Secular variation of solid earth and surface environment -How to use all samples for decording of whole earth histrory

Tsuyoshi Komiya[1]

[1] Earth & Planet. Sci., Tokyo Inst. Tech.

Many factors produce errors; just one of them is analytical error, which is relatively insignificant in Earth Sciences. For example, the oldest terrestrial material is an inherited core of a detrital zircon in Jack Hills, and is 4404:8 Ma (Wilde et al., 2001). The fact that even the core has wide variation of the age, over 100 Ma, clearly indicates that we should consider many factors in the errors rather based on geology and others than analytical error. We reinvestigated geology, geochronology and geochemistry of the 4.0 Ga Acasta Gneiss Complex for studying continental formation and growth in early Earth. 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. The intersection relationship, principal theory of geology, indicates that the Gray Gneiss is older than the well-dated WG (ca. 4.0Ga). In addition, we classified many separated zircons into primary, inherited and recrystallized types more effectively using the Cathodoluminescence images. We found many inherited zircons up to 4,203:58 Ma, 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. 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).

The Isua supracrustal belt is the oldest, 3.8 Ga, accretionary complex with MORB, OIB, and pelagic/terrigenous sediments. The estimate of the tectonic setting of the volcanics (application of accretionary geology to Archean greenstone belts) and elimination of post-magmatic alteration (first discovery of the oldest igneous clinopyroxene and the in-situ analyses of ME and REE) were essential to estimate the secular variation of composition and temperature of the upper mantle since 3.8 Ga (Komiya, 2004). The result showed that the upper mantle was highly enriched in FeO (10 wt%), but that the FeO content was constant until early Proterozoic, and then decreased. The potential mantle temperature was hotter by at most 150 to 200 C even in the Early Archean, and cooled episodically, concomitant as FeO decreased.

Continental growth is one of the important subjects to understand not only the evolution of solid earth but also surface environment. Especially, continental growth rate and mechanism of its formation are essential. Recently, we showed that quite amount of continental crust was formed around 2.2 and 2.7 Ga from the in-situ U-Pb dating of hundreds of detrital zircons from river sands (Rino et al., 2004). For the latter subject, we made in-situ analyses of ME and REE of relict igneous plagioclases in the Archean and Phanerozoic granitoids. The method is very useful to estimate the primary composition of the coexisting magma because many granitoids still contain relict igneous plagioclases even if post-magmatic alteration/metamorphism and accumulation of crystallized minerals influence the whole rock composition. The results showed that slab melting was more significant mechanism of formation of granite rather than previously considered.

Our philosophy is accumulation of multidisciplinary investigation like pyramid system. In the system, geology gives us basic but necessary constraints to tectonic settings of volcanism, metamorphism and sedimentation, and outlines of tectonothermal events as well as geological mapping over wide areas, and collection and detailed petrographic description of many fresh samples eliminate any secondary modification. As a result, it minimizes bulk errors. Finally, we try to decode the whole history of the earth from the samples collaborating with many geochemists and mineralogists.