Hydrothermal system on the 2.77 Ga Mt Roe basalt, Pilbara Craton, Western Australia

M.Nedachi, T.Sugita (Kagishima Univ.), Y.Nedachi (Kagoshima Imm. Heart Univ.), T.Kakegawa, S.Niituma (Tohoku Univ.), K.Terashima (Kagoshima Univ.), J.Nozaki (Dowa) and H.Ohmoto (Penn State Univ.)

The 2.77 Ga Mt. Roe basalt near Whim Creek, Pilbara, Western Australia, exhibits extensive developments of sericite and pyrophillite alteration zones. Based on detailed mineralogical and geochemical investigations on a large number of outcrop samples, we have suggested that the alteration zones are products of submarine hydrothermal activity at shallow water depths and that methanogenic microbes were actively producing methane in the hydrothermal system. The ABDP drilling was carried out at a location ~1 km from the outcrop sites in order to recover fresh samples of the alteration zones of the Mt. Roe basalt for investigations aimed at resolving the controversy on the origin and significance of the alteration zones.

Two units of unaltered basalt, altered basalt, and thick clastic sediments are observed in a 300 m drill core section. The lithology and geochemistry of the drill core are characterized by 1) organic rich black shale with abundant sulfide nodules, 2) lighter C isotopic ratios (−40 to −60 permil) of black shale than those (−40 to −50 permil) in sandstone and shale on the surface outcrop, suggesting the existence of methanotroph, 3) the rare existence of micro-stromatolite in sandstone with the C isotopic ratios of −20 to −30 permil, 4) the S isotopic ratios of the black shale with the peak at about −5 permil and tailing toward heavier value (up to +5 permil), 5) the agitated and altered bedding plane overlying altered basalt, 6) the thinner and weaker alteration zone, 7) the existence of lack of diaspore vein but only black veins, 8) many methane-rich fluid inclusions, 9) slightly higher filling temperature, 10) the lower salinity of fluid inclusion, and 11) various veins showing the difference of mineral assemblage and elemental distribution.

These evidences observed in the drilling core the hydrothermal alteration might occur essentially concurrent with the eruption of the Mt. Roe basalt. Comparisons of mineralogical and geochemical data on the core samples with those on the outcrop samples suggest that a large-scale submarine hydrothermal activity with different colony took place at various water depths. In the wide area methanogens were highly active in the various hydrothermal veins, and that the methanotrophs near the sea floor had exhausted methane gas from the hydrothermal system using the free oxygen produced by stromatolite in the shallow depth and using the oxygen from sulfate ions decomposed by sulfate reducing bacteria in the depth.

Keywords: Mt Roe basalt, 2.77 Ga, hydrothermal alteration, Pilbara, microbe

*Corresponding author; Nedachi@sci.kagoshima-u.ac.jp