Early oxygenic photosynthesis in 3.2 Ga Fig Tree Group, Barberton Greenstone Belt?

*Takeshi Kakegawa[1]

1. Graduate School of Science, Tohoku University

Reconstructing Archean ecosystem is important to constrain the evolution of early life. Less metamorphosed sedimentary rocks in ca. 3.2 Ga Fig Tree Group gives us an opportunity to examine where and how the early life habituated. Here I report results of geological and geochemical studies on Fig Tree Group, in particular for Jesefsdal (southern section) and Waggon Road Mine (northern section) areas. For both areas, clastic sedimentary rocks were dominant at the base. Northern section is more dominated by fine-grained black shales rich in various sulfides. Southern section is more dominated by conglomerate. Such horizontal change and mineral characteristic suggest that northern section deposited in deep basin where submarine hydrothermal activities were taking place, and southern section deposited shallow and high energy sedimentation environments. Most of these sedimentary rocks are rich in Cr (up to 900 ppm in black shale). Chromite is often found under microscope. Such finding suggests significantly high flux of clastic materials from ultramafic rocks in ca. 3.4 Ga Onverwacht Group to sedimentary basin of early Fig Tree Group. Some chromite crystals in examined samples have distinct chemistry (very low Mg#) compared to detrital chromite (high Mg #). This suggests that a part of chromite were chemically precipitated from 3.2 Ga ocean water. This further implies the presence of oxidized Cr species (e.g., Cr6+) in 3.2 Ga shallow ocean water. Those clastic sedimentary rocks are overlain by banded iron formations. In particular, silica-rich band in banded iron formation in northern section contain appreciable amounts of organic carbon (up to 0.2 wt %). Surprisingly carbon isotope compositions are constant (at around -25 per mil) from early clastic sedimentary rocks to banded iron formations, although their sedimentary environments and ages were different. Such homogheneous carbon isotope compositions require single and high productive primary producer, which maybe lived in photic zone, through sedimentation of Fig Tree Group. Presence of oxygenic photosynthesis in 3.2 Ga oceans well explains oxidation of Cr (and also Fe2+) and high primary production.

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