Using ^{228}Ra to assess ocean mixing and nutrient fluxes in the Cape Basin

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In the South Atlantic Ocean, the Cape Basin holds an important position for dynamic inter-ocean exchange between the Atlantic Ocean and the Indian Ocean (e.g. Agulhas Current Leakage), and for transition from the macronutrient-limited subtropical gyre to the micronutrient-limited Southern Ocean [1]. Nutrients and micronutrients play important roles in marine productivity in the Cape Basin, but their sources and fluxes to this region remain unclear.

Radium-228 has been applied to the study of a variety of oceanographic processes, including tracing of water masses; quantifing mixing processes; and constraining fluxes of dissolved species to the ocean [2]. With a short half-life of 5.75 years, ^{228}Ra is very suitable to assess ocean mixing rates, and the fluxes of nutrients and trace metals into the euphotic zone by vertical and horizontal mixing [3]. In this study, we measure the distribution of seawater ^{228}Ra and ^{226}Ra in the water column of the Cape Basin during the UK-GEOTRACES cruise (GA10E) and use these measurements to calculate horizontal and vertical mixing rates, and resulting nutrient fluxes to the surface ocean of the Cape Basin. A newly developed MC-ICP-MS technique with improved analytical precision has been applied to measure of seawater ^{228}Ra and ^{226}Ra in this study [4]. Vertical and horizontal ^{228}Ra profiles are used to determine the diapycnal and isopycnal mixing rates respectively in the surface ocean of the Cape Basin. The ^{228}Ra-derived vertical mixing rates coupled with the vertical nutrient profiles (nitrate, phosphate and silicate) are then used to estimate the upward nutrient fluxes into the euphotic zone. Assuming steady state, the upward nitrate fluxes are coverted to the organic carbon fluxes in the surface ocean. The observations of the vertical nutrient fluxes suggest that the marine productivity in the Cape Basin is nitrogen-limited in early spring of the southern hemisphere. This study provide important estimates of ocean mixing and nutrient fluxes in the Cape Basin, which enable us to understand the nutrient cycles and biological activities in the macronutrient-limated subropical gyre.

[1] Gordon (1985) *Science* **227**, 1030-1033. [2] Moore et al. (2008) *Nature Geosci.* **1**, 309-311. [3] Ku and Luo (2008) *Radioactivity in the Environment* **13**, 307-344. [4] Hsieh and Henderson (2011) *J. Anal. At. Spectrom.* **26**, 1338-1346.

The Reduction and Surface Complexation of Mercury by *Geobacter sulfurreducens* PCA

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Understanding the biogeochemical processes that control mercury (Hg) redox transformations is necessary to predict Hg availability for microbial methylation, its fate and transport in the environment. Previous studies have shown that a wide variety of microorganisms are capable of reducing the mercuric Hg(II) to elemental Hg(0) under anaerobic conditions, but others have indicated an inverse correlation between microbial biomass and Hg(0) production. In this study, we systematically examined the reduction kinetics and surface interactions between Hg(II) and washed cells of *G. sulfurreducens,* as influenced by the growth stage of cells, cell density, the presence or absence of various complexing ligands, including glutathione and naturally dissolved organic matter (DOM). We found that Hg(II) can be rapidly reduced to Hg(0) upon contact with washed cells, but reduction rates and extent are influenced by the growth stage, cell density and Hg(II)/cell ratio. The initial reduction rates can generally be described by a pseudo-first order kinetics with half-lives on the order of minutes to less than 2 hr. An optimal reduction of Hg(II) at a fixed concentration of 50 nM was observed at a cell density of ~10^{11} L^{-1}; an increase in cell density inhibited the reduction of Hg(II) due to surface adsorption and complexation of Hg(II) on bacterial cells. Similarly, the presence of complexing organic ligands inhibited the Hg(II) reduction at varying degrees, with glutathione among the most effective in inhibiting Hg(II) reduction and surface complexation by *Geobacter* cells. Our findings explain some previously observed inconsistencies with respect to the roles of microorganisms in Hg(II) reduction and may have important implications to the availability and bioaccumulation of Hg in the aquatic food web.