^{234}TH:^{238}U DISEQUILIBRIA AND SEDIMENT TRAPS: A DUAL APPROACH TO ESTIMATING CARBON EXPORT FROM THE UPPER WATER COLUMN OF NW MEDITERRANEAN COASTAL WATERS

J.C. Miquel[1]*, E.N. Laurent[1], S.W. Fowler[1] and K.Cochran[2]

[1] - IAEA Marine Environment Laboratory (IAEA-MEL), Principality of Monaco - J.C. Miquel@iaea.org; S.Fowler@iaea.org
[2] - Marine Sciences Research Center, State University of New York, USA - Kcochran@notes.cc.sunysb.edu

Abstract

Experiments were carried in coastal waters off Monaco to test the hypothesis that the degree of ^{234}Th:^{238}U disequilibrium in the overlying waters may be a reasonable indicator of particle and ultimately carbon flux that are traditionally measured using sediment traps. Sediment trap data indicated that fluxes measured by traps on three separate moorings were in quite good agreement. Furthermore, predicted ^{234}Th fluxes based on ^{234}Th deficiency measurements in the overlying waters were similar to actual particulate ^{234}Th fluxes measured with the traps. Likewise, carbon fluxes were derived using experimentally-determined C/^{234}Th ratios in the sinking particles.

Key words: Particle flux, carbon, radionuclides, sedimentation, particulates

Introduction

Sediment traps have been widely used over the past 30 years to study the downward flux of particles under in various marine environmental conditions. They are a unique tool for measuring particle flux in the water column and for collecting samples to estimate fluxes of a variety of elements and compounds [1]. Also, they permit recording fluxes over long periods of time to observe seasonal and annual changes in sedimentation [2]. Their records have provided key data for the better understanding of ocean biogeochemical processes. It is widely accepted that traps deployed in calm environments or the deep ocean provide a reasonable estimate of *in-situ* sedimentation. The situation is not always the same when traps are deployed in high energy environments or shallow waters. Trap data obtained under the latter conditions may be affected by hydrodynamic bias [3].

Since the activity of ^{234}Th in sea water is primarily controlled by production from its soluble parent ^{238}U and losses through radioactive decay plus sorptive removal on sinking particles, the accuracy of trap measurement in shallow waters can be verified by studying the ^{234}Th:^{238}U disequilibria in the overlying water column. From the ^{234}Th deficiency in sea water one can predict the ^{234}Th flux down to the depth of radionuclide disequilibrium [4]. Given this and a ^{234}Th measurement in the traps, one has an independent check whether the trap is collecting ^{234}Th-bearing particles in a predictable fashion. In a similar way, carbon fluxes can be predicted by using experimentally determined C/^{234}Th ratios.

Field test and results

During a spring bloom, a field intercomparison of the three Technicap models of sediment traps (Fig.1a) was carried out off Monaco. During one month the traps were deployed at 170 m depth on three independent moorings over a bottom 370 m deep. Currents were also recorded during the entire period of the experiment. In order to relate the measured fluxes to changes in the environment, using Niskin bottles the water column was sampled weekly for basic physico-chemical parameters such as temperature, salinity, fluorescence, chlorophyll *a* and particulate organic carbon. In addition, particulate and dissolved ^{234}Th were measured in the water column using *in-situ* large volume pumps (Fig.1b) in order to compare ^{234}Th trap-measured fluxes with fluxes predicted based on ^{234}Th-deficiency, and to estimate carbon fluxes from the observed ^{234}Th:^{238}U disequilibria.

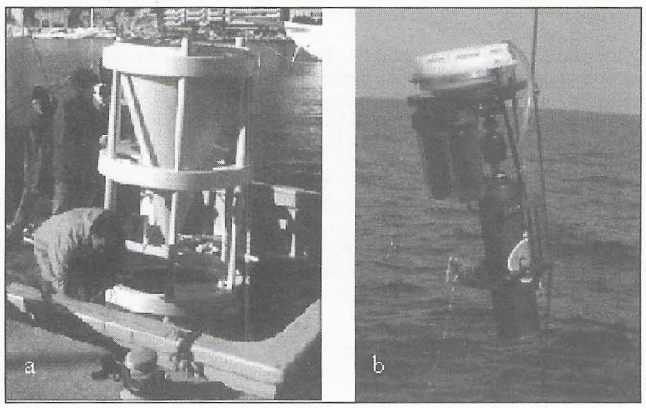

Figure 1. Sampling devices: a) conical sediment trap with a 1 m^2 surface collection area; b) large volume in-situ pump.

Fluxes measured by the three sediment traps were in good agreement during most of the sampling period. Only during short periods of high sedimentation did the measured fluxes present a high variability between traps but without any consistent differences for any given model. Similar trends were observed for carbon fluxes and, to a lesser extent, for pigment fluxes. Thorium data, although preliminary, indicate that ^{234}Th trap-measured fluxes and predicted ^{234}Th fluxes based on ^{234}Th-deficiency were relatively similar and, thus, suggest that the collection of particles by the traps was representative of the actual *in-situ* fluxes off Monaco during the experiment.

References

[1] Fowler S.W. and Knauer G.A., 1986. Role of large particles in the transport of elements and organic compounds through the oceanic water column. *Prog. Oceanogr.*, 16: 147-194.

[2] Miquel J.-C., Fowler S.W. and La Rosa, J., 2000. "Seasonal and interannual variations of particle and carbon fluxes in the open NW Mediterranean: 10 years of sediment trap measurements at the Dyfamed station. In: Ocean Biogeochemistry: A New Paradigm, JFOFS Open Science Conference, Norway, p.133.

[3] Gust G., Byrne R.H., Bernstein R.E., Betzer P.R. and Bowles, W., 1992. Particle fluxes and moving fluids: experience from synchronous trap collections in the Sargasso Sea. *Deep Sea Res.* 39: 1071-1083.

[4] Charette M.A. and Moran S.B., 1999. Rates of particle scavenging and particulate organic carbon export estimated using 234Th as a tracer in the subtropical and equatorial Atlantic Ocean. *Deep Sea Res.* II, 46: 885-906.