Distribution patterns of long-lived Ra isotopes in Bransfield Strait surface water – OPERANTAR XXIX and XXX expeditions

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Abstract

The Bransfield Strait in the Antartic Peninsula is a basin strongly influenced by processes occurring on its continental shelves. The modified shelf waters feed the polar surface layer or ventilate the subsurface layers of the interior basin and products of biogeochemical interactions within the shelf environment are transferred into surface and subsurface layers of the Southern Ocean. The overall goal of this study was to apply an isotopic tracer technique to investigate the rate of exchange between the Antartic Peninsula islands and the Brasnfield Strait interior. This technique was based on the measure of the surface water column ratio of two naturally occurring radium isotopes, ^{228}Ra/ ^{226}Ra. Because ^{228}Ra is derived solely through input from shelf sediments, it is an unambiguous marker of water that has been in contact with shelves. Its relative distribution in shelf and basin water is therefore useful for assessing the degree of shelf-basin interaction. Seawater samples were collected between 8th March - 1st April 2011 (Operantar XXIX) and 13th October – 14th November 2011 (Operantar XXX) onboard the RV Ary Rongel, from Brazilian Navy. In March/11, ^{228}Ra/^{226}Ra activity ratios up to 4.0 were determined, the highest value being observed at station EB13, closest to the cost in Admiralty Bay. During October/11 ^{226}Ra activities ranged from 18 to 138 mBq 100 L^{-1}, while ^{228}Ra activities varied from < LLD to 140 mBq 100L^{-1}. Elevated ^{228}Ra activities were found in surface waters in the vicinity of Bransfield Island and Trinity Peninsula. Contact of the water masses with the shallow lithogenic sediments present in that area likely explains these high ^{228}Ra activities. When combined with physical observations and nutrient distributions, these results suggest that the water mass advected onto the Bransfield Strait originates from the Weddell Sea. This northward advection might represent a supply of trace elements, mainly iron, for the observed phytoplankton bloom. Regression analyses indicate that the physical properties of the water masses have a subtle control on the radium isotopic characteristics of the surface waters. Higher proportions of siliciclastic source lithologies are positively correlated with ^{228}Ra/^{226}Ra activity ratios during summer (+0.3 at the 95% significance level). Surface water ^{226}Ra activity is also controlled to a considerable degree by the presence of dissolved ^{238}U. In summer, the aforementioned relantionship is clearly illustrated by a positive correlation between ^{226}Ra and ^{238}U content (+0.4 at the 95% confidence level). The change in activity concentration with time as a function of distance offshore was studied for both ^{226}Ra and ^{228}Ra. For ^{226}Ra, a non-conservative increase of the activity concentration with the respective increasing distance from coast was observed. For ^{228}Ra, a linear gradient was observed and implies that mixing controls its distribution in the studied area.