Moored Sediment Traps

Introduction

This document covers the moored sediment trap data in files STCNFX, STRDFX and STSPFX (fluxes) and STCN and STRD (composition analyses). The space and time co-ordinates of the samples collected may be determined from the index files STINDX and EVENT.

Sample Acquisition

Settling particles were collected using Parflux 7G-13 time-series sediment traps (Honjo and Doherty (1988)) moored at the sea bed. A typical mooring configuration is described by Newton (1990). These traps have a sampling aperture of 0.5m² covered with a honeycomb baffle of 2.5cm diameter/6.25cm depth cells.

Sample collection methods were consistent with JGOFS protocols (Knauer and Asper (1989)). Sampling cups were filled prior to deployment with deep seawater from the vicinity of the mooring site mixed with a buffered formalin-sodium chloride solution (analytical grade 40% formaldehyde solution with analytical grade sodium tetraborate and stripped of trace metals on a Chelex-100 NH₃-form resin column (Bruland et al (1979)) to a final concentration of 5% w/v formalin (2% w/v formaldehyde) and 5ppt excess salinity. An aliquot of this solution was stored frozen for subsequent analysis.

On trap recovery, 30ml of supernatant were immediately decanted from each sample and 1.0 ml buffered 40% formaldehyde (Chelex 100-stripped as above) added to give a formaldehyde concentration supplement of 0.15%. Samples were stored refrigerated in the dark until further manipulation on land. Decanted supernatants were stored frozen for subsequent analysis. Sample bottles and solutions contacted only plastic surfaces precleaned using 10% HCl and then soaked with high quality deionised water (MilliQ).

Sample Pre-treatment

Each sample was resuspended in its remaining supernatant and qualitatively described under x6 to x50 magnification. Swimmers were identified and removed during this descriptive step using plastic forceps according to the criteria of Knauer and Asper (1989) and Michaels et al (1990), and preserved in formalin. Samples were split into eight sub-samples using a rotary splitter based on that described by Honjo (1978).

About 100ml of supernatant were decanted from each sample just prior to splitting and were used in rinsing procedures to effect quantitative transfer of sample through the splitting process. All manipulations were conducted in filtered air laminar flow environments. Sample splits were stored refrigerated until analysis.

Sample Split Analyses

Sample splits were distributed throughout the BOFS community for analysis, the situation at November 1993 being:
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Laboratory/Contact</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass flux</td>
<td>UEA/Jickells</td>
<td>19°N, 24°N, 28°N, 48°N</td>
</tr>
<tr>
<td>Total Carbon</td>
<td>UEA/Jickells</td>
<td>19°N, 24°N, 28°N, 48°N</td>
</tr>
<tr>
<td>Inorganic Carbon</td>
<td>UEA/Jickells</td>
<td>19°N, 24°N, 28°N, 48°N</td>
</tr>
<tr>
<td>Organic Carbon</td>
<td>UEA/Jickells</td>
<td>19°N, 24°N, 28°N, 48°N</td>
</tr>
<tr>
<td>Opal</td>
<td>UEA/Jickells</td>
<td>19°N, 24°N, 28°N, 48°N</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>UEA/Jickells</td>
<td>19°N, 24°N, 28°N, 48°N</td>
</tr>
<tr>
<td>Plankton counts</td>
<td>IOSDL/Lampitt</td>
<td>19°N, 24°N, 28°N, 48°N</td>
</tr>
<tr>
<td>Natural radionuclides</td>
<td>IOSDL/Thomson</td>
<td>48°N</td>
</tr>
<tr>
<td>Natural radionuclides</td>
<td>CFR, France/Newton</td>
<td>19°N</td>
</tr>
<tr>
<td>$^{13}$C, $^{15}$N</td>
<td>UBC, Canada/Calvert</td>
<td>19°N, 24°N, 28°N</td>
</tr>
<tr>
<td>$^{13}$C, $^{15}$N</td>
<td>UCNW/Kennedy</td>
<td>48°N</td>
</tr>
<tr>
<td>Al &amp; trace elements</td>
<td>Univ. Edinburgh/Shimmield</td>
<td>48°N</td>
</tr>
<tr>
<td>Al &amp; trace elements</td>
<td>CFR, France/Newton</td>
<td>19°N</td>
</tr>
<tr>
<td>Bacterial counts</td>
<td>PML/Turley</td>
<td>48°N</td>
</tr>
<tr>
<td>Foram isotope studies</td>
<td>Univ. Cambridge/Beveridge</td>
<td>19°N</td>
</tr>
<tr>
<td>Organic biomarkers</td>
<td>Bristol OGU/Eglinton</td>
<td>48°N</td>
</tr>
<tr>
<td>Dinoflagellate species</td>
<td>Univ. Oxford/Dodge</td>
<td>48°N</td>
</tr>
</tbody>
</table>

**Mass Flux**

Dry mass of a given 1/8th sample split was determined gravimetrically following filtration onto a preweighed Nuclepore polycarbonate membrane filter (0.4 µm pore size, 47mm diameter). Filtration was followed by rapidly rinsing with 10ml 0.56N ammonium formate solution (pH 7) to remove salt and excess formalin, and then drying to constant weight at 40°C. Mass flux data are based on gravimetric determinations of 2 to 5 one-eighth splits by this or similar (in other laboratories) methods. Measured dry mass variability of splits was generally <±10%. Mass flux error bars reflect measured analytical (splitting and weighing) uncertainties.

