

# Groundwater Discharge of Mercury to California Coastal Waters

Russell Flegal, UC Santa Cruz • Adina Paytan, UC Santa Cruz



L. Jennings/UCSC

*UCSC graduate student Priya Ganguli (left) and former UCSC graduate student Frank Black collect groundwater samples from Stinson Beach.*

## PROJECT HYPOTHESIS

The hypothesis tested, and subsequently validated, during this one-year project was: Measurable amounts of mercury are transported in groundwater to California's coastal waters.

## METHOD

Radiometric analyses, based on radium isotopes, as well as trace metal techniques, were used to quantify concentrations and fluxes of total and organic mercury in groundwater discharging to Stinson Beach in Marin County, north of San Francisco, and Elkhorn Slough in Monterey County, south of San Francisco.

## FINDINGS

Groundwater flowing into the ocean may be a significant source of a highly toxic form of mercury.

According to UC Santa Cruz researchers, underground flows discharging to Stinson Beach and Elkhorn Slough contain surprisingly high levels of methylmercury and may be as big a source of inorganic mercury in coastal waters as that deposited from atmospheric pollution.

Methylmercury accumulates in the food chain, leading to levels in some seafood that can be dangerous if too much is consumed. This toxic form of mercury is produced from inorganic mercury by sulfur- and iron-reducing bacteria found in wet, low-oxygen soils and sediments.

"The big question for public health is, 'Where is all the mercury in seafood coming from?'" says Russell Flegal, a professor of environmental toxicology at UC Santa Cruz. "What we have shown is that methylmercury is coming from groundwater in California at surprisingly high levels."

The scientists did not attempt to identify sources of mercury or where and how the mercury was converted into methylmercury. They believe, however, that septic tanks in the vicinity of Stinson Beach, because they provide nutrients to methylating bacteria, may be contributing to methylmercury formation. At Elkhorn Slough, groundwater may be flushing out methylmercury from sediments where it is being produced.

## RELEVANCE TO MANAGERS

This study advances the scientific community's understanding of biogeochemical cycling of mercury in coastal waters. Such information is of primary importance in developing mandatory total maximum daily load (TMDL) regulations for mercury in state waters and for identifying the most cost-effective ways to limit mercury pollution.

Cynthia Gilmour, a microbial ecologist and senior scientist at the Smithsonian Environmental Research Center in Maryland, says the study is also consistent with "a growing consensus that coastal fishes are acquiring mercury from methylmercury produced in the coastal zone."

## STUDENTS

Frank Black received a Fulbright Fellowship to conduct research on mercury pollution in aquatic food chains in Africa and is now continuing that research at Princeton University.

Several undergraduate students participated in the project, although they were not funded by it. Two, Lydia Jennings and Ngoh Huang, are from under-represented demographic groups in the sciences.

## PUBLICATIONS

Black, F.; Paytan, A.; Knee, K.; de Sieyes, N.; Ganguli, P., Gray, E. and Flegal, R. 2009. Submarine groundwater discharge of total mercury and monomethyl mercury to central California coastal waters. *Environ. Sci. and Tech.* 43:5652-5659.

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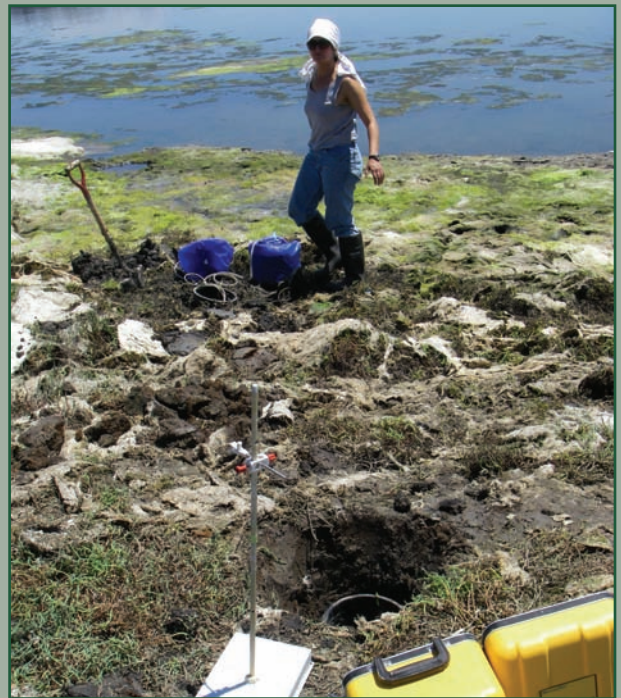
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*UCSC graduate student Priya Ganguli collects groundwater at Elkhorn Slough.*

*Coal-burning power plants are the planet's single largest producer of man-made mercury emissions.*  
Getty Images



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