Sr-Nd-Hf Isotopic Characterization of Granitoids in Accretionary Orogens of Asia and Implications for Crustal Development

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Asia is composed of several major Precambrian cratons (Siberia, Sino-Korean, Tarim, India) welded by Phanerozoic mobile belts or orogens. Three giant mobile belts are best recognized: (1) the Altaid or Central Asian Orogenic Belt (CAOB), (2) the Tethysides, and (3) the Nipponides (Sengor and Natal’in, 1996) or Western Pacific Orogenic Belt. Mobile belts were formed through successive accretion of island arc terranes and dispersed micro-continental fragments within the Paleo-Asian Ocean (for the CAOB), Paleo- and Neo-Tethys (for the Tethysides), and Paleo-Pacific and Pacific Oceans (for the Nipponides). The Phanerozoic mobile belts comprise many accretionary orogens which are important building blocks of the continental crust. In this talk, new and literature isotopic data (Sr-Nd-zircon Hf) will be used to address the issue of granitoid generation and crustal development, particularly in the CAOB and Nipponides. Extensive geochemical and isotopic studies of granitic rocks in the last decade have revealed that (a) the generation of these rocks from the CAOB involved significant contribution from the upper mantle; that is, substantial amount of juvenile crust has been added to the Asian continent; (b) the CAOB appears to have formed by assemblage of Precambrian micro-continental fragments and Phanerozoic juvenile crust produced by both lateral accretion of arc complexes and vertical accretion of underplated material of mantle derivation (e.g., Jahn, 2004; Kovalenko et al., 2004; Wang et al., 2009). In the Nipponides, the formation style of the Japanese Islands has long been taken as a classic model of the accretionary orogeny and often serves as an example for understanding the crustal evolution of other accretionary orogens (Isozaki, 1996; Maruyama et al., 1997; Isozaki et al., 2010). Available geochemical and isotopic data on granitic rocks from SW Japan suggest that Mesozoic and Cenozoic granitoids possess signatures of old crustal component (Jahn, 2010). Thus, the subduction-accretion complexes in SW Japan are probably composed much of “recycled” continental crust of Proterozoic ages. By contrast, the bulk crust of the Pre-Tertiary basement rocks in NE Japan (north of the Tanakura Tectonic Line) and the island of Hokkaido are quite “juvenile” based on geochemical and Sr-Nd-Hf isotopic compositions of the granitoids (Jahn et al., 2014).

New zircon dating on the granitoids from the Sikhote-Alin Range (Jahn et al., in prep.) indicates that the granitoids occurring in the coastal area (south of 45°N), in the Tauka Zone, were emplaced from ca. 90 to 56 Ma; whereas those emplaced along the Central Sikhote-Alin Fault, in the Samarka Zone, were intruded during ca. 110 to 75 Ma. The Tauka and Samarka zones are Cretaceous and Jurassic accretionary complexes, respectively. Whole-rock Sr-Nd and zircon Hf isotopic data suggest that the granitoids were derived from mixture of juvenile and recycled source rocks.

A comparison between the orogens of the CAOB and Nipponides leads to the following conclusions. (1) The crustal development of NE Japan (mostly juvenile) is distinguished from that of SW Japan (juvenile + recycled); NE Japan (with Hokkaido) is quite similar to the Junggar Terrane of NW China and the Lake Zone of Mongolia (CAOB), whereas SW Japan is more comparable with the composite Tian Shan orogen. (2) Accretionary orogens could be distinguished by the nature of the accreted lithological assemblages. Orogenes with dominantly island arc assemblage would lead to generation of granitoids with juvenile characters, as shown by the granitoids of NE Japan (Hokkaido included), the Junggar Terrane of China (Chen and Jahn, 2004; Tang et al., 2012) and the Lake Zone of Mongolia (Kovach et al., 2011). (3) By contrast, orogens with accretionary complexes developed in a Precambrian continental margin would have granitic rocks with more crustal signature. This is represented by SW Japan, in which the “recycled Precambrian crust” component is significant in the granitoid magma generation; (4) the isotopic signature of SW Japan may support the tectonic model of Maruyama et al. (1997) and Isozaki et al. (2010) in which Proto-Japan was initially developed along the coast of SE China, and shared a similar source region (the Cathaysia) with Taiwan during the late Paleozoic to late Mesozoic. The shared source of SW Japan-Taiwan-SE China is witnessed by the Nd isotopic signatures and inherited zircon age patterns; (5) Sr-Nd isotopic differences are observed between SW Japan, NE Japan and Sikhote-Alin, suggesting that the existing tectonic correlation schemes (e.g., Khanchuk et al., 2001) of Sikhote-Alin with the Japanese Islands should be revisited with the new age and isotopic constraints.

引用文献