Granitoids in Poland, AM Monograph No. 1, 2007, 217-229

Internal structure of the granite and tonalite intrusions in the Strzelin massif, Fore-Sudetic block, SW Poland

Teresa Oberc-Dziedzic

Abstract: The Strzelin granitoids are petrographically variegated, from diorite to peraluminous granite. These rocks occur as (a) numerous small intrusions formed by the emplacement of single or multiply pulses of one type of magma, and (b) composite intrusions formed by the superposition of a few magma episodes. The differentiation of magma took place in a magma chamber prior to the emplacement and in an intrusion after the emplacement. The differentiation processes of tonalite magma were complicated as evidenced by petrographic and mineral features. The homogeneity of granites suggests an insignificant role of granite magma differentiation after the emplacement and the observed differences in the chemical and mineral compositions of the granites representing three magma episodes in the Strzelin intrusion point to the differentiation before the emplacement. The composite character of the Strzelin and Gęsiniec intrusions suggests that the magma in successive episodes used the same ways of migration.

Key words: granitoid, magma differentiation, composite pluton, Fore-Sudetic block

GEOLOGICAL SETTING

The Strzelin and Lipowe Hills massifs are situated in the eastern part of the Fore-Sudetic Block, 35 km south of Wrocław (Fig. l). Two rock complexes separated by the Strzelin thrust are distinguished in this area: the structurally lower Strzelin complex (the footwall of the thrust), more widespread in the Strzelin massif, and the upper Stachów complex (the hanging wall of the thrust), predominating in the Lipowe Hills massif. The Strzelin thrust may be interpreted as the northern extension of the boundary between the East and West Sudetes, *i.e*. part of the boundary between the Brunovistulian and Moldanubian terranes in the NE part of the Bohemian massif (Oberc-Dziedzic *et al*. 2005).

The Strzelin complex is composed of a core unit, an inner envelope (older schist series), and an outer envelope (younger schist series = the Jeglowa beds, *cf*. Fig. 1).

The core unit comprises Neoproterozoic gneisses: fine- to medium-grained, porphyritic biotite-muscovite gneiss, typical of the northern part of the Strzelin massif, with zircon age values of 600±7 and 568±7 Ma (Oberc-Dziedzic *et al*. 2003a), and migmatic sillimanite gneiss, occurring in the southern part of the Strzelin and Lipowe Hills massifs, with a mean zircon age of 1020±1 Ma (Kröner, Mazur 2003).

The inner envelope of the gneisses, the older schist series of Neoproterozoic or Early Palaeozoic(?) age, is composed of amphibolites, mica schists, calc-silicate rocks and marbles.

