Australia, Delle and Phosporia Formations. Proposals are solicited to evaluate a possible genetic link between phosphate deposits and exhalative hydrothermal systems. Proposed work may involve use of petrographic and analytical resources and lab facilities at the U.S. Geological Survey in Denver including: (1) petrographic microscopy (transmitted, reflected, cathodoluminescence) and SEM facilities for study of sedimentary phosphate; (2) trace element analyses of phosphate using microprobe and laser ablation ICP-MS analyses to evaluate post depositional alteration of isotopic systematics; (3) Rb-Sr, U-Th-Pb, Nd-Sm analyses of phosphate using new methods and facilities established by the Brines project for sample preparation and analyses using TIMS and the new multi-collector; and (4) $\delta^{18}O$ and $\delta\ ^{34}S$ analyses of phosphate in the stable isotope lab using new methods development by the Brines project. Poul Emsbo, U.S. Geological Survey, Denver Federal Center, P.O. Box 25046, MS 973, Denver, Colorado 80225; pemsbo@usgs.gov; 303-236-1113.
- **Porphyry copper: geomicrobiology and mineralizing systems** - Proposals addressing geomicrobiological studies of active exotic copper- and manganocrete-depositing systems are solicited. Cu-, Fe-, and Mn-depositing reactions at temperatures commonly less than 25^{o}C are almost certainly microbially mediated.

New studies are needed to identify the microbes involved and define the role that the metal-depositing reactions play in metabolic processes, with the goal of increasing understanding of the chemical pathways of metals precipitation. Proposals addressing Jurassic mineralization and alteration systems in the Sonoran Desert region are also solicited. This work should include a comparison of Jurassic systems to Laramide mineralization systems and associated plutonic rocks, particularly with regard to petrology and geochemistry. Features that these two systems have in common may directly or indirectly reflect characteristics of the continental crust within which they both developed. Significant differences between mineralizing systems of these two ages may result from contrasts in Jurassic and Laramide tectonic and petrogenetic regimes, such as extensional versus compressional deformation, or alkaline versus calc-alkaline magmatism. Contact: Bob Kamilli, 520 N. Park Ave., Tucson, AZ, 85719-5035, bkamilli@usgs.gov, 520-670-5576.

- **Thermochronologic approaches to decipher tectonic evolution of extensional terranes** – Proposals in thermochronologic approaches to the tectonic evolution of extensional terranes are solicited by the "Metallogeny of the Great Basin" project. To decipher the cooling history of the Ruby Mountain-East Humboldt core complex in north-eastern Nevada, requested studies include research on Ar-Ar, fission-track, and possibly U-Th-He dating using a variety of mineral systems. The goal of the study is to generate a whole-crust geologic framework of the Carlin-Elko metallogenic province. This work is important in reconstructing the Paleogene and Neogene geologic frameworks, integrating the processes that led to producing the Carlin-type deposits, and building a 4-D database as a foundation for understanding metallogeny in the Great Basin. Contact: Keith Howard, U.S. Geological Survey, 345 Middlefield Road, MS 973, Menlo Park, CA, 94025; khoward@usgs.gov; 303-236-5530.
- **U-series dating of hydrothermal silica minerals, High Cascades volcanoes** - Dating young (≤2 Ma, mostly ≤500 Ka) hydrothermal alteration on active and recently active volcanoes in the High Cascades (Mount Rainier, Mt. Adams, Maidu, and Brokeoff volcanoes) using conventional $^{40}Ar/^{39}Ar$ techniques has proven difficult, mostly due to the lack of suitable minerals for dating. Confirmation of inferred field relations and development of detailed genetic models require accurate and precise dating of the hydrothermal systems. U-series dating of hydrothermal silica phases (opaline silica and/or fine-grained quartz) similar to techniques developed for studies at Yucca Mountain offers a potential method for dating this alteration. Proposals are solicited for testing U-series dating on well characterized samples from these volcanoes using LA-ICP-MS and/or SHRIMP. Contact: Dave John, U.S. Geological Survey, 345 Middlefield Rd., MS 901, Menlo Park, CA, 94025; djohn@usgs.gov; 650-329-5424.

