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The granitoids of the Lipowe Hills (Fore-Sudetic Block) and their relationship to the Strzelin granites

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Key words: Fore-Sudetic Block, Lipowe Hills crystalline complex, Variscan granitoids, Rb/Sr dating.

Abstract Muscovite-biotite granites, medium-grained biotite tonalites and fine-grained granodiorites from three boreholes situated in the middle part of the Lipowe Hills were characterized. It was found that the muscovite-biotite granites from the boreholes correspond to the Górka Sobocka granite known from the northern part of the Lipowe Hills. This granite was in turn compared to the light coloured granitoids, the so-called Gębczyce and Biały Kościół granites, from the Strzelin crystalline massif. The age link between the muscovite-biotite granites from the Lipowe Hills crystalline complex and those from the Strzelin massif was confirmed by the result of the whole-rock Rb-Sr analyse of a muscovite-biotite granite sample collected in the Górka Sobocka quarry. This result plots on the isochron obtained previously for the muscovite-biotite granites from the Strzelin and Gębczyce quarries at *ca* 330 Ma, with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7055.

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INTRODUCTION

The paper presents granitoids found in three boreholes made in the middle part of the Lipowe Hills in 1985. These rocks were compared with the well known Górka Sobocka granitoids and two mica granitoids from the Strzelin crystalline massif.

The Lipowe Hills crystalline complex is situated in the eastern part of the Fore-Sudetic Block, between the Oława river and the Mała Ślęża river, 5 km west of the Strzelin crystalline massif. It consists of four types of gneisses (Fig. 1) (Wójcik, 1968, 1973; Oberc-Dziedzic, 1988, 1995): light, laminated or augen gneisses (the light Stachów gneisses), dark, fine-grained, streaky, sillimanite gneisses (the dark Stachów gneisses), light migmatitic gneisses with sillimanite nodules (the Nowolesie gneisses), and mylonitic chlorite gneisses (the Henryków gneisses). The dark gneisses are closely connected with sillimanite-biotite schists, amphibole schists and amphibolites. The amphibolites not only coexist with the dark gneisses but also with calc-silicate rocks and quartzities. This metamorphic complex was intruded by Variscan granitoids.

The granitoids (Fig. 2) are mainly represented by muscovite-biotite granites which are exploited in the Górka Sobocka quarry, in the northern part of the Lipowe Hills. The muscovite-biotite granites were also found in the Sa-1, ST-1, ST-2 boreholes (Fig.1), along with three other varieties: medium-grained biotite tonalites, fine-grained tonalites and fine-grained granodiorites. The later three were cut by thin veins of muscovite-biotite granites, ie. they are older than the granites.

The muscovite-biotite granites correspond to two mica granites from the Strzelin crystalline massif, the so-called Gębczyce and Biały Kościół granites (Morawski, 1973).

The granitoids of the Lipowe Hills form small bodies of unknown shape. Their contacts with the country rocks are usually sharp and discordant although transition zones can also be present. The gneiss foliation at the contact is locally bent. Such deflected structures are characteristic of forceful intrusions.

The geological context and structural features of the Górka Sobocka granite were studied by Cloos (1922). He drew attention to the fact that the biotite lineation in the granite at the Górka Sobocka quarry plunges at low angles to ENE (60°) like in the Strzelin granites. He claimed that the Górka Sobocka granite might bridge the gap between the Strzelin massif and the Strzegom–Sobótka massif.

The Lipowe Hills crystalline complex used to be treated as a part of the Niemcza crystalline complex (Oberc, 1972) but according to Oberc-Dziedzic (1988, 1995) it shows close relationships with the Strzelin crystalline massif. Both metamorphic complexes are composed of similar types of rocks and show the same tectonometamorphic history.