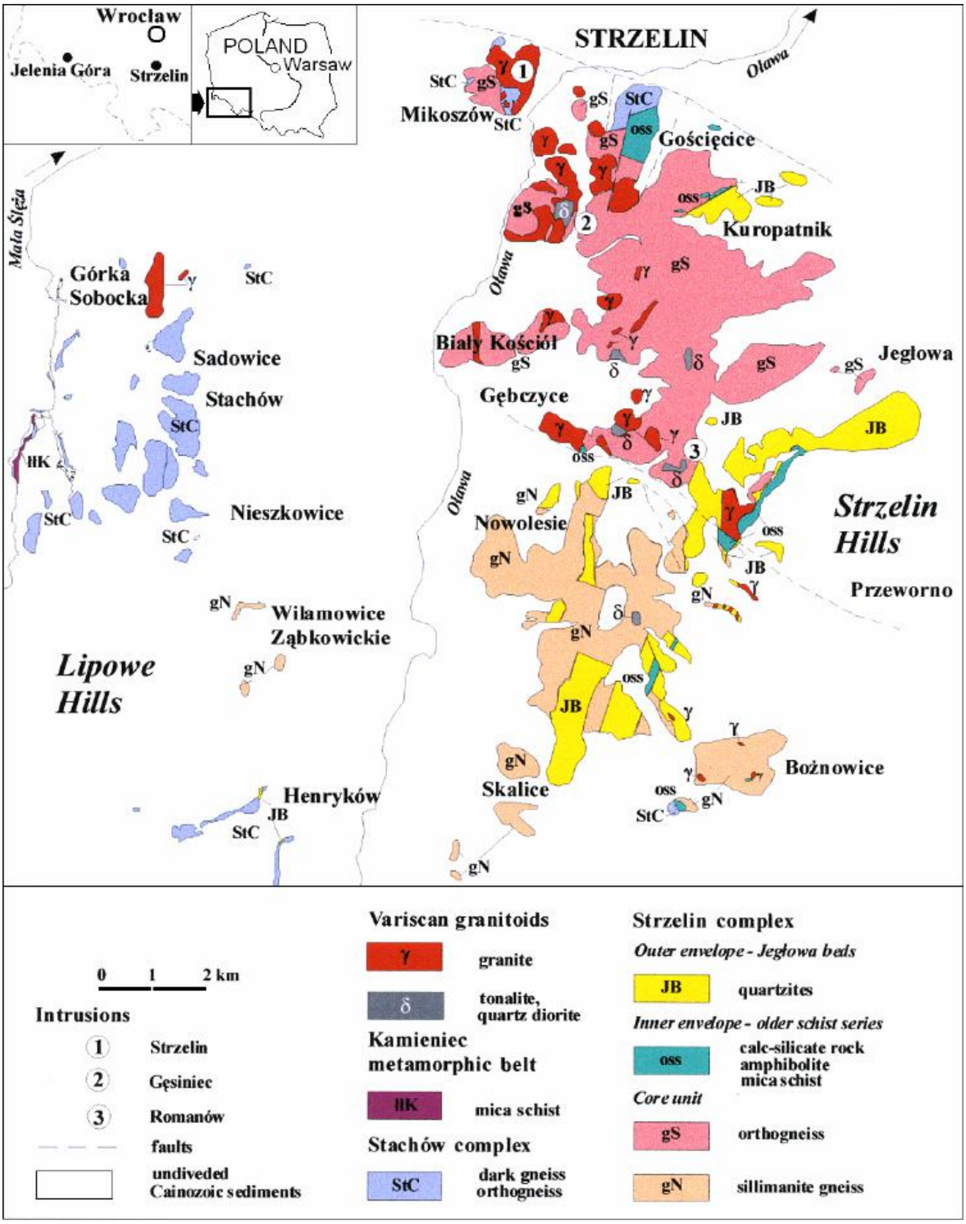

Fig. 1. Geological map of the Strzelin massif (Oberc *et al*. 1988) and the Lipowe Hills Massif (Wojcik 1968, Wronski 1973, Badura 1979).

The outer envelope or ***the younger schist series*** (the Jegłowa beds; Oberc 1966), consists of quartzites, quartz-sericite schists and metaconglomerates, the protoliths of which were deposited in a continental margin setting during Early- to Mid-Devonian times (Patočka, Szczepański 1997). The Jegłowa beds were correlated with the quartzite formation in the Jeseniki Mts. of the East Sudetes (Bederke 1931, Oberc 1966), containing Early Devonian fossils (Chlupač 1975).

The Stachow complex forms several tectonic klippen in the Strzelin massif and in the Lipowe Hills massif. It contains orthogneisses which yielded Early Ordovician (~500±7 to 5 Ma) zircon age values (Oliver *et al*. 1993; Kröner, Mazur 2003; Oberc-Dziedzic *et al*. 2003b), and the dark, fine-grained gneiss. The intercalations of dark gneiss with mica schists and amphibolites are interpreted as Neoproterozoic or Lower Palaeozoic metasediments, representing the metamorphic envelope of the granitoid protolith of the orthogneisses (Oberc-Dziedzic, Madej 2002).

The orthogneisses in the Strzelin and Stachów complexes correspond to peraluminous *S*-type granites, but they have different inherited zircon age values and display contrasting trace element characteristics, indicating different sources and petrogenetic histories (Oberc-Dziedzic *et al*. 2005). The Strzelin and Stachów complexes were deformed and metamorphosed during the Variscan orogeny. The rocks underwent polyphase deformation **(D_1-D_4)** and metamorphism (M_1-M_4), as evidenced by Oberc -Dziedzic *et al*. (2005). The Strzelin and Stachów complexes were intruded by four groups of Variscan granitoids: (1) granodiorites, (2) tonalites and quartz diorites, (3) medium- and fine-grained biotite granites (347±12 Ma, Rb-Sr whole rock method), and (4) two mica granites (330±6 Ma, the same method), *see* Oberc-Dziedzic *et al*. (1996) and Oberc-Dziedzic and Pin (2000). More recently, Pietranik and Waight (2005) obtained an age of 294 Ma from three internal rock isochrones for the Gęsiniec tonalite.

The proportions of granites and tonalities are different in the northern and southern part of the Strzelin massif. The biotite granite intrusions prevail over the tonalite and quartz diorite bodies in the northern part of the massif. In the middle part, tonalites, quartz diorites and biotite-muscovite granites occur, whereas in the southern part, tonalites are most frequent. The granodiorites are found mainly in the southern part of the massif. The granitoids of the Lipowe Hills massif are mainly represented by muscovite-biotite granites, medium-grained biotite tonalites, fine-grained tonalites and fine-grained granodiorites, the three latter found mainly in boreholes.

GEOLOGICAL FEATURES OF THE GRANITOIDS

The Strzelin granitoids are unique in the Sudetes because they do not form one big intrusion but small isolated bodies, mostly stocks and flat veins up to tens of metres thick. Their size and three-dimensional form were deduced by combining mapping, structural data, thermal aureole and by observation of mutual relationships between granitoids and their metamorphic envelope in outcrops and numerous boreholes. The largest intrusions are located in the northern and middle parts of the massif. They are exposed in abandoned and active quarries. Several other tonalite and diorite intrusions, up to 80 m thick, are only known from boreholes located in the middle and southern part of the massif.

The Strzelin granite intrusion

This intrusion is situated in the northern part of the Strzelin massif, close to the fault which borders the massif from the north. It is very well exposed in the huge, active Strzelin I and Strzelin II quarries. The intrusion is a stock type. A thick, flat apophysis and numerous dykes branch off it (Fig. 2).