Long-term goal 2: Ensure availability of up-to-date geoenvironmental assessments of priority Federal lands

- **Bioaccessibility of potentially toxic metals, central Colorado** - MRP is currently conducting an environmental assessment of central Colorado (Central

Colorado Assessment Project). In this work, the environmental effects of selected watersheds affected by historical mining are being evaluated. The goal is to provide a sediment—water—biofilm—macroinvertebrate baseline to evaluate bioaccessibility of potentially toxic metals and metalloids (Al, As, Cd, Cu, Pb, Zn) in the aquatic environment within the study area. In FY 2006, the USGS is conducting an assessment of the physical and chemical characteristics of about 100 small drainage basins (5-10 km^2) to assess water and sediment quality using standard environmental protocols. Proposals related to the collection, identification, and preparation of macroinvertebrates and biofilm for analysis are solicited. Invertebrates will be identified down to the genus level. The Caddis fly *Arctopsycse grandis* will be the primary target species for metals analysis although other species may be collected if *Arctopsycse grandis* is not present. Metals analysis will be conducted using ICP-MS. This biological study is essential in assessing the effects of past mineral development on the aquatic life in the riparian habitat and development of environmental assessment protocols. Contact: Stan Church, U.S. Geological Survey, Denver Federal Center, P.O. Box 25046, MS 973, Denver, CO, 80225-0046; schurch@usgs.gov, 303-236-1900.

- **Bioavailability of metals in soil using microbial biosensors** - Total element concentration is not always the most useful parameter for characterizing the impact of metallic elements in soils on ecosystems and potentially human health. Bioavailability of metal is more critical than total concentration as a measure of the potential of an element to participate in environmental impacts. The MRP is presently pursuing a number of research directions designed to determine bioavailability of elements. However, there is a particularly promising research direction that we are not presently equipped to study. That direction is the use of bacterial probes to determine metal bioavailability. This technology utilizes bacteria that have been genetically modified to quantitatively produce light proportional to their metal uptake. Literature data indicate that these bacterial sensors are available for Zn, Cd, Cu, Pb, Ni, As, and Cr. Proposals are solicited to compare and contrast these biosensors with our existing measures of bioavailability (typically selective leach studies) in a variety of geologic environments of relevance to the MRP. A particularly attractive geographic area for research is in northern California where MRP scientists have identified a number of naturally and anthropogenically impacted environments where the elements As, Cd, Cr, and Ni are present in elevated concentrations in rocks and soils. Contact: Marty Goldhaber, U.S. Geological Survey, Denver Federal Center, P.O. Box 25046, MS 973, Denver, CO, 80225-0046; mgold@usgs.gov, (303) 236-1521.
- **Dating of pediment surfaces at the Gunnison Gorge National Conservation Area, Colorado** - At least four distinct pediment levels have been identified on the Gunnison Gorge National Conservation Area (GGNCA). The apparent oldest level has outcrops of Yellowstone volcanic ash dated at 640,000 years. The age of the three younger levels is unknown, but if they could be dated with cosmogenic isotopes, a chronosequence of soils could be established in this semi-arid environment. Proposals focused on dating pediment levels using cosmogenic isotopes are solicited. This information, in combination with

chemical data that are currently being collected, can be used to determine rates of chemical weathering of the Mancos Shale through a time period that has undergone significant climatic variations. These data will be useful in predicting changes in the rates of chemical erosion and rates of element release to the environment that might occur as the result of future climatic changes. Or, the data may be useful in the short-term, in determining changes in those rates due to anthropogenic activities such as agricultural and urban development and the use of off-highway vehicles. This work would be a major contribution to the "MRP Mancos Shale Landscapes: Science and Management of Black Shale Terrains" project. Contact: Dick Grauch, U.S. Geological Survey, Denver Federal Center, P.O. Box 25046, MS 973, Denver, Colorado 80225, rgrauch@usgs.gov, 303-236-5551.

