Multiple exsolutions in a rare clinopyroxene megacryst from the Hannuoba basalt, North China: Implications for subducted slab-related crustal thickening and recycling

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A rare large clinopyroxene megacryst (type 1) collected from the Hannuoba basalt, North China was studied. It is distinguished from the prevalent clinopyroxene megacrysts (type 2) by garnet and orthopyroxene exsolutions and by chemical and Sr-Nd isotopic compositions. The type 1 clinopyroxene megacryst has higher Cr (2100 ppm) and Mg# (83) than the type 2 clinopyroxene megacrysts as well as more evolved Sr and Nd isotopic compositions. These characteristics suggest that the type 1 clinopyroxene megacryst could have been formed by a recycled crust-related melt-peridotite reaction. The type 2 clinopyroxene megacrysts exhibit good correlations between Mg# and major and trace element compositions. Their Sr-Nd isotopic compositions cluster in the least evolved field of the Hannuoba basalt. These observations imply that the type 2 clinopyroxene megacrysts were crystallized from the host lava at high pressure.

The type 1 clinopyroxene megacryst contains abundant coherent cryptocrystalline lamellaes and orthopyroxene exsolutions within it. The bulk composition of the cryptocrystalline lamellaes, composed of fine plagioclase and olivine, shows typical chemical features of garnet and Sr isotopic composition similar to the clinopyroxene host. These observations indicate that the cryptocrystalline lamellaes are decomposition products of garnet exsolutions in the clinopyroxene megacryst. This garnet exsolution could be caused by increasing pressure or decreasing temperature, as indicated by experimental results. Although the temperature decreases during basalt eruption, the much quicker decrease in pressure will suppress the garnet exsolution in clinopyroxene. Therefore, we suggest that the type 1 clinopyroxene megacryst could have experienced pre-Mesozoic crustal uplifting and thickening at the north margin of the North China Craton. Garnet decomposition could have taken place prior to orthopyroxene exsolution during the eruption of the host lava.

Noble gases in mantle xenoliths from the Tan-Lu fault zone, North China Craton

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The Tan-Lu fault zone, which extends NNE-SSW for more than 3000km, is a major lithospheric discontinuity along the eastern Asia continent and is believed to have acted as a major channel for the ascending of asthenosphere and played an important role in the Mesozoic-Cenozoic thinning of the North China Craton (NCC) lithosphere. From North to South, there are many Cenozoic volcanic areas which are located in the Tan-Lu Fault Zone. Ultramafic xenoliths, mainly lherzolite and pyroxenite, are common in alkali basalts in these volcanic areas. Detailed petrological and geochemical studies suggest that these low Mg# peridotites (Fo 88-91) represent fragments of the newly accreted lithospheric mantle.

This study performed a comprehensive investigation of petrology, mineral chemistry and noble gases of mantle xenolith in Changle-Linqu (in the middle part of Tan-Lu Fault Zone) and Nvshan (in the south part of Tan-Lu Fault Zone) and try to trace the post destruction evolution of North China Craton (NCC) lithospheric mantle.

Olivines in wehrlites and lherzolites in Changle-Linqu and Nvshan yield $^{3}He/^{4}He$ ratio range from 6.9 to 7.6 Ra, a little bit lower than MORB value (8±1Ra), suggest that lithospheric mantle in the Tan-Lu fault zone would thus most likely have been metasomated by melts/fluids derived from an asthenospheric reservoir or lithospheric mantle is cooling from asthenospheric. However, wehrlites and lherzolites have significant lower $^{3}He/^{4}He$ ratios, lower helium abundance and lower $^{4}He/^{40}Ar^{*}$ in Cpx than in co-exist Ol. ^{4}He abundance and $^{3}He/^{4}He$ ratios of Opx are lower than co-exist Ol and higher than co-exist Cpx. Our thin section study indicates there is a direct link between sieve texture/melt-pocket and low helium abundance, low $^{3}He/^{4}He$ ratios and low $^{4}He/^{40}Ar^{*}$. This may suggest that the noble gas in Cpx were lost during partial melting and there is diffusive fractionation between ^{3}He, ^{4}He, and ^{40}Ar.

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DOI:10.1180/minmag.2013.077.5.8