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Natural Organic Matter in Groundwater: Carbon Source or Sink?

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Carbon plays an essential role in all biological processes on the earth and hence it is important to Mustin the environment. The concentration of organic matter in groundwater, with a global median of 1.0 mg C/L, is often significantly lower than in adjacent soil and surface waters. The likely processes that are responsible for this decrease are sorption to mineral surfaces and biological processing by microbes as water travels through sediments. While these processes have been quantified individually at different sites, they have not been investigated concurrently, and hence the relative importance of each process is unknown. Therefore, the role of organic matter processes in groundwater and in the terrestrial global carbon budget is unknown.

To investigate this a series of laboratory-based experiments were conducted, in conjunction with the organic matter characterization of field samples by Liquid Chromatography-Organic Carbon Detection (LC-OCD). LC-OCD is a size-exclusion based chromatography technique that separates dissolved organic carbon into five fractions based on their mass, plus a hydrophobic fraction, which remains in the column. For the laboratory-based experiments, the amount of sorption onto pure mineral surfaces (quartz sand, iron-coated sand, and calcium carbonate), desorption from natural sediments and biological degradation was investigated at a range of different locations in New South Wales, Australia. The sites covered a range of different aquifer materials (coastal sands, river alluvium and fractured meta-basalts), land cover and recharge type. At each site, groundwater samples were collected from wells located with varying distance from surface water bodies for the subsequent laboratory experiments.

The results showed that predominately the humics fraction was adsorbing onto the mineral surfaces and the low-molecular weight neutrals were being biologically degraded. For the desorption experiments several fractions desorbed with the humics and hydrophobic fraction being dominant. The amount of desorption increased with increasing salinity and increasing number of cycles of drying and wetting. The LC-OCD results of field samples indicated that proportionally, sorption is more dominant than biological degradation. Hence changing environmental conditions, such as increasing salinity and/or drier conditions, could lead to a release of sorbed carbon.