The contacts of the granites with the country rocks belonging to the Stachow Complex are sharp and discordant. The foliation in the metamorphic rocks, which generally dips to the NNW at moderate angles, adjacent to the contact becomes steeper nearly vertical and, locally, bent (Fig. 3). The Strzelin granite intrusion has produced little contact

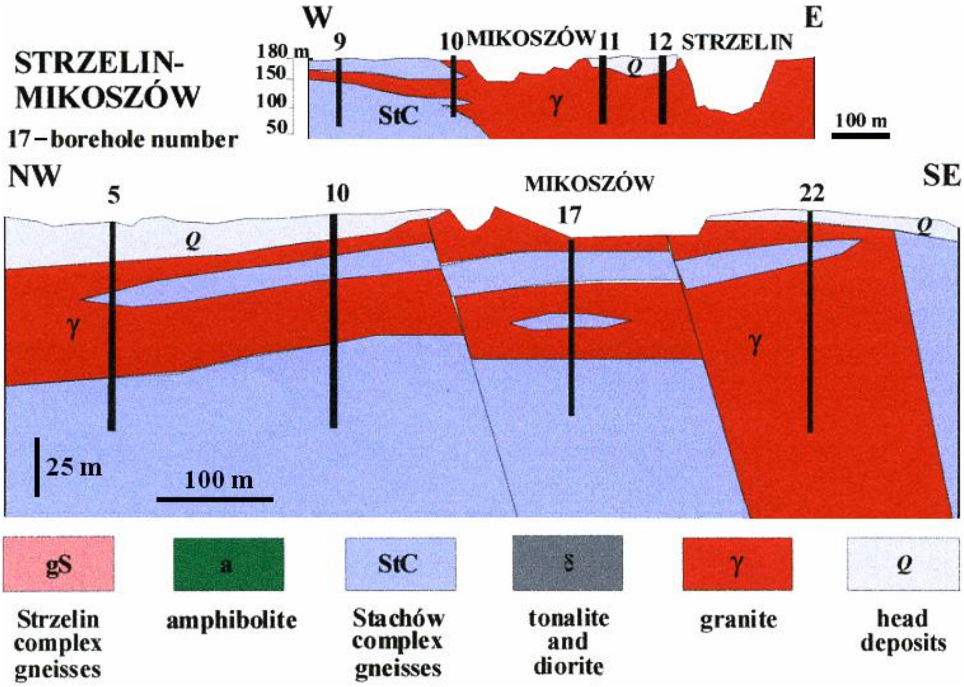

Fig. 2 Geological cross-section through the Strzelin intrusion after Balawejder *et al*. (1988; *upper drawing*) and Borek (1987; *lower drawing*).

metamorphic effects. Generally, the schists were not transformed into hornfelses, although a static mineral growth resulting in an isotropic fabric and pinite psedomorphs after cordierite are observed in places. The lack of distinct contact metamorphic effects is related to the small size of the granite body.

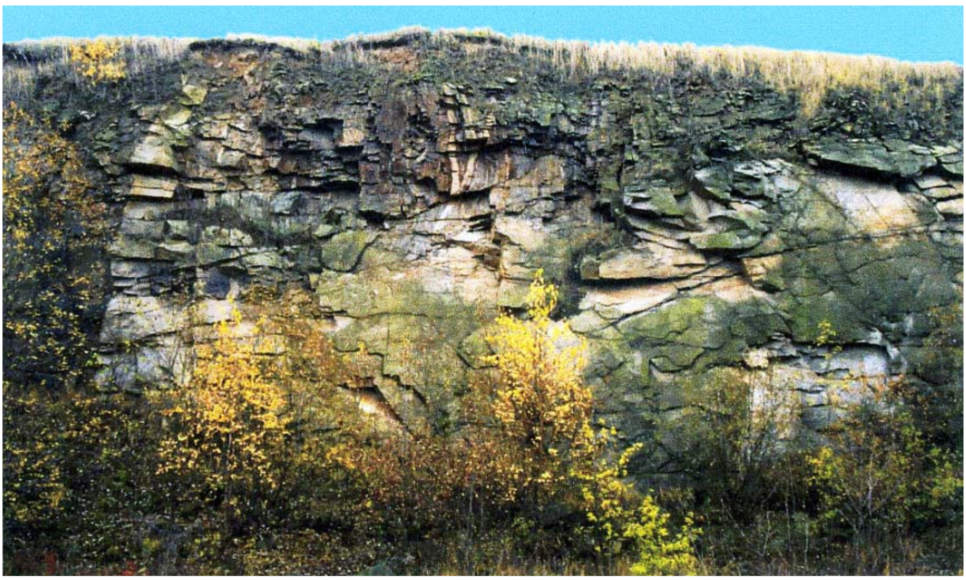

Fig. 3. The contact of the medium-grained granite with country rocks; the foliation at the contact is nearly vertical, and locally bent (in the middle of the photo). The Strzelin II quarry.

The Strzelin granite intrusion is a composite pluton made of three varieties of granite: medium-grained biotite granite, fine-grained biotite granite and pale, fine-grained biotite-muscovite granite (Table 1).

