Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37225

The Importance of Agulhas Leakage in Indo-Atlantic Transport of Iron, Manganese and Cobalt

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The Agulhas Current is a western boundary current that flows south-west along the southern African continental slope (27°S-37°S) carrying 77±5 Sv of warm, salty (sub)tropical Indian Ocean waters. Much of this transport is redirected west, back into the Indian subtropical gyre, via the Agulhas Return Current. However, in the upper 1000 m of the water column, approximately 15 Sv (1 Sv = 10^6 m^3/sec) 'leak' into the southeast Atlantic Ocean via a combination of mean flow and mesoscale features such as eddies and filaments, contributing to the maintenance of Atlantic Meridional Overturning Circulation. The importance of Agulhas Leakage in terms of inter-ocean exchange of heat, salt and nutrients has been documented, however bio-essential trace elements such as iron (Fe), manganese (Mn) and Cobalt (Co) have yet to be considered. Due to rapid current velocities (up to 2 m/s) and interactions with the African continental margin, we hypothesize that Agulhas waters can entrain and transport significant amounts of resuspended Fe, Mn and Co long ranges to potentially act as a natural fertilization mechanism in the oligotrophic southeast Atlantic.

To test our hypothesis, we combine measurements from multiple cruises (RESILIENCE, SCALE, SWINGS, BONUS-GoodHope) which sampled along the Agulhas Current pathway and surrounding waters to 1) determine the concentrations of trace elements transported by the Agulhas Current, 2) determine the Indo-Atlantic flux of trace elements via Agulhas leakage waters, 3) examine potential downstream impacts on primary productivity using satellite data. Preliminary surface (2 m) data from transects along the South African margin show elevated dFe, dMn and dCo in tropical surface waters (1.25±0.75 nmol/kg, 2.59±0.16 nmol/kg and 19±5 pmol/kg respectively) and subtropical surface waters (0.92±0.40 nmol/kg, 2.91±0.61 nmol/kg and 47±23 pmol/kg respectively), the two water masses contributing to Agulhas Current waters in the upper water column. To assess the significance of the Agulhas leakage-derived trace element flux, we compare to other known significant trace element sources to the southeast Atlantic, such as atmospheric aerosol deposition and upwelling along the west African margin (Benguela Upwelling System).