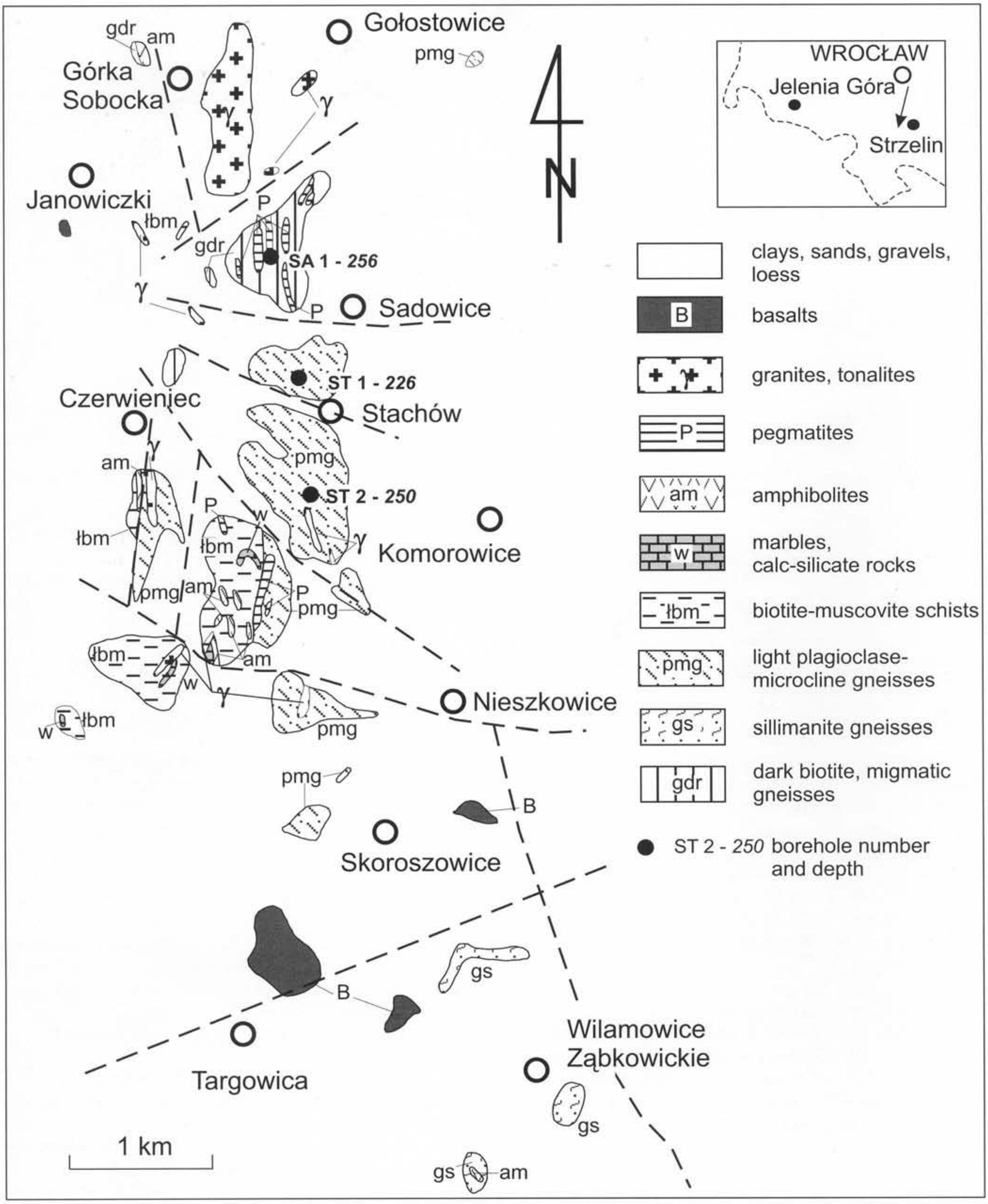

Fig. 1. Geological map of the Lipowe Hills crystalline complex. Based on the 1:25000 geological map by Wójcik (1968), faults according to the authors.

PETROGRAPHY

The muscovite-biotite granites are represented by three varieties which differ slightly from each other in composition and structure.

