

## Nanoparticle bioremediation: Application of solid phase capture

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The use of engineered nanoparticles continues to expand rapidly. As this intensifies, so does the environmental risk posed if they are released into the environment. This is of particular concern due to the potential toxicity of some nanoparticles. As it stands, we are poorly prepared to deal with nanoparticle pollution and thus remediation strategies must be developed. Here ureolysis-driven calcium carbonate precipitation by the urease positive bacterium *Sporosarcina pasteurii* is investigated as a means of removing nanoparticles from aquatic systems. This technology has been investigated for the solid phase capture of radionuclide and trace element contaminants in groundwater systems [1]. However its potential to capture nanoparticles has yet to be examined.

Batch experiments showed the successful removal of highly stable organo-metallic nanoparticles at concentrations up to 10mg/l (the highest concentration tested thus far). Over 90% of nanoparticles were captured within 24 hours and capture efficiency appeared to be inversely proportional to calcite precipitation rate. As calcite precipitated, the nanoparticles became trapped within the growing calcite crystal. As the calcite-nanoparticle composite continued to grow, it adhered to surfaces (such as the edge of the reaction flask, or the edge of a pore space), immobilizing the nanoparticles from solution. Nanoparticles are believed to act as nucleation sites for the precipitating calcite. First order reaction kinetics were calculated to determine reaction rate constants, and in particular,  $S_{crit}$ , the critical saturation required for nucleation. This technology has the potential for application in contaminated groundwaters and soils as an *in situ* remediation technique for nanoparticle pollutants.

[1] Warren, L.A. Maurice, P.A. Ferris (2001) *N.P.F.G.* **18**, 93–115.

## Testing a geochemical tracer tool in New Zealand water

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Deteriorating water quality along the Tarawera River, in Kawerau (New Zealand), is thought to be correlated to the solid and liquid waste disposal practices of the local pulp and paper mill in conjunction with naturally occurring geothermal discharge in the area. Due to high concentrations of boron in the liquid from both of these sources this study investigates the use of this element as a tool to assist in improving the management of the waterways and water quality in the region.

Comprehensive scientific studies that have been conducted for over 20 years have identified boron as a successful natural tracer for use in water bodies in different parts of the world. [1-3] Drawing on this information we executed a temporal water quality survey to assess the consistency of boron isotope composition values at a localised scale. This survey included monthly sampling over a six-month period spanning the wet and dry seasons. The water samples were a selection of pond, river, ground (shallow and deep zones), and geothermal, coupled with leachate and aeration pond water from a pulp and paper solid waste site. The boron concentration data and isotope ratios were established using ICP-MS and negative TIMS, respectively.

This paper discusses: 1) the effectiveness of boron isotope composition values as signatures for water; 2) the reliability of these signatures as a tool for water quality and management purposes; 3) the level to which sampling, analytical and environmental anomalies have influenced the results.

[1] Vengosh *et al.* (2005) *Water Resources Research* **41**, 1–19.  
[2] Barth *Water Resource* (1998) **32**, 685–690. [3] Tonarini *et al.* *Isotopes in Environmental & Health Studies* (2009) **45**, 169–183.