Mercury isotopes in the Ocean

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Hg facts

- Natural : anthropogenic Hg sources (2:3)
- Long range transport -> global impact
- Hg is methylated in the open ocean water column forming MeHg
- MeHg is a potent neurotoxin
- MeHg accumulates to potential harmful concentrations in the marine food web
- We are all exposed via the consumption of marine fish
- Hg has 7 stable isotopes that fractionate mass-dependent and mass-independent

Outline

Mercury (Hg) is a globally distributed, redox active and highly toxic element because of the stability of naturally occurring bioaccumulating methylated species. Both mass-dependent (MDF) and mass-independent fractionation (MIF) provide new insights into the marine biogeochemical cycle of Hg. In particular, the MIF fingerprints may provide information about specific chemical pathways, that have to potential to trace where in the oceanic water column the toxic methylated species of Hg is formed. No data has yet been reported for Hg isotope geochemistry in natural marine waters. We propose to revisit the marine Hg cycle using ultra-trace and stable isotope techniques.

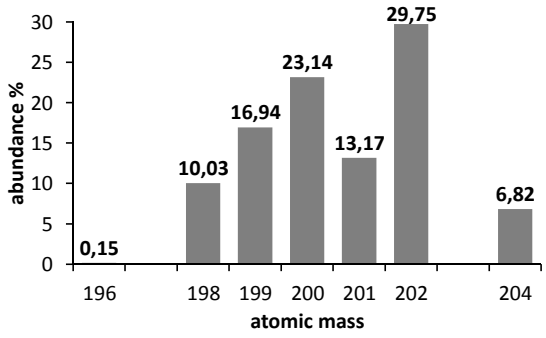

Figure 1: Mercury's 7 stable isotopes and their abundances

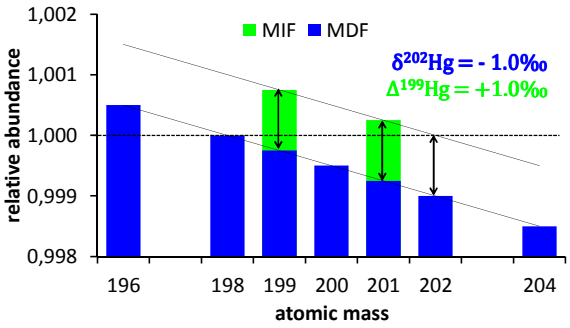

Figure 2: Abundances of Mercury's isotopes relative to NIST SRM 3133

Hg isotopic fingerprinting

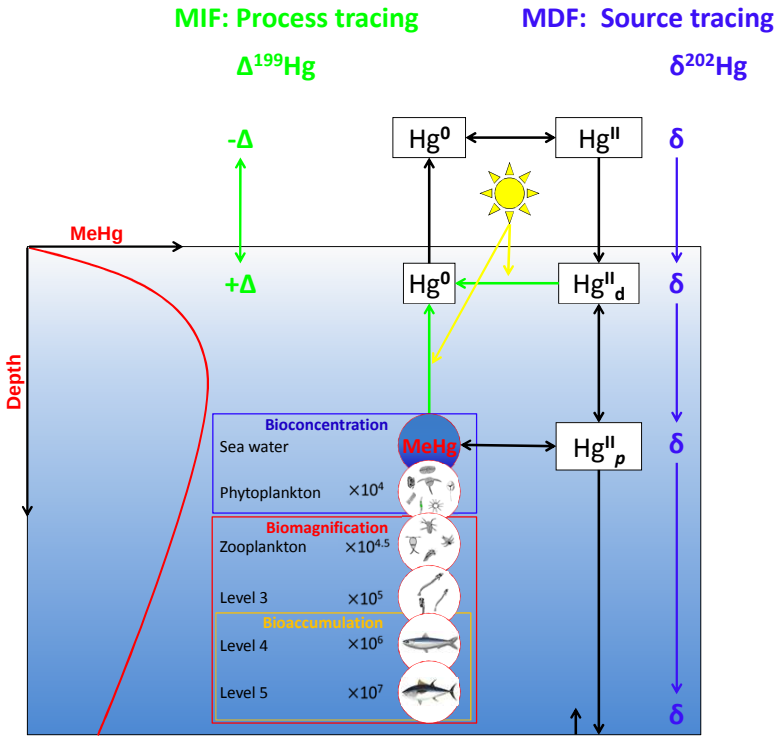

Figure 3: Marine biogeochemical cycle of mercury including isotopic fingerprinting: MIF is induced through photoreduction/-degradation of Hg species at the surface ocean

$$\delta^{202}Hg = \left(\frac{\left(\frac{^{202}Hg}{^{198}Hg}\right)_{sample}}{\left(\frac{^{202}Hg}{^{198}Hg}\right)_{SRM3133}} - 1 \right) \times 1000‰$$

Eq.1: Relative isotope ratio differences from SRM 3133 on the permil (‰) scale are defined according to delta (δ) notation, using ^{198}Hg as the reference mass (Blum and Bergquist, 2007).

$$\Delta^{199}Hg = \delta^{199}Hg - (\delta^{202}Hg \times 0.252)$$

Eq.2: The difference between an anomalous MIF observation and a reference MDF line is quantified using the 'capital delta' notation (Δ).

(De Baar et al. 2008)

1. Sampling 50L sea-water @ 0.2ng/L Hg (1pM)
2. Chemical oxidation of all Hg species to Hg^{II}
3. Pre-concentration on ion-exchange resin *(Chen et al. 2010)*
4. Extraction into aqueous solution
5. Analysis via CV-MC-ICP-MS

Thermo Scientific NEPTUNE
Multicollector ICPMS

Bergquist, B.A., Blum, J.D., 2007. Science 318: 417-420.
Chen, J.B., Hintelmann, H., Dimock, B., 2010. JAAS 25: 1402-1409.
De Baar et al. 2008. Mar Chem 111: 4-21.