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Granulitic inliers amidst a gneissic/migmatitic complex of the Owl Mts, Sudetes

ABSTRACT: In NW part of the Owl Mts, Sudetes, the granulites are characteristically accompanied by serpentinized ultramafic and pyribolitic rocks, including garnetiferous peridotite and websterite of an upper mantle provenance. The ultrabasites display irregular intrusive contacts against the granulites which pass diaphtoretically into their migmatitic surroundings through a zone of transitional gneissic rock in which the retrogressive replacement of Gr+Ksp by Bio+Plg has been extensively accomplishing. Along the granulite/gneiss contact a belt of strongly recrystallized blastomylonite developed. Both the granulites and serpentinites are foliated and lineated, having received a distinct imprint from the F_2+M_2 tectonometamorphic episode that affected the gneissic/migmatitic complex. Hence interpretation that the upper mantle ultrabasites had intruded a deep-seated granulitic domain, localized outside the actual Moldanubian Sowie Mts complex, in another level or portion of the earth's crust. Then, during the pre-F_2 movements, some indetermined slices were tectonically cut from the parent granulitic domain and after undefined vertical or lateral transport (or both) became upthrust along the ductile shear zones, or otherwise inlaid, into the gneisses just undergoing intense regional folding, metamorphism, and migmatization. Since F_2+M_2 episode the granulites and accompanying ultramafites have had their further tectonothermal history in common with the Owl Mts gneisses and migmatites.

INTRODUCTION

The Owl Mts gneissic block is one of the geological units of the Middle Sudetes. The block of triangular shape is bordered on all its sides by faults or fault zones. Besides, it is divided into two parts by the Sudetic marginal fault, owing to which the mountainous part of the block belongs to the Sudetes, while the other belongs to the Sudetic Foreland, where it is hidden beneath a vast cover of Cainozoic deposits (Text-fig. 1).

The mountainous part, called the Owl Mts (in Polish: *Góry Sowie*) is composed of Moldanubian gneisses and migmatites (more than 95%) mostly of pelitic and subordinately of quartzofeldspathic composition. The remainder of rocks are represented by various amphibolites (para- and ortho-, garnetiferous and garnet-free varieties), serpentinites, and granulites.

Granulites are known but from the Owl Mts, and they are absent from the foreland part of the block (Text-fig. 1). There are three outcrops of granulitic rocks over here, all being localized close to one another near the villages of Bystrzyca Górna, Zagórze (Klinek), and Lubachów in the northwestern part of the Owl Mts (Text-figs 1—2). Each outcrop has its own way in which the granulites occur. Contacts with the surrounding gneisses are commonly obscured by weathered debris or cultivated ground.

A few ideas were developed to account for this scarce presence of granulites within gneisses and migmatites.

POLAŃSKI (1955) suggested that the whole Owl Mts complex was progressively metamorphosed under conditions of the high amphibolitic and then granulitic facies. Granulitic metamorphism lasted, however, but short span and soon amphibolitic conditions — this time retrogressive — dominated again. That is why the granulites were by him viewed upon as metastable relic of the granulitic facies, with kyanite and garnet representing the metastable minerals. Identical opinion was expressed a bit later by JUSKOWIAK & RYKA (1960).

