Seasonal fluxes and processes in the water column

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Introduction

The Iberian Margin is strongly influenced by upwelling, river inputs and slope currents. Such sporadic input of nutrients is likely to produce considerable spatial and seasonal variability of biological activity, and consequently of particle flux. Powerful tracers for studying particle dynamic in the ocean are radionuclides. In particular the natural radionuclides: ^{234}Th ($t_{1/2}$ = 24.1 days), ^{228}Th ($t_{1/2}$ = 1.9 years) and ^{210}Pb ($t_{1/2}$ = 22.2 yr.) are produced continuously by decay of their parents (^{238}U, ^{228}Ra, ^{210}Pb) in the water column and are scavenged onto particles within a few days. Such partition of Th between the particulate phase and seawater may be used to constrain particulate fluxes and residence times of particles. In particular, ^{234}Th ($t_{1/2}$ = 24.1 d.) is the most suitable tracer with its short period for studying particle export on timescales of days to weeks, as can be observed in surface waters.

Sampling

During CD105 cruise, samples for dissolved and particulate ^{234}Th determination were collected. In order to estimate the mesoscale variability of fluxes, 23 stations were sampled in an area covering 41 to 43°N and 9° to 10°E. Except at 3 stations where detailed profiles were established, seawater was sampled between surface and 50 m as a single vertically integrated sample for each station.
During CD110 cruise, the mesoscale sampling was not achieved due to the bad weather. The samples for Th measurements were mostly surface water (underway samples: 10). Three vertical profiles were established with the CTD in the upper 200 m.
During PE109 cruise, profiles of ^{234}Th/^{238}U and ^{228}Th / ^{228}Ra (dissolved and particulate) were established in intermediate (1) and bottom (3) nepheloid layer.

Methods

Each seawater sample (20 to 60 litres) is filtered through a 0.45 µm filter. After addition of ^{229}Th yield tracer and Fe carrier, separation of dissolved ^{234}Th from its ^{238}U parent is carried out on board by passage through an anion exchange column, within 24 hours after seawater collection (to avoid ^{234}Th ingrowth correction).
Within two month after the cruise, particulate ^{234}Th (and ^{228}Th) is directly measured on the filter with a low background-high efficiency γ detector. Back to the laboratory, purification of dissolved thorium is achieved. Thorium activities (^{229}Th for chemical yield, ^{234}Th, ^{228}Th) are determined by γ-counting.
Radium isotopes are extracted from seawater by coprecipitation with $BaSO_4$. After recovering, each precipitate is rinsed, dried prior analysis by low background-high efficiency γ counting.
The vertical flux and related seasonal variations of particulate matter to the benthic environment will be followed by using non destructive ultra low level γ spectrometry: ^{210}Pb, ^{228}Th, ^{226}Ra, ^{228}Ra and ^{137}Cs in suspended matter obtained with sediment traps, provided by the others partners of the programme.

Results *(Task II.5.3)*

In summer (CD105), total ^{234}Th presents a mean deficiency of about 25% in upper 50 m over the Iberian Margin. This seems to indicate that, during the sampling period, particle export was occurring at rates higher than decay production in surface waters. In contrast particulate ^{234}Th ($^{234}Th^{P}$) activities

are more variable (figure). In the shelf waters, $^{234}Th^{P}$ exhibits large scatter, may be in relation with water dynamic. From the slope to open waters, $^{234}Th^{P}$ activities present a gradual increase. There is no clear different trend between the north and the south of the area.
In winter (CD110), total ^{234}Th activities are greatly variable, and both deficit / equilibrium situations are observed. Moreover, in the shelf waters, $^{234}Th^{P}$ presents higher levels when compared with the summer results, may be due to higher resuspension of shallow sediments.
In deep waters (PE-109), ^{234}Th is always at equilibrium with its parents, except in bottom nepheloid layers.

Discussion *(Task II.5.3)*

In summer, $^{234}Th^{P}$ activities are clearly related to the thermocline. Indeed during CD105 cruise, the thermocline, at about 50-m depth, was, weak over the slope and more pronounced in the open waters. This can explain the increase of $^{234}Th^{P}$ with distance from the coast. Particle residence time, derived from the deficit of ^{234}Th, indicates too an increase: from about 10 days over the slope to nearly 30 days in open ocean (figure). ^{234}Th seems to indicate, in June, a situation before upwelling, with stratified and depleted waters, and subsequently reduced settling fluxes.

These results of the CD105 cruise have been presented at the EGS ("Mesoscale estimation of particle dynamic derived from ^{234}Th in surface waters across the Iberian Margin", EGS, 20-24 April 1998, communication, Nice).

Figure : Particulate ^{234}Th (left) and particle residence time (right), derived from Th data, in the upper surface waters over the Iberian margin. Sample were collected along N, P, S and V lines during CD105 cruise.