- **Enhancing the predictive capability of ecosystem models -** Historical mining activities have resulted in the transport of metal-enriched sediment and water into Coeur d'Alene Lake. Successful management of this lake by local, State, Federal, and Tribal agencies during and after up-stream remediation efforts requires an understanding of the complex physical, chemical, and biological processes that affect the cycling of metals (particularly Zn) and nutrients in the lake. Our current understanding of these processes is being incorporated into coupled quantitative models (ELCOM-CAEDYM) that include hydrodynamics, ecological communities, and biogeochemical reactions. The models will be powerful management tools for evaluating how Coeur d'Alene Lake responds to changes in metal and nutrient loading. Although we can incorporate biogeochemical reactions into the models, there is a notable lack of information from Coeur d'Alene Lake to constrain values of critical biogeochemical parameters used in the models, including the fluxes and composition of organic matter, manganese oxides, iron oxides, and other metal phases to the sediment (sediment trap studies), sediment accumulation rates and detailed information (0.5 to 1 cm intervals) on the amount of organic carbon, reducible manganese and iron oxides and associated elements, iron and other metal sulfide phases with depth in the sediment (sediment studies), seasonal concentrations of oxygen, nitrate, ammonium, manganese, iron, sulfate, sulfide, methane, and metals (e.g., As, Cu, Cd, Zn) in porewater (detailed porewater studies), and seasonal benthic flux measurements (metals and nutrients). Proposals addressing these types of information are solicited. Such information would complement the modeling efforts in the "Pathways Project" and, ultimately, would provide for better management of metals and nutrients in a lake impacted by mining activities. Contact: Laurie Balistrieri, U.S. Geological Survey, University of Washington, P.O. Box 355351, Seattle, WA, 98195, balistri@usgs.gov, 206-543-8966.
- **Evaluation of mercury methylation in Salmon Falls Creek Reservoir, Idaho -** Salmon Falls Creek Reservoir (SFCR) is one of several reservoirs in Idaho that is listed with a mercury advisory, where mercury concentrations in fish exceed the safe level recommended by the State of Idaho and the World Health Organization. The source of mercury contamination to SFCR is uncertain and is presently under investigation as part of an MRP study in the "Geochemical Landscapes" project, a cooperative project with the Department of Environmental Quality, State of

Idaho. The primary objective of the study is to collect reservoir sediment cores to evaluate historical trends of mercury deposition and relate any trends found to possible sources of mercury that have influenced mercury input into the reservoir over time. Thus far, mercury trends in collected sediment cores have not shown significant patterns of mercury variation with time, however, a few limited determinations for methylmercury in water from SFCR suggest unusually high mercury methylation. The greatest mercury threat is exposure to methylmercury, a neurotoxin that damages the central nervous system in humans and the dominant form of mercury in fish. Consumption of fish is the primary pathway of mercury to humans. The formation of methylmercury in SFCR needs further study. To evaluate mercury contamination and mercury transformation to methylmercury in SFCR, the "Geochemical Landscapes" project solicits proposals to (1) measure total Hg, ionic mercury (II), methylmercury concentrations in sediment and water collected from SFCR, and (2) measure rates of mercury methylation and methylmercury demethylation in sediment from SFCR using isotopic tracer methods. Analysis of samples will be carried out jointly through cooperative studies at the USGS, Denver, and applicant. Contacts: John Gray, U.S. Geological Survey, Denver Federal Center, P.O. Box 25046, MS 973, Denver, CO, 80225-0046; jgray@usgs.gov; 303-236-2446.

