Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

BPT25-P08 Room:Convention Hall Time:May 24 17:15-18:30

Origin of organic matter in 3.2 Ga black shale revealed by infrared and laser Raman microspectroscopy

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To reveal the origin and degree of thermal alteration of organic matter (extracted kerogen) preserved in the 3.2 Ga-old, least metamorphosed black shales recovered by DXCL-DP (Yamaguchi et al., 2009), a combined spectroscopic study was performed utilizing laser raman microspectroscopy and micro FT-IR. In the Raman spectra, almost uniform and relatively broad FWHM of D and G bands suggests that the samples were subject to only weak metamorphism, and almost identical positions (central wavenumber) of the D and G bands suggest that such metamorphism evenly affected the unit. In the IR spectra, in order to constrain the origin of organic matter, we use the parameter $R_{3/2}$, the ratios of peak heights for the asymmetric stretching vibration of the CH_3 group and the CH_2 group of aliphatic hydrocarbons. Based on a previous study suggesting that the $R_{3/2}$ ratios can be used to classify the origin of organic matter into three types; that derived from eukarya, bacteria, and archaea (Igisu et al., 2009), the $R_{3/2}$ ratios of our samples indicate that bacteria and eukarya are the likely origin of organic matter in the 3.2 Ga black shale. Such conclusions have important and provoking implications for the evolution of eukaryotes, because it has been commonly believed that eukaryotes first appeared on Earth ˜2 Ga ago, or possibly 2.7 Ga ago. These ages are far younger than the depositional age of our samples (3.2 Ga). To critically investigate the validity of our interpretaion, it is necessary to examine how valid the classification scheme proposed by Igisu et al. (2009) is and how robust the $R_{3/2}$ ratios are against thermal alteration or acid treatment.

Keywords: Australia, Black Shales, Kerogen, Laser Raman, Fourier Transform Infrared, Archean