could have originated in another, probably much younger metamorphic event.

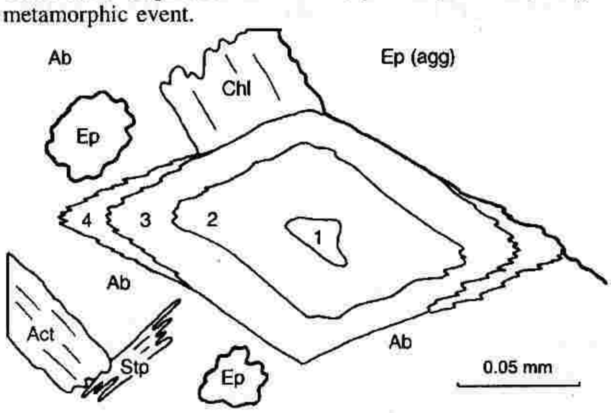

Fig. 2. Microscope image of the composite amphibole grain in the cataclastic Stp bearing FeActHbl-Chl-Ep-FeGln/Css-Ab gneiss from the E slope of the Lasocki Range near Kopina hill - E Karkonosze Complex (after Smulikowski 1995). 1 - subcalcic ferroactinolitic hornblende (FeActHbl); 2 - ferroglaucophane (FeGln); 3 - crossite (Css); 4 - Actinolite (Act). Ab = albite, Chl = chlorite, Ep = epidote, Stp = stilpnomelane.

To the south, in the Lasocki Range and Rýchory where alkali amphibole bearing rocks occur, the following zoned amphibole grains were observed: 1) subcalcic ferroactinolitic hornblende (or winchite) - ferroglaucophane - crossite - actinolite (Smulikowski 1995); 2) magnesioriebeckite - crossite; 3) glaucophane - subcalcic magnesiohornblende; 4) ferroglaucophane - subcalcic ferrohornblende; 5) ferroglaucophane - ferrobarroisite; 6) magnesiohornblende - barroisite - magnesioriebeckite; 7) actinolitic hornblende - winchite - riebeckite; 8) magnesioriebeckite - subcalcic actinolite. Coexisting plagioclase is always albite often with numerous epidote inclusions. Stilpnomelane, forming veins and nests, is observed in alkali amphibole bearing rocks as well as in low-Ti hornblende rich rocks. All mafic minerals were often replaced by chlorite. In some greenschists in the Lasocki Range and of the Poniklá Group in Rýchory crossite relics survived only as inclusions in larger albite grains.

The most complete record of the changing P-T conditions during metamorphism is represented by the zonation (1). It indicates the increase of pressure, to glaucophane-schist facies conditions, then the gradual decrease and ends up in the greenschist facies. The other examples of zonation correspond to various sections of the P-T-t path, some of the increasing and some of the decreasing pressure. The temperature variations may also be estimated. They may be rather interpreted as P-T changes during the same metamorphic event.

It is very probable that the low-Ti blue-green hornblende rims on high-Ti hornblende in amphibolites of Rudawy Janowickie and the alkali amphiboles in metabasites of the Lasocki Range and Rýchory are results of the same high P/T metamorphic episode corresponding to epidote-amphibolite facies and glaucophane-schist facies respectively. In both Kaczawa Complex and East Karkonosze Complex after the high P/T metamorphism greenschist facies metamorphism took place. It could correspond to the decompression stage of the same metamorphic event or to a separate, younger metamorphic event.

An important point made by Evans and Brown (1987) is that "depending on the whole-rock composition blueschist and greenschist lithologies can occur together at the same P and T". Local equilibria and variations of oxygen fugacity play also important roles in the formation of alkali amphiboles. This together with the selective survival of blueschist parageneses in the subsequent metamorphism of regional, contact and dislocation type may explain the very erratic and irregular distribution of the glaucophane schist facies rocks in the both complexes.

Maluski and Patočka (1996) with the $^{40}Ar/^{39}Ar$ method on phengite from the blueschists of Sněžný potok dated the glaucophane-schist facies metamorphic episode as ca. 360 Ma and the following greenschist facies episode as ca. 340 Ma. A similar attempt of Maluski and the present author on stilpnomelane from the Lasocki Range did not bring the results. In any case the regional metamorphism events were predating the contact metamorphism resulted from the intrusion of the Karkonosze granite.

References

EVANS B. and BROWN E. H. 1987. Reply to blueschists and eclogites. *Geology*, 773-775.

MALUSKI H. and PATOČKA F. 1997. Geochemistry and ^{40}Ar-^{39}Ar geochronology of the mafic metavolcanic rocks from the Rýchory Mountains complex (West Sudetes, Bohemian Massif): paleotectonic significance. *Geol. Magazine*, 134, 703-716.

SMULIKOWSKI W. 1990. Alkali amphiboles of the low grade metavolcanic rocks of Kaczawa Mts., West Sudeten, Poland. *Geol. Sudetica*, 25, 29-58.

SMULIKOWSKI W. 1995. Evidence of glaucophane-schist facies metamorphism in the East Karkonosze complex, West Sudetes, Poland. *Geol. Rundsch.*, 84, 720-737.

