Tectonic and dynamic evolution of Eastern Asia since ˜100 Ma: constraints from magmatism and metamorphism

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The Japanese island arcs and the surrounding area have undergone various types of magmatism and metamorphism, associated with remarkable tectonic events. In this presentation, we review the major geological events and propose a model in which the various events near the surface may be linked as a consequence of subduction dynamics that has been changing systematically with time.

During the mid to late Cretaceous, regional metamorphic belts, the Sambagawa (high P/T-type) and Ryoke (low P/T-type) belts, have been formed sharing at least partly their formation ages. This 'paired metamorphism' (Miyashiro, 1961) has been reproduced in numerical modeling as a natural consequence of ridge subduction (Iwamori, 2000), rather than an accidental amalgamation of two contrasting metamorphic belts separately formed. Both heat and water were supplied to the fore-arc region, where a large geothermal gradient has been produced to cause both high and low P/T-types of metamorphism within a single fore-arc domain during a relatively short period of time.

During this event near the trench at that time, in South Korea, the Cretaceous granitic magmatism has occurred associated with the basaltic magmatism. Park et al. (2005) has revealed that, based on U-Pb dating of zircon, this granitic magmatism has migrated systematically over 50 m.y. to SSE (i.e., toward the trench side at that time). In addition, Park (2009) petrologically deduced that partial melts from the lower crustal amphibolite and the simultaneous basaltic magmas were hybridized to produce the rock suite, and that the bimodal magmatism and its migration could have been attributed to delamination under South Korea. By contrast, the granitic magmatism in the SW to central Japan arcs has migrated towards the continental side, possibly due to thermal effect triggered by ridge subduction stated above (Park, 2009). Consequently, both magmatisms have encountered at SE Korea and the San-in area at around 45-35 Ma, which is exactly the site where the Japan sea started to open 5 to 10 m.y. after the cessation of the granitic magmatism. Then around and after opening of the Japan sea, several different types of magmatisms corresponding to green tuff, the Setouchi volcanics, and monogenetic alkaline-subalkaline volcanism have occurred in Southwest Japan.

All these metamorphic and magmatic activities can be understood by a continuous change in terms of configuration of subducted plates: (1) hot plate subduction (ridge subduction) to cause paired metamorphism, associated with delamination beneath the back-arc region, which could have been triggered by a weak plume originated from the former subducted ridge, (2) subsequent subduction of a colder plate, which hit the 660 km and applied tensile stress to the back-arc region through trench retreat, resulting in opening of the Japan sea, and (3) stagnation of the cold slab from which volatiles have been released to create wet region in the eastern Asia, including the alkaline-subalkaline magmatism. The near-surface tectonics, metamorphism and magmatism have been probably controlled by the slab configurations and dynamics.