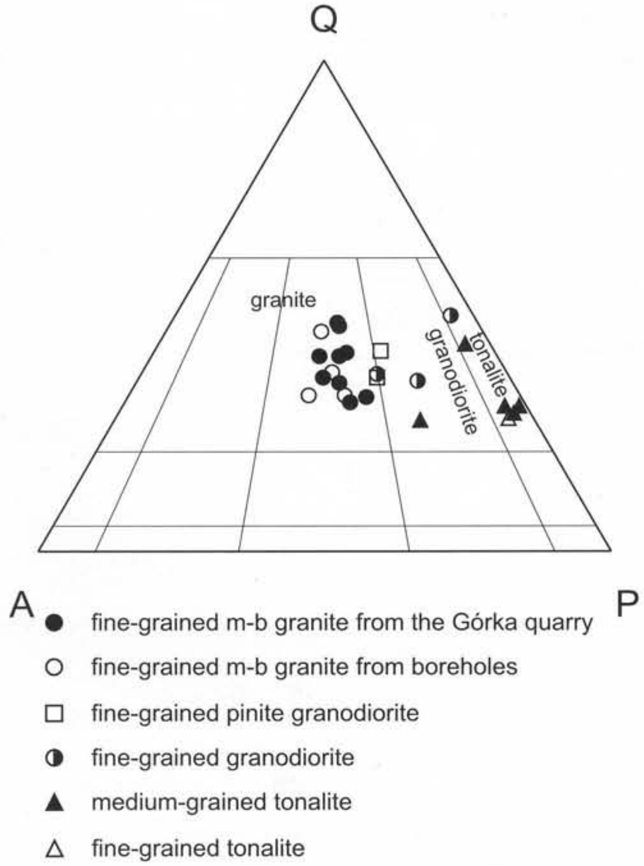

Fig. 2. Systematics of the Lipowe Hills granitoids on the QAP plot.

The first variety of muscovite-biotite granites, the so-called Górka Sobocka granite, forms an intrusion, about 1 km long and 0.5 km wide, located in the northern part of the Lipowe Hills, near Górka Sobocka village. The granites are well exposed in a large quarry at Górka Sobocka and in small outcrops south of this village. The petrography of the Górka Sobocka granite was studied by Borkowska (1959), Morawski (1973) and Wojnar (1977). This is a fine-grained rock, composed of quartz, potassium feldspar, two generations of plagioclase, parallel-arranged biotite, and muscovite (Tab.1). The potassium feldspar forms xenomorphic grains. The cross-hatched pattern typical of microcline is restricted to small fragments of the grains. The first plagioclase generation forms euhedral, seldom zoned grains (28.5–31.5% An→13% An), which are usually strongly altered. The second generation of plagioclase (9.0–13.5% An) is fresh. Abundant myrmekite was found on the contact of this plagioclase generation with microcline. Dark brown biotite is more common than muscovite (Tab. 1). It contains inclusions of zircon and apatite.

Two other varieties of muscovite-biotite granites are known from the boreholes. The second variety, light grey, very fine-grained granite, forms a dozen or so veins 0.4–8.3 m thick. These granites abound in quartz-potassium feldspar intergrowths and contain less biotite than the granites from Górka Sobocka (Tab. 2: ST-1 113.4, ST-2 105a, ST-198.6, ST-2 202.1). The third variety, muscovite-biotite granites (granodiorites) with pinite grains up to 1 cm in size, has been drilled at the SA-1 borehole (Tab. 1: SA.-1 152.4, 157.3). It forms several veins at a depth of 148.0–157.3 m among the dark sillimanite gneisses.

Besides the muscovite-biotite granites, three other

Table 1

Mineral composition of the Lipowe Hills granitoids

Minerals	Fine-grained granodiorite			Fine-grained tonalite	Medium-grained biotite tonalite					Fine-grained muscovite-biotite granite					Fine-grained pinite granodiorite	
										boreholes				quarry		
	ST-1 55.0	ST-1 117.6	ST-1 113.2	ST-1 167.2	ST-2 90.6	ST-2 100.5b	ST-2 101.0	ST-2 111.3	ST-2 151.8	ST-1 113.4	ST-2 100.5a	ST-2 198.6	ST-2 202.1	average of 9 anal.*	SA.-1 152.4	SA.-1 157.3
Quartz	29.8	45.8	32.8	15.5	22.6	22.5	24.4	25.1	38.1	34.6	30.1	42.1	30.4	35.9	33.3	35.4
Plagioclase	40.8	45.7	37.2	39.5	44.8	55.1	55.4	59.0	48.6	31.6	35.7	25.7	30.1	30.0	38.9	34.6
K-feldspar	14.4	3.8	20.7	2.5	16.7	2.4	3.2	1.2	3.9	28.6	28.8	26.5	35.0	24.9	22.0	17.3
Biotite	12.0	4.7	6.7	25.1	12.8	16.3	17.0	14.7	5.4	3.8	1.1	0.3	4.0	5.7	4.3	2.4
Muscovite	0.4				0.2				0.9		2.5	2.1	0.5	3.1	1.0	0.5
Hornblende				10.8												
Pinite															0.5	9.8
Chlorite	1.2			2.0	1.2	1.1			1.8	0.3	0.2	1.3				
Ore	0.6		2.6	2.9	0.6	1.3			0.4	0.3	1.0	1.4		0.1		
Accessory min.	0.8			1.7	0.9	1.3			0.6	0.8	0.6	0.6		0.3		
Calcite					0.2				0.3							

