Radionuclide Determinations in Sediment Cores

Introduction

This document covers the data in files PBISO and UTHISO. The former contains lead isotope profiles obtained from multicore and box core samples. The latter contains uranium and thorium isotope data obtained from box core samples.

The multicorer samples were analysed by a group at Edinburgh University. The box core samples were analysed by IOS Deacon Laboratory and the Scottish Universities Research and Reactor Centre. The data have been extensively used by Brand and Shimmield (1991), Thompson et al (1993a) and Thompson et al (1993b).

Sample Acquisition

The cores used for the radionuclide determinations were obtained with either a multicorer or box core. The multicorer used was a Duncan and Associates instrument which could take up to 12 5.5cm core tubes, 20cm apart, distributed over an area of 1 m$^2$. The individual core tubes were based on the Craib Corer with tightly fitting caps at each end of the core tube which snapped into place as soon as the corer was lifted clear of the sediment.

The cores obtained typically consisted of 10cm to 30cm of sediment overlain by 10cm to 20cm of bottom water. Multicorers are designed to obtain samples with the sediment-water interface undisturbed. The cores obtained for this study had clear overlying bottom water and many fine scale features such as worm tubes, settled planktonic faecal and degradation matter and brittle stars on the sediment surface showing that undisturbed cores had, in fact, been obtained.

The cores were subsampled using a piston and screw jack mechanism fitted to the core barrel. In general, the top 1cm of the core was divided into 1mm sections, the next 1cm into 2mm sections, the next 8 cm into 5mm sections and the remainder into 1cm sections. Occasionally, alternative sampling schemes were used. The data include sufficient information to allow the precise sampling scheme for each core to be determined.

The box cores were obtained using an IOS box corer (Peters et al (1980)) which takes 30x30 cm square cores up to 0.5m in length. Ten centimetre internal diameter polyacrylate tubes were used to obtain subcores up to 0.5m long. These were extruded using a precision screw device and divided into 5mm sections for the top 10cm and 1cm sections thereafter.

Sample Preparation

The multicorer samples were dried at 50°C and porosity and salt corrected dry bulk densities calculated. The samples were then ground in a tungsten carbide Tema mill.

The box core samples were dried at 100°C and the dry bulk density computed from the wet weights, dry weights and sample volumes.

Lead Isotope Determinations

The multicorer samples were digested in nitric, hydrofluoric and perchloric acids using $^{208}$Po as a yield tracer, followed by pH adjustment and auto-plating at 30°C onto silver discs. $^{210}$Pb activity was determined via measurement of its granddaughter $^{210}$Po on surface barrier alpha detectors with which it was assumed to be in secular equilibrium. The data were salt-corrected.
The box core samples were determined by a different technique. Unsupported $^{210}$Pb concentrations in the sample were determined by subtraction of the $^{226}$Ra concentration from that of total $^{210}$Pb. Both were determined by gamma spectroscopy.

Sediment samples (dry weight 20g except for a few near surface samples where insufficient material was available) were prepared as 4.7cm diameter compressed discs using a hydraulic press to apply a pressure of 20 tonnes. The discs were wrapped in thin plastic film and placed in a defined position on the detector end cap for analysis. Several types of intrinsic Ge gamma photon detectors, including co-axial and planar, were used for this purpose.

The detection efficiency for $^{210}$Pb was determined using sediment spiked with a known quantity of a calibrated $^{210}$Pb solution. The $^{226}$Ra detection efficiency was determined using sediment containing a known amount of a sandstone of certified uranium content.

The effects on accuracy of the gamma spectroscopy analysis of variations in source thickness and chemical composition were shown to be less than 2% by observation of the degree of transmission of photons from a $^{210}$Pb source through individual samples.

**Uranium and Thorium Isotopes**

The methods used for the uranium and thorium determinations are fully described in Thompson (1982). Briefly, the samples were digested with nitric acid, spiked with a calibrated $^{232}$U/$^{228}$Th spike (to assess yield), dried and fused with potassium fluoride flux. The cake was digested in concentrated sulphuric acid and fused again, this time with sodium sulphate flux, before being digested in hydrochloric acid and hydrogen peroxide solution. The hydrated oxides were precipitated by adding concentrated ammonia liquor until the pH was in the range 7-8.

The solution was transferred to an anion exchange column which retained iron and uranium whilst aluminium and thorium passed through. The uranium was eluted from the column and further purified by a second anion exchange step. The thorium aliquot was purified in a similar manner.

The purified solutions were plated onto stainless steel discs and assayed by alpha spectrometry on silicon surface barrier detectors.

**References**


