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Editorial

In-situ analyses of zircon and other minerals: Contributions to the Asian geology and tectonics

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Various techniques for in-situ isotopic analyses have been available at least for a couple of decades, but it has not been exactly so in the Korean community. In order to not only lessen this gap but also celebrate the introduction of a sensitive high-resolution ion microprobe (SHRIMP) into Korea, we organized a theme session at Busan during the 2008 AOGS Meeting, entitled as "In-situ dating of zircon and other accessory minerals: Contributions to the Asian geology and tectonics". This session has gained much attention from the AOGS participants and resulted in this Special Issue in *Geosciences Journal*. In the mean time, the Korean SHRIMP has been successfully installed at the Korean Basic Science Institute (KBSI) in November, 2008, as planned, and ready for external researchers to use it for their own or cooperative project (for further details, refer to http://shrimp.kbsi.re.kr/). We hope this issue introduces a variety of in-situ analytical technique available at the present time which may help East Asian community, including Korean colleagues, to step forward in understanding the tectonics and other related fields in Asia.

This Special Issue publishes a total of ten papers, not only dealing with various topics on in-situ analyses but also covering geographically wide regions including Gabon, Korea, Russia, Taiwan, and Viet Nam. The first six papers deal with the U–Pb dating of zircon, using the SHRIMP and LA-ICP-MS (laser ablation-inductively coupled plasma-mass spectrometry). These papers on zircon dating are followed by two papers on monazite dating, using not only the SHRIMP but also the CHIME (chemical Th–U–total Pb isochron method) techniques. Both papers report the monazite dating in the same metamorphic region (Hwacheon granulite complex) and thus provide good reading materials for comparing different approaches involved. Next one is a paper on allanite dating, which timely introduces new research field emerging from the in-situ SHRIMP dating of metamorphic minerals. Final paper of this issue ends with the in-situ micro-sampling and $^{40}Ar/^{39}Ar$ geochronology of hornblende intercalated with biotite. In the following, each paper is briefly introduced.

The first paper of by Horie et al. (2009) presents the SHRIMP U–Pb zircon ages of 1937 ± 6 Ma and 293 ± 31 Ma from migmatitic gneisses in the Busan gneiss complex, Gyeonggi massif, Korea. They interpreted these ages as the timing for regional migmatization and subsequent metamorphic overprint, respectively. In conjunction with the monazite Th–total Pb age of ca. 289 Ma, the authors concluded that the Busan gneiss complex was affected by the Early Permian metamorphism during the Ogcheon orogeny. As a consequence, the Busan gneiss complex is interpreted as a part of the Gyeonggi massif being emplaced as an exotic block or as a basement rock. The authors further suggest that the Busan complex is possibly linked with the Hida-Oki terrane in Japan.

Park et al. (2009) report the SHRIMP U–Pb zircon ages, together with geochemical and Sr–Nd isotopic data, for Jurassic granitoids from the southwestern Gyeonggi massif, Korea. Foliated and non-foliated I-type granitoids are dated at ca. 179 Ma and 167 Ma, respectively, whereas a non-foliated body of A-type alkali-feldspar granite is dated at ca. 165 Ma. The authors suggest that I-type granitoids are the product of subduction of the paleo-Pacific plate, whereas the latter has intruded in an extensional setting after the termination of arc magmatism. Based on K–Ar ages, they further suggest that deformation event(s) occurred during the Latest Jurassic to Early Cretaceous.

Lan et al. (2009) report the in-situ U–Pb geochronology and Hf isotope characteristics of Precambrian (>2.3 Ga) detrital zircons from Taiwan. Zircons from the eastern Backbone Range and Eastern Central Range yielded Paleoproterozoic to late Neoarchean ages, whereas those from the Hsuehshan Range gave Neoarchean to Mesoarchean ages (2.6–3.2 Ga). The $\varepsilon_{Hf}(T)$ values for the Paleoprotero-

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zoic to late Neoarchean zircons range from –7.4 to +5.1, implying both juvenile crustal growth and the reworking of old crustal materials. The latter might have operated since the Mesoarchean–Paleoarchean (3.0–3.4 Ga). Based on the in-situ isotopic result, the authors predict that the discovery of Eoarchean zircon in Taiwan is highly likely.

