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Mantle Replacement in South China Block during the Mesozoic and the Cenozoic

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Deep–seated mantle xenoliths could provide important compositional and thermal information for the sub–continental lithospheric mantle (SCLM). We have conducted petrolgoical and geochemical studies on both Mesozoic and Cenozoic mantle xenoliths from the South China Block (SCB). In particular, we have analysed the whole–rock Re–Os isotopes, aiming to constraining the formation of the SCLM. In the South China Block (SCB), mantle xenoliths have been rarely found in both Paleozoic and Mesozoic volcanic rocks. The Paleozoic mantle xenoliths have been only discovered in the Dahongshan lamproite, which were emplaced at *ca* 480 Ma. P–T estiamtes indicate that they have hot temperatures of 1024~1155 ^{o}C and pressures of 3.4~3.6 Gpa, corresponding to depths of 110~120 km. The garnet lherzolites display enriched characteristics of both trace elements and isotopes (Zhang et al., 2001). Their clinopyroxenes have $^{87}Sr/^{86}Sr$ and ε_{Nd} of 0.707844~0.706614 and –4.33~–5.7, respectively. Meanwhile, the Dahongshan lamporites also have enriched Sr–Nd isotopes, with ε_{Nd} of –3~–12. Similarly enrihced Sr–Nd isotopes are also shown by lamporites that were coevally empalced at Zhengyuan in Guizhou Province (Fang et al., 2002). All these evidence support the existence of enrihced SCLM beneath the South China Block during the Plaeozoic.

The Mesozoic mantle xenoliths have been only discovered in the hinterland of the South China Block, e. g., Ningyuan and Daoxian in soutehrn Hunan Province. The Ningyuan mantle xenoliths mainly consist of spinel lherzolites, with few harzburgites (Zheng et al., 2004; Liu et al., 2012a). No garnet peridotites have been found yet. The studied Ningyuan mantle xenoliths have fertile compositions, with bulk–rock MgO and Al_2O_3 conents of 32.72~38.01% and 1.72~4.09%, respectively (Liu et al., 2012a). Olivines have Fo contents of 88.3~90.8 and spinels have low Cr# varying from 0.07 to 0.24. Clinopyroxenes commonly show depleted trace–element patterns. Both whole–rock and mineral chemical compositions support the Ningyuan mantle xenoliths represent mantle residues after low degrees of partial melting. The Ninyuan mantle xenoliths have Re and Os contents of 0.08~0.28 ppb and 2.09~4.07 ppb, respectively. All but one Ningyuan xenoliths have $^{187}Os/^{188}Os$ ratios of 0.12116~0.12929, giving young rehenium depletion ages (T_{RD}) of 0.25~1.61 Ga. One sample (TYS07) have a slightly lower $^{187}Os/^{188}Os$ ratio of 0.11681, corresponding to a T_{RD} age of 1.82 Ga. The $^{187}Os/^{188}Os$ ratios of all Ningyuan mantle xenoliths are plotted within the scale defined by modern abyssal peridotites (Snow and Reisberg, 1995; Brandon et al., 2000; Harvey et al., 2006; Liu et al., 2008). Meanwhile, Zhang et al. (2008) reported that clinopyroxenes from Ningyuan mnatle xenoliths have depleted Sr–Nd isotopes, with ε_{Nd} of +11~+13.5. Both Os and Nd isotopes support that the Ningyuan mantle xenoliths represent the juvenile mantle that was accreted from asthenosphere. Therefore, we suggest that the ancient enriched mantle beneath Ningyuan, that was existed during the Paleozoic, has been removed and repalced by juvenile mantle. This mantle replacement event occurred at the late Triassic, and was triggered by the regional lithosphere extension (Fan et al., 2003).

Cenozoic basalts are widespread along the coastal areas of the South China Block, which commonly contain abundant mantle xenoliths. Mantle xenoliths from two localities, Xingchang and Mingxi, have been selected for Re–Os isotope study (Liu et al., 2012b). Both spinel– and garnet–facies peridotites have been recovered from these two localities. Twelve Xinchang mantle xenoliths, including two spinel lherzolites, seven spinel harzburgites and three garnet lherzolites, have been analyzed. The relatively refractory spinel harzburgites contain 0.95–1.73% Al_2O_3, and 0.65–1.49% CaO. They have $^{187}Re/^{188}Os$ ratios ranging from 0.01 to 0.06 and

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$^{187}Os/^{188}Os$ ratios varying from 0.11999 to 0.12258, giving rehenium depletion ages (T_{RD}), relative to the primitive upper mantle, of 0.99–1.35 Ga and model ages (T_{MA}) of 1.09–1.48 Ga. In contrast, the fertile spinel– and garnet–lherzolites have higher Al_2O_3 contents (2.4–5.43%) and more radiogenic $^{187}Os/^{188}Os$ (0.12424–0.12801), which yield T_{RD} of 0.22–0.75 Ga. The studied twenty–six Mingxi mantle xenoliths include eight spinel lherzolites, eight spinel harzburgites, nine garnet lherzolites and one garnet harzburgite. The spinel lherzolites have Al_2O_3 contents of 1.89–4.46%, whereas spinel harzburgites have lower Al_2O_3 contents (0.83–1.41%). The garnet lherzolites have Al_2O_3 contents of 1.41–3.59%, whereas the only garnet harzburgite contains 0.83% Al_2O_3. The spinel harzburgites display $^{187}Os/^{188}Os$ ratios ranging from 0.11685 to 0.12197, giving T_{RD} ages of 1.08–1.97 Ga. The $^{187}Os/^{188}Os$ ratios of the spinel lherzolites (0.11889–0.13037) are more radiogenic than the spinel harzburgites, which yield T_{RD} ages ranging from 1.51 Ga to modern age. The garnet lherzolites have $^{187}Os/^{188}Os$ ratios of 0.12313–0.12733 and T_{RD} ages of 0.33–0.96 Ga. In contrast, the garnet harzburgite has a depleted $^{187}Os/^{188}Os$ ratio of 0.11737 and an old T_{RD} age of 1.72 Ga.

Our bulk–rock Re–Os isotopes of spinel harzburgites support the existence of Paleoproterozoic lithospheric mantle beneath both Xinchang and Mindxi areas during the Cenozoic. Similar bulk–rock old T_{RD} ages have also been obtained for the Cenozoic mantle xenoliths from Suwan Basin (Reisberg et al., 2005). Furthermore, sulfides in mantle xenoliths from several localities along the coastal areas in southeastern China also have T_{RD} ages of the Paleoproterozoic (Xu et al., 2008). Therefore, the anicent lithospheric mantle beneath the coastal areas of SE China have not been completely removed, although it might have been variably thinned. Meanwhile, mantle thinning in SE China was accompanied by accretion of juvenile mantle, represented by the garnet lherzolites with young Os ages. Mantle thinning and replacement in SE China could be caused by lithospheric extension, triggered by the roll–back of the subducted Pacific plate.

Key words: Mantle xenoliths; Re–Os isotopes; SCLM; South China Block;

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