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GEO-THERMOBAROMETRY OF SELECTED METAPELITES  
FROM THE GÓRY SOWIE, SUDETES

**Abstract:** Garnet-biotite and muscovite-biotite geothermometry, and muscovite geobarometry were used on nine selected rocks from the Góry Sowie, West Sudetes, SW Poland to determine PT conditions of metamorphism. In the northern part, near the Bystrzyckie Lake, retrogressive granulite and sillimanite-bearing layered gneiss yielded temperatures 600–663°C. To the south, layered gneiss and metapegmatite from the Przygórze area, and finely laminated gneiss and diatexite from the Potoczek region yielded temperatures 565–632°C and pressures 4,5–6,8 kbar. A similar temperature (587 ± 20°C) was obtained out of flaser gneiss from the Kietlice region in the Fore-Sudetic part of the Góry Sowie Block. We suggest those data to represent amphibolite-facies metamorphism during isothermal decompression (exhumation) of the massif.

**Keywords:** geothermobarometry, metapelites, Góry Sowie, Bohemian Massif, West Sudetes

INTRODUCTION

The Góry Sowie is the mountainous portion of the SW Góry Sowie Block located in the Polish Sudetes, NE Bohemian Massif. This metamorphic complex consists of various types of gneisses and migmatites with minor amounts of granulites, metabasites, peridotites and eclogites. The Góry Sowie Block was affected by five deformational events (D<sub>1</sub>–D<sub>5</sub>) each associated with coeval metamorphism (Żelaźniewicz 1990); metamorphic isograds increase to sillimanite-cordierite zone towards the NW within massif.

In previous works (e.g. Żelaźniewicz 1990), estimates of metamorphic conditions that affected gneisses and migmatites were based mainly on the presence of mineral paragenesis in these rocks and structural investigations. In this paper we report quantitative determinations of maximum temperatures and maximum pressures of metamorphism of selected rocks from Góry Sowie.

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## SAMPLE SELECTION AND METHODS OF INVESTIGATION

During microscope investigations 9 from 31 collected samples were chosen for geothermometry (Fig. 1). To determine temperatures we used muscovite-biotite geothermometer (Hoisch 1989) and garnet-biotite geothermometer (Bhattacharya *et al.* 1992) with Hackler and Wood's (1989) mixing parameters. For geobarometry Ramírez and Sassi's (2001) muscovite geobarometer was chosen.



Fig. 1. Sketch of the Góry Sowie Block with sampling locations.

Microprobe analyses were performed with the use of JEOL JXA-50A electron microprobe at the Department of Mineralogy, Petrography and Geochemistry, AGH, Kraków. Twenty five mineral grains from 9 samples were analyzed in 44 points using 15 kV accelerating voltage, a sample current of 20 nA, 40 seconds counting time, and a beam diameter of 2–5  $\mu\text{m}$  focused on the thin section coated with carbon. Common silicate and oxide mineral standards were used.

For muscovite geobarometer a Phillips X'Pert diffractometer was used to measure the  $d_{060,331}$  spacing directly on the rock slices cut perpendicularly to the rock foliation. A pattern was recorded in the range of  $59\text{--}63^\circ 2\theta$  ( $\text{CuK}\alpha$  radiation). Quartz present in the rock matrix was used as an internal standard.

## RESULTS

For geothermometry of the northern part of Góry Sowie, composition of garnet-biotite pairs from the retrogressive granulite (GS-3) and sillimanite-bearing layered gneiss (GS-2C) were determined with an electron microprobe. Point analyses along traverses in garnets from both analyzed pairs allowed us to ascertain zonation in these blasts. Peak temperatures revealed in these samples are  $600\text{--}663^\circ\text{C}$  (Tab. 1). To the south, finely laminated gneiss (GS-10B) and diatexite (GS-10A) from the Potoczek region, and layered gneiss (GS-14A) and metapegmatite (GS-14B) from the Przygórze area yielded temperatures  $565\text{--}632^\circ\text{C}$  and pressures 4,5–6,8 kbar. In case of two samples (flaser gneisses GS-12 and GS-15) it was impossible to determine temperatures of metamorphism using muscovite-biotite geothermometer. Large differences between mica composition and the range in the calibration data set (Hoisch 1989) caused us to reject these results. Additionally garnet-biotite geothermometry was used on one sample from the Fore-Sudetic part of the Góry