Usuki et al. (2009) present ca. 450 Ma zircon overgrowth rims mantling Late Neoproterozoic to Neoarchean inheritance cores, based on the SHRIMP analyses of paragneisses from the Kham Duc Complex, central Vietnam. These results are respectively interpreted to represent the timing for an Early Paleozoic medium-pressure metamorphism, and to reflect the ages of Precambrian protoliths derived from sediments at the Gondwana margin. Thus, the Permo-Triassic $^{40}Ar/^{39}Ar$ ages documented by previous workers are interpreted to result from an Indosinian overprint.

Kikuchi and Hidaka (2009) report in-situ U–Pb analyses of highly altered zircon from sediments overlying the Bangombé natural fission reactor, Gabon. The analyzed zircon grains widely vary in the U contents ranging up to 59000 ppm, and the conventional SHRIMP U–Pb calibration technique is inapplicable for the high-U zircon. Therefore, the authors used the analytical combination of U/Pb elemental ratios from electron microprobe (EPMA) analyses and Pb isotopic ratios using the SHRIMP, especially for the U–Pb determination of zircon containing greater than 2500 ppm U.

Using the LA-ICP-MS technique, Jwa et al. (2009) analyzed magamatic zircons from the Kusandong Tuff which has been known as a key bed for the subdivision of the Upper Cretaceous strata in the Gyeongsang Basin, Korea. The depositional age of this tuffaceous bed is estimated as ca. 97 ± 2 Ma, whereas xenocrystic zircons are dated at 107.9 ± 3.0 Ma.

Suzuki (2009) document in detail the monazite ages in granulites and paragneisses from the Hwacheon area, Korea, using his trade-mark CHIME technique. The monazite grains in fresh granulites yielded a CHIME age of 1868 ± 24 Ma, whereas those of mylonitic granulites contained metamorphic domains dated at ca. 241 Ma. In contrast, pelitic gneisses in the neighboring gneiss complex yielded a metamorphic age of ca. 245 Ma. The author further suggests that the widespread occurrence of Permo-Triassic paragneisses and mylonites in the Gyeonggi massif could be attributed to the detachment of upper-crustal piece of the South China block, thrusting over the Paleoproterozoic granulite complex.

Yi and Cho (2009) present the SHRIMP geochronology and reaction texture of monazite from a retrogressive transitional layer in the Hwacheon Granulite Complex, Korea. Their result is comparable with that of Suzuki (2009) in this issue. In addition, the crystallization age of symplectic allanite is also reported to be either Devonian or Triassic, based on Th–Pb and U–Pb ages, respectively. This study demonstrates that a detailed investigation is required to understand the temporal relationship between accessory mineral growth and its microstructure such as corona or symplectite.

Kim et al. (2009) report the SHRIMP U–Th–Pb dating of allanite from tonalitic gneisses in Daeijak Island, central Korea. The U–Pb and Th–Pb isotopic systems in allanite provide the timing for bimodal metamorphic events in the range of ca. 228–215 Ma in a Neoarchean migmatite terrane. The authors suggest that the U–Th–Pb system of allanite can be used as a new chronometer to investigate the metamorphic event not recorded in other isotopic systematics of a migmatitic terrane.

Final paper of this issue is given by de Jong (2009) who discusses the staircase-shaped $^{40}Ar/^{39}Ar$ age spectra of hornblende, with apparent partial loss, from the Palaeoproterozoic Lapland-Kola orogen, Russia. The extraction of hornblende grains by drilling thin sections allowed him to demonstrate that the apparent complexity in age spectra is a product of the contamination effect from biotite inclusions in hornblende. His result suggests that in-situ micro-sampling geochronology is a powerful tool for gaining geologic insight in poly-metamorphic terranes.

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