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Investigation of hydrothermal activity in the South West Indian Ridge region using Ra isotopes and ^{227}Ac as tracers

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Hydrothermal vents have been shown to be important vectors for various chemical elements into the ocean. In particular, radium is a naturally occurring radionuclide present in low concentrations in the ocean but is significantly enriched in hydrothermal fluids. Additionally, radium is only slightly impacted by scavenging or biological removal, which makes it a valuable tracer to evaluate the fate of the chemical elements released by hydrothermal vents.

However, both the intensity of the chemical fluxes associated with these systems and the fate of the chemical elements along the plume are still largely overlooked. In this study, we report vertical distributions of the Ra quartet (^{223}Ra, ^{224}Ra, ^{226}Ra and ^{228}Ra) and ^{227}Ac activities at two stations located above the South West Indian Ridge in the Southern Ocean sampled during the SWINGS cruise (GEOTRACES GS02).

We observed high excess ^{223}Ra and ^{224}Ra activities up to 7 and 1 dpm 100L^{-1}, respectively near the seafloor that we attributed to the presence of a hydrothermal activity which location has been better constrained thanks to modeling and *in-situ* physical observations (ADCP data). The high activities of $^{223}Ra_{ex}$ and $^{224}Ra_{ex}$ compared ^{226}Ra and ^{228}Ra could be explained by a faster regeneration rate of these isotopes during seawater circulation within the crust. Moreover, these high $^{223}Ra_{ex}$ activities unaccompanied by his parent, ^{227}Ac suggests that ^{227}Ac is adsorbed onto mineral surfaces during seawater circulation within the crust releasing $^{223}Ra_{ex}$ into the dissolved phase.

A 1D diffusion model applied to the vertical profiles of short-lived Ra isotopes provided an estimation of the vertical eddy diffusivity coefficients (K_z) ranging from 38 to 149 cm² s^{-1}. By combining these K_z with the vertical gradient of dissolved Fe (dFe), we estimate a vertical flux of dFe that ranges from 193 to 1131 nmol m^{-2} d^{-1}. By combing physical and geochemical observations, we confirm that low-expansion-rate ridges could be significant sources of dFe to the deep ocean, which when combined to a strong vertical mixing, can be transported upward.