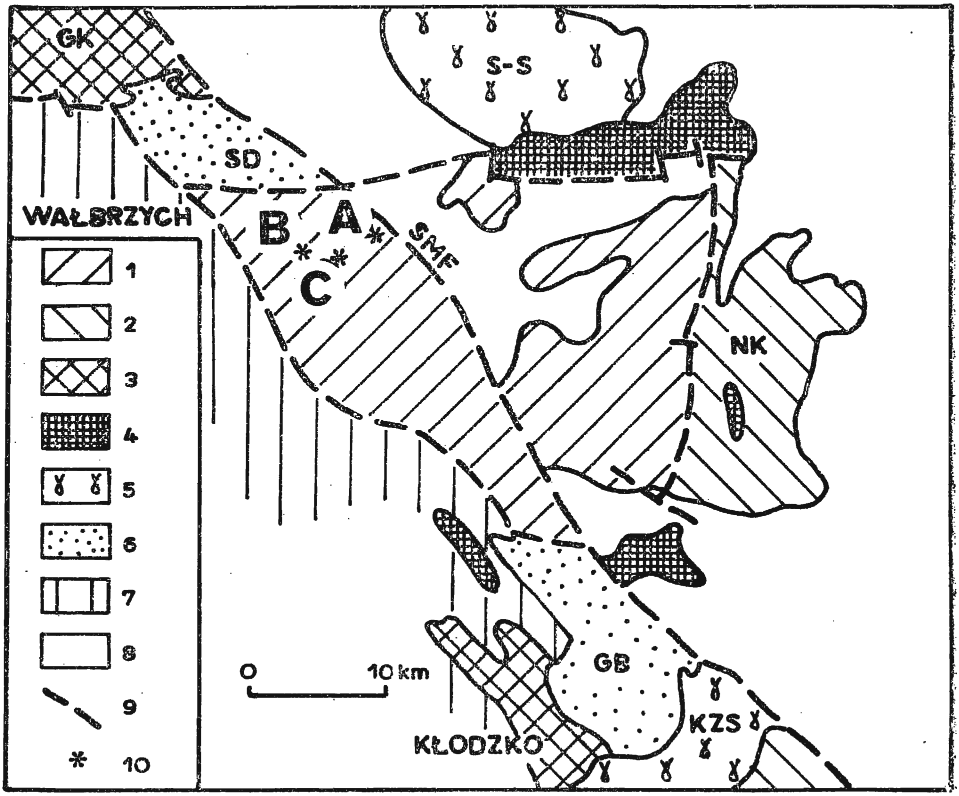

Fig. 1

Index map showing the Owl Mts block against the adjacent Sudetic units

1 — high-grade gneissic/migmatitic complex of the Owl Mts block, **2** — medium-grade metamorphic complex, **3** — low-grade metamorphic complex, **4** — serpentinites and gabbros, **5** — Variscan granitoids, **6** — pre-Upper Carboniferous sedimentary rocks, **7** — Intra-Sudetic Depression, **8** — Cainozoic deposites, **9** — faults, **10** — granulite (*see.* Text-fig. 2) occurrences

GK — Kaczawa Mts metamorphic unit, **S-S** — Strzegom-Sobótka granitoid massif, **SD** — Świebodzice Depression (Upper Devonian — lowest Carboniferous), **NK** — Niemcza — Kamieniec metamorphic unit, **KZS** — Kłodzko — Złoty Stok granitoid massif, **GB** — Bardo Mts unit (Ordovician — Lower Carboniferous); **SMF** — Sudetic marginal fault

KRYZA (1981) arrived at a conclusion that the granulites represent the metastable relics of the HP conditions, which survived later migmatization owing to the original paucity of H_2O in a parent rock of likely acidic tuff provenance. According to him, the Owl Mts rocks with very low H_2O content were able to develop a Kya-Gr-Ksp paragenesis during the HP metamorphism, but the majority of rocks, being originally richer in H_2O, were turned merely into gneisses of the amphibilitic facies.

ORŁOWSKI (1983) came out with an explanation assuming that the granulites were produced by differential migmatization, when lighter H_2O was locally pushed upward by heavier CO_2 in deeper levels of the tectogene. This explanation refers to steadily growing body of evidence for a decrease of H_2O contents of fluid inclusions with depth and increasing grade of metamorphism. Hence a boundary between the amphibolitic and granulitic facies may be defined by the composition of fluid inclusions in the quartz grains, which has been suggested by TOURET (1971).

All the aforementioned explanations seem unsatisfactory as they do not pay enough attention to many significant and decisive features of the outcropped granulites.

CHARACTERISTICS OF THE GRANULITES

The biggest occurrence site of the granulites is that at Bystrzyca Górna (Text-fig. 2*A*). At eastern side of a triangular granulitic outcrop there are two lensoid bodies of serpentinized ultrabasites and pyribolites; scarcely present is also the amphibolitized eclogite. The granulites grade into coarse layered migmatitic gneisses through a some tens of metres thick zone of strongly recrystallized blastomylonitic, occasionally augen, gneiss. The eastern granulite/gneiss border, in the vicinity of ultrabasic rocks, is followed by a few metres wide belt of hornblende gneiss with good record of blastomylonitic history as well. The latter gneiss embraces quite frequently coarse granular hornblende or hornblende-feldspar pods. Also such pods, with intensely sheared margins, are occasionally encountered within the blastomylonitic gneiss.

The granulites exposed at Zagórze (Klinek) appear as loosened lumps and rock debris in cultivated fields and meadows. There is no contact exposed, with neither country gneiss nor accompanying serpentinites and pyribolites (Text-fig. 2*B*). Both the lithologies form jointly a strongly elongate lensoid body.

The granulites exposed at Lubachów are exposed in two sites: at a road-cutting on eastern side of the Bystrzyca dam-lake and on a southern slope of the WNW-ESE lateral stream-valley, some 500 m northeastwards (Text-fig. 2*C*). These are the smallest but the best exposed granulitic occurrences in the Owl Mts. At the lake-side granulite appears in the hinge zone of a tight fold plunging steeply eastsoutheasterly to southeasterly (Text-fig. 3). The granulite is a granular but discretely banded rock due to alternation of garnet-rich and garnet-poor bands. The exposed fold is in the very banding. The fold nose is apparently bounded on either side by zonally developed axial foliation, conforming generally with the compositional layering. The foliation planes are in places conspicuously underlined by the presence of quartz ribbons, suggestive of a high ductile deformation. Parallel to the foliation there occur zones of transitional gneiss, with clearly retrograde biotite, growing at the expense of garnet and orthoclase of the former granulite (*see* Text-fig. 6). Also a 10 m thick lens of granulite occurring at the side valley grades into the migmatitic layered gneisses through the transitional gneissic rock, in which orthoclase, garnet and kyanite are distinctly retrogressively altered to biotite and plagioclase. The two granulitic bodies of Lubachów are accompanied irregularly in several metres wide

