Researchers unlock mysteries of toxic metals in the largest contaminated site in United States

http://www.voyle.net/Nano%20Environment/Green-2004-0009%20.htm

Blacksburg, Va. -- Copper mining in Butte and Anaconda, Montana, starting in 1860's, poisoned the air, the land, and the water; well over 100 years later, contaminants are still found as far as 300 miles down the Clark Fork River, whose headwaters are in that area.

The presence of the contaminants has been known for many decades. But the interaction of the heavy metals and other compounds in the soil, streams, and rivers were unknown until Virginia Tech professor of geosciences Michael Hochella went all the way to the University of Munster, Germany as a Fulbright Scholar, then as a Humboldt Fellow, to use sophisticated equipment that allowed him to examine lead, arsenic and other materials at the nanometer level (a nanometer being about the size of 10 atoms). He will present his findings, including the discovery of a new mineral, at the 116th national meeting of the Geological Society of America in Denver Nov. 7-10.

When the mine was active, ore smelting on the site poured arsenic and sulfur into the air. House cats, because they lick their fur trying to stay clean, died young. People in the area had very pale skin as a result of arsenic poisoning.

"Waste material from mining was dumped in piles that now cover hundreds of acres of land," said Hochella. "This material has been rained on and snowed on for a hundred years and run off into the river. The mining pits have now filled with water, contaminating ground water. If you go into the stream beds and flood plains and dig up muck and dirt, just with a garden trowel, and analyze that dirt, you will find high levels of arsenic, zinc, lead, and copper. Zinc and copper, not ordinarily considered contaminants, are in these concentrations. Nothing grows in these areas."

"So, we knew the metals are there, but we have not known where they reside in the streams and soils," said Hochella. "Is the lead associated with other minerals or with biological material, or is it in a separate phase? No one knew."

To predict bioavailability and movement, you need to know what holds the metal, he said.

Hochella used a transmission electron microscope (TEM) to take a close look. "It takes months. You have to prepare the samples properly before you do the microscopy. But then you can magnify the material by hundreds of thousands of time. With that magnification, you can find what you are looking for," Hochella said.

Hochella, Munster professor Andrew Putnis, and Japanese post-doc Takeshi Kasama looked at samples and found important minerals three to 200 nanometers in size. "We found what we think is a new mineral, a manganese oxide hydrate that takes up lead, arsenic, copper, and zinc like a sponge. We hadn't even known it was there."

The researchers also found another iron oxide mineral that is well known, ferrihydrite, that had been thought to be the most active phase for taking up the contaminant metals. " And we found other minerals that take up these metals. But the manganese mineral is much more reactive then even the ferrihydrite," Hochella said.

"We were not necessarily surprised," he said. "Former PhD student Erin O'Reilly did related lab experiments that showed this activity. But now we've found a real case in nature."

The next step is to find out what the presence of manganese does to the bioavailability of the toxic minerals, he said. Virginia Tech will be purchasing a new TEM soon for this and other research that requires extremely high magnification.

Pyrite, which is plentiful throughout the mining area, breaks down in weathering environments – from sulfides to sulfates – then reforms to sulfides in the stream, taking up heavy metals as it crystallizes. "These are extremely tiny crystals, a couple of nanometers, and are very reactive," Hochella said. "It allows the metals to be bioavailable, when it gets on a fish's gills, for instance."

Hochella will present the paper, "The importance of nanoparticles and their unusual properties in sediments and soils from heavy-metal contaminated sites," at 3:40 p.m. Monday, Nov. 8, in rooms 104/106 of the Colorado Convention Center. Co-authors are PhD candidate and NSF Graduate Student Fellow Andrew Madden, and Johnnie N. Moore. At the time, Moore was a faculty member in the department of geology at the University of Montana and had studied the site for about 20 years. He is now science director of the California Bay-Delta Authority (www.calwater.ca.gov).

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