The behaviour of thorium isotopes during the decomposition of large marine particles: *in vitro* experiments and field data

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Thorium isotopes are used as tracers of solution/particle interactions in the ocean. ^{232}Th is a tracer of lithgenic matter. ^{230}Th is also present in lithogenic matter but it is mainly produced by the *in situ* radioactive decay of ^{234}U in the water column. In this work, we compare the ^{232}Th flux obtained by *in vitro* experiments with ^{232}Th flux infered from the ^{230}Th/^{232}Th data in the Mediterranean Sea.

In vitro experiments

The behaviour of organic matter, trace elements and Th isotopes (^{232}Th and ^{230}Th) has been studied during the decomposition of large marine particles under laboratory controlled conditions (Sempéré *et al.*, 1998, Arraes-Mescoff *et al.*, 1998). The sampling site (DYFAMED) is located in the Mediterraenan Sea 5 miles off Nice. Large volumes of seawater were filtered through 60 μm grids using *in situ* pumps at 30 m and 200 m. The particles were then distributed among different batches in sterile (0.2 μm filtration) seawater and left for variable incubation times (from 0 to 20 days) in the dark, at the in situ temperature and with oxic conditions. Each incubations was stopped by filtration on a 0.2 μm filters yielding a filtered solution and residual particles. Some samples were sterilized by gamma irradiation in order to distinguish between biotic and abiotic processes. We obtained results on the particles collected at 30 m. ^{230}Th and ^{232}Th were analysed on the filtered solutions and some residual particles by isotope dilution and TIMS. After 20 days of incubation, less than 1% of the ^{232}Th initialy present on the particles is dissolved. The temporal evolution of ^{232}Th in solution seems to mimic the temporal evolution of Mn (Arraes-Mescoff *et al.* 1998, fast initial dissolution and possible biology-related scavenging at the end of the experiment), but some Th contamination of the samples may have occured. The variations of the ^{230}Th/^{232}Th ratio of the filtered solutions suggest that during the experiment ^{230}Th and ^{232}Th have identical behaviours.

Field data

Seawater collected on a vertical profile 30 miles off Nice was analysed for Th isotopes. Surface waters (20 m) have ^{232}Th concentrations of 176 pg/kg (filtered, 0.2 μm) and 204 pg/kg (unfiltered) and ^{230}Th/^{232}Th ratios of 1.77×10^{-5} (filtered) and 1.41×10^{-5} (unfiltered). Deep water (1000 m) have ^{232}Th concentrations of 176 pg/kg (filtered) and 222-238 pg/kg (unfiltered) and ^{230}Th/^{232}Th ratios of 2.9-3.0 $\times 10^{-5}$ (filtered and unfiltered). Preliminary measurement suggests about 90% of the ^{232}Th present in the 1000 m filtered water is carried on colloids larger than 1000 Daltons.

Comparison

The ^{230}Th/^{232}Th ratio in the western basin of the Mediterranean Sea depends on the flux of Th brought by lithogenic material (FL_{232} and FL_{230}), the percentage of dissolution of this material (D) and the production of ^{230}Th by *in situ* radioactive decay (P_{230}). At steady state, $(^{230}Th/^{232}Th)_{medsea} = (FL_{230} \times D + P_{230})/(FL_{232} \times D)$. If 1% of dissolution of large marine particles is the only source of ^{232}Th in the western basin, we should obtain $(^{230}Th/^{232}Th)_{medsea} = 10^{-3}$. The ^{230}Th/^{232}Th ratios of $2.9-3.0 \times 10^{-5}$ in deep waters would requeire that D = 60%. Nd isotope data suggest that $30 \pm 20\%$ of the Nd carried by lithogenic particles is exchanged with seawater in

the deep western basin of the Mediterranean Sea (Henry *et al.*, 1994). Exchange of Th isotopes between seawater and particulate mater could also contribute to the apparently large D infered from seawater data. Large particles may disaggregate into small particles with a low settling velocity that could exchange with seawater on a longer time scale than large particles. This hypothesis is supported by the similar $^{230}Th/^{232}Th$ ratios obtained for filtered and unfiltered samples of deep water. Other sources (Eastern Basin, slope material) may also contribute to the ^{232}Th flux.

References

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