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Prograde segment of the Variscan P–T path in the Saxothuringian domain: inferences from phengite(–lawsonite?) eclogites from the Kamieniec Metamorphic Belt (Sudetes, SW Poland)

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The Kamieniec Metamorphic Belt (KMB) located at the NE margin of the Bohemian Massif (SW Poland) forms isolated outcrops of volcano-sedimentary succession metamorphosed during Variscan times. The prevailing metapelites comprise intercalations and lenses of paragneisses, quartz-graphite schists, calc-silicate rocks, amphibolites and eclogites. This study focuses on the eclogites collected in the southern part of KMB and presents the insight into the prograde portion of their metamorphic path.

The eclogites are composed of clinopyroxene, garnet, epidote, white mica, amphibole, rutile and quartz with subordinate ilmenite, biotite, zircon and apatite. They are characterised by porphyroblastic and random texture. Euhedral garnet porphyroblast mainly appear in clusters of several crystals abundant with inclusions of matrix minerals. The matrix comprises clinopyroxene of omphacite composition which is partly replaced by diopside–albite symplectites. Clinopyroxene is accompanied by white mica, epidote, rutile and quartz. At the rims of symplectites and around garnet aggregates a blue-green pleochroic layer of amphibole is present. Likewise, ilmenite with titanite grew at the expense of rutile.

Chemical composition of major minerals of the least retrogressed sample showed that omphacite and white mica are fairly homogeneous, with jadeite content in omphacite X_{jd} up to 0.49 and $Si4^{+}$ in mica up to 3.48 a.p.f.u. In turn, garnet porphyroblast developed a marked compositional zoning with spessartine-rich cores and rims enriched in pyrope and almandine. A P–T pseudosections phase equilibria modelling in the system MnNCFMASTHO ($MnO–Na_2O–CaO–FeO–MgO–Al_2O_3–SiO_2–H_2O–TiO_2–Fe_2O_3$) with fixed XFe_2O_3 (5%) were performed with Perple_X software. The calculations for the whole rock composition obtained by XRF analysis allowed to constrain the conditions of the earliest metamorphic stage preserved only in core of garnet. The water content in the system (ca. 2.5 wt%) was assessed through a series of P–X sections at various temperatures. The position of the calculated compositional isopleths of garnet core indicates pressures of 1.5–1.6 GPa at temperatures of 340–350°C. Textural relationships suggest that the assemblage of omphacite, phengite and garnet (rims) is pertinent to the subsequent metamorphic stage. The second P–T pseudosection was calculated for effective bulk composition respecting the fractionation of rock composition concurrent with garnet growth. Compositional isopleths of the minerals point to pressures of 2.4–2.8 GPa and temperatures of 550–570°C. The model predicts ca. 6 vol% of lawsonite in the assemblage, however, the mineral was not found in the sample. Based on textural evidence, it is postulated that lawsonite must have reacted out during the retrogression and was most probably replaced by now ubiquitous epidote-rich aggregates.

Therefore, a considerably cold conditions of subduction are postulated as the obtained segment of the P–T path for the KMB eclogite suggests a 6–7°C/km geotherm. The conclusion is in line with the data recently obtained for the metapelites of the KMB. Hence their mutual relationship during progression of Variscan metamorphism is evidenced.

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