- **Identification of microbes involved in the production and destruction of methylmercury in California's mine impacted ecosystems -** Mercury (Hg) was produced in the elemental form (Hg^o) from mines in the Coast Range mercury belt and then used to extract gold from placer and lode gold deposits in the Sierra and Trinity gold belts. Substantial losses of Hg from these operations disseminated Hg across California's ecosystems. Combined with natural sources of Hg such as connate waters and geothermal springs that locally contribute to high loadings of Hg, these sources now pose a threat to sensitive aquatic habitats. However, the degree of bioaccumulation or biomagnification of Hg is directly related to the conversion of relatively inert forms of Hg (such as Hg^o) to methylmercury (CH_3Hg^+) and to the relative rates of CH_3Hg^+ production and destruction. Methylmercury is a potent neurotoxin that is readily bioaccumulated and biomagnified in aquatic food webs. It is widely accepted that microorganisms play a major role in both the production and destruction of CH_3Hg^+ species, but different groups of organisms perform these functions, leading to a decoupling of methylation and demethylation rates in time and space. The microbial communities responsible for Hg methylation and demethylation have been identified at only a handful of sample sites, not the statistically significant number needed to provide the scientific basis necessary for successful remediation of mine impacted sites and for the planning and execution of river restoration projects in placer mine impacted watersheds on federal lands. The USGS has recently acquired new molecular biology tools (quantitative PCR and denaturing HPLC) that allow rapid assessment of microbial community composition and the quantity and diversity of genes used for key processes such CH_3Hg^+ destruction. Proposals to address the research questions outlined above are solicited; the use of qPCR or DHPLC is a preference but not a requirement. The research area described above is in support of assessment and remediation of mercury-impacted

sites on Federal lands through two projects: (1) the MRP "Pathways of metal transfer from mineralized sources to bioreceptors" project, and (2) the Science Leadership Project jointly funded by BLM and BOR. Contacts: Andrea Foster, U.S. Geological Survey, 345 Middlefield Rd., MS 901, Menlo Park, CA, 94025; afoster@usgs.gov; 650-329-5437; Jim Rytuba, U.S. Geological Survey, 345 Middlefield Rd., MS 901, Menlo Park, CA, 94025; jrytuba@usgs.gov; 650-329-5418.

- **Geochemical processes controlling elemental fluxes away from mineral deposits and their mine wastes -** Mineral deposits contain unusually high concentrations of minor elements that are released to the environment naturally and as a result of mining and ore processing. Understanding the environmental signature of mineral deposits and their mine wastes requires the identification of geochemical dispersal pathways and quantification of the concentrations and fluxes of elements. Proposals are solicited to identify the important dispersal pathways of environmentally significant minor and trace elements, especially metals and metalloids, from their host minerals through secondary minerals to the aqueous phase, and to quantify the concentrations of these elements in solutions along with their rates of uptake and release by the various solid-phase reservoirs. Delineation of these pathways will provide the fundamental quantitative information needed to understand baseline signatures of unmined deposits, to manage active mining operations, and to design remediation systems for abandoned mine sites. Proposals for laboratory, field, or integrated studies will considered, particularly those designed to yield quantitative rather than exclusively qualitative information. Opportunities are available for the collaborative use of USGS laboratory facilities for mineralogical characterization, geochemical characterization, and stable isotope analysis. Potential field studies are not restricted to a specific location, but the potential for field collaborative studies is mostly restricted to the Eastern Region. Contact: Bob Seal, U.S. Geological Survey, National Center, MS 954, Reston, VA 20192; rseal@usgs.gov, 703-648-6290.
- **Influence of graphite-rich Ordovician to Precambrian metamorphic rocks (Nome Group) on the regional biogeochemistry of willow and moose in Alaska -** Sedimentary and igneous metamorphic rocks dominant much of the landscape over the south-central portion of the Seward Peninsula in western Alaska. Lithologically these rocks are composed of schist, quartzite, and marble and are highly variable in their graphite content and associated geochemistry. Soils that develop over these rocks can be very high in bioavailable cadmium, a naturally occurring toxic metal. Willows, the dominant shrub throughout the Seward Peninsula, bioaccumulate cadmium in both the leaf and stem tissue. Moose feeding on willow accumulate variable amounts of cadmium in their kidney tissue. The natural geochemical variability across the landscape (rock, soil, willow, moose) is largely unknown and because moose kidney (as well as liver and muscle) is a significant subsistence food source for the local population, it is important to define this natural variability. The University of Alaska, Fairbanks has an interest in understanding the extent of trace element concerns, both natural and human caused, in the Seward Peninsula. The Native population has also

