

Mass independent isotope fractionation of mercury during its photochemical reduction by low-molecular-weight organic compounds

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Photochemical reduction of Hg (II) by various low-molecular-weight organic compounds (LMWOC) was investigated to evaluate the effect of specific functional groups that are typically encountered in natural dissolved organic matters (DOM) on the photo-reactivity and isotope fractionation of Hg. LMWOC with reduced sulfur functional groups (e.g. cysteine, glutathione) resulted in slower photochemical reduction of Hg (II) than those without reduced sulfur groups (e.g. serine, oxalic acid). Reduction rate constants were specifically determined for two contrasting LMWOC: DL-serine (0.640 h⁻¹) and L-cysteine (0.047 h⁻¹). Different mass independent isotope effects of Hg were induced by the two types of LMWOC. S-containing ligands specifically enriched magnetic isotopes (¹⁹⁹Hg and ²⁰¹Hg) in the product (Hg (0)) while sulfurless ligands enriched ¹⁹⁹Hg and ²⁰¹Hg in the reactant (Hg (II)), suggesting that opposite magnetic isotope effects (MIE) were produced by different type of ligands. The direction of MIE depends on the initial spin multiplicity of the radical pairs generated as intermediates of primary photochemical procedures. Nuclear field shift effect was also observed in the photochemical reduction by serine. These isotope effects are related to specific functional groups and reduction mechanisms. Therefore, they are used to distinguish between the primary and secondary photochemical reduction mechanisms of Hg (II) and to explain the isotope fractionation during the photochemical reduction of Hg (II) by natural DOM, which provides a mixed bonding conditions.

Evaluation of water quality from deep wells in Bangladesh

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Deep wells, usually installed at depth > 150 m, emerged as the dominant safe water option to mitigate the wide spread arsenic problem in Bangladesh. At present, there is a scarcity of water quality data for deep groundwater. This knowledge is needed to guide further development of the deep aquifers for safe water provision.

Concentrations of arsenic, fluoride, nitrate, manganese, and iron of 211 water samples from deep wells from 19 upazilas of 9 districts were measured in the field. The WHO guideline values for drinking water for arsenic, fluoride and nitrate are 0.1, 1.5 and 50 mg/L, respectively. The Bangladesh drinking water standard for arsenic, fluoride and nitrate are 0.5, 1.0 and 10 mg/L, respectively. WHO has guideline values for manganese (0.4 mg/L) but not for iron based on taste. We found that 57% of samples contained > 1 mg/L iron and 19% contained > 0.1 mg/L manganese, the respective Bangladesh drinking water standard.

Arsenic: Concentrations ranged from < 0.01 mg/L to 0.18 mg/L, with 6% (n=12) exceeding 0.5 mg/L and 26% samples (n=55) above 0.1 mg/L. The highest ten values were from Dharmopasha upazila of Sunamgonj district.

Fluoride: Concentrations ranged from below detection to 21 mg/L, with 18% (n=38) exceeding 1.0 mg/L and 6% samples (n=16) above 1.5 mg/L. Eight wells from Comilla and Rangpur districts contained > 10 mg/L fluoride.

Nitrate: Concentrations ranged from below detection to 31 mg/L, with 3% (n=7) exceeding 30 mg/L and none above 50 mg/L. Seven wells containing > 10 mg/L nitrate were from Raipura, Narshingdi (n=6) and Banchrampur, Brahmanbaria.

The reasons for geographic patterns are under investigation. The subsidence rate in Northeastern Bangladesh is high resulting accumulation of a thick sequence of Holocene sediment. This may explain why As is high at 150 m and below in Sunamgonj.