Zircon Hf-O isotope evidence for Late Triassic subduction initiation in South Alaska

JIN-HUI YANG[1, 2, *], HAO WANG[1], RONALD COLE[3], YU-SHENG ZHU[1], SUN-LIN CHUNG[4]

[1] State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China
[2] University of Chinese Academy of Sciences, Beijing 100049, China
[3] Department of Geology, Allegheny College, 520 N. Main St., Meadville, PA 16335, USA
[4] Institute of Earth Sciences, Academia Sinica, Taipei 11529, Taiwan
*E-mail: jinhui@mail.igcas.ac.cn

Subduction of oceanic lithosphere is the primary driver of plate tectonics on the Earth. Subduction-related magmatism and metamorphism have been provided insights into the processes of normal subduction of oceanic plate. However, it is still poorly understanding those at the inception of subduction, hindering our understanding the development of subduction zones. Here we present an integrated study of in situ Hf-O isotopes in zircons from Late Triassic to Late Jurassic plutonic rocks in the southern Alaska. The Late Triassic trondhjemites have sub-normal mantle $\delta^{18}O$ (average 4.77 ± 0.09‰) and positive $\varepsilon_{Hf}(t)$ values, with low MgO, high Y and HREE contents and negative Eu anomalies, indicating that they were derived from partial melting of high-temperature hydrothermally altered oceanic crust at shallow depths with plagioclase in residue. Whereas, the Late Jurassic trondhjemites have elevated $\delta^{18}O$ (average 5.78 ± 0.06‰) and positive $\varepsilon_{Hf}(t)$ values with low Y and HREE contents and positive Eu anomalies, suggesting that they were produced by partial melting of juvenile lower mafic crust at high pressures with garnet in residue. Between these two stages, Early to Middle Jurassic diorite and granite have similar geochemical characteristics and zircon Hf-O isotopes to the typical arc magmatism. Combined with the occurrence of high pressure blueschists in this region, our results show that the Late Triassic to Middle Jurassic magmatism possibly reveals the subduction-related magmatism from initial to mature stages. The distinct features between initial and mature subduction would be whether the cold mantle wedge occur that control the temperatures and depths of magma generation. Models of subduction initiation predict a hot mantle above the subducted slab at initial stage of subduction, where temperatures are high (> 700 °C) enough to induce partial melting of subducted oceanic crust at shallow depths. If our model accurately describes the formation of subduction processes of oceanic lithosphere from initial to mature stages, it opens new avenues for reconceptualization of the initiation and processes of global plate tectonics.