Table 1. Average mineral compositions of the Strzelin granitoids

Component	Gęsiniec tonalite	Quartz diorites	Medium-grained biotite granite	Fine-grained biotite granite	Fine-grained muscovite biotite granite
Quartz	9.4-20.8	3.7-15.2	27.5-34.5	28.7-30.9	33.4-34.9
Perthitic microcline	–	–	24.1-34.0	24.1-33.3	30.6-31.3
Plagioclase	32.3-58.2 An 50-32	43.0-55.6 An 58-38	20.6-40.1 An 30-13	29.8-38.7 An 38-19	28.4-29.7 An 24-12
Hornblende	4.7-24.1	10.5-26.9	–	–	–
Biotite	8.5-41.5	7.1-21.2	3.7-6.6	4.6-8.9	1.8-2.6
Muscovite	–	–	–	–	1.8-2.6
Pyroxene relics	–	1.5	–	–	–
Post-pyroxene products	–	<6.3	–	–	–
Post-hornblende products	–	<10.4	–	–	–
Sphene	~0.1	–	–	–	–
Opaque minerals	0.1-1.3	–	–	–	–

The medium-grained biotite granite consists of quartz, perthitic microcline, subhedral-euhedral zonal plagioclase (30 to >13% An) and biotite. ***The fine-grained biotite granite*** has characteristic bluish-grey colour, and displays a monzonitic texture. It is composed of quartz, euhedral plagioclase (38->19% An), perthitic microcline, biotite and chlorite (up to 1.2%). In comparison with the medium-grained variety, the fine-grained granite contains less quartz and more biotite (Table l). ***The pale, fine-grainedy biotite-muscovite granite*** is composed of quartz, microcline, plagioclase (24→12% An), biotite and muscovite. The biotite-muscovite granite which forms separate inclusions in the middle part of the massif contains muscovite, andalusite and pinite pseudomorphs after cordierite (Bereś 1969; Lorenc 1987).

The Strzelin intrusion only occasionally contains ***pegmatites*** composed mainly of quartz, microcline, small amount of oligoclase and biotite (Bereś 1969). The spatial relationships between granites suggest that the medium-grained biotite granite intruded as the first. It occurs in the southern and northern part of the intrusion and forms also numerous apophyses.

Close to the contact with the country rocks, the medium-grained granite contains many xenoliths of dark and pale gneisses belonging to the Stachów Complex. The xenoliths are often surrounded by white haloes composed of granite devoid of biotite or by several

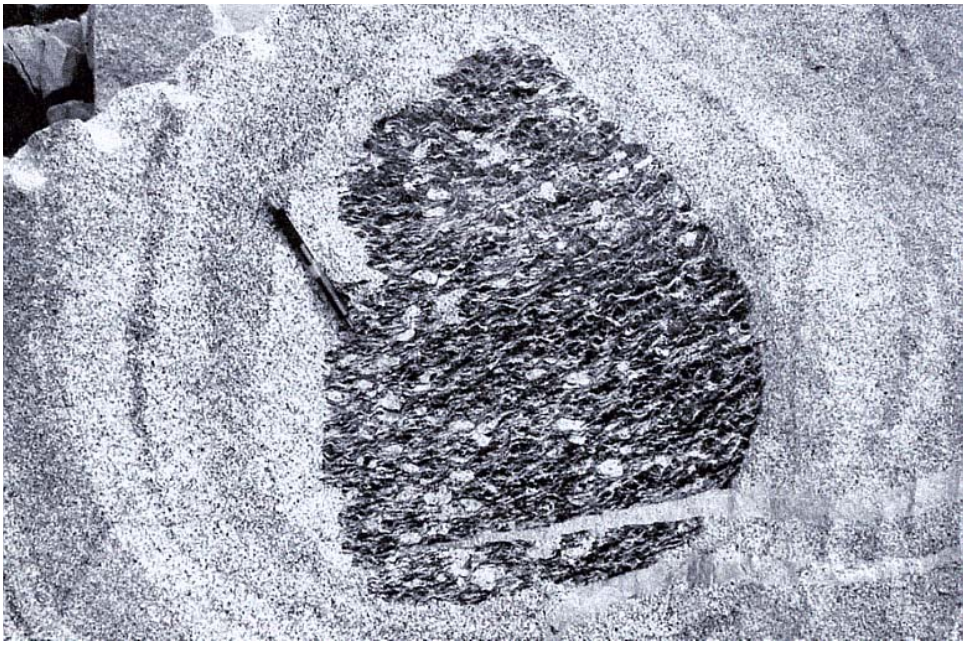

Fig. 4. Xenolith of augen gneiss surrounded by schlieren, the lineation is parallel to the pen; length of the pen is 14.5 cm. The Strzelin I quarry.

concentric bands of granite rich and poor in biotite (Fig. 4). The longer axes of minerals in these bands define a lineation which is oblique to their margins. Similar compositional bands (schlieren) defining a magmatic foliation appear near the contact of the granite with country rocks. In places, they are deformed into tight and open folds (Fig. 5).

Fig. 5. Folded schlieren in the Strzelin granite. The Strzelin I quarry.

The middle part of the intrusion is formed of the fine-grained biotite granite which intruded after the medium-grained variety. The fine-grained biotite granite forms an E-W trending dyke dipping to the north (Morawski, Kościówko 1975). Near the contact of the two granites, streaks and lenses of the fine-grained granite appear within the medium-grained one. Their amount and volume increase and the fine-grained granite becomes the only rock. Such the contact can be interpreted as an intrusion of the fine-grained granite into not fully consolidated medium-grained granite. In the contact zone, xenoliths of country rocks are relatively abundant in the fine-grained granites, but after several tens of meters they disappear and the granite becomes monotonous or contains only sparse enclaves, 1-3 centimetres in size. The pale, fine-grained, biotite-muscovite granite occurs as tens of centimetres-sized dykes cutting the medium- and fine-grained granites. The contacts between the fine-grained biotite granite and the two mica granite are usually sharp, although locally gradual transitions can be observed.

