Testing the utility of thallium isotopes to track dissolved oxygen using modern marine sediments

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Introduction

It has been recently shown that thallium (Tl) isotopes are a reliable proxy to track redox (reduction-oxidation) processes of the overlying oceanic water column due to their affinity to be absorbed in ferrous-manganese sediments. Manganese oxides (MnOx) found in sediments are sensitive indicators for the presence of oxygen. Thus when present, oxygen will bond with Mn to form MnO, which Tl adsorbs readily, but if the above water becomes oxygen free, anoxic, then MnOx is re-dissolved. Previous studies have found that the global Tl budget of seawater is not affected by the inputs (dust, riverine and hydrothermal fluxes) because they all have very similar isotopic values. Only the two oceanic water column due to their affinity to be absorbed in ferrous-

Materials and methods

- Samples heated at 45°C to remove water and were powdered to original grain size using a mortar and pestle.
- Stiffened ~50 µg of sample and leached in solution of 2M HNO₃ at 130°C for ~16 hours
- Centrifuged for 10 minutes at 2000 rpm 3 times to separate leachate from silicate faction.
- Dissolved using standard HNO₃ and HCl and any organics eliminated using H₂O.
- Chromatography used to separate naturally existing Pb from Tl using Br, HNO₃, and HCl; solutions: Tl from sample was eluted using HCl-63; solution
- Organics from nmo and HCl-SO₃ dissolved using HNO₃.
- Collected Tl prepared for Multi-Collector Inductively-Coupled-Plasma Mass-Spectrometry

Results

Cariaco Basin

- An euxinic basin, meaning it is anoxic and has sulfide in the water column
- The large shifts in ε²⁰⁵Tl is possibly due to global and local shifts in dissolved oxygen.
- Slightly heavier value in the Younger Dryas (the last occurrence of enhanced glaciation) suggests less global bottom water oxygen as seen through a decreased amount of MnOx in sediments.
- ε²⁰⁵Tl during oric restriction records the local MnOx burial of +4.

Santa Barbara Basin

- Site 1, 3, 4, and 5
  - None of the cores seem to record the seawater value of each site.
  - While there is a variability in the ε²⁰⁵Tl values found, sites with similar depths have consistent values.

Conclusions

- Initial data from Cariaco Basin suggests further and higher resolution data is needed to fingerprint glacial-interglacial bottom water oxygen.
- New data suggest predominantly anoxic sediments archive seawater Tl isotopes which allow a wider array of ancient sediments to be used to record climate oxygen variability.

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Future Work

- Additional samples from oxygen minimum zones such as Peru-Chile Margin and Namiba Coastline to confirm their utility for tracking seawater Tl isotopes.
- Analyze Santa Barbara Basin samples for trace metal geochemistry, to better understand local redox conditions.
- Obtain a deep core from the Santa Barbara Basin that goes through glacial-interglacial cycles.