Scientific objectives and preliminary results of the Archean Biosphere Drilling Project (ABDP)

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The Archean Biosphere Drilling Project (ABDP), an international scientific drilling project involving scientists from the USA, Australia and Japan, was initiated in Pilbara Craton, Western Australia, in the summer of 2003. The major goal of the ABDP is to increase our understanding of the co-evolution of life and environment during the Archean Era. During a two-month period, we completed drilling 150 - 300 m deep holes at locations to recover fresh (modern weathering-free) geologic formations that range from ~3.5 to ~2.7 Ga in age.

The major drilling targets were: (1) one of the oldest (3.45 Ga) chert/jasper unit and submarine pillow lavas of the Towers formation at Marble Bar; (2) one of the oldest black shale (3.45 Ga) during the eruption of mafic volcanisms of the towers formation at Salgash; (3) black shale in the Archean lake of the Hardey formation at Stoney Creek (2.74 Ga), (4) explosive stromatolite unit and mafic volcanisms of the Tumbiana formation at Meentheena Creek (2.76Ga), (5) black shale in the mid-Archean (2.8-3.2 Ga) Mosquito basin at Eastern Creek, and (6) one of the oldest (2.77 Ga) paleosol? on the Mount Roe basalt at Whim Creek.

The initial investigations on the ABDP drill cores by the Japan-US members have already produced many exciting and interesting data and observations. For example, we have recognized the original textures and mineral assemblages, including hematite crystals of sub-micron size, in the 3.46 Ga Marble Bar chert, and drastic changes in sulfide/organic carbon ratios in black shales of Archean ages.

The focus of this presentation will be on the drill cores of the 2.77 Ga Mount Roe basalt. The drilling site is located ~1 km west of the outcrop areas where previous paleosol investigations were carried out by Macfarlane et al. (1994) and Nedachi et al. (2002). The 330 m-long core is mostly composed of basalt flows with various degrees of alteration and some beds of black shale with thin sandstone. The abundance of black shale, the scarcity of sandstone, the absence of evaporite, the eruption of basalt on unsolidified black shale, and the weak alteration zone, all suggest that the sedimentation depth deepened toward west and that the alteration and volcanism occurred simultaneously in submarine environments. The biomarkers ditected from the surface samples are sterane and hopane, and C isotopic ratios range from -46 to -35 permil. Although sulfides are poorly preserved in outcrop samples, pyrite and/or pyrrhotite nodules are abundant in the black shale. The S and C isotopic ratios range from -5 to +2, and from -56 to -45 permil, respectively. The three dimensional geochemical data suggest that the environment from oxic at shallow site (outcrop) to strongly euxinic due to the activities of sulfate reducers and methanogens at the deeper site (drilling site).

References

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