The medium and fine-grained biotite granites do not show evidence of intracrystalline plastic strain, except weak undulatory extinction in quartz. It suggests magma flow with sufficient amount of melt present to prevent crystal damage. The presence of the compositional banding around xenoliths indicates that the temperature gradient between them and the magma was high enough to keep schlieren parallel to the xenolith margins. However, faint magmatic lineation observed in the medium and fine-grained biotite granites has a constant orientation even when it cross-cuts the schlieren-bordered xenoliths. This feature and the deformation of schlieren into folds close to the margins of the intrusion, suggest that the granite magma was emplaced into an active tectonic structure.

The biotite-muscovite granite shows structures typical of submagmatic deformation. Such deformation may have been caused by fast crystallization of magma in active fractures, as it is evidenced by the orientation of the foliation in narrow veins of the biotite-muscovite granite.

The Gęsiniec tonalite intrusion

The Gęsiniec intrusion (Fig. 1) is the largest and best exposed composite, tonalite intrusion in the Strzelin massif. Based on borehole data, it forms a stock cut by a dyke of leucocratic, fine-grained biotite-muscovite granite (Fig. 6). The Gęsiniec intrusion caused distinct contact metamorphic effects in the surrounding amphibolites which were transformed into pyroxene homfelses. The composite Gęsiniec intrusion was formed by three magmatic injections: tonalitic, granodioritic and granitic (Puziewicz, Oberc-Dziedzic 1995).

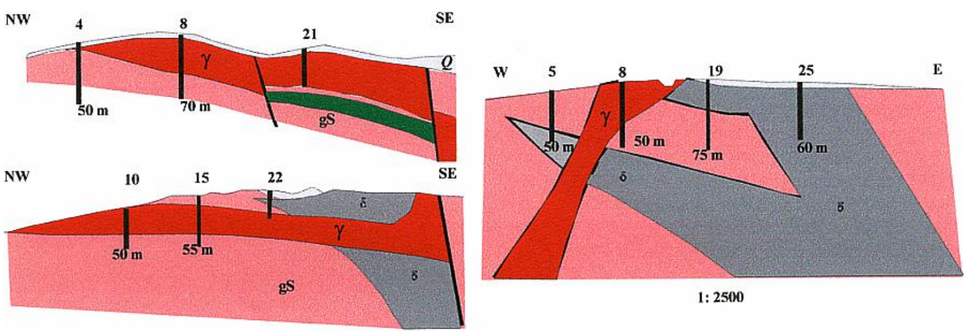

Fig. 6. Geological cross-section through the Gęsiniec intrusion (*after* Borek 1987). Explanations as to Fig. 2.

Dark grey, very fine-grained ***quartz diorite*** forms the marginal fades of the intrusion, corroded or brecciated by tonalites. It displays a parallel alignment of plagioclase grains and the presence of biotite plates up to 3 mm in size, surrounded by white quartz-plagioclase rims in places. The quartz diorites are composed of quartz, plagioclase (58 to >34% An), hornblende and biotite.

The inner part of the intrusion consists of tonalites of several facies. They differ in texture and proportion of main components. The shape of apatite, titanite and plagioclase grains is highly variable. Plagioclases usually show a very complicated zoning and the presence of corroded cores. Dark minerals have random or parallel arrangement and they form clusters in places. The most common variety is ***light-grey, medium-grained tonalite*** with uniformly distributed dark minerals. Locally, it shows an indistinct parallel texture. This variety contains quartz, plagioclase (50 to >32% An), hornblende, biotite, apatite, sphene and opaque minerals. The sum of biotite and hornblende is rather constant - about 30-35 %. The medium-grained tonalite forms transitions to ***dark tonalite*** with irregularly distributed dark minerals which concentrate into clusters or spots, up to 5 mm in size. The dark minerals are arranged into layers and schlieren in places. Another variety of the dark tonalite contains single plates of biotite, up to 5 mm in size. The light grey, medium-grained and dark varieties of the tonalite can gradually change into the *white tonalite.* In the transition zones, the dark tonalites display a schlieren structure. The white tonalite contains up to 1% microcline. Biotite is the only dark mineral. This type of tonalite also forms small veins in the darker varieties.

The origin of all the varieties of the tonalites is connected with magma differentiation after the emplacement. The white variety of the tonalites represents the most acid residual fractions of the crystallizing melt.

The second magmatic injection in the Gęsiniec intrusion is represented by ***the grey, fine -grained granodiorite*** (Puziewicz, Oberc-Dziedzic 1999). This rock forms uregular streaks or veins within the tonalites. Biotite and plagioclase composing the granodiorite are arranged parallelly to the borders of the veins. Detailed study of the granodiorite magma evolution was presented by Pietranik *et al*. (2006).

The granodiorite is very rich in small, dark enclaves of mica schists, up to 3 cm in size. Gneissic enclaves are also very common. They are sometimes surrounded by thin quartz-feldspathic or biotite rims. Some enclaves are divided into parts of different orientation, suggesting their rotation in the magma.

The contacts of the granodiorite with surrounding medium-grained tonalite are usually sharp. However, the granodiorite can also penetrate the tonalite. In that case, the contacts of the two rocks become irregular and small enclaves of tonalite appear in the granodiorite. Apparently, the granodiorite intruded when the tonalite was nearly solidified. The granodioritic magma probably went by the same channel which was next used by the biotite-muscovite granite. It seems that there is a close spatial relationship between the two rocks. The abundance of reoriented metamorphic enclaves proves that the channel walls were built of metamorphic rocks.