expressed interest in a better understanding of this complex relation. Shared laboratory capabilities between UAF and USGS include HPLC (identification of metal-bound proteins), ICP-MS (moose tissue trace element levels), greenhouse and growth chamber facilities, and SEM. This type of study supports MRP's goal of addressing environmental and public health issues as well as understanding the natural variability of geochemical landscape. Contact: Larry Gough, U.S. Geological Survey, National Center, MS 954, Reston, VA, 20192; lgough@usgs.gov; 703-648-4404.

- **Laboratory experimental oxidation studies of massive sulfides from Prince William Sound, Alaska -** Proposals are solicited for predictive laboratory studies of oxidation of massive sulfides in diurnally alternating marine and fresh water conditions in the intertidal zone from Prince William Sound. Field expeditions in 2003 and 2005 provided natural massive sulfide samples containing pyrite, pyrrhotite, sphalerite, chalcopyrite plus silicate and carbonate gangue minerals. These samples range from nearly pristine to substantially altered after nearly 100 years in the surficial intertidal zone. Laboratory oxidation experiments on complex natural samples from Prince William Sound would augment and extend MRP studies under the "Modeling of Near-surface Processes in Mineral Systems" project that has focused on field studies of oxidation and mine drainage problems in the intertidal zones at the Ellamar, Threeman, and Beatson mine sites. In addition, such studies would provide a critical link between our ongoing USGS predictive laboratory studies of inorganic and bacterially mediated oxidation of pure sphalerite, chalcopyrite, and pyrite mineral separates and would help clarify field geochemical processes in Prince William Sound. Contact: Pat Shanks, U.S. Geological Survey, Denver Federal Center, P.O. Box 25046, MS 973, Denver, CO, 80225-0046; pshanks@usgs.gov, 303-236-2497.
- **Rates of sulfide mineral dissolution at the mineral surface -** USGS researchers are measuring rates of sulfide dissolution in the field and in bulk laboratory experiments. In an attempt to bridge the issue of measurement scale, and to increase understanding of the role of mineral surface chemistry versus factors of climate and weathering solution, proposals are solicited to directly measure rates of sulfide mineral dissolution at the mineral surface. Proposed work should utilize techniques such as vertical scanning inferometry (VSI) and/or atomic force microscopy (AFM) to observe retreat and enlargement of surface features such as steps and etch pits. Contacts: Lisa Stillings, U.S. Geological Survey, Mackay School of Earth Sciences, MS 176, Reno, NV, 89557-0047, stilling@usgs.gov; 775-784-5803; Pat Shanks, U.S. Geological Survey, Denver Federal Center, P.O. Box 25046, MS 973, Denver, CO, 80225-0046; pshanks@usgs.gov, 303-236-2497; Mark Stanton, U.S. Geological Survey, Denver Federal Center, P.O. Box 25046, MS 964, Denver, CO, 80225-0046, mstanton@usgs.gov, 303-236-1924**.**

Long-term goal 3: Ensure availability of reliable geologic, geochemical, geophysical, and mineral locality data for the United States

