Speciation of mercury in mining environments

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Hg, in its methylated form, is one of the most toxic contaminants in the environment and is also one of the most highly biomagnifed contaminants in aquatic ecosystems. Hg in various chemical forms enters the environment from a number of activities, including Hg mining, historic gold mining, and gaseous emissions from coal-fired power plants and crude oil refineries. For example, 90-100 lbs/d of Hg was released into the local environment from individual kilns used for roasting cinnabar ore during operations of the New Almaden and New Idria Hg mines in N. California over a sustained time period, and about 3,000 lbs/y of Hg is released through gaseous emissions into the San Francisco Bay area from five crude oil refineries in the north Bay. Key questions concerning Hg are what are its most common chemical forms, what is the potential bioavailability of Hg in its various forms, and in what chemical forms is it transported from mining environments, where it is typically present as cinnabar (HgS[hex]) or metacinnabar (HgS[cubic]). Over the past few years, we have conducted a number of field- and laboratory-based studies to address these questions. Using a combination of column experiments, XAFS spectroscopy, and TEM, we have found that nanoparticles of cinnabar and metacinnabar are likely forms transported from Hg mines in the California Coast Range. Such nanoparticles are also found in the placer gold deposits in the Sierra Nevada Foothills of N. California. We have also found that certain Hg minerals result in higher evasion of gaseous Hg than others, and that oxidized and reduced forms of S and Fe affect the reactivity of Hg and cause its desorption from goethite. In addition, we have found that a bacterial consortium in the New Idria acid mine drainage can enhance the solubility of HgS by $\approx 10^{30}$. The impact of these processes on the cycling of Hg in mining environmenta will be discussed.

NEO-sample return mission

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Small bodies, as primitive left-over building blocks of the solar system formation process, offer clues to the chemical mixture from which the planets formed some 4.6 billion years ago. Near Earth Objects (NEOs) representative of the population of asteroids and dead comets are thought to be similar in many ways to the ancient planetesimal that accreted to form the planets. NEOs are interesting and highly accessible targets for scientific research. The chemical investigation of NEOs having primitive characters is thus essential in the understanding the planetary formation. They carry records of the solar system's birth and early phases and the geological evolution of small bodies in the interplanetary regions. Moreover, collisions of NEOs with Earth pose a possible hazard to present life and, additionally, they could have been one of the major delivers of water and organic molecules on the primitive Earth playing an active role in the origin of life on Earth. For all these reasons the exploration of these objects is particularly interesting. A sample return mission to a NEO and its scientific objectives will be here presented.