Growth of Garnet Porphyroblasts during Decompression of the Eclogite-bearing Mica Schists in the Fore-Sudetic Block, SW Poland

Izabella NOWAK

Institute of Geological Sciences, Polish Academy of Sciences, ul. Podwale 75, 50-449 Wroclaw, Poland

Dark, two-mica schists with eclogite lenses occur in the vicinity of Kamieniec Ząbkowicki, the Fore-Sudetic Block. The metapelites consist of white mica, quartz, biotite, garnet, plagioclase, staurolite, andalusite, kyanite and sporadically fibrolite. Common garnet porphyroblasts show chemical and structural zoning and contain inclusions of the oldest HP assemblage minerals. The mica schists underwent a complicated metamorphic and structural evolution – four sets of structures (F_1-F_4) are visible. The schists recorded a clockwise metamorphic P-T path with pressure and temperature peaks (Nowak 1998). The maximum pressure was achieved under conditions of the blueschist/eclogite facies transition and was followed by constant decompression, during which the temperature peak was achieved under amphibolite facies conditions, with late recrystallization under greenschist facies conditions. Precise examinations of the garnet porphyroblasts revealed the great part of decompressional evolution of the mica schists. Inner zones of the garnets, rich in numerous parallel inclusions, are surrounded by zones free of inclusions. The centres of garnets are enriched in spessartine and grossularite (16 to 32 %). Their content decreases in the direction to the grain border, to few percent at the boundaries of those parts of the garnets which are rich in inclusions, and to zero at the edges of inclusion-free haloes. The amount of almandine increases from 58 % in the cores to 70 % at the edge of the central parts of the garnets which contain inclusions. The outer parts of the garnets are characterized by higher almandine contents of 70 to 80 %, and pyrope contents of 14 to 18 %. This kind of zoning comes into existence when garnet growth occurs under conditions of increasing temperature (Tracy 1989). These observations indicate that garnet growth in the studied rocks was complicated and at least two-stage. Garnets of the first generation Grt*I* (Ca-Mn-almandine, rich in inclusions) contain inclusions of HP minerals forming the S_1 foliation surface – phengite, paragonite, chloritoid, rutile and replacement pseudomorphs after lawsonite. From examinations of trails of these inclusions it is possible to conclude that the centres of Grt*I* garnets began their growth after F_1 folds, which led to the local preservation of undeformed fragments of S_1 surface. P-T conditions (490±17°C, 10.0±0.4 kbar) during the growth of the centres of Grt*I* garnet and post-lawsonite replacement pseudomorphs (mostly composed of clinozoisite, margarite and kyanite) indicate that garnet Grt*I* growth started after the lawsonite breakdown curve had been crossed in the direction of lower pressures and higher temperatures. Grt*I* garnets contain staurolite inclusions in their peripheral areas. Blasts of staurolite also sometimes contain spiral traces of S_1 surface. These observations indicate that the main phase of Grt*I* garnet growth was syntectonic with F_2 and simultaneous with the growth of staurolite, but also that Grt*I* blastesis began before F_2, post-tectonically relative to F_1. The zoning of the garnets indicates that this mineral formed under conditions of constantly rising temperature until the rocks reached their maximum temperature. The peak temperature of metamorphism in these schists was rached under amphibolite facies conditions at a temperature of 579±35°C and a pressure of 7.4±0.2 kbar (Nowak 1998) and took place just at the end of the garnet Grt*I* blastesis. After the peak temperature of metamorphism was achieved, a fall in temperature connected with further decompression began, leading to a halt in the growth of garnet Grt*I*. This P-T change was approximately simultaneous to F_3 folding. Before the end of and partially after the F_3 folding event, a second generation of garnet Grt*II* (pyrope-almandine) formed, growing as inclusion-free haloes around earlier grains or as separate blasts enclosing the S_2 foliation surface folded in F_3 deformation. The growth of garnet Grt*II* occurred as a result of different reactions to those causing Grt*I* blastesis and was probably related to a fluctuation in P-T conditions. An insignificant increase in temperature after passing the peak temperature of metamorphism could have given rise to the mobilization in the rock of components which made the renewed growth of garnet possible. The chemical zoning of Grt*II* garnet indicates blastesis of this mineral under PT conditions of 530±55°C and 4.8±0.2 kbar (Nowak 1998), determining the metamorphic conditions after F_2 shear. This indicates that garnet Grt*II* generally formed at an only slightly lower temperature than that of the peak metamorphism, but at a significantly lower pressure, and thus after a significant uplift of the complex. Precise examinations of garnet porphyroblasts allowed to reconstruct the metamorphic evolution during decompression of the eclogite-bearing mica schists from Kamieniec Ząbkowicki, which was also shared by the eclogites themselves. The process of uplift of the mica schists and the eclogites towards the surface was related to decompression which at first took place under conditions of rising temperature, moving through the epidote-amphibolite facies conditions until a temperature peak was achieved during amphibolite facies conditions and further decompression was isothermal. This stage of decompression was coeval with the upwelling of the Variscan granitoid magmas.

References

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