Distribution of $^{236}$U in the North Pacific Ocean

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$^{236}$U is a mainly anthropogenic, rare uranium isotope with a half-life of 23.4 M yrs. In recent years, the development of accelerator mass spectrometry (AMS) has made the detection of $^{236}$U in the general environment possible and research was conducted towards the application of this nuclide as oceanic tracer. $^{236}$U seems well suited as oceanic tracer, because it has a well-defined, temporally resolved source function and shows conservative behaviour in seawater with a long residence time of ~ 5$x10^5$ yrs. In this work, we focus on the North Pacific Ocean, where no data on $^{236}$U has been published so far and will present a new pre-treatment method to treat small size (1 L) seawater samples.

Seawater samples were collected from the North Pacific Ocean in GEOTRACES cruises with R/V Hakuhomaru, in 2011, 2012 and 2014 (KH-11-07, HK-12-4 and KH14-6). 1 L, 5 L and 20 L of seawater samples were collected from several depths in each site, and immediately after the sampling, the water was filtered with about 0.45 mm pore-size cartridge filters. $^{238}$U concentrations in seawater were measured with ICP-MS after acidification. As for 1 L of seawater samples, uranium was purified with UTEVA resin, and precipitated in only 100 µg of iron carrier to prepare targets for the measurement of $^{236}$U/$^{238}$U by AMS. In the 5 L and 20 L samples, no column separation for uranium was done, but actinide elements were separated by a simple co-precipitation with iron hydroxide, which leaves the possibility of detecting several actinides (U, Np, Pu) from one sample.

Using the newly constructed target preparation procedure for the measurement of $^{236}$U in small sizes of seawater samples, 5-10 times higher ion currents were achieved compared to the conventional method and $^{236}$U was successfully determined on all levels of the water column. Also, measurement times could be significantly reduced, which seems promising for future applications of $^{236}$U as oceanographic tracer, when large numbers of samples from vast ocean areas need to be analysed in a timely and cost-efficient way. $^{236}$U/$^{238}$U isotopic ratios were highest (7.6$x10^{-10}$ to 1.4$x10^{-9}$) in shallow water. From surface level to a depth of about 1000-1500 m, all depth profiles showed a steep decrease in $^{236}$U concentrations and $^{236}$U/$^{238}$U ratios in deep water were in the order of $10^{-11}$-$10^{-12}$. The inventories of $^{236}$U on the water column were calculated as (3.6-7.3)x10¹² atoms/m², which is significantly lower than for the Sea of Japan with (1.4-1.6)x10¹³ atoms/m². These results show the lower extent of vertical transport in the Pacific Ocean and are probably an indicator for lower precipitation rates in the North Pacific Ocean. $^{238}$U distributions were in correspondence to the main water masses (as defined by physical oceanographic parameters) and $^{236}$U concentration patterns were similar to those of $^{137}$Cs, which has been conventionally used as oceanographic tracer in this area.

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