- **Arsenic geochemistry of soils in the vicinity of the Mother Load Belt of gold deposits in the foothills of the Sierra Nevada, California** - The foothills of the Sierra Nevada in northern California host a major gold district; the Mother Load Belt. Although this district is largely mined out, it is still the source of potentially toxic environmental contaminants. Specifically, the gold mineralization is associated with significant As content. The As occurred in ores as either the mineral arsenopyrite (FeAsS) or arsenic-bearing pyrite ($Fe(As)S_2$). Natural weathering and mining may disperse the As away from the mine sites. The occurrence of this As in mine-related spoil piles and nearby stream sediments has been extensively studied. However, As geochemistry of spatially associated soil has received less attention. Regional soil geochemistry data from northern California obtained by the MRP "Geochemical Landscapes" project indicate that elevated As contents occur in soil samples in the vicinity of the district. Proposals are solicited to conduct a study of the soil geochemistry of a portion of the mineral belt. The research could include site-specific evaluations of individual mine areas, including the three dimensional (soil profile) and aerial distribution of As. The studies could also include geochemical/mineralogical evaluations of the residence of the As, as well as its potential for transport away from the site in soil particles and ground water. Of particular interest would be studies of geochemical and biogeochemical mechanisms of As transformation in the soils. Research that utilizes phospholipid fatty acid, DNA, and other detailed probes of the microbial ecosystems of impacted soils would be welcomed. Contact: Marty Goldhaber, U.S. Geological Survey, Denver Federal Center, P.O. Box 25046, MS 973, Denver, CO, 80225-0046; mgold@usgs.gov, (303) 236-1521.
- **Deposit models, ore genesis, and unique metallogenetic environments of Alaska -** Assessment of mineral potential within Alaska is at an early stage of development, limited in particular by a dearth of baseline information, and by known deposits that deviate substantially from published deposit models in character, size, grade, and genesis. We solicit proposals that address these limitations, identify whether the deviations from worldwide "norms" are significant, and clarify the genesis of several styles of mineralization common or unique to Alaska. These deposit types include: PGE lode and placer deposits related to Alaskan-type zoned ultramafic complexes, "Chugach-type" low sulfide gold deposits, Kennecott-type Cu lodes, intrusion-related gold, BC-AK type porphyry copper systems, volcanogenic massive sulfide deposits in bimodal volcanic suites, and others. Topics of particular interest are: (1) petrogenesis, geochronology, and tectonic setting of Alaskan-type zoned ultramafic complexes and the relationship between magma dynamics and flow rates of the intrusions and the metal contents, texture and mineralogy of associated sulfide occurrences; (2) developing appropriate grade-and-tonnage models for mineral deposit types unique to, or abundant in Alaska; (3) the relationship between the composition of felsic magmas and levels of emplacement in the crust, and the mineralogy and character of associated metallic mineralization (for example, are there direct analogues beneath porphyry Cu deposits of the deep level deposits, e.g. Ft. Knox, within the "intrusion-related gold" system); and (4) the genesis of magmatic sulfide deposits related to extrusion of Nikolai large igneous province lavas and of

epigenetic deposits related to the subsequent burial history and thermal evolution of the Nikolai. Contact: Jeanine Schmidt, U.S. Geological Survey, 4200 University Drive, Anchorage, AK, 99508-4664; jschmidt@usgs.gov; 907-786-7494.

- **Development of techniques in the laboratory or applications of laboratory capabilities to fundamental problems of ore genesis** - The MRP has a unique combination of integrated state-of-the-art laboratories devoted to study of fundamental process of ore fluids responsible for a wide range of ore deposit types. These include stable isotope mass spectrometry, ion chromatography, rare gas isotope mass spectrometry and active gas quadrupole mass spectrometry for study of both fluids and minerals. In addition, plans are underway to construct a state-of-the-art system for measurement of trace element compositions and gas chemistry of single fluid inclusions by LA-ICP-MS and quadrupole mass spectrometry, respectively. Each laboratory is under the leadership of scientists who have pioneered the development of techniques and their application to fundamental problems of ore genesis. The MRP also has numerous geologists who have built the time space frameworks necessary for geochemical study of a broad spectrum of deposit types. Proposals related to the development of techniques in the laboratory or applications of laboratory capabilities to fundamental problems of ore genesis are solicited. Contact: Bob Rye, U.S. Geological Survey, Denver Federal Center, Box 25046, MS 963, Denver, CO 80225-0046, rrye@usgs.gov, 303-236-7907.
- **Evolution of ore-hosting terranes in southwest Alaska** - The USGS is conducting geologic and ore deposit studies in the poorly known central part of southwest Alaska, currently concentrating in the Taylor Mountains quadrangle. The area contains gold and mercury deposits that are spatially associated with Late Cretaceous-early Tertiary intrusive rocks cutting older terranes. Proposals that address the evolution of these older ore-hosting terranes including the Goodnews, Togiak, Nyac, and Kilbuck are solicited. Approaches might include, but need not be restricted to, sedimentary petrology, paleontology, igneous geochemistry, and structural geology. Contact Marti Miller: U.S. Geological Survey, 4200 University Drive, Anchorage, AK, 99508; mlmiller@usgs.gov; 907-786-7437.
- **Nature and genesis of mineralization at new mining sites in Alaska –** Proposals addressing the nature and genesis of mineralization at new mining sites in Alaska are solicited, where improved access and ephemeral exposures related to development can be a benefit to research. Examples include but are not limited to: (1) the Pogo intrusion-related gold system, (2) the Kensington gold vein system, (3) the Nixon Fork gold skarn, (4) the Pebble copper-gold porphyry system, and (4) the Kemuk iron-titanium-PGE system. Contact: Alison Till, U.S. Geological Survey, 4200 University Drive, Anchorage, AK, 99508; atill@usgs.gov; 907-786-7444.
- **The role of natural organic matter (NOM) in the metal mobility and isotopic fractionation in mineralized systems** - Soils and associated unsaturated-zone waters are often organic rich, especially in cold regions where organic matter decomposition is slow. Natural organic matter (NOM) is known to interact with

