DISSOLVED IRON AND ALUMINIUM CYCLING IN THE INDIAN OCEAN: FROM HIGH-RESOLUTION SHIPBOARD SECTIONS TO THE PROSPECT OF MINIATURIZED AUTONOMOUS DETERMINATIONS

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ABSTRACT

The development of a mechanistic understanding of the Fe cycle in the ocean requires assembling a global database of observations with adequate spatial and temporal resolution. This first part of this dissertation is concerned with more than 2,000 measurements of dissolved Iron (Fe) and Aluminium (Al) collected at ~60 nautical miles intervals during four sections of the US CLIVAR-CO_2 Repeat Hydrography Program in the upper 1000m of the Indian Ocean. These data are used to explore the effects of circulation, dust deposition, riverine inputs, fluxes from margin sediments and remineralization processes on the biogeochemical cycles of Fe and Al. Along the 4 transects, the surface distribution of Al reflects the deposition of mineral dust and is used to produce 155 estimates of deposition. Below the surface, the distribution of Al is mainly influenced by the large-scale circulation of the Indian Ocean with additional inputs from sediments. In the Indian sector of the Southern Ocean, elevated subsurface Fe concentrations are sourced from topographic upwelling of Fe-rich deep waters and sedimentary inputs from the Kerguelen Plateau. In the Northern Indian Ocean, elevated subsurface Fe concentrations are sustained by remineralization of settling organic matter combined with sedimentary inputs. In the South Indian Subtropical Gyre along 32°S, the zonal distribution of N* and aeolian Fe inputs are coupled, suggesting that Fe inputs from dust deposition regulate nitrogen fixation rates.

The second part of this dissertation explores the applicability of micro-Sequential Injection Lab-On-Valve (μSI-LOV) for trace element analysis and describes the development and validation of a novel μSI-LOV method for Zn determinations. This technique exploits the attributes of μSI-LOV and a novel fluorescent probe to measure Zn with high precision and detection limit of 0.1nM. This low detection limit is achieved without pre-concentration, using 50μL of reagent and 75μL of sample and an analytical cycle of ~1min in a compact, fully automated system that requires little maintenance. This work may facilitate the development of a new generation of miniaturized analytical systems, which, when deployed on moorings and other platforms, will provide a much-needed temporal dimension to the current observational database of biogeochemically active trace elements.