*according to Wojnar (1977)

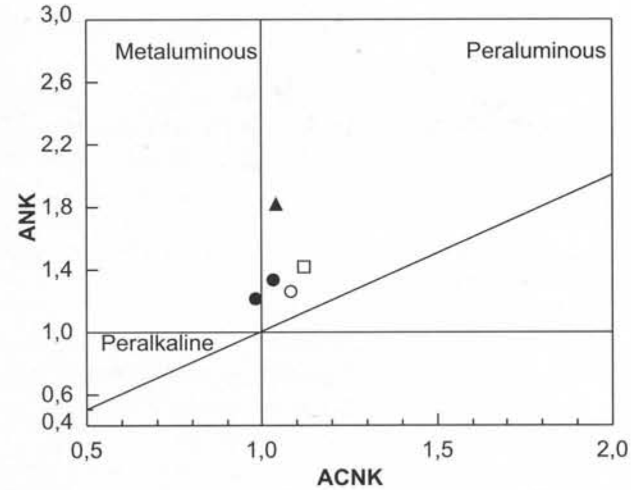

Fig. 3. Aluminousity of the Lipowe Hills granitoids. Legend as on Figure 2.

types of granitoids are known from the Lipowe Hills crystalline complex: fine-grained granodiorites, medium-grained biotite tonalites and fine-grained hornblende-biotite tonalites.

The fine-grained granodiorites were only found in boreholes ST-1 and SA-1. They form several dykes 0.5–4.0 m wide with dark biotite-plagioclase enclaves. They are composed of (Tab. 1, ST-1 55.0, 117.6, 113.2) euhedral and subhedral plagioclase with very distinct and complicated zoning. The plagioclase grains contain apatite, quartz and biotite inclusions. The potassium feldspar grains are always anhedral and less frequent than the plagioclase grains. Myrmekite formed between the plagioclase and potassium feldspar grains. The granodiorites also contain quartz and reddish-brown biotite.

The medium-grained tonalites were drilled in borehole ST-2. They form a body 27.2 m thick at a depth of 87.5–114.7 m. The tonalites are dark grey rocks composed of plagioclase, quartz, biotite and microcline (Tab. 1). The plagioclase grains are euhedral or subhedral and usually zoned (34% An→22% An). Microcline is rare. Grains of this mineral include plagioclase crystals. The only dark mineral is reddish-brown biotite.

The dark grey, fine-grained hornblende-biotite tonalites were found in the ST-1 borehole at a depth of 166.4–166.2 m. They are composed of parallel-aligned, zoned plagioclase, green hornblende, dark brown biotite, quartz and microcline (Tab. 1). Accessory minerals are represented by apatite, zircon allanite and ore minerals.

Table 2

Chemical analyses of the Lipowe Hills granitoids

	Górka 1[a]	Górka 2[b]	ST-2 111.3[c]	ST-2 202.1[c]	SA-1 152.4[c]
SiO_2	74.36	73.93	66.97	74.72	74.28
TiO_2	0.27		0.58	0.17	0.18
Al_2O_3	12.88	13.93	16.67	13.25	13.87
Fe_2O_3	0.68	0.32	0.1	0.1	1.02
FeO	1.01	1.15	3.42	1.42	0.63
MnO	0.04	0.03	0.05	0.2	0.02
MgO	1.08	0.2	1.29	0.22	0.37
CaO	1.38	1.68	3.75	0.93	1.39
Na_2O	3.89	3.14	4.34	3.06	3.3
K_2O	3.95	4.86	1.85	5.09	4.03
P_2O_5	0.28	0.25	0.15	0.05	0.1
LO	0.38	0.16	0.7	0.27	0.43
Total	100.47	99.65	99.69	99.48	99.62
Q	32.7	33.0	22.5	34.1	36.4
C	0.4	1.0	1.1	1.1	1.8
Or	23.4	28.7	10.9	30.1	23.8
Ab	32.9	26.5	36.7	25.9	27.9
An	5.0	6.7	17.6	4.3	6.2
En	2.7	0.5	3.2	0.6	0.9
Hy	0.9	1.9	5.3	2.6	0.1
Il	0.5	0.0	1.1	0.3	0.3
Mt	1.0	0.5	0.1	0.1	1.5
Ap	0.6	0.5	0.3	0.1	0.2
%An	13.3	20.2	32.5	14.2	18.3

[a]Kamieński, Kraus 1960; [b]Wojnar, 1977; [c]Chemical Laboratory of the Institute of Geological Sciences, University of Wrocław

Calcite and chlorite are present as the products of decomposition of biotite and hornblende.

