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Pulsed granitic crust formation revealed by comprehensive SHRIMP zircon dating of the SW Japan granitoids

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The origin of continental crust is a fundamental question in Earth's evolution. Granitoids, its volcanic equivalents, and metamorphic and sedimentary rocks with granitic compositions, are the main components of the upper continental crust. It is therefore important to understand the geodynamic settings in which juvenile granitic magma is generated from mantle-derived sources. Convergent plate margins, such as the Mesozoic circum-Pacific orogenic belts, are regarded as one of the plausible candidates for the post-Archean continental crust formation, as they are associated with abundant calc-alkaline I-type batholiths. However, the fundamental tectonic processes that triggered these voluminous granitic crust formations in the Mesozoic have remained largely unresolved due to the lack of precise temporal constraints on the granitic magmatism. We are currently undertaking a comprehensive geochronological study of the granitic batholith exposed in the Southwest Japan Arc, which is typical of the Mesozoic circum-Pacific orogenic belts utilizing high-precision zircon U/Pb geochronology.

In order to precisely determine the space-time distribution of the granitic magmatism that occurred in the SW Japan Arc during the Mesozoic, we have used the zircon U/Pb method to date a comprehensive suite of granitic rocks from the Chugoku Region in the SW Japan. Contrary to the results previously obtained using conventional geochronological methods, which suggested that the magmatism occurred gradually from ~100 to ~50 Ma, with the plutons forming over long time intervals, the newly obtained zircon ages reveal three clear pulses of granitic crust formation at 85, 60 and 35 Ma separated by 25 million year intervals. The 85 Ma magmatism was the most voluminous and was distributed in a broad zone that extends ~120 km across-strike, whereas the magmatism at 60 and 35 Ma were focused on the northern margin of the SW Japan Arc. Furthermore, the granitic magmatism at 85 Ma involved sediment-incorporated, ilmenite series granitic rocks, while the magmatism at 60 and 35 Ma involved more juvenile, mantle-derived, magnetite series rocks. Thus, not only did the granitic magmatism in SW Japan occur in pulses, there was also a spatial and compositional transition in the magmatism through time. This can be best explained by enhanced subduction zone magmatism during the Mesozoic, rather than the previously proposed model in which it was suggested that the granitic crust was formed by the subduction of a mid-ocean ridge on the Pacific Plate during the Middle Cretaceous.