The third, youngest magmatic injection is represented by ***the pale, fine-grained biotite muscovite granite.*** This granite forms a dyke about 15 mm in thickness and several dykes 1-2 m. thick (Fig. 7). It resembles the light-coloured granite occurring in the Strzelin quarry. The granite which forms thin veins contains small pseudomorphs after cordierite.

The Gęsiniec tonalites display often a parallel arrangement of dark minerals which define lineation and foliation. The lineation in the tonalites is parallel to the lineation in the country gneisses. The magmatic foliation was followed by the late-magmatic shear zones. The sense of motion of these shear zones coincides with the sense of motion along the foliation in the country rocks. It is thus possible that the emplacement and crystallization of the tonalites took place during the decline of the regional deformation. This deformation ceased completely before the emplacement of the biotite-muscovite granite which does not display any foliation and lineation (Oberc-Dziedzic 1999).

Fig. 7. The Gęsiniec tonalite cut by a vein of the biotite-muscovite granite.

Tonalite and quartz diorite sills

These sills are several metres to several tens of metres thick. In boreholes, their margins are usually parallel to the foliation in the country rocks. The sills are always internally differentiated into several varieties which differ in colour, structure, main mineral contents and chemical composition. The colour of the rocks depends on the dark mineral content and on the way of their arrangement in the rock. The rock seems to be lighter and more coarse-grained where dark minerals are gathered into clusters than in the case when they are uniformly distributed. Among the quartz diorites, three types can be identified: ***medium-grained diorite (type B)***, fine-grained ***diorite with biotite phenocrysts (type C)*** and ***microdiorite (type D)***. These types gradually pass into one another. ***Tonalite (type E)*** is usually a grey, fine-grained rock in the southern part of the Strzelin massif, and medium-grained is found in its northern part (Oberc-Dziedzic 2002).

The medium-grained ***quartz diorite (type B)*** displays an allotriomorphic or hipidiomorphic texture. Plagioclases are twinned and normally zoned (68-44% An in the darker variety, and 52-38% An in the lighter variety) with amoeboid shaped cores, sometimes strongly altered. Green hornblende forms single grains or clusters together with biotite. Xenomorphic quartz grains show spotty or undulose extinction.

Fine-grained quartz diorite (type C) is a dark grey-greenish rock with black or brown spots of biotite, up to 3 mm in size. This rock often contains relics of pyroxene.

Microdiorite (type D) is a dark grey or black very fine-grained rock with small flakes of biotite, up to 0.5 mm in size. Plagioclase laths are arranged in a manner resembling ophitic texture or show more or less visible parallel alignment. This variety always contains more hornblende than biotite, and is very poor in quartz.

Tonalite (type E) shows a hipidiomorphic or ophitic texture. Plagioclase forms laths usually 0.8×0.3 mm in size, or bigger idiomorphic zoned grains, up to 1.2 mm. Tonalite usually contains more biotite than hornblende, and, locally, is rich in titanite. The outer parts of thin sills, correspond to chilled margins, are usually composed of microdiorite (type D) whereas the inner part consists of grey, fine- to medium-grained tonalite (type E) or diorite (type B).

The inner structure of the several tens of metres thick sills is complicated (Oberc-Dziedzic 2002). It was well recognized in the Romanów intrusion penetrated by the RG 2 (60.0-136.6; 76.6 m thick) borehole (Fig. 1). The Romanów sill is inclined at an angle of 45°.