Most of the granitoid samples show the presence of dark spots up to 1 cm in size. Such spots examined beneath the microscope represent nets of thin fissures filled with ore minerals.

The Lipowe Hills granitoids are peraluminous rock (Fig. 3) with normative corundum (Table 2), high potassic (muscovite-biotite granites) or mildly potassic (tonalites) varieties.

THE AGE OF THE LIPOWE HILLS GRANITOIDS

One representative sample of the fine-grained, two mica granite collected from the large quarry at Górka Sobocka was studied using the $^{87}Rb/^{86}Sr$ system. Rb and Sr concentrations were determined by wavelength dispersive X-Ray fluorescence spectrometry with a Philips PW 1400 sequential spectrometer following the analytical procedure described by Harvey and Athin (1981) with a calibration using USGS and CRPG international standards. The result (Table 3, GS 1) is the average of six replicate measurements of a pressed powder pellet, with a relative standard deviation better than 1%. The Sr isotopic composition was measured using a VG54 E thermal ionisation

Table 3

Rb-Sr isotopic results

Sample	Rb ppm	Sr ppm	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$
GS 1	219	78	8.15	0.74457
STIN 1	239	31	22.8	0.81191
STIN 2	255	23	32.6	0.85863
GR 1	220	90	7.1	0.73857
GR 2	212	85	7.2	0.73901

muscovite-biotite granites: GS 1 – Górka Sobocka quarry, STIN 1, STIN 2 – Strzelin quarry, GR 1, GR 2 – Gębczyce quarry (Oberc-Dziedzic *et al.*, 1996)

mass spectrometer in the double collection mode after chemical separation using standard cation exchange techniques (see Pin *et al.* 1989 for details).

At the first sight this sample belongs to the same "family" as the fine-grained, muscovite-biotite granite from the Strzelin and Gębczyce quarries (Oberc-Dziedzic *et al.*, 1996), which gave a 330 ± 6 Ma age with a 0.7053 ± 8 initial ratio. Plotting this point on the already obtained isochron gave the following results: age 329 ± 11 Ma,

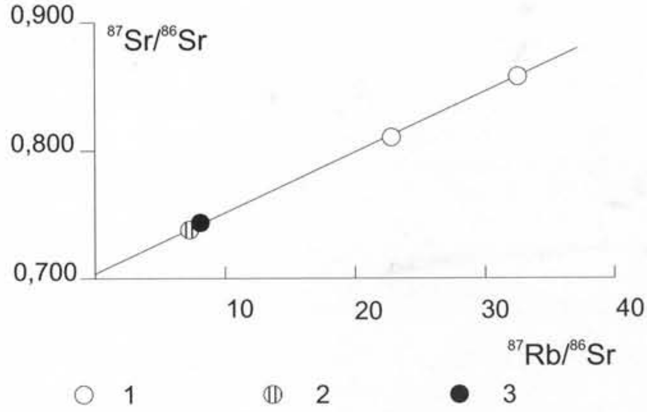

Fig. 4. Rb-Sr isochron diagram for whole rocks of fine-grained biotite-muscovite granites: 1. the Strzelin main quarry, 2. the Gębczyce quarry, 3. the Górka Sobocka quarry.

$^{87}Sr/^{86}Sr_i$ 0.7055 ± 8, which are almost identical within analytical uncertainties to the above cited data (Fig. 4).

This result confirms a close link between all the young light coloured granitoids from the Strzelin Hills crystalline massif and Górka Sobocka.

CONCLUDING REMARKS

The granitoids of the Lipowe Hills crystalline complex differ from the Strzelin granitoids (Oberc-Dziedzic *et al.*, 1996) in several features. First of all they are less frequently found in outcrops and boreholes and less petrographically differentiated than the Strzelin granitoids. Rock types which are common in and typical for the Strzelin massif such as fine-grained and medium-grained biotite granites, and quartz diorites were not found in the Lipowe Hills crystalline complex. Biotite tonalites like those in the St-2 borehole do not occur as separate bodies in the Strzelin massif. On the other hand, hornblende-biotite tonalites, which are common in the Strzelin massif, are nearly absent in the Lipowe Hills.

