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The Solubility of Sulfur Hexafluoride in Organic Matter

In Bangladesh, an estimated 50 million people have been exposed to Arsenic (As) levels that exceed the WHO guideline of $10 \mu g L^{-1}$ for drinking water by up to two orders of magnitude. Recent work based on environmental tracers ($^3H/^3He$ and SF_6) has shown that groundwater flow dynamics play an important role in controlling the concentrations of dissolved As. Sulfur Hexafluoride (SF_6) is an inert gas whose origins are mainly anthropogenic. SF_6 is mostly used in the electrical power industry and its concentration as a function of time in the atmosphere is known for the last 40 years. By comparing measured groundwater SF_6 concentrations with the known variation of atmospheric SF_6 we can concentrations the year a sample of ground water last was in equilibrium with the atmosphere. However, a recent study of groundwaters in Bangladesh suggests that SF_6 concentration in groundwater may be affected by either exchange with gas bubbles in the subsurface, absorption by organic matter, or degradation. The goal of this project is to determine the solubility of SF_6 in natural organic phases to evaluate the question if SF_6 can be used as an inexpensive, analytically fast, and reliable alternative to other groundwater tracers, such as $^3H/^3He$.

We developed a method to measure the solubility of SF_6 in fluids and slurries by using dual head-space analysis of samples equilibrated in 60ml plastic syringes. Storage tests showed that no significant quantities of SF_6 leaked in or out of the syringes or were taken up by the plastic material over periods of 24 hours. We were able to reproduce the known solubility of SF_6 in water within ~10% for 15 and 25ºC. We prepared slurries using peat and river sediments and determined the solubility of SF_6 in the slurries at room temperature. After correcting for the amount of organic matter in the slurries determined by LOI (loss on ignition) measurements, we determined tthat solubility of SF_6 in peat (expressed as Bunsen coefficient) as 0.01, which is about twice that of water at the same temperature. We also measured the organic matter content of Bangladesh sediments by LOI and found concentrations ranging from 65.75% to 0.41% We converted the measured solubility and LOI data into a SF_6 retardation factor and concluded that organic matter is not significantly limiting the use of SF_6 as a conservative tracer in typical Bangladesh aquifers.