Secular (136 to 0 Ma) Chemical Variation of Mantle-Derived Mafic Magmas in the Sino-Korean Craton: Constraints on Mantle Evolution

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Geochemical studies of mantle xenoliths from early Paleozoic kimberlites in North China demonstrate that the subcontinental lithospheric mantle (SCLM) beneath the Sino-Korean Craton was then cold, refractory and about 200 km thick. In contrast, mantle xenoliths from late Tertiary basalts of the region suggest that the present SCLM is hot, relatively fertile and <80 km thick, consistent with geophysical data. This contrast indicates a removal of at least 120 km of old mantle root during the period. Systematic geochemical variations of mantle-derived magmas (136 – 0 Ma) in the region can constrain the nature and evolutionary history of the SCLM beneath the North China craton.

The mantle-derived rocks include high-Mg andesites (136-107 Ma), minettes (103-91 Ma), tholeiites (61-25 Ma), and strongly alkaline basalts (16-0.7 Ma). The Cretaceous high-Mg andesites form a Sr-Nd isotope trend pointing to EM1 ($^{87}Sr/^{86}Sr$ =0.7040-0.7049 and ε_{Nd}=-5 to -14), while the minettes have very low ε_{Nd} (-13 to -18) and variable high $^{87}Sr/^{86}Sr$ ratios (0.7056-0.7100), showing a trend between EM1 and EM2 mantel source types. Both of them have fractionated incompatible-element patterns. The Late Tertiary alkaline basalts have Sr-Nd isotopic ratios (0.7032-0.7037 and +3.8 to +5.8) and incompatible element patterns indistinguishable from Ocean Island Basalts (OIBs). The Early Tertiary tholeiites are intermediate between the old and young rocks in terms of Sr-Nd isotope ratios and incompatible element patterns. The Late Tertiary alkaline basalts have $^{206}Pb/^{204}Pb$ ratios between 17.89 – 18.49 with Δ8/4 values of +50 to +70, typical of the Dupal-OIB signature. In contrast, most of the Cretaceous lavas have lower $^{206}Pb/^{204}Pb$ (mostly between 16.59-17.84), but higher Δ8/4 values (+55 to +120). Some of the early tertiary tholeiites have Pb isotopic signatures similar to the Cretaceous rocks, but others show both high $^{206}Pb/^{204}Pb$ (19.37-19.44) and Δ7/4 values (+20).

The integration of these new data with published data for the Paleozoic kimberlites, Mesozoic and Tertiary basalts and mantle and lower crustal xenoliths entrained in these rocks indicates that the temporal geochemical variations can be explained as the consequence of the diminishing role of the Archean SCLM beneath the Sino-Korean Craton in magma generation as it was gradually destroyed since Late Cretaceous. The enriched geochemical signatures of the Cretaceous mafic lavas may have derived directly by contamination from the old metasomatised refractory SCLM beneath the North

China craton without the necessity for the involvement of crustal material from the subducted Yangtze plate during Early Triassic times.