

Expeditions to the world's deepest serpentinite-hosted seep system, the Shinkai Seep Field, the southern Mariana forearc

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A serpentinite-hosted cold seep and associated ecosystem in the southern Mariana forearc near the Challenger Deep [Ohara et al., PNAS, 2012] was serendipitously discovered as a massive vesicomyid clam colony site during a DSV Shinkai 6500 dive for mantle peridotite mapping in September 2010. Although seeping fluids were not observed during the dive, the presence of a massive clam colony strongly indicated the presence of reduced fluid seepage. The site was therefore named the Shinkai Seep Field (SSF).

Serpentinite-hosted systems are believed to be significant incubators and habitats of early life on Earth as well as for extraterrestrial life such as on Saturn's moon Enceladus. The SSF is the fourth known major location of such a serpentinite-hosted system in the ocean, following the Lost City hydrothermal field in the Mid-Atlantic Ridge, South Chamorro Seamount in the Mariana Forearc, and the Prony Bay hydrothermal field in New Caledonia. Among these, the SSF is the world's deepest, located ~5700 m below the surface. In this contribution, we will outline past SSF expeditions and some research progress.

Following the SSF discovery, three JAMSTEC expeditions with DSV Shinkai 6500 (YK13-08, YK14-13 and YK15-11 cruises) and a single NSF-funded US expedition with a deep-towed side-scan sonar IMI-30 (TN273 cruise) investigated the SSF. These follow-up expeditions further discovered brucite and carbonate chimney sites and another vesicomyid clam colony sites [Okumura et al., G3, 2016], and a new species of *Provanna* (Gastropoda: Aabysochrysoidea) [Chen et al., J. Marine Biol. Assoc. UK., 2016]. In spite of many trials during the past expeditions, seeping fluid has not been observed. However, growth of chimneys and active biota from year-to-year indicates continued fluid flow [Okumura et al., G3, 2016].

The SSF formed in the southern Marianas, which is young and tectonically active. This tectonic setting differs from the Mariana forearc to the east, which has been stable for much longer, allowing large serpentinite mud volcanoes to grow. In contrast, SSF is very young and disorganized. SSF appears to be located just below the Moho and in a region with recent basaltic volcanism [Stern et al., Island Arc, 2014]. Based on the observations from the past expeditions, we estimate that the areal extent of the SSF is approximately 500 m by 300 m. However, this estimation is based on the shipboard multibeam bathymetry of R/V Yokosuka, which has the grid size of ~50 m. Therefore, our understanding of the spatial relationships of chimneys and clam colonies is not as well-constrained as it could be, hindering to discuss the subseafloor hydrological structure and geological background of the SSF.

In order to sample the seeping fluid and understand the detailed spatial relationship between SSF chimneys, a JAMSTEC expedition with ROV Kaiko Mk-IV (KR16-14 cruise) was performed in 2016. The expedition obtained the first *in situ* alkaline fluid sample (pH = 9.9) from the SSF. During the expedition, the Kaiko employed a multibeam sonar system, SeaBat 7125, obtaining the first near-bottom

high-resolution bathymetric data with grid size of ~1 m. These new data and observations from KR16-14 cruise will help us understand the structure and evolution of the SSF, and provide avenues for further discoveries in the region.

Keywords: Shinkai Seep Field, Mariana forearc, serpentinite, brucite, carbonate, vesicomyid clam