Evolution of solid earth and surface environment

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Ancient crustal rocks provide the only direct evidence for evolution of the surface environment and solid earth. The Acasta Gneiss Complex is the oldest terrane in the world. We reinvestigated geology, geochronology and geochemistry of the Acasta Gneiss Complex. We recognized six distinct lithofacies, and at least eight tectonothermal events based on 1:5000 scale geological mapping and petrographic investigation of ca 1000 samples. It mainly comprises early Archean Gray (GG), White (WG) and Layered (LG) Gneisses and middle Archean Foliated Granite. GG originated from quartz-diorite, and occurs as enclaves within the WG and LG, which are originally pale-gray tonalitic and white granitic rocks. The gneissic structure of WG is concordant with the shape of the included GG blocks, but completely discordant to those within the GG. The intersection relationship indicates that the GG is older than the well-dated WG (4.0 & 3.7 Ga). In addition, we classified many separated zircons into primary, inherited and recrystallized types more effectively using the Cathodoluminescence images. The REE patterns of primary zircons within the WG are consistent to those of the host Whole rock, whereas WG contain many inherited zircons, up to 4,203:58 Ma (Iizuka et al., 2005a), whose REE pattern is consistent to quartz-dioritic magma based on the discrimination methods. The result indicates that the oldest rocks are the 4.2 Ga quartz-dioritic enclaves within WG, and that the WG was formed accompanied with recycling of some portion of the preceding GG. In addition, recent in-situ analyses of Hf isotope and U-Pb ages of hundreds of detrital zircons from sands of Mississippi River clearly show the significance of recycling of continental materials, and imply extensive distribution of continent in early Earth (Iizuka et al., 2005b).

Redox state of seawater and atmosphere of early Earth is still controversial. Especially, it is still poorly known the detailed secular change of redox state of shallow and deeper part of the seawater, respectively. Composition of carbonate minerals gives constraints on physical and chemical properties of paleoseawater because they are deposited equilibrated with ambient seawater in microbial or abiotic environment. This work presents in-situ analyses of major, trace and rare earth elements of well-preserved carbonate minerals in shallow and deep-sea (over 500 m) deposits. Especially, we focus on carbonates with original textures because of elimination of post-depositional alteration. The shallow marine deposits include sedimentary carbonates in Pongola (3.0), Tumbiana (2.7), Wittenoom and Campbellrand (2.5), Mooidraai (2.4), Kazput (2.3), Duck Creek (2.2), Slave (1.9), Nepal (1.0), Altai (0.58), South China (0.6-0.5) and modern Solomon Islands, and amygdaloidal carbonates within hot-sport basalts in North Pole (3.5), Belingwe and Mount Roe basalts (2.7), Hamersley and modern OIB. Especially, samples in South China comprise carbonate rocks from cap carbonate just after Marinoan global glaciation to middle Cambrian, recording recovery from global anoxic event. The deep-sea carbonates include amygdaloidal carbonates within mid-oceanic and mature rift-type basalts in North Pole, Belingwe, Hamersley, Glengarry (1.9) and modern MORB. Deep-sea carbonates have LREE-enriched pattern with faint Ce and Eu anomalies between 3.5 and 1.9 Ga. In contrast, negative Ce anomalies in shallow carbonates were frequently deviated from those in deep-sea carbonate with the equivalent ages. The negative Ce anomalies increase since 2.78 Ga, but they decreased until 2.72 Ga, again. They significantly increased after 2.6 Ga, but vanished after 2.4 Ga global glaciation, and gradually increased between 2.2 and 1.0 Ga, but vanished after 0.8 Ga global glaciation. They suddenly increased since 0.5 Ga. The evidence implies the complicated secular change of redox state even in shallow water whereas deep-sea environment was anoxic until Proterozoic.