Nanoparticles seek and destroy groundwater toxins

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Dr. Denis O'Carroll and colleagues at groundwater test site in Ontario, Canada

(Phys.org) -- Iron nanoparticles encapsulated in a rust-preventing polymer coating could hold incredible potential for cleaning up groundwater contaminated with toxic chemicals, a leading water expert says.

Hundreds of sites around Sydney where soils have been contaminated from past industrial waste, landfills and gas leaks are known to exist, including the former HMAS Platypus submarine base in Neutral Bay and the Orica site in Botany Bay.

"Toxic contamination of soils is an historical problem," says Dr. Denis O'Carroll, a visiting academic at the UNSW Water Research Lab. "Until the 1970s, people wrongly believed that if we put these toxins into the ground they would simply disappear – that the subsurface would act as a natural filtration unit."

"The possibility of this waste polluting the environment, and potentially contaminating groundwater sources and remaining there for decades was ignored," he says.

Far from magically disappearing, chemical contaminants from spilled gas and solvents, when not directly polluting surface waters, seep down into the earth, travelling through microscopic soil cracks, where they accumulate and can eventually reach the groundwater table.

Traditional clean-up methods have focussed on pumping out the contaminated water or flushing out toxins with a specially designed cleansing solution, but these are limited by difficulties in accurately pinpointing and accessing locations where contamination has occurred, says O'Carroll.

His approach is to tackle toxic contaminants with nanotechnology. O'Carroll, who is visiting UNSW from the University of Western Ontario in Canada, has been trialling an innovative new groundwater clean-up technology using metal nanoparticles 500 to 5,000 times narrower than a human hair.

The iron particles are injected directly into contaminated soil where they flow to the contaminants and initiate a redox reaction, whereby electrons are transferred between the particle and the pollutant. This reaction changes the oxidation state of the pollutant and diminishes its overall toxicity to safer levels, says O'Carroll.

"The tiny scale of these nanoparticles allows them to move through microscopic flow channels in soil and rock to reach and destroy pollutants that larger particles cannot," says O'Carroll.

In addition, iron nanoparticles are particularly safe for use in the environment as they are not very mobile and dissolve quickly, says O'Carroll. This, in fact, is somewhat of a detriment as it limits the nanoparticles' ability to seek out and degrade toxins.

To optimise the nanoparticles, O'Carroll is experimenting with different formations of iron, and encapsulating the particles in a rust-preventing polymer, which slows the dissolution process and increases their mobility, without any adverse environmental impacts.

Two contaminated sites in Ontario have been used for field trials of the novel technology and "significant degradation of the contaminants at both sites has been observed", says O'Carroll, whose research has been featured on David Suzuki's *The Nature of Things*.

Provided by University of New South Wales