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Evidence of a Hydrothermal Plume in the Pacific Sector of the Southern Ocean

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Hydrothermal activity along the global mid-ocean ridge system injects mantle-derived Helium-3 into the ocean. This signal, characterized by high Helium-3/Helium-4 ratios, can be detected throughout much of the intermediate waters of the global ocean and is used for studying deep ocean circulation as well as for tracking and identifying hydrothermal input of trace elements into the ocean. Here, we examine the distribution of Helium-3 in the Southern Ocean using meridional transects through the Pacific Basin (WOCE P16, P17) as well as zonal sections (WOCE IOS4, S4P, S4A) in all sectors of the Southern Ocean.

Throughout most of the Pacific Ocean north of the Antarctic Circumpolar Current (ACC), the maximum helium signal is found along the gamma=28 neutral surface, corresponding to a depth of about 2500m, the typical injection depth at the East Pacific Rise system. Between 50 and 60 South, this surface is tilted upward in the water column indicating upwelling of the mantle-derived helium in the ACC regime and subsequent (partial) release in the region south of the ACC.

Along WOCE section S4P in the Pacific sector of the Southern Ocean, we find a distinct He-3 maximum along a denser isopycnal surface, gamma=28.2. This neutral surface does not occur north of about 55 South in the Pacific Ocean. The gamma=28.2 surface along S4P is tilted along the zonal transect, with a shallower depth of about 1500 m in the west extending down to about 3000 m in the eastern part of the section.

The feature identified in the Pacific sector of the Southern Ocean contrasts with the Indian and Atlantic sector transects where no comparable signature below the gamma=28 surface is found. The helium isotope data provide first tracer observations of mid-ocean ridge hydrothermal activity in the Pacific sector of the Southern Ocean. We hypothesize that the excess helium is injected into the deep Southern Ocean where

the gamma = 28.2 surface crosses the top of the Pacific Antarctic Ridge (PAA).