Both complexes contain muscovite-biotite granites. The Górka Sobocka granite was compared by several authors (Borkowska, 1959; Morawski, 1973; Wojnar,1977) with the muscovite-biotite granites from the Strzelin massif (the so-called Biały Kościół and Gębczyce granites) due to their petrographic resemblance. The result of the Rb/Sr dating supports such a point of view. However, there is also a difference between the muscovite-biotite granites of both complexes. The muscovite-biotite granites from the Lipowe Hills show a distinct lineation, whereas lineation in the muscovite-biotite granites from the Strzelin massif is exceptionally rare.

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REFERENCES

BORKOWSKA, M., 1958. Granitoidy kudowskie na tle petrografii głównych typów kwaśnych intruzji Sudetów i ich przedpola. [On the granitoids of Kudowa as compared with the main types of the acid intrusions of the Sudeten Mts. and the Sudetic Foreland]. *Archiwum Mineralogiczne*, 21: 229–382.

CLOOS, E., 1922. Tektonik des Granits von Gorkau. (Kr. Nimptsch) in Schlesien. Tektonik und Magma. Untersuchngen zur Geologie der Tiefen. *Abhandlungen des Preussische Geologische Landesanstalt. Neue Folge*, 89: 93–102. Berlin.

HARVEY, P.K. & ATHIN, B.L., 1981. The rapid determination of Rb, Sr and their ratios in geological material by X-Ray fluoroscence spectometry using a Rhodium X-Ray tube. *Chemical Geology*, 32: 291–301.

KAMIEŃSKI, M., & KRAUSS, E., 1960. Granity śląskie i ich kwasoodporność. [Silesian granites and their acid-resistance]. *Prace Instytutu Geologicznego*, 30/2: 123–176.

MORAWSKI, T., 1973. Granity masywu Strzelin–Žulova. *Kwartalnik Geologiczny*, 17: 924–925. {in Polish only}

OBERC, J., 1972. Budowa geologiczna Polski t. IV, Tektonika, cz. 2, Sudety i obszary przyległe: 1–307. {in Polish only}

OBERC-DZIEDZIC, T., 1988. Serie metamorficzne Wzgórz Strzelińskich i historia ich przeobrażeń. *Sesja naukowa: Budowa, rozwój i surowce skalne krystaliniku strzelińskiego. Instytut Nauk Geologicznych Uniwersytetu Wrocławskiego, Przedsiębiorstwo Geologiczne Wrocław*: 6–21. {in Polish only}

OBERC-DZIEDZIC, T., 1995. Problematyka badań serii metamorficznych Wzgórz Strzelińskich w świetle analizy materiału wiertniczego. [Research problems of the Wzgórza Strzelińskie metamorphic series in the light of the analysis of borehole materials]. *Acta Universitatis Wratislaviensis* 1739, *Prace Geologiczno-Mineralalogiczne*. 50: 75–105.

OBERC-DZIEDZIC, T., PIN, C., DUTHOU, J.L. & COUTURIE, J.P., 1996. Age and origin of the Strzelin granitoids (Fore-Sudetic Block, Poland): $^{87}Rb/^{86}Sr$ data. *Neues Jahrbuch für Mineralogie. Abhandlungen*. 171: 187–198.

PIN, C., Puziewicz J. & Duthou, J.L., 1989. Ages and origins of a composite granitic massif in the Variscan belt: a Rb-Sr study of the Strzegom–Sobótka Massif, W. Sudetes (Poland). *Neues Jahrbuch für Mineralogie. Abhandlungen*. 160: 71–82.

WOJNAR, B., 1977. Petrografia granitu z Górki Sobockiej na bloku przedsudeckim. The petrography of granite of Górka Sobocka (Fore-Sudetic Block). *Acta Universitatis Wratislaviensis 378. Prace Geologiczno-Mineralogiczne* 6: 139–156.

WÓJCIK, L., 1968. Szczegółowa mapa geologiczna Sudetów. Arkusz Ciepłowody 1:25000. Instytut Geologiczny. Warszawa.

WÓJCIK, L., 1973. Objaśnienia do szczegółowej mapy geologicznej Sudetów. Arkusz Ciepłowody 1:25000: 1–57. Instytut Geologiczny. Warszawa. {in Polish only}