The oldest terrestrial material with life-forming elements

*Yukio Isozaki[1], Shinji Yamamoto[2], Shuhei Sakata[3], Hideyuki Obayashi[4], Takafumi Hirata[5]

1. Department of Earth Science and Astronomy, Multi-disciplinary Sciences - General Systems Studies, Graduate School of Arts and Sciences, The University of Tokyo, 2. Department of Human Environmental Studies, Yokohama National University, 3. Department of Chemistry, Gakushuin University, 4. Department of Geology and Mineralogy, Kyoto University, 5. University of Tokyo

Besides amino acid detected in meteorites, terrestrial material that preserves information on the Earth’s earliest life is extremely poor. The oldest C-isotope record for life has been tracked back to ca. 3.9 Ga (Eoarchean), whereas the oldest solid material (zircon) from the Earth to ca. 4.4 Ga (Hadean). The latter represents a potential target to check evidence for life; nonetheless, total amount of the oldest zircon is highly limited; 3 grains out of 100 thousands dated ones. Despite the recent development in radiometric dating techniques, mineral separation still remains as a major obstacle, particularly in the search for the oldest zircon of the Earth. To improve the efficiency in zircon separation, we newly designed and developed a new machinery, i.e. automatic zircon separator (AZS) that operates in three functions; 1) image processing to choose target individual zircon grains out of all heavy mineral fraction, and 2) automatic capturing of individual zircon grains with micro-tweezers, and 3) placing them one-by-one in a coordinate alignment. A new software for automatic and continuous capturing was also designed/created for continuous mineral picking without human attendance for long hours. We tested the practical efficiency of AZS, by analyzing the Archean Jack Hills conglomerate of the Mt. Narryer complex in Western Australia, i.e. the oldest zircon-beqaring rock. Preliminary results are quite positive; we could obtain more than 42 zircons of over 4.0 Ga out of ca. 1,400 checked grains with 4 zircons of over 4,300 Ma with the oldest one of 4,371.1 +- 6.7 Ma. This new AZS system guarantees much higher gain in hunting older zircons. As to the origin of life, we identifiied tiny mineral inclusions in the oldest zircons, apatite, by Raman spectroscopy. These apatite inclusions naturally contain one of the bioessential element P, halogens (F and Cl), and possibly OH. These indicate that early Earth, at least at 4.37 Ga, has prepared inevitable elements and water potentially for generating the first life in near-surface crust.

Keywords: Hadean, life, zircon, automatic separator, apatite

