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Decadal evolution of dissolved lead in the Cape Basin: the role of Agulhas Current in transporting anthropogenic lead from Southern Africa

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Using the oceanographic expeditions conducted in the Southern Ocean between 2015 (South African National Antarctic Expedition) and 2019 (Southern Ocean Seasonal Experiment), this study presents the dissolved lead (dPb) data for the GEOTRACES GIPY04 transect (Bonus Goodhope Line) and the Indian Ocean along the east coast of South Africa. The data from this study, together with the published data (2008-2010)[1,2], show the decadal evolution of dPb in different regions of the Southern Ocean after the complete phase-out of leaded petroleum in Southern Africa. South of the Subtropical Front, dPb concentrations in the surface water (<25m) dropped approximately three folds between 2008-2019. The highest dPb (30 pmol kg^{-1}) and a rate of decrease (2.7±0.2 pmol $kg^{-1}y^{-1}$) in the Cape Basin indicate nearby sources of Pb. The vertical dPb profiles further show that Agulhas Current (AC)-derived water and underlying subtropical surface water (STSW) in the Cape Basin were well mixed during the 2010s, whereas in 2008, dPb concentrations in the AC-derived water were twice as high compared to the underlying STSW. The difference is due to a rapid decrease in dPb in the AC-derived water (from 40±6.3 to 23±0.2 pmol kg^{-1}) between 2008-2010, which is consistent with the change in Pb emissions resulting from the phasing out of leaded petroleum by Southern African countries (between 2006-2008). However, during 2015-2019, an increase in dPb (17±0.8 to 20±0.6 pmol kg^{-1}) in upper water (AC and STSW) suggests a recent increase in Pb emissions from Southern African developing countries possibly resulting due to the increased use of Pb-emitting raw materials, as observed in South Asia[3]. Despite the Cape Basin not receiving wind-driven airborne dust directly from Africa, we propose that a substantial fraction of measured dPb in the Cape Basin is contributed by the Southern African aerosols that are precipitated in the West Indian Ocean and then transported by the AC. We estimate ca. 65-90% of the measured dPb in the Cape Basin is contributed by the AC-derived water.

[1]Boye et al. (2012), Biogeosci. Discuss. 9, 3579–3613

[2]Schlosser et al. (2019), Deep-Sea Res. 148, 132–142

[3]Samanta et al. (2022), App. Geohcem. 136, 105164