trace elements, including As, Sb, and Hg. Many mineralized areas have organic rich soils, for example east central and southwest Alaska. Trace elements-NOM interactions can increase primary mineral solubility and/or alter sorption characteristics onto secondary minerals (i.e., iron oxide coatings). Consequently, trace element-NOM interactions may alter the mobility and/or toxicity of some trace elements in mineralized systems that are NOM rich relative to their mobility and toxicity in other mineralized systems. In addition, trace element-NOM complexes may induce fractionation between the isotopes of an element, for example Hg. Isotopes of the trace elements can be a useful fingerprinting tool, but fractionation dynamics must be known. Organic matter-trace element interactions are a function of both the trace element and organic matter chemistry. To fully explore these interactions, it is necessary to determine the chemical form of the trace element (the geochemical species), and the quantity and quality of the organic matter (degree of aromaticity and chemical composition). Proposals to increase understanding of metal-NOM interactions to improve our ability to evaluate metal mobility and bioavailability in cold organic-rich environments are solicited. Contact: Bronwen Wang, U.S. Geological Survey, 4200 University Drive, Suite 201, Anchorage, AK, 99508-4664; bwang@usgs.gov; 907-786-7110.

Long-term goal 4: Ensure availability of long-term data sets describing mineral production and consumption

- **Development of a sampling methodology for the iron and steel scrap and pig iron canvass** - The U.S. Geological Survey (USGS) sends canvasses monthly and annually to consumers of iron and steel scrap and pig iron. Because of the large number of consumers of these materials, it is only possible to obtain reports from a fraction of the universe of consumers. A sampling procedure, which has not been updated in the last 10 years, is used to estimate the remainder. There are no measurements of estimation error. The USGS is required by the U.S. Office of Management and Budget (OMB) to examine the feasibility of redesigning the sample for these canvasses. Proposals are solicited for projects that would develop a new sampling methodology for the Iron and Steel Scrap and Pig Iron canvasses that will be easy to update and will provide measurements of estimation error. Contact: Kenneth Beckman, U.S. Geological Survey, National Center, MS 988, Reston, VA, 20192; kbeckman@usgs.gov; 703-648-4916.
- **Materials flow analysis: A decomposition of U.S. apparent consumption of nonfuel mineral commodities** - Apparent consumption of nonfuel mineral commodities in the United States is considered to be the tonnage produced plus imports minus exports plus or minus stock changes. Underlying this simple concept may be both nonlinear relationships and significant uncertainties; these factors could be quantified by decomposition analysis. More rigorous nonfuel mineral commodity apparent consumption numbers would be advantageous for U.S. Government strategic planning agencies such as the Department of State, Department of Defense, and the Department of Homeland Security. Proposals are requested for decomposing changes in U.S. nonfuel mineral commodities apparent consumption. Decomposition analysis attributes the development of a

