

## The Ridge Flank Flux of Uranium and Seawater

Rachel Dunk (rmd398@soton.ac.uk), William Jenkins (william.j.jenkins@soc.soton.ac.uk) & Rachel Mills (rachel.a.mills@soc.soton.ac.uk)

Southampton Oceanography Centre, European Way, Southampton, UK

The oceanic U budget is of interest to the geochemist because of the extensive use of U series isotopes as tracers and time indices of oceanographic processes. U is conservative in seawater with a concentration of 13.9nmol/kg at a salinity of 35. The fossil coral record suggests that the oceans have been in steady state with respect to U for the last 4-5Ma. That U is uniformly distributed throughout the oceans and in steady state implies a balance between the source and sink terms. A revised oceanic mass balance of U (Dunk et al., 2000) is presented in Figure 1 and the major aspects are discussed briefly below.

Riverine runoff is the major source of U to the ocean, although processes operating in the river-sea mixing zone may modify it. For example coastal retention of U in salt marshes and mangroves, via reduction of U(VI) to U(IV), adsorption or complexation, acts to decrease the present-day riverine flux, although such retention does not represent a sink on geological timescales. The groundwater U flux may be significant, however the poor constraint on the volume of groundwaters flowing to the ocean and the mean U content of such waters results in a high degree of uncertainty in the magnitude of this flux.

Oxygen depleted pelagic and shelf slope sediments are one of the principal sinks of U, where removal occurs via diffusion into the sediments and reduction at depth. The crustal sequestration of U during hydrothermal circulation through the mid-ocean ridge (MOR) system may represent an equally important U sink. The magnitude of the hydrothermal U sink, calculated assuming a net basalt U gain of 350-500ppb, is critically dependent on the mean depth of alteration, assumed here to lie between 500 and 2000m (Hart and Staudigel 1982). Although the quantitative removal of U from seawater during high temperature hydrothermal circulation (Chen et al., 1986) implies that U sequestration occurs at depths of 2000m, evidence from DSDP/ODP Hole 504b suggests that enhanced U concentrations are confined to the upper 1000m (Verati and Lancelot 1998).

U undergoes  $\alpha$  decay to produce He with a distinctive  $^4\text{He}/^3\text{He}$  ratio. The diffusive flux of this He through the ridge flank sediments will depend on the total U sequestered into the underlying rocks. Evaluation of the crustally sequestered uraniumic He flux through MOR flank sediments would therefore allow an estimate of the total crustal U sink, independent of the variation in basalt alteration with depth.

The recent sampling of a warm spring situated on 3.5 Ma crust suggests that U removal is also quantitative during lower temperature hydrothermal circulation on the young ridge flanks (Mottl et al., 1998). If quantitative U removal from seawater during both high and low temperature hydrothermal circulation

is assumed, an estimate of the U sink would also provide a minimum constraint on the volume of fluids circulating through the MOR system.

A novel method of sub-sampling sediment cores for He analysis has been developed and was employed during the EXCOII cruise over the west ridge flank of the East Pacific Rise. Sediment cores were collected from locations overlying oceanic crust with estimated ages of 0.3, 1.5, 4.0 and 8.0Ma. The rapid diffusion of He in waters and plastics was circumvented by slicing the core into 10cm segments and sub-coring along the axis with a small diameter copper tube. Sub-coring was carried out under water to avoid air trapping. The metal sub-core tube was then pressure sealed to form a temporary vacuum tight seal and stored prior to extraction of pore water gases at a later date. The decay of sediment or porewater U or Th, or the upwelling of mantle derived He, will also contribute to the observed He in porewaters. These contributions need to be evaluated and subtracted from the measured He profile in order to obtain the desired signal. Preliminary results from the EXCOII samples will be presented.

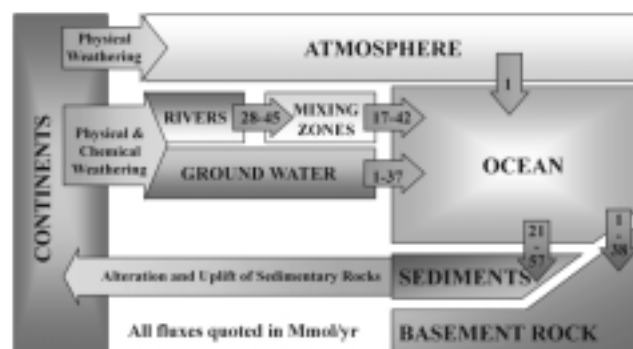


Figure 1: The Oceanic Cycle of Uranium

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