Late Archean Diversity of Microorganisms: Evidence from Carbon Isotopic Analyses of the Fortescue Group

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Carbon isotope compositions of Precambrian carbonaceous material exhibit a negative excursion yielding up to -60 permil at ca. 2.8Ga (Schoell and Wellmer, 1981; Schidlowski et al., 1983; Hayes, 1994). Carbon isotope fractionation caused by anaerobic methanotrophic bacteria or aerobic methanotrophic bacteria only could explain this negative excursion. But exact timing and the transition from the anaerobic to aerobic condition, and the relationship between the $d^{13}C$ and lithologies are still unknown. We analyzed 117 carbon isotope composition of organic carbon ($d^{13}C_{org}$: -10.25 to -51.84 permil) and inorganic carbon ($d^{13}C_{carb}$: 0.60 to -6.08 permil) in varied lithological samples based on the description of lithology of the Fortescue Group in Redmont area, Western Australia. The high resolution analyses of carbon isotope ratio and detailed stratigraphy of sedimentary rocks revealed that there are two large negative excursions found in mudstone beds in Mingah Tuff Member and stromatolite beds in Meentheena Carbonate Member. Considering the relationship between lithology and $d^{13}C$, we conclude the cause of these excursions might have different origin. The negative excursion in the Mingah Tuff Member results from activities of anaerobic methanotrophic bacteria, whereas that in the Meentheena Carbonate Member results from activities of aerobic methanotrophic bacteria. The former is consistent with the suggestion of Hinrichs (2002) and the latter is also consistent with the biomarker data from stromatolite in Hamersley Province (Eigenbrode et al., 2008). The fact accounts for the presence of extremely low-13C kerogen in ca. 2.8Ga sediments.