Deformation and Metamorphism in the Southern Part of the Kamieniec Metamorphic Complex (SW Poland)

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Geological setting

Mica schists form a N-S elongated outcrop zone to the east of the Góry Sowie Massif and Niemcza shear zone. This schist belt is referred here as the Kamieniec metamorphic complex. The northern part of the complex is N-S aligned along the eastern margin of the Niemcza zone whereas its southern part forms an isolated outcrop in the vicinity of Kamieniec Ząbkowicki. The mica schists contain intercalations of quartzo-feldspatic schists, marbles and subordinate lenses of quartzo-graphitic schists, amphibolitic schists and eclogites.

Petrography

Two main types of mica schists occur in the vicinity of Kamieniec Ząbkowicki. The first type comprises coarse- to fine grained mica schists composed of quartz, muscovite, biotite, garnet, plagioclase (10-25% An), andalusite, staurolite and chlorite with scarce kyanite and sillimanite. Accessory minerals are tourmaline, apatite, zircon, allanite, rutile, and ilmenite. The second type are fine grained mica schists with numerous porphyroblasts of albite and scarce garnet porphyroclasts. Tourmaline, apatite and ilmenite occur as accessories.

Deformation structures

The mica schists in the vicinity of Kamieniec Ząbkowicki have recorded three deformation events. Deformation D_1 produced a steep, NW dipping foliation S_1 and stretching lineation L_1. The locally preserved L_1 lineation trends generally E-W, although it is locally reoriented in the limbs of younger folds F_2. Axes of the F_2 folds are oriented NE-SW whereas the accompanying penetrative axial cleavage S_2 dips gently to W, SW or NW. The S_2 foliation is either represented by crenulation cleavage or, more often, by a transposition foliation that completely replaced the older foliation S_1. Intersection of S_2 and S_1 planes parallels penetrative stretching lineation L_2, the most prominent one in the area. Deformation D_3 was confined to low-angle normal shear zones dipping to SW. The S_3 foliation in these zones is parallel to S_2 and the L_3 stretching lineation parallels the lineation L_2. Transposition of the S_1 foliation into S_2 was accompanied by reduction of grain size. Thus, foliation S_1 is the dominant structure in the coarse-grained mica schists, whereas a younger foliation S_{2+3} is pervasively developed in the fine-grained schists.

Metamorphic conditions

Chemical composition of minerals that define foliation S_1 in the coarse-grained mica schists together with composition of synkinematic garnet porphyroblasts in these rocks indicates that the deformation D_1 took place under a temperature of 590±30°C and a pressure of 9,6±2,0 kbars. The chemical composition of minerals synkinematic with reference to the D_2 event in fine-gained schists records a temperature of 518±25°C and a pressure is 7,7±1,0 kbar. Chemical zoning in garnet porphyroblasts in the fine-grained schists indicates an increase of temperature during the D_2 event. The last D_3 event operated near the andalusite-sillimanite stability field boundary (temperature over 520°C and pressure under 4,0 kbar).

There is a distinct contrast of metamorphic grade between (1) coarse- to fine-grained mica schists with garnet and staurolite and (2) mica schists with albite porphyroblasts. The latter rocks recorded a lower grade of metamorphism during all three tectonic events. Albite-bearing schists were metamorphosed under low amphibolite facies conditions (temperature of 500-550°C and pressure 3-5 kbar) during D_1, D_2 events and under the greenschist facies conditions in D_3 event.

Based on the contrast of metamorphic grade, two large tectonic units were distinguished in the study area: the Kamieniec unit (higher grade) and Byczeń unit (lower grade).

Discussion and conclusion

Kinematic indicators and orientation of <c> quartz axes points to E-directed overthrust of the Kamieniec unit on top of the Byczeń unit during the D_1 event. The tectonic juxtaposition of these units resulted in metamorphic grade inversion. The next deformation D_2 involved NE-directed thrusting combined with an non-rotational shortening in an approximately NW-SE direction. Progressive shortening was followed by development of normal low-angle shear zones D_3 characterised by top-to-SW or to-WSW sense of shear (Mazur et al. 1997). They were related to SW-directed extensional collapse D_3 in the eastern margin of the Sudetic foreland.

The D_1 and D_2 events were coeval with the overthrusting of the West Sudetes over the East Sudetes. They took place under decrease of temperature from the upper to lower amphibolite facies conditions. The deformation D_3, related to extensional collapse of regional extent, was accompanied by MT/LP metamorphism induced by rapid uplift and exhumation. It led to almost isothermal decompression of the Kamieniec metamorphic complex during the D_3 event.

References

MAZUR S., PUZIEWICZ J. and JÓZEFIAK D. 1997. Tektonika i metamorfizm serii skalnych między blokiem sowiogórskim a masywem niedźwiedzia (Blok przedsudecki). *Prace Specjalne*, 9, 39-44.