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Interaction of extended mantle plume head with ancient lithosphere: evidence from deep-seated xenoliths in basalts and lamprophyre diatremes in Western Syria

Evgenii Sharkov

Institute of Geology of Ore Deposits, Petrograpgy, Mineralogy and Geochemistry RAS, Petrology, Moscow, Russian Federation (sharkov@igem.ru)

The Middle Cretaceous lamprophyric diatremes of the Jabel Ansaria Ridge contain xenoliths of ancient lower crustal rocks mainly represented by the suite of partly altered garnet granulite and eclogite-like rocks, which were formed at the expense of ferrogabbros and ferroclinopyroxenites most likely in the course of underplating of Fe–Ti basalt.

Garnet (Alm26Grs11Py63) megacrysts and coarse-granular garnet–clinopyroxene intergrowths are most likely the varieties of rocks of this series. Garnet megacrysts are represented by large (up to 10 cm in diameter) round "nodules," often molten from the surface. Garnet is usually fractured, and the kelyphite material similar to that in rocks of the eclogite-granulite series occurs in fractures. In addition, we found several intergrowths of garnet with large (up to 3–5 cm in length) crystals of high-Al augite with the low of Ti and Na contents like in rocks of the eclogite–granulite suite.

Coarse-grained garnet–clinopyroxene–hornblende rocks with spinel, as well as megacrysts of Al–Ti augite with kaersutite, form the second group in prevalence. This group is close to mantle xenoliths of the "black series" in alkali Fe-Ti basalt worldwide. Kaersutite in these rocks contains gaseous cavities, which provides evidence for the origin of rocks at the expense of a strongly fluidized melt/fluid. In contrast to rocks of the eclogite–granulite series, these rocks did not undergo alteration. Garnet Alm19–26Grs12–13.5Py59–67.5 usually associates with dark opaque spinel.

In contrast, the Late Cenozoic plateaubasalts of the region practically do not contain lower crustal xenoliths, whereas xenoliths of mantle spinel lherzolite (fragments of the upper cooled rim of the plume head) are widely abundant.

According to data of mineralogical thermobarometry, rocks of the eclogite–granulite suite were formed at 13.5–15.4 kbar (depths of 45–54 km) and 965–1115°C. Rocks of this suite are typical representatives of the continental lower crust. Formation of clinopyroxene–hornblende rocks (analogs of the "black series" of mantle xenoliths in basalt) occurred at close P–T parameters: 12.6 kbar, 1100°C. Judging from the absence of deformations in the rocks, their parental melts were intruded into the stabilized lower crust.

Hence, it follows that the ancient continental lower crust existed there in the mid-Cretaceous, but in the Late Cenozoic it was replaced by the spreading mantle plume head. In other words, the deep structure of the region was reconstructed radically in the Late Cenozoic, and only the uppermost horizon of the ancient lithosphere (sialic crust) was not changed.

According to the geological and petrological data, the heads of mantle plumes reached the base of the upper sialic crust, and the level of the lower crust of the continents (30–40 km) is optimal for abundant adiabatic melting of the mantle plume head. If this level was not reached, melting was limited, and an excess of volatile components appeared, which resulted in the formation of lamprophyric and even kimberlitic diatremes.

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