Variscan Metamorphism of the Devonian Quartzites from the NE Part of the Bohemian Massif (Strzelin Crystalline Massif, Fore-Sudetic Block, Eastern Sudetes)

Jacek SZCZEPAŃSKI and Darek JÓZEFIAK

University of Wrocław, Institute of Geological Sciences, Pl. M.Borna 9, 50-204 Wrocław, Poland

Geological setting

The Strzelin crystalline massif crops out in the eastern part of the Fore-Sudetic Block north of the Jesenik Mts. (SW Poland). The massif comprises the Upper Cambrian to Lower Ordovician orthogneisses (Oliver et al. 1993), mantled by mica schists and paragneisses of unknown, probably Neoproterozoic age. Several thrust sheets of Devonian quartzites (Bederke 1931, Oberc 1966), so called the Jeglowa beds (Oberc 1966), are tectonically alternated with orthogneisses. They are considered as a nappe pile developed in the East/West Sudetes contact zone (Oberc 1966, Cymerman 1993, Oberc-Dziedzic et al. 1995). The protholith of the quartzites were described mainly as quartzitic sandstones with intercalations of arkosic and lithic varieties (Wójcik 1974, Oberc-Dziedzic 1995, Patočka and Szczepański 1997). Metamorphic rocks are intruded by Variscan granitoids dated at ca. 330 and 347 Ma (Oberc-Dziedzic et al. 1996).

Sampling and analytical techniques

The total of 60 quartzite samples were collected in the Strzelin crystalline massif. Eight representative samples were examined, at the laboratory of Wroclaw University, using electron microprobe. The analytical conditions were: 15 kV accelerating voltage, 5 nA beam current and 20 s counting time.

Petrography

Common mineral assemblage observed within the studied quartzites is represented by: quartz+muscovite biotite K-feldspar plagioclase (An_{1-4}) with zircon+rutile tourmaline hematite+ilmenite as accessory phases. Sillimanite and andalusite occur, additionally, in the quartzites of the middle part of the massif whereas only sillimanite is present in its southern part.

Chemical Composition of white micas

Basing on the Si^{4+} content two sets of white micas have been distinguished. The older set defines relics of the S1 foliation whereas the younger one bounds the main S_2 penetrative foliation.

	northern part		middle part		southern part	
	core	rim	core	rim	core	rim
first generation	6,03-6,40	6,25-6,61	5,93-6,18	6,15-6,35	6,01-6,32	6,03-6,56
second generation	6,31-6,59	6,21-6,52	6,12-6,22	6,08-6,20	6,21-6,25	6,21-6,15

Tab. 1. Si^{4+} content in the white micas from the Strzelin quartzites.

Conditions of metamorphism

Observed mineral assemblages and chemical zonation of white micas provide an evidence for two episodes M_1 and M_2 of the Variscan metamorphism. The first M_1 event took place under the greenschist facies conditions and was accompanied by increase of pressure reflected by growth of the Si^{4+} content from the core to the rim of muscovite plates. A coeval increase of temperature was independently recorded by growth of Ti content from the core to the rim of the same plates. Conditions of the first metamorphic event can be estimated at approximately max. pressure and temperature of 6,5 kbars and 450°C respectively. P-T conditions of the second M_2 event varied in different parts of the Strzelin massif. In the northern part M_2 episode took place under the greenschist facies conditions at pressure and temperature gradually decreasing from 6,5 kbars and 450°C respectively. In the southern part of the massif, however the M_2 event may be characterised by lower pressure and higher temperature conditions in comparison to M_1 event. The M_2 episode involved in this area the amphibolite facies conditions at temperature and pressure decreasing from 3,5 kbars and 650°C respectively.

Conclusions

The M_1 event represents the regional metamorphism related to the nappe stacking in the East/West Sudetes contact zone. Subsequent the M_2 episode reflects HT/LP event contemporaneous with granite intrusions and doming. This latter episode may be correlated with extensional collapse of the overthickened nappe pile.

References

BEDERKE E. 1931. Die moldanubische berschiebung in Sudetenvorlände. *Zbl. Mineral. B, Stuttgart*, 8, 394-408.

CYMERMAN Z. 1993. Geological units of the Strzelin crystalline massif in the light of new structural analysys (Lower Silesia), (in Polish). *Przegl. Geolog.*, 6, 421-427.

OBERC J. 1966. Geology of crystalline rocks of the Wzgórza Strzelińskie Hills, Lower Silesia. *Studia Geol. Pol.*, 20, 1-187.

OBERC-DZIEDZIC T. 1995. Problems in the investigations of the rocks of the Strzelin crystalline massif in the light of the borehole drill-core data, (in Polish, with English abstract). *Acta. Univ. Wratisl.*, 50, 77-103.

OBERC-DZIEDZIC T. and SZCZEPAŃSKI J. 1995. Geology of the Wzgórza Strzelińskie crystalline massif, (in Polish, with English abstract). *Ann. Soc. Geol. Pol. Special issue.*, 111-126.

OBERC-DZIEDZIC T., PIN C., DUTHOU J. L. and COUTURIE J. P. 1996. Age and origin of the Strzelin granitoids (Fore-Sudetic Block, Poland) $^{87}Rb/^{86}Sr$ data. *N. Jb. Miner. Abh.*, 171, 187-198.

OLIVER G. J. H., CORFU F. and KROGH T. E. 1993. U-Pb ages from SW Poland: evidence for Caledonian suture zone between Baltica and Gondwana. *Journ. Geol. Soc. London*, 150, 355-369.

PATOČKA F. and SZCZEPAŃSKI J. 1997. Geochemistry of quartzites from the eastern margin of the Bohemian Massif (the Hrubý Jeseník Mts. Devonian and the Strzelin Crystalline Massif): provenance and tectonic setting of deposition. *Polish Mineralogical. Soc. Spec. Issue*, 9, 151-153.

WÓJCIK L. 1974. Geology of the Strzelin crystalline massif near Strzelin. *Institute of Geol. Sciences Bull. (in Polish)*, 23, 5-58.