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Chronology, Petrology and Numerical Simulation for Cretaceous to Paleogene Granitic Rocks, SW Japan

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Granitoid is one of the main components of the continental upper crust, and is thought to provide key information on evolution of the continental crust yet the origin of granitoid remains enigmatic. In order to address this important and unresolved problem, we have studied the origin of the Cretaceous to Paleogene granitic rocks in SW Japan. We especially focus on (1) spatial-temporal variation of granitoid, (2) temporal variation of petrological signature of granitoid, and (3) tectonic and dynamic setting that caused the observed spatial-temporal variation and provided heat for the melt generation, based on the U-Pb zircon age, whole rock chemistry, and numerical simulation for the thermal field of subduction zone. As a result, systematic spatial-temporal variations of magmatism and the spatial variations of petrological signatures in SW Japan have been observed. Numerical modeling suggests that ridge subduction model can explain spatio-temporal variation of granitic rocks in SW Japan. Based on these results, we discuss the origin of these variations.

U-Pb zircon age determinations using LA-ICPMS was performed on total 91 rock samples. The obtained age range from 95 Ma to 30 Ma, with a possible temporal gap between 60 Ma and 50 Ma. During 95-60 Ma, the systematic migration of granitoid magmatism from the south to the north occurred. Temporal variation of petrological signatures is also observed: with time, (1) initial ratio of Sr isotopes (87Sr/86Sr) decreased from enriched characters (0.7090-0.7065) to depleted ones (0.7065-0.7050), and (2) rock types of granitoid changed from ilmenite-series to magnetite-series.

In order to investigate the mechanism of temporal changes observed, ridge subduction model has been tested with numerical simulation, especially in terms of thermal impact of the subducted ridge as a function of subduction velocity and angle with or without slab window. The numerical results suggest the following points: (1) thermal impact of ridge subduction is potentially large especially when subduction velocity changes from high to low (i.e., the leading plate subducts faster), creating a slab window, (2) after the ridge subduction, melting region, mainly of slab melting, shrinks from the trench side to the rear arc side, and (3) subduction angle together with subduction velocity is important to control the overall duration and spatial range of magmatism, required to explain the observed wide horizontal range of the magmatism.

Finally, the numerical results have been compared with the observed spatio-temporal variation of the granitoid magmatism in SW Japan. The comparison suggests that the observed features (e.g., long duration (greater than 35 m.y.), a wide across-arc distance (˜150 km) of the magmatism, and northward (toward backarc side) migration of the magmatism) require a shallow subduction angle (˜10 degrees) with velocity change of the plates from high to low is required. With these specific conditions, it is inferred that the ridge subduction could have been the primary cause of Cretaceous to Paleogene granitoid magmatism in SW Japan.