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# Magmatic evolution of Baekdusan (Changbaishan) volcano as revealed by zircon U-Th geochronology and O-Hf isotopes from the Millennium Eruption

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The silicic volcanism of Baekdusan (also Romanized as Paektusan in Korea, Changbaishan or Baitoushan in China, and Hakutosan in Japan), an active 2,744-m-high stratovolcano located on the border between North Korea and China, was initiated in the Middle Pleistocene and culminated in the 10th century with a tremendous (volcanic explosivity index = 7) commendite-trachyte eruption commonly referred to as the "Millennium Eruption (ME)." The present study uses in situ U-Th disequilibrium ages and O-Hf isotopic compositions of zircons from trachydacitic pumices ejected during the ME to trace the magmatic evolution at Baekdusan. The mass spectrometric U-Th isotope data yield an earliest Holocene cluster (11.3 $\pm$ 1.3 ka) and Middle-Late Pleistocene populations (ca. 230 and 110 ka). These multiple age components indicate that the Baekdusan magma has been generated at intervals of ca. 120–100 ky. The consistent age pattern of the zircons suggests the persistent existence of the same magmatic plumbing system beneath Baekdusan since the ME. The zircon crystals have a moderate inter-grain variation in $\delta$18O (with reference to V-SMOW) from 3.69‰ to 5.03‰Ṫhese values are consistently lower than the normal mantle range, and interpreted to have resulted from the digestion of meteoric-hydrothermally altered intracaldera rocks in the shallow magma chamber beneath Baekdusan. The wide range of zircon $\varepsilon$Hf values (+5.8 to –3.5) reflects an interaction between the primitive magma from enriched mantle source and pre-existing crustal materials, which is evidenced by the presence of a xenocrystic zircon core showing a significantly negative $\varepsilon$Hf value (= –21). A broad negative correlation observed between zircon $\varepsilon$Hf and $\delta$18O values could be ascribed to the progressive assimilation of weathered supracrustal rocks. Zircon O-Hf isotope data lead to the conclusion that the primitive Baekdusan magma has assimilated magma chamber roof rocks and adjacent basement rocks, most likely in the course of shallow crustal cannibalization and magma expansion.