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Tectonic background of a unique hydrogen-rich Kairei Hydrothermal Field, Central Indian Ridge: Results from Taiga Projec

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The Central Indian Ridge (CIR) is slow-intermediate spreading systems and its southern end forms a R-R-R triple junction with SWIR and SEIR. Kairei Hydrothermal Field (KHF) is unique hydrothermal system, located at the southern end of CIR. The fluids venting from the KHF are characterized by its high concentration of hydrogen with low methane/hydrogen ratio, and a hydrogen-based hyperthermophilic subsurface lithoautotrophic microbial ecosystem was confirmed (Takai et al., 2004). The KHF lies on basaltic lava area on the shoulder of ridge axial wall, being different from other hydrogen-rich hydrothermal fields hosted by ultramafic rocks. We selected this area as an integrated site for the Taiga Project, and conducted series of research cruises to characterize this unique system and to understand how the tectonic setting controls the fluid and ecosystem.

We discover that the KHF itself is located above basaltic lava field but gabbro and ultramafic rocks are widely exhumed around the KHF. Besides a previously known oceanic core complex, small oceanic core complexes exist just east of the KHF (Kumagai et al., 2008) and the NTO massif north of the KHF shows peridotite exposure on its top. The unique fluid geochemistry of the KHF can be attributed to serpentinization of troctolites around or beneath the KHF and subsequent hydrothermal reactions with basaltic wall rocks (Nakamura et al., 2009). We also find several small hills where we collect deep crustal and mantle rocks. These hills suggesting melt-limited environment extends mainly along 2nd order segment boundary from the axial valley to 30km off-axis, i.e. ~1.7 Ma. Detailed gravity analysis shows that the OCCs are accompanied by very high residual Bouguer anomaly (RMBA) and that the KHF is situated at the edge of high RMBA area centered at the Uraniwa OCC. This suggests that the dense material may exist in shallow subsurface and magmatic budget may increase toward the axis. Deep-tow magnetic profile across the area indicates the asymmetric spreading, that are consistent with the detachment faulting. The seismic profiles across the axis, KHF and the Uraniwa OCC shows that the vent site is located along a inward faces steep scarp of normal fault and the fault may play an important role of circulation path and the heat is likely mined from axial magma. The basalt samples collected from the axial valley are normal MORB, while the samples around the KHF is highly depleted in highly incompatible elements. It probably suggests that the source mantle is highly depleted and is difficult to melt. The collected peridotites might preserve relics of older partial melting events, resulting in the formation of heterogeneous mantle material beneath the current CIR axis. The latest stage of decompression melting beneath the CIR might be limited because the presence of depleted peridotite formed by ancient partial melting.

We also discover dead chimneys on the NTO massif north of the KHF. The AUV-attached magnetometer detects a higher positive magnetization around the chimney sites, suggesting hydrothermal alteration of ultramafic rocks. Although densely operated CTD tow-yo surveys do not detect clear evidence of another active hydrothermal vent, an ultramafic-hosted hydrothermalism exists or at least existed on the NTO massif.

All these observations indicate that the KHF is supported by both serpentinization of olivine rich rocks and reaction with basalt maybe in shallow subsurface. The heat source is likely on-axis magmatic heat and inward facing fault can help the circulation. This magma assisted, hydrogen rich hydrothermalism has implications for global incidence and hydrothermal activities and for hydrothemalism in early stage of the Earth history. Our last survey in Taiga project in this area has conducted in January to March, 2013. The preliminary results from this cruise, including submersible dives and OBS and OBEM experiments, will also be presented.

Keywords: hydrothemal system, Central Indian Ridge, oceanic core complex (OCC), mantle rock, geophysical mapping