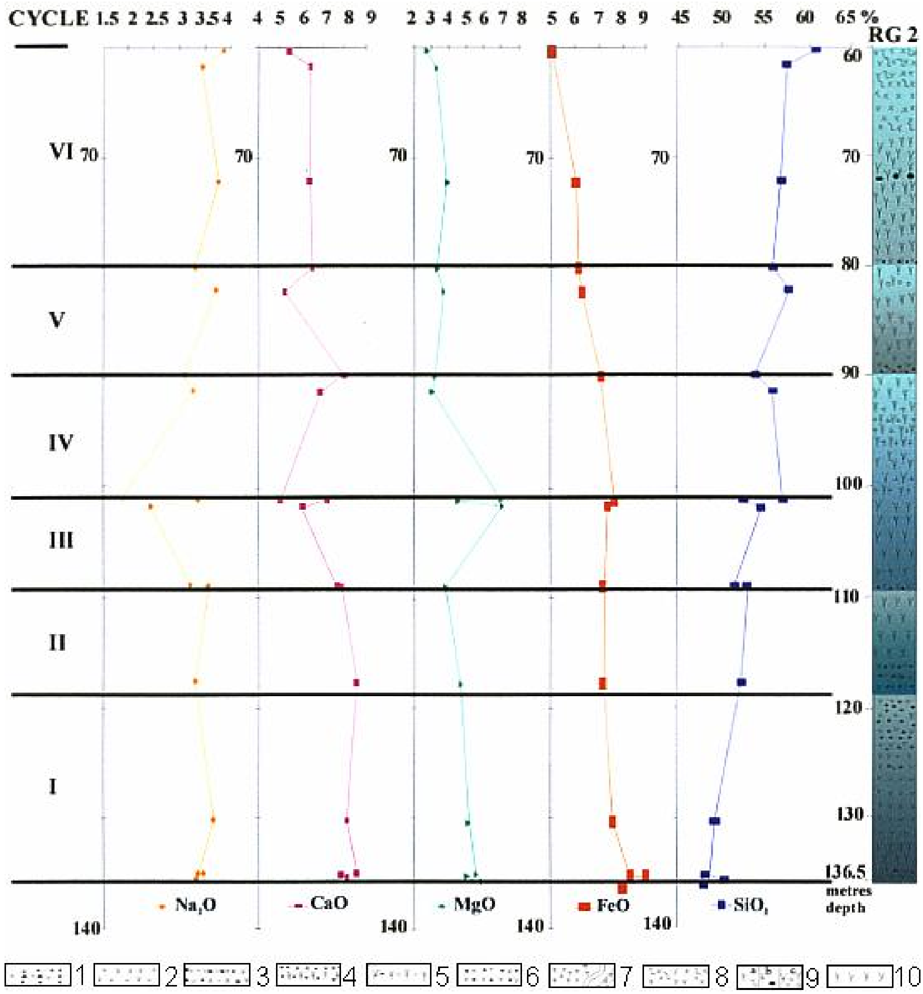

Fig. 8. Borehole column of the RG 2 sill. Plots show the changes of the major element contents from top to bottom of the sill; 1 – fine-grained quartz diorite with magmatic foliation (C), 2 – microdiorite (D), 3 – microdiorite (D) with magmatic foliation, 4 – dark quartz diorite (B), 5 – quartz diorite (B) with magmatic foliation, 6 – fine-grained quartz diorite (C) with spots of biotite, 7 – leucoctaric veins and schlieren, 8 – tonalite with schlieren, 9 – quartz diorite with schlieren (a), enclaves (b) and titanite (c), 10 – medium-grained quartz diorite (B).

Generally, toward the bottom of the sill, the diorite is increasingly darker and the grain size diminishes. Besides this tendency, six cyclic sequences quartz diorites are also visible. The thickness of one cycle varies from 6 to 20 m. Each cycle has a fine-grained quartz diorite (type C) or microdiorite (type D) at the bottom and a medium-grained diorite (type B) at the top. Inside the C type, a thin layer with a parallel texture is usually present. The zones of schlieren and leucocratic veins are visible 1/3 or 1/2 way from the top of each cycle. Chemical analyses of the fine-grained (type C) and medium-grained (type B) quartz diorites from RG 2 borehole confirm the presence of the magmatic cycles (Oberc-Dziedzic 2002). A rapid increase of the SiO_2 contents on the border between the cycles, and a general increase of silica towards the top of the sill are visible. In the same direction, the contents of FeO, MgO, CaO decrease (Fig. 8).

Multi-element diagrams (not shown here) for several samples from the RG 2 sill display similar patterns. This indicates a common source of the quartz diorite magma. The RG 2 sill can be interpreted as an intrusion which was formed by 6 pulses of magma coming from one magma chamber. Differentiation in the chamber prior to emplacement caused the pulses to become more and more acidic. The presence of the fine-grained quartz diorite and microdiorite, which are interpreted as chilled margins, and the zones of diorites with parallel texture close to these margins, suggest that each pulse solidified as an individual sill intruded alongside the others.

CONCLUDING REMARKS

The Strzelin granitoids are in petrographic sense exceptionally varied: from diorite to peraluminous granite. These rocks form many small intrusions showing different internal structures, depending on the number of magma pulses, magma differentiation and superposition a few magma episodes. The internal structure of the several metres thick tonalite sills is an effect of magmatic differentiation after emplacement. Thicker (several tens of metres) diorite sills, such as RG 2, may have been formed due to several pulses of magma coming from one magma chamber. The differentiation of magma took place prior to the emplacement, in the magma chamber, and after the emplacement. The differentiation processes of the Gęsiniec tonalite magma must have been much more complicated that those in the Strzelin granites (Pietranik, Waight 2006). The extent of the differentiation of the granite magma after the emplacement was probably insignificant; the granites are relatively homogeneous. Nevertheless, differences in the chemical and mineral compositions of the granites, representing three magma episodes in the Strzelin intrusion, point to differentiation before the emplacement. The composite character the Strzelin and Gęsiniec intrusions suggests that the magmas of successive episodes used the same ways of migration.

Acknowledgements

I am grateful to Ryszard Kryza for his helpfiil comments that improved the manuscript. The study was supported by research grants No 2022/W/ING/06-29.

REFERENCES

Badura J. 1979. *Szczegółowa mapa geologiczna Sudetów. Arkusz Stolec*, 1:25000. Instytut Geologiczny, Wydawnictwa Geologiczne, Warszawa.

Balawejder J., Kryza G., Kuśnierz A. 1988. Stosunek granitów do skał metamorficznej osłony. *Sesja naukowa: Budowa, rozwoj i surowce skalne krystaliniku strzelinskiego*. Inst. Nauk Geol. Uniw. Wrocł., Przeds. Geol. Wroclaw, 80-85. [in Polish]

