

Mechanism of Symplectite Formation in Lower Crustal Granulite Xenoliths from the Bakony-Balaton Highland Volcanic Field

Dégi, Júlia¹ Wirth, Richard² Abart, Rainer³ Török, Kálmán⁴ Rhede, Dieter²

¹Eötvös University, Budapest, Hungary ²GeoForschungsZentrum Potsdam, Germany ³Freie Universität Berlin, Berlin, Germany ⁴Eötvös Loránd Geophysical Institute of Hungary, Budapest, Hungary

Lower crustal garnet granulite xenoliths from the Bakony–Balaton Highland Volcanic Field, Central Pannonian Basin, were studied to investigate crustal processes during the Tertiary evolution of the Pannonian Basin. The rock-forming mineral assemblage (Grt–Cpx–Pl ± Opx ± Amp ± Scp) was formed at peak metamorphic conditions of 1.0–1.6 GPa and 850–1050°C, during the Alpine orogenesis. This was followed by 100–200°C temperature increase and 0.3–0.8 GPa pressure decrease during the extension of the Pannonian Basin, which is reflected by various breakdown reactions of the rock-forming minerals.

We studied the most conspicuous breakdown reaction, the replacement of garnet by a symplectite comprised of vermicular intergrowth of submicron sized anorthite, Ca-free pyroxene and spinel. Based on element distribution maps the transformation of garnet to symplectite appears to have been isochemical. Phase diagram calculations indicate that garnet breakdown was driven by relevant pressure decrease, which we associated with the extension of the Pannonian Basin. The garnet–symplectite reaction interface was studied in 3D by high resolution element mapping with a thermal field emission gun electron microprobe and by transmission electron microscopy of thin foils cut perpendicular and parallel to the reaction interface.

Close to the replacement front the anorthite forms about 200 nm thick rods oriented sub-perpendicular to the reaction front. These rods are surrounded by Ca-free pyroxene, which forms the matrix of the symplectite. Hercynitic spinel is only found within the pyroxene, where it forms discontinuous rods of about 20 nm width, which are also oriented sub-perpendicular to the reaction front. In a 2D section perpendicular to the reaction front this appears as a lamellar structure. The reaction front is sharp on the nanometer scale, but the anorthite systematically propagates faster into the garnet than the orthopyroxene and the spinel. This results in 5 nm steps along the reaction front. This may suggest that the bulk reaction $\text{Grt} = \text{An} + \text{Px} + \text{Spl}$ proceeds by two reaction steps:

1. $\text{Grt} = \text{An} + \text{“Al-Px”}$
2. $\text{“Al-Px”} = \text{Opx} + \text{Spl}$

The atomic structure of the reactant garnet is partially desintegrated within a 2–5 nm wide zone right at the interface to the symplectite. This zone of disordered garnet is also characterized by substantial Fe-enrichment. We argue that the chemical mass transfer, which was necessary during the transformation of the homogeneous reactant garnet into the chemically heterogeneous aggregate of the symplectite occurred in this zone. The rate at which garnet was replaced by the symplectite was thus controlled by component mobility within the migrating reaction front.

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