Recycling deep cratonic lithosphere and generation of intraplate magmatism

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Recycling continental lithosphere via foundering is suggested to be an important geodynamic process but is difficult to document (Sobolev et al., 2005). Here we show that Early Cretaceous alkaline picrites and high-magnesium basalts from the North China craton provide evidence for such recycling. These mantle-derived lavas contain both xenocrystic and magmatic olivines. The former have high Fo\(_{92-93}\) and low CaO (<0.10%) and suggest derivation from the Archean mantle lithosphere. More importantly, these lavas contain unusual reversely zoned clinopyroxenes. Compositions of their low Mg cores and high Mg mantles are consistent with crystallization from eclogite- and peridotite-derived melts, respectively. The cores are high in Na\(_2\)O (up to 2.4%) and frequently contain ilmenite exsolution lamellae, whereas the mantles are low in Na\(_2\)O (<0.92%) and lamellae-free. These lines of evidence suggest that the cores formed at a significantly greater depth (>2.5 GPa) than the surrounding mantles (>1.5 GPa). The whole-rock compositions of the basalts also contain chemical evidence (high Ni/Fe, Fe/Mn, Sr/Y, La/Sc, and Th/U ratios and low Lu/HF ratio) for their derivation from an olivine-free source and incorporation of melts derived from foundered eclogitic continental crust. Together with our previous studies of the late Jurassic high-Mg intermediate to felsic lavas from western Liaoning in the northeastern North China craton (Gao et al., 2004), these findings indicate that thinning of the North China craton was caused by recycling of the lower lithosphere (mantle and lower crust), and demonstrate that continental lithosphere recycling is a viable means of producing mantle heterogeneity.

References