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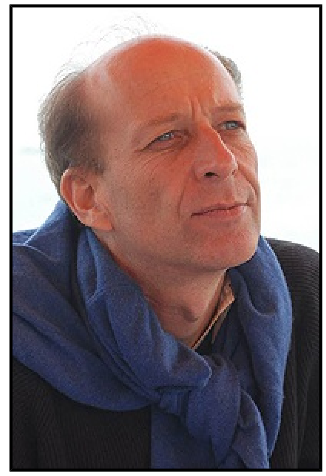
Scientists document arsenic spread to previously unpolluted aquifer in Vietnam

By Nancy Lamontagne



A study led by Alexander van Geen found that, although arsenic moved into a clean aquifer near Hanoi, the contamination is moving relatively slowly. "There is no reason to reject the use of low-arsenic aquifers without treatment, until alternatives become available," he said. (Photo courtesy of Paolo Casella)

NIEHS Superfund Research Program (SRP) researchers from Columbia University report clear evidence that human activity can increase the extent of naturally occurring arsenic in water. Their study,
(http://www.ncbi.nlm.nih.gov/pubmed/24025840)
published in Nature, shows that the dramatic increase in pumping of groundwater from an uncontaminated aquifer near Hanoi, Vietnam, is slowly drawing arsenic-contaminated water into the aquifer.

Under specific conditions, arsenic that naturally occurs in rocks can pollute wells used for drinking water. Arsenic contamination is widespread in South Asia, where an estimated 100 million people are exposed to levels high enough to cause heart, liver, and kidney problems, diabetes, and various cancers. Understanding the chemical processes involved in arsenic pollution could lead to the development of methods to remediate the problem.

"This is the first time we have been able to show that a previously clean aquifer has been contaminated," said lead author and SRP grantee Alexander van Geen, Ph.D."
(http://www.ldeo.columbia.edu/~avangeen/)
"The amount of water being pumped really dominates the system. Arsenic is moving."

The good news is that the arsenic is not moving as fast as the scientists feared it might, which leaves time, maybe even decades, for water managers to try to deal with the problem.

"While our findings stress the importance of periodic monitoring, they also point to the fact that increases in groundwater arsenic, if any, will be relatively slow," said van Geen, a geochemist at Lamont-Doherty Earth Observatory at Columbia University.

SRP researchers van Geen, seated, and co-author Benjamin Bostick, Ph.D., (http://eesc.columbia.edu/faculty/benjamin-bostick) also of Columbia University, examined gray and orange drill cuttings from Van Phuc. Pumping for Hanoi's municipal water supply nearly doubled from 2000 to 2010, and is causing the safe aquifer in Van Phuc to pull water from the contaminated one. (Photo courtesy of Michael Berg, Eawag:

The carbon link

The researchers studied 31 wells around Van Phuc, a village about 5 1/2 miles southeast of Hanoi and bordered by a river. In this and other areas, the amount of arsenic in aquifers is associated with levels of dissolved organic carbon.

Water in an unpolluted aquifer in the village has little organic carbon, but water flowing into it, through the riverbed and from organic-rich soil and clay on top of the aquifer, contains high levels of organic carbon. As water enters the unpolluted aquifer, the carbon reacts with abundant iron rust stuck to sand grains, which appear orange. Arsenic in the sediment tends to stick to this rust, but the carbon causes the rust and arsenic to dissolve, leaving arsenic in the water. As the reactions proceed, the orange sands fade to grey.

The researchers found that in areas of Van Phuc closer to Hanoi, shallow wells draw from the safe orange sediments. However, wells closer to the river reach into the polluted grey sediments. Although high water levels in the safe aquifer should drain the polluted water toward the river, the increased water pumping in Hanoi is causing the safe aquifer to pull water from the contaminated one, as well as from the river.

Using helium and hydrogen isotope dating techniques, the investigators showed that over the last 40 to 60 years, water from the contaminated aquifer has migrated inland more than a mile. During the same period, high levels of arsenic contamination only moved about 370 feet.

Swiss Federal Institute of Aquatic Science and Technology)

Enhanced carbon supply?

More research is needed to identify where the reactive carbon in the contaminated aquifers originates. "It could be organic clays capping the deposit of the river bank, in which case the change in groundwater flow, caused by Hanoi pumping, may have not only released arsenic, but also enhanced the reactive carbon supply," van Geen said.

The research findings could have applications in other parts of the world. Similar situations may be occurring in the Indian state of West Bengal, but it is hard for researchers to study what is happening there, because of the large number of wells. In addition, landfills in the United States can sometimes release considerable levels of reactive carbon, which triggers the release of arsenic from uncontaminated aquifers downstream.

Citation: van Green A, Bostick BC, Pham TK, Vi ML, Nguyen-Ngoc M, Phu DM, Pham HV, Radloff, Aziz Z, Mey JL, Stahl MO, Harvey CF, Oates P, Weinman B, Stengel C, Frei F, Kipfer R, Berg M.
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2013. Retardation of arsenic transport through a Pleistocene aquifer. Nature 501(7466):204-207.

(Nancy Lamontagne is a science writer with MDB Inc., a contractor for the NIEHS Division of Extramural Research and Training.)

Bostick, center, collected a sediment core in Van Phuc. The arsenic contamination moves about 10 to 20 times slower than water travels - a benchmark rate that can be used to better understand how quickly arsenic will migrate at contaminated sites in the United States. "Furthermore, the study helps us to understand the sustainability of groundwater resources and the effects of groundwater use on water quality," Bostick said. *(Photo courtesy of Charles Harvey, Massachusetts Institute of Technology)*