Sowie Block. Flaser gneiss (GS-17C) from the Kietlice region yielded temperatures of  $587 \pm 20^\circ\text{C}$ .

Table 1. Temperatures and pressures yielded by analyzed samples.

Sample symbol	Method			Sample symbol	Method		
	Gr-t-Bt	Mu-Bt	Mu		Gr-t-Bt	Mu-Bt	Mu
	T [ $^\circ\text{C}$ ]	T [ $^\circ\text{C}$ ]	P [kbar]		T [ $^\circ\text{C}$ ]	T [ $^\circ\text{C}$ ]	P [kbar]
GS-2C	$631 \pm 31$	-	-	GS-14A	$585 \pm 20$	$610 \pm 22$	$5,9 \pm 0,9$
GS-3	$643 \pm 20$	-	-	GS-14B	$587 \pm 20$	$615 \pm 22$	$5,6 \pm 0,8$
GS-10A	-	$594 \pm 22$	$5,2 \pm 0,7$	GS-17C	$587 \pm 20$	-	-
GS-10B	-	$597 \pm 22$	$5,2 \pm 0,7$				

Gr-t-Bt – garnet-biotite geothermometer, Mu-Bt – muscovite-biotite geothermometer, Mu – muscovite geobarometer.

## CONCLUSIONS

Data presented in this paper indicate that metapelitic sequences from Góry Sowie that envelope eclogites and granulites were metamorphosed in middle-upper amphibolite-facies conditions (Fig. 2). These results are consistent with previously published P-T estimations for the  $M_{2,3}$  event in the massif (e.g. Żelaźniewicz 1990, Żelaźniewicz 2003). The  $M_{2,3}$  event most likely documents isothermal decompression of the terrane, and initial exhumation of the eclogites, granulites and gneisses to mid-crustal depths at ca. 380–370 Ma (e.g. Timmermann et al. 2000, Gordon et al. 2003). This was then followed by later, probably weaker, tectonometamorphic events ( $D_4$ ,  $D_5$ ) resulting in final exhumation of the Góry Sowie Block at 340–330 Ma (e.g. Oliver et al. 1993, Zahniser et al. 2003).

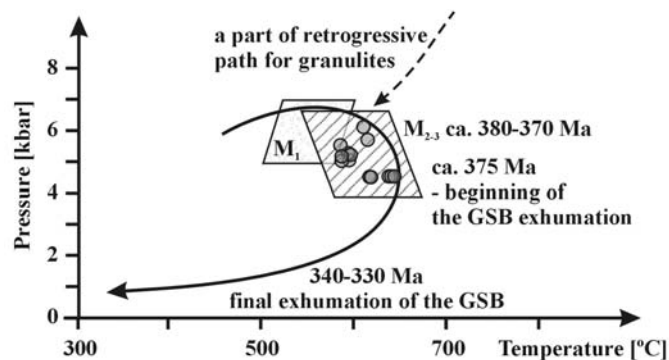


Fig. 2. P-T-t path determined using data for  $M_{2,3}$  event presented in this paper (filled circles). Conditions of  $M_1$  event after Żelaźniewicz (1990). Dates after Oliver *et al.* (1993), Timmermann *et al.* (2000), Gordon *et al.* (2003), Zahniser *et al.* (2003). A part of retrogressive path for granulites determined using data from Żelaźniewicz (1990) and O'Brien *et al.* (1997). GSB – the Góry Sowie Block.

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