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Endemic fauna and complex mineralization linked to combined venting and seepage at the Karambusel vent field, PNG

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The Tabar-Lihir-Tanga-Feni (TLTF) island chain in northeastern Papua New Guinea (PNG) is host to highly alkaline magmatism, economic gold deposits and a highly endemic hydrothermal vent fauna. However, new observations and geochemical data indicate some sites of chemosymbiotic fauna exhibit combined venting of hydrothermal fluids and seeping of cold hydrocarbons.

During expedition SO299 aboard the German RV Sonne in 2023, we discovered the first deep-sea hydrothermal vents of the area – the Karambusel vent field, a name we assigned to the site. Radiometric dating and Pb isotope fingerprinting indicate a direct relationship between the mineralization at Karambusel and Conical Seamount, as well as the emplacement of the Karambusel volcanic edifice at 88.5 ka. Our new results indicate that this is the youngest volcanic event in the Lihir island group. The mineralization at Karambusel records a multi-stage history, resembling that known from the top of Conical Seamount. At both sites, an older high-temperature (~340°C) polymetallic and Au-rich stage is overprinted by a more recent As-Sb-Tl-Hg-rich stage that – in the case of Karambusel – is associated with the active venting at moderate temperatures of up to 51°C. The hydrothermal fluids at Karambusel are characterized by high contents of Si and Li, and exhibit low salinity (<300 mmol L^{-1} Cl). The loss of Cl relative to seawater at near constant Na to Cl ratios indicate sub-critical phase separation (boiling) during ascent within the volcanic edifice. Unique to the active vent field is the concomitant emission of hydrocarbons with free gas samples containing >80 mol.% methane of thermogenic origin, CO_2, N_2, and significant amounts of the longer-chain hydrocarbons from ethane to pentane. Whereas the impact of the hydrocarbons on ore mineral precipitation remains ambiguous at this stage, their impact on chemosymbiotic life is important, as implied by the faunal similarities between Karambusel and the nearby Mussel Cliff seep.

We propose that the superposition of venting and seepage at a single locality may contribute to faunal endemism. However, future interdisciplinary studies are required to fully understand the specific geological and biological links between hydrothermal venting and hydrocarbon seepage, and their associated faunal communities.