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Sr, Nd, Pb and Hf isotopic Compositions of Late Cenozoic Alkali Basalts in South Korea: Evidence for Mixing Between the Two Dominant Asthenospheric Mantle Domains Beneath East Asia

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We have determined the Sr, Nd, Pb and Hf isotopic compositions of 13 samples from six late Cenozoic centers of basaltic volcanism in South Korea, including Baengnyeong Island, Jogokni, Ganseong, Jeju Island, Ulleung Island and Dok Island, in order to understand the nature of the mantle source and melt-generating processes. The basalts have OIB-like trace element abundance patterns, and also contain mantle-derived xenoliths of primarily spinel peridotite. Combining our new isotopic data with previously published data from areas with late Cenozoic basalts throughout East Asia shows that the mantle source has a DMM-EM1 array for northeast China and a DMM-EM2 array for Southeast Asia.

The Korean Peninsula basalts we have studied are geographically located between these two broad domains, and interestingly, define an array between DMM and an intermediate end member between EM1 and EM2 on various isotopic correlation diagrams. Variations along the array on isotopic correlation diagrams are systematic regionally, with EM2 signatures predominant on Jeju Island and EM1 becoming increasingly more important toward Ulleung and Dok Islands, the Ganseong area, and Baengnyeong Island. This is without any corresponding changes in the basement and the lithospheric mantle beneath the region. These observations suggest that the Korean Peninsula late Cenozoic basalts we have studied and other East Asia late Cenozoic intraplate volcanism are sourced in the asthenospheric mantle. This mantle is characterized by two distinct, large-scale domains - one a mixture of DMM and EM1 components, and the other a mixture of DMM and EM2.

Previous studies on East Asian Cenozoic volcanic rocks have advocated origins by either plume activity or decompressional melting of the mantle lithosphere in a rift environment. On the basis of our new trace element and isotopic compositions, which have OIB-like characteristics, we rule out an origin in the mantle lithosphere. Furthermore, because of the absence of typical hotspot tracks with clear age progressions, and so far, lack of unequivocal tomographic images delineating distinct, deep-seated thermal anomalies that could be interpreted as plumes, we suggest that the late Cenozoic alkalic magmatism in East Asia originated in the shallow asthenosphere, largely in response to dramatic changes in stress regimes. The interplay between the India-Eurasia collision and subduction of the Pacific Plate beneath the eastern margin of Eurasia resulted in a late Cenozoic tensile setting in East Asia capable of inducing melting in the asthenosphere by decompression. This is contrary to previous studies which advocated a plume or a mantle lithospheric origin for the East Asia late Cenozoic alkalic volcanism.