Alteration zones of the 2.8 Ga Mount Roe Basalt, Pilbara, Western Australia

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The 2.77 Ga Mt. Roe basalt near Whim Creek, Pilbara, Western Australia, exhibits extensive developments of chlorite and sericite alteration zones. Because of strong depletions of Fe from the sericite zones, it was interpreted as a paleosol formed under an anoxic atmosphere (e.g., Rye and Holland, 2000). However, 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 (Nedachi et al., 2002). 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 Mount Roe basalt for investigations aimed at resolving the controversy on the origin and significance of the alteration zones.

Alternating sequences of unaltered basalt, chloritized basalt, sericitized basalt, and thick black shale are observed in a 300 m drill core section. The alteration zones in the drill core differ from those in the outcrops: 1) the thickness is thinner, 2) the intensity of alteration is weaker, and 3) no diaspore vein, but only black quartz veins are present. Some quartz veins contain fluid inclusions with filling temperature of 100 to 200 degree centigrade, they contain high-salinity fluid (10 to 15 wt% NaCl equiv.), and methane-rich gas phase. Organic carbons (kerogen) with d13C values less than -50 permil were found from the shale and hydrothermal veins. Comparisons of mineralogical and geochemical data on the core samples with those on the outcrop samples suggest that a large-scale submarine hydrothermal activity took place at various water depths and that methanogens were highly active in the environment. Euhedral apatite occurs in the hydrothermal vein, coexisting with bolivarite. Variscite also occurs with replacement texture after bolivarite. They contain rather small amount of uranium and large amount (up to 1.2 wt%) of lead probably decayed from uranium. The SHRIMP age of the apatite in hydrothermal veins is 2.8+/-0.2 Ga, and that of variscite is (21.5+/-0.3 Ga); thus the hydrothermal alteration occurred essentially concurrent with the eruption of the Mount Roe basalt. The age of variscite coincides with the age of metamorphic event including the metasomatism of potassium addition in the Pilbara