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Importance of Natural Lead (Pb) to the Pb Isotope Signatures of Water Masses in the Southern Ocean

Authors: Yerim Kim, Nathan T. Lanning, Kristie A. Dick, Edward A. Boyle, Jessica N. Fitzsimmons, Franco Marcantonio

Anthropogenic activities, such as leaded gasoline usage and coal combustion, have disrupted the natural geochemical cycle of lead (Pb). These industrial sources can be differentiated from natural (lithogenic) Pb in seawater through the measurement of Pb isotope ratios. Indeed, anthropogenic Pb, much of which was introduced to seawater decades ago, serves as a valuable and potentially useful tracer in tracking water circulation patterns. Here, we present dissolved Pb concentration and isotope ratio data from samples collected across the Pacific sector of the Southern Ocean during the U.S. GEOTRACES GP17-OCE cruise, located remotely from continents and, thus, isolated from anthropogenic activities. The cruise had three parts – a meridional section from 20°S to 67°S along 152°W-135°W, a zonal section along 67°S from 135°W to 100°W, and a "continental" section toward the South American continent from 100°W northeast to Punta Arenas, Chile. The dissolved Pb concentrations range from 2.4-12.9 pmol/kg, showing a decrease with increasing depth, while the $^{206}Pb/^{207}Pb$ isotope ratios, in general, follow water masses, which would not necessarily be expected for a scavenging-type element like Pb. In the meridional section, we observe the highest $^{206}Pb/^{207}Pb$ isotope ratios (~1.19) at the deepest depths, which is likely due to the predominance of natural Pb in the lowermost water column. These high Pb isotope ratios coincide with the potential density anomaly (σ_0) of 27.86 kg/m^3, which differentiates newly formed Antarctic Bottom Water (AABW) from Lower Circumpolar Deep Water (LCDW). Furthermore, the water column profiles near the Pacific-Antarctic Ridge capture distinct Pb isotope ratios associated with both LCDW (1.17-1.19; σ_0=27.7-27.86 kg/m^3) and Upper Circumpolar Deep Water (1.16-1.17; σ_0=27.5-27.7 kg/m^3), indicating a mixture of natural and Australian Pb isotope signatures. These patterns are maintained along the Antarctic Circumpolar Current fronts along the zonal transect. Lastly, the "continental" transect, which samples the oldest deep waters (Pacific Deep Water), is characterized by $^{206}Pb/^{207}Pb$ isotope ratios of ~1.16, suggesting a likely lithogenic influence from the margin of the South American continent.

Character count (1997/2000)