

Th isotopes (^{234}Th , ^{230}Th and ^{232}Th) and ^{231}Pa during the expedition Zero and Drake (PS71/), Southern Ocean

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Sampling and Methods

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Venchiarutti C., Rutgers van der Loeff M. and Stimac I. (Deep-Sea Research II, in press). Scavenging of ^{231}Pa and thorium isotopes based on dissolved and size-fractionated particulate distributions at Drake Passage (ANT-XXIV/3)

Summary

On board Polarstern

Dissolved Samples: collected with AWI-CTD, using 20L of seawater. Filtered at $0.45\mu\text{m}$ (Supor filters, 142 mm diameter), acidified, weighed and stored

Particle Samples: collected with in-situ pumps, using 3 different filters (Nitex $50\mu\text{m}$ and $10\mu\text{m}$, Supor $0.8\mu\text{m}$ of 142 mm diameter). 400-800 L filtered seawater. Ultrasonication of the Nitex filters and second filtration to collect the fractions $50\mu\text{m}$ and $10\mu\text{m}$ on Supor filters 47 mm diameter.

In the AWI clean-lab

Dissolved samples: coprecipitated with iron, cleaning and separation by centrifugation, column chemistry, analysis with HR-ICP-MS (Element 2, AWI)

Particle Samples: successive leaching in strong acid media, column chemistry, analysis with HR-ICP-MS (Element 2, AWI)

Please refer to cited publication for details on mass spectrometric measurements and correction applied to the isotopic ratios and concentrations

Dissolved ^{230}Th , ^{232}Th and ^{231}Pa

All the concentrations are reported in excess (noted with subscript xs), i.e. corrected for the detrital contribution (fraction)

$$^{230}\text{Th}_{\text{xs}} = ^{230}\text{Th}_{\text{measured}} - ^{232}\text{Th}_{\text{measured}} * (^{238}\text{U}/^{232}\text{Th})_{\text{litho}}$$

with $(^{238}\text{U}/^{232}\text{Th})_{\text{litho}} = 0.4 \pm 0.1$ South of the Antarctic Polar Front

(Anderson et al. 1990; Rutgers van der Loeff and Berger, 1993; Walter et al., 1997)

$$^{231}\text{Pa}_{\text{xs}} = ^{231}\text{Pa}_{\text{measured}} - (^{235}\text{U}/^{238}\text{U})_{\text{natural}} * (^{238}\text{U}/^{232}\text{Th})_{\text{litho}} * ^{232}\text{Th}_{\text{measured}}$$

with $(^{235}\text{U}/^{238}\text{U})_{\text{natural}} = 0.04605$

(Scholten et al., 1995, 2005; Moran et al., 2005)

Note: All the dissolved concentrations are corrected for Th-ingrowth and Pa-ingrowth from ^{234}U and ^{235}U decay respectively (based on storage time)

Total Particulate ^{230}Th , ^{232}Th and ^{231}Pa

It is the sum of the concentrations (activities in dpm/m^3) in the three size-fractionated particle samples $>50\mu\text{m}$, $10-50\mu\text{m}$ and $0.8-10\mu\text{m}$

It corresponds to all the particles $> 0.8\mu\text{m}$

Lithogenic concentrations (in excess) are calculated like dissolved concentrations (see explanation above)

Total Particulate ^{234}Th

Directly measured on board

for stations: PS71/131-6, PS71/161, PS71/178-3 only fractions $50\mu\text{m}$ and $10\mu\text{m}$ and

for stations: PS71/193, PS71/222-2, PS71/230 and PS71/241-7: all the three fractions Measured using a RISØ-beta counter (cf. Rutgers van der Loeff et al., 2010 doi.10.1594/PANGAEA.745451).

The total particulate concentration is here also the sum of the concentrations of the three particulate size-fractions

Conversions

	fg/kg in dpm/m ³
²³¹ Pa (T _{1/2} =32760 yrs)	0.1078
²³⁰ Th (T _{1/2})=75380 yrs	0.0470
	pg/kg in dpm/m ³
²³² Th (T _{1/2})=14.0*10 ⁻¹⁰ yrs	0.00025

taking into account density of seawater $\rho=1.027 \text{ kg/m}^3$

error: standard deviation [+/-] = 1-sigma propagated error

References

Anderson R.F., Lao Y., Broecker W.S., Trumbore S.E., Hofmann H.J., Wolfi W. (1990). Boundary scavenging in the Pacific Ocean: a comparison of ¹⁰Be and ²³¹Pa. *Earth and Planetary Science Letters*, **96**, 287-304.

Moran S.B., Shen C-C., R.L. Edwards, Edmonds H.N., Scholetn J.C., Smith J.N., Ku T-L. (2005). ²³¹Pa and ²³⁰Th in surface sediments of Arctic Ocean: implications for ²³¹Pa/²³⁰Th fractionation, boundary scavenging, and advective export. *Earth and Planetary Science Letters*, **234**, 235-248.

Rutgers van der Loeff M.M., Berger G.W. (1993). Scavenging of ²³⁰Th and ²³¹Pa near the Antarctic Polar Front in the South Atlantic. *Deep-Sea Research I*, **40**, 339-357.

Scholten J.C., Rutgers van der Loeff M.M., Michel A. (1995). Distribution of ²³⁰Th and ²³¹Pa in the water column in relation to the ventilation of the deep Arctic basins. *Deep-Sea Research II*, **42**, 1519-1531.

Scholten J.C., Fietzke J., Mangini A., Stoffers P., Rixen T., Gaye-Haake B., Blanz T., Ramaswamy V., Sirocko F., Schulz H., Ittekkot V. (2005). Radionuclide fluxes in the Arabian Sea: the role of particle composition. *Earth and Planetary Science Letters*, **230**, 319-337.

Walter H.J., Rutgers van der Loeff M.M., Hoeltzen H. (1997). Enhanced scavenging of ²³¹Pa relative to ²³⁰Th in the South Atlantic south of the Polar Front: Implications for the use of the ²³¹Pa/²³⁰Th ratio as a paleoproductivity proxy. *Earth and Planetary Science Letters*, **149**, 85-100.