Bederke E. 1931. Die moldanubische Überschiebung im Sudetenvorlande. *Zbl. Mineral. Geol. Paläont*. Abt. B, 349-408.
Bereś B. 1969. Petrography of granite of the environments of Strzelin. *Acta Geol. Polon*., 28, 5-105. [in Polish, English summ.]
Borek Z. 1987. *Kompleksowa dokumentacja geologiczna złóż granitoidów „Strzeliński Okręg Eksploatacji Surowców Skalnych"*. Archiwum Przedsiębiorstwa Geologicznego Proxima we Wrocławiu.
Chlupač I. 1975. New finds of fauna in the metamorphic Devonian of the Hruby Jesenik Mts. (Moravia, Czechoslovakia). *Čas. Mineral. Geol.*, 20, 259-268. [in Czech, English summ.]
Kröner A., Mazur S. 2003. Proterozoic and Palaeozoic crustal components across the East/Central Sudetes boundary at the eastern margin of the Bohemian massif: new U/Pb single zircon ages from the eastern Fore-Sudetic block (SW Poland). *Journ. Czech Geol. Soc. Abstr. vol*., 48 (1-2), 83-84.
Lorenc M. W. 1987. Cordierite in granitoid rocks of Hercynian massifs of the Central System (Estremadura, Spain) – a preliminary comparative study. *Ann. Soc. Geol. Polon*., 57, 89-106. [in Polish, English summ.]
Morawski T., Kościówko H. 1975. Granity rejonu Strzelina i ich kontakty. *Przewodnik 47 Zjazdu PTG*, 181-183. Warszawa. [in Polish]
Oberc J. 1966. Geology of crystalline rocks of the Wzgórza Strzelińskie Hills, Lower Silesia. *Studia Geol. Polon.*, 20, 1-187. [In Polish, English summ.]
Oberc J. (ed.), Oberc-Dziedzic T., Klimas-August K. 1988. *Mapa geologiczna Wzgórz Strzelińskich w skali 1:25 000*. Inst. Nauk Geol. Uniw. Wrocł., Przed. Geol. Wrocław.
Oberc-Dziedzic T. 1999. Geology of the Strzelin granitoids (Fore-Sudetic block, SW Poland). *Mineral. Soc. Poland, Special Papers*, 13, 22-32.
Oberc-Dziedzic T. 2002. Polycycle structure of the tonalite-diorite dykes in the Strzelin massif: a result of magmatic differentiation or separated magmatic pulses? *Mineral. Soc. Poland, Special Papers*, 20, 159-161.
Oberc-Dziedzic T., Madej S. 2002. The Variscan overthrust of the Lower Palaeozoic gneiss unit on the Cadomian basement in the Strzelin and Lipowe Hills massifs, Fore-Sudetic block, SW Poland; is this part of the East-West Sudetes boundary? *Geologia Sudetica*, 34, 39-58.
Oberc-Dziedzic T., Pin C. 2000. The granitoids of the Lipowe Hills (Fore-Sudetic block) and their relationship to the Strzelin granites. *Geologia Sudetica*, 33, 17-22.
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. *N. Jb. Miner. Abh*., 171, 187-198.
Oberc-Dziedzic T., Klimas K., Kryza R., Fanning C. M. 2003a. SHRIMP U-Pb zircon geochronology of the Strzelin gneiss, SW Poland: evidence for a Neoproterozoic thermal event in the Fore-Sudetic Block, Central European Variscides. *Int. Journ. Earth Sci.* (*Geol. Rundschau*), 92, 701-711.
Oberc-Dziedzic T., Klimas K., Kryza R., Fanning C. M., Madej S. 2003b. SHRIMP zircon ages from gneiss help locate the West-East Sudetes boundary (NE Bohemian massif, SW Poland). *Journ. Czech Geol. Soc. Abstr. vol*., 48 (1-2), 98.
Oberc-Dziedzic T., Kryza R., Klimas K., Fanning M. C., Madej S. 2005. Gneiss protolith ages and tectonic boundaries in the NE part of the Bohemian massif (Fore-Sudetic block, SW Poland). *Geol. Quart*., 49, 363-378.
Oliver G. J. H., Corfu F., Krogh T. E. 1993. U-Pb ages from SW Poland: evidence for a Caledonian suture zone between Baltica and Gondwana. *Journ. Geol. Soc. London*, 150, 355-369.
Patočka F., Szczepański J. 1997. Geochemistry of quartzites from the eastern margin of the Bohemian massif (the Hrubý Jesenik Mts. Devonian and the Strzelin crystalline massif). *Mineral. Soc. Poland. Special Papers*, 9, l51-154.
Pietranik A., Koepke J., Puziewicz J. 2006. Crystallization and resorption in plutonic plagioclase: implications on the evolution of granodiorite magma (Gęsiniec granodiorite, Strzelin crystalline massif, SW Poland). *Lithos*, 86, 260-280.
Pietranik A., Waight T. 2005. Sr isotopes in plagioclase from Gęsiniec tonalite using microdrilling method (Strzelin crystalline massif). *Mineral. Soc. Poland, Special Papers*, 26, 231-234.
Puziewicz J., Oberc-Dziedzic T. 1995. Age and origin of granitoids of the Fore-Sudetic block. *Ann. Soc. Geol. Polon. Przewodnik LXVI Zjazdu PTG*, 273-284. [in Polish, English summ.]

W6jcik L. 1968. *Szczegółowa mapa geologiczna Sudetów*. *Arkusz Ciepłowody*, 1:25000. Instytut Geologiczny. Wydawnictwa Geologiczne. Warszawa.
Wroński J. 1973. *Szczegółowa mapa geologiczna Sudetów. Arkusz Ziębice*, 1:25000. Instytut Geologiczny. Wydawnictwa Geologiczne.

Author's address:

Teresa Oberc-Dziedzic
Institute of Geological Sciences, University of Wrocław, Pl. M. Borna 9, 52-204 Wrocław, Poland; e-mail: toberc@ing.uni.wroc.pl