variable by explanatory factors such as economic growth (or scale), economic structure, and substitution (or intensity). Preference will be given to innovative approaches that allocate material use by, for example, NAICS sector. This work is important for achieving the U.S. Geological Survey's goal of advancing the understanding of how nonfuel mineral commodities are acquired in a global context and used in the sustainable development of the national economy. Contact: William Dillingham, U.S. Geological Survey, National Center, MS 988, Reston, VA, 20192; wdillingham@usgs.gov; 703-648-4911.

- **Methodology development for research and analysis of U.S. embodied mineral commodity trade -** The United States imports and exports large volumes of mineral commodities contained in intermediate or final products. Trade statistics for most mineral commodities are readily available; however, trade statistics can underestimate the actual flows of some commodities when those commodities are contained in intermediate or final products. More information is sought where these embodied flows concern commodities that are of strategic or environmental interest. This work is integral to the U.S. Geological Survey's mission of advancing the understanding of the Nation's primary and secondary availability and use of mineral resources in a global geologic, economic, and environmental context. Proposals are solicited to develop methodologies for research and analysis of U.S. international trade in nonfuel mineral commodities that are embodied in products such as automobiles and computers. Methodology and examples of analysis should identify data needs and possible data sources for at least two important mineral commodities, with emphasis on areas where technological or policy innovation leverages economic or environmental benefits. Contact: William Dillingham, U.S. Geological Survey, National Center, MS 988, Reston, VA, 20192; wdillingham@usgs.gov; 703-648-4911.
- **Service lifetimes of mineral end uses: Analyzing potential for increased use of secondary metals -** With increasing concern over sustainable development, end of life management of products, product stewardship, and design for recycling, it is important to have detailed information on service lifetimes of mineral end uses and current product disposition in order to create a benchmark for future analysis as well as to identify opportunities for process improvement. Proposals are solicited to develop a baseline of service lifetimes for use in the analysis of the potential for increased use of secondary metals in order that resources (fuel and nonfuel) may be conserved through recycling. Sufficient detail should be provided so as to estimate the recycling efficiency (metal recycled divided by quantity available for recycling, in percent) of contained metals within these products and uses on reaching their point of obsolescence. Estimations of lifetimes of broad categories of use, such as automobiles and trucks, electronic equipment, white goods (appliances), and bridges, covering the whole spectrum of use of metals, should be made. Product end use categories should conform as closely as possible to the North American Industry Classification System (NAICS). Innovative approaches to making these estimations are encouraged, and publication is anticipated on completion. Contact: Scott Sibley, U.S. Geological Survey, National Center, MS 989, Reston, VA, 20192; ssibley@usgs.gov ; 703-648-4976.

- **Tracking end uses of carbon and stainless steel -** Materials flow studies try to identify mineral commodity use by industry sector as defined by NAICS. The USGS uses that information to estimate material flow by end use. In the case of steel, which accounts for most ferrous metals use, the American Iron and Steel Institute reports shipments by end-use industry. More than one-half of the reported steel shipments go to steel service centers, where it is subdivided and redistributed in smaller amounts. The destinations, amounts, and end uses of these shipments are not tracked. To gain a thorough understanding of the steel industry, it is important to have a complete accounting of steel use. Proposals are solicited to determine the amount of steel shipped from steel service centers by the same end use industry sectors used by the American Iron and Steel Institute for carbon steel and stainless steel for a particular base year (2003 or 2004). As this information is not readily available from trade associations, innovative approaches and methodologies for making these estimations are encouraged, and interviews with manufacturers, distributors (service centers), and consumers would be expected. Critical to this study would be an algorithm that would allow data from the base year to be used to project future and historical distributions. Publication is anticipated on completion. Contact: Scott Sibley, U.S. Geological Survey, National Center, MS 989, Reston, VA, 20192; ssibley@usgs.gov ; 703-648-4976.