**Total Carbon and Nitrogen**

Filtered, dried material was prepared as for mass flux determination. The filter cake was peeled from the filter and finely ground in an agate pestle and mortar. Sub-samples (1 to 10 mg) were analysed for total carbon and nitrogen by detection of the gaseous products of combustion at 1021°C using a Carlo-Erba EA1108 CHN elemental analyser. Procedural blanks using finely-ground oxides demonstrated that C & N contamination of samples due to the (highly volatile) ammonium formate was below detection limits. Error estimates are based on the reproducibility of replicates.

**Inorganic Carbon, Organic Carbon and Opal**

Filtered, dried material was prepared as for mass flux determination. Samples for opal analyses were crushed with a plastic rod in a plastic tube. Sub-samples (3 to 25 mg) in plastic tubes were soaked for 30 min in 5.0ml 10% H$_2$O$_2$, after which 5.0ml 1N HCl (analytical grade) were added. This solution was sonicated for 1 minute and left to stand for 30 minutes. 20.0ml deionised water (MilliQ) were added, the particles redispersed by manual agitation, and the suspension centrifuged down at 3000g for 10 minutes.

The supernatant was removed for subsequent Ca and Na analysis by flame atomic absorption spectrometry, and the residue dried at 60°C. Ca data were converted to inorganic carbon assuming all Ca is as CaCO$_3$ (justified in Newton et al, submitted). Error estimates are based on the reproducibility of replicates.
Organic carbon was calculated by difference from total and inorganic carbon data.

Opal contents were determined using a method based on that of Mortlock and Froelich (1989). Opal was extracted from the dried residue by adding 40.0 ml 2M Na$_2$CO$_3$, sonicating for 1 minute and incubating in a water bath at 80°C for 5 hours (sonicating for 1 minute after 2 and 4 hours). Extractions of 4 to 10 hours did not produce results distinguishable from replicates of 5 hour extractions: the slow extraction of Si from aluminosilicates (Mortlock and Froelich (1989)) is not significant over this time period.

Samples were removed from the water bath and immediately centrifuged down at 3000g for 10 minutes. Supernatants were immediately removed for spectrophotometric dissolved reactive silicate analysis within 24 hours (based on Parsons et al (1984)).

The solutions used to fill the sediment trap sampling cups at deployment, as well as the filtrates and rinse solutions from the 1/8th sub-samples filtered for opal analysis, were similarly analysed for dissolved reactive silicate to provide a minimum estimate of opal losses due to dissolution during sample storage and rinsing. Derived Si contents were converted to opal contents assuming all measured silicate derives from SiO$_2$·0.4H$_2$O (Mortlock and Froelich (1989)). Error estimates are based on the reproducibility of replicates.

**Radionuclide Data**

The samples were stored in 2% formaldehyde preservative with a 5% NaCl enhancement prior to analysis. They were then filtered onto preweighed 0.4 µm Nuclepore filters and dried at 105°C before reweighing.

The dried material was then recombined with the storage solution and $^{208}$Po or $^{209}$Po and $^{229}$Th tracers, together with Pb and Fe carriers, were added. The samples were then taken to dryness, treated with concentrated nitric acid, and then dissolved with HF and HClO$_4$. The tracers were intercalibrated with a $^{232}$U/$^{228}$Th spike and with a calibrated uraninite solution from Harwell. $^{210}$Po was determined using the method of Flynn (1968). The isotopes were then purified by ion exchange (one long column in 6M HCl followed by two short columns in 7M HNO$_3$) and then plated according to the method of Thompson (1982).

A further ion exchange column in 1.5M HCl purified the Pb fraction and the yield was quantified by PbCrO$_4$ gravimetry. This fraction was set aside in 6N HCl solution for a few months to develop a new generation of $^{210}$Po. This was freshly spiked and analysed for $^{210}$Po to allow the $^{210}$Pb activity at the time of collection to be determined. The initial $^{210}$Po activity was determined from the two polonium determinations using the radioactive ingrowth and decay relationships of Friedlander et al (1964).

Radionuclides in the electroplated sources were assayed by alpha spectrometry using silicon surface barrier detectors. Further details may be found in Thompson (1982).

**Species Flux Data**

Wet subsamples from the original splitting (Honjo/Erez splitter) were usually split several times further and examined microscopically using the Utermöhl (1958) technique. The principle of this technique is to pour a subsample of the material into a settling chamber and allow all the solid material to settle to the bottom of the column for a period of two days.
The upper portion of the chamber was then removed, leaving the solid material and a small volume of the overlying water in a small slide. The sample was viewed from beneath, using an inverted microscope, and identifiable particles counted over a known area of the slide.

The technique requires that at least 100 particles of a particular type are counted to obtain a satisfactory level of precision in the estimate of their abundance in the whole sample. At times, this demanded that different subsamples were counted for entities of different abundance in the original sample.

Once the abundance of a particular entity in the original sample had been determined, it was converted to a flux in the usual manner, based on the trap area and the duration of sample acquisition.

Data Warnings

The data set contains two estimates of mass flux; one determined at IOS Deacon Laboratory from the radiochemistry split, the other based on the mean of 2-5 determinations in several laboratories, including the radiochemistry split.

These are broadly similar but do contain some significant differences. It is recommended that the pooled mass flux data be used in preference to the single split data. However, the latter are included in the data set because they have been used in the determination of the radiochemical fluxes.

The data from sites other than 47°N were undergoing interpretation at the time of the CD-ROM going to press. The shallow trap at 28°N exhibits significantly lower mass fluxes than the deeper traps. It is as yet undetermined whether this is real or an artifact, possibly due to excessive currents. Until this is resolved, the data from this trap should be used with caution.

References


