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Crustal xenoliths in post-collisional Variscan lamprophyres: records of late Variscan collision and orogenic extension

Christian Soder (1), Thomas Ludwig (1), Winfried Schwarz (1,2), Mario Trieloff (1,2)

(1) Institut für Geowissenschaften, Universität Heidelberg, Germany (Christian.Soder@geow.uni-heidelberg.de), (2) Klaus-Tschira-Labor für Kosmochemie, Universität Heidelberg, Germany

Crustal xenoliths entrained in post-collisional shoshonitic lamprophyres from the Variscan Odenwald (Mid-German Crystalline Zone, MGCZ) include felsic granulites (garnet, quartz, plagioclase, K-feldspar, biotite, omphacite, rutile) and basaltic eclogites (omphacite, garnet, quartz, kyanite, phengite, epidote, rutile). Classical thermobarometry, Zr-in-rutile thermometry and equilibrium phase diagrams reveal temperatures of 700–800°C and pressures of 1.7–1.8 GPa. Both lithologies record isothermal decompression resulting in partial melting at still elevated pressures (1.3–1.5 kbar) before entrainment into the magma. The development of diverse fine-grained microstructures is linked to the interaction with the rising melt.

The eclogitic garnet preserves compositional sector zonation patterns, which indicate rapid crystal growth, shortly followed by overgrowth/recrystallization during decompression. The preservation of these zonation patterns indicates crystallization immediately before the lamprophyre magmatism. These findings are supported by SIMS U-Pb dating of zircon rims, which gave ages of 330±3 Ma for both lithologies, indistinguishable from the published age of lamprophyre emplacement. Therefore, the xenoliths are a unique document of the late Variscan collisional process with marked crustal thickening to ∼60 km and a subsequent decompression event.

Magmatic protolith ages are ∼430 Ma for the basaltic eclogite and ∼2.1 Ga for the felsic granulite. Silurian magmatism is well established within the MGCZ while the Paleoproterozoic age represents a hitherto unknown magmatic event.