AAPG Search and Discovery Article #90172 © CSPG/CSEG/CWLS GeoConvention 2010, Calgary, Alberta, Canada, May 10-14, 2010

Biogeochemical Defluoridation

Kerry Evans-Tokaryk
Geology Dept, University of Toronto, 22 Russell St, Toronto, ON, M5S 3B1 Canada
kerry.tokaryk@utoronto.ca

and

F. Grant Ferris
Geology Dept, University of Toronto, 22 Russell St, Toronto, ON, M5S 3B1 Canada

At concentrations above 1 mg/L, fluoride in drinking water can lead to dental and skeletal fluorosis, a disease that causes mottling of the teeth, calcification of ligaments, crippling bone deformities and many other physiological disorders that can, ultimately, lead to death. Conservative estimates are that fluorosis afflicts tens of millions of people worldwide. As there is no treatment for fluorosis, prevention is the only means of controlling the disease. While numerous defluoridation techniques have been explored, no single method has been found to be both effective and inexpensive enough to implement widely. Our research began in India, with a large-scale geochemical study of the groundwater in a fluoride-contaminated region of Orissa. Having developed a better understanding of the geochemical relationships that exist between fluoride and other parameters present in an affected area, as well as the complex relationships that arise among those parameters that can impact the presence of fluoride, we began investigating certain remediation scenarios involving iron oxides. A common approach to remediation involves the partitioning of fluoride from groundwater by sorption onto a variety of materials, one of the most effective of which is hydrous ferric oxide (HFO) whose surface area acts as a scavenger for fluoride. In the presence of iron oxidizing bacteria, the oxidation rate of iron has been shown to be ~6 times greater than in their absence; fluoride should, therefore, be removed from an aqueous environment by bacteriogenic iron oxides (BIOS) much more quickly than by abiotic iron oxides. This paper will examine the results of: 1) titration studies, 2) kinetics experiments, and 3) batch sorption studies. All three sets of experiments were conducted using both BIOS and synthetic HFO in order to compare the behavior between the biotic and abiotic sorbents. The apparent sorption constants determined by the titrations indicate that BIOS and HFO share approximately the same affinity for fluoride. Sorption envelopes and sorption isotherms, however, show BIOS to be a better sorbent than HFO at neutral to high pH values. The kinetics work and batch sorption experiments further elucidate the strengths of the two materials and clearly show BIOS to be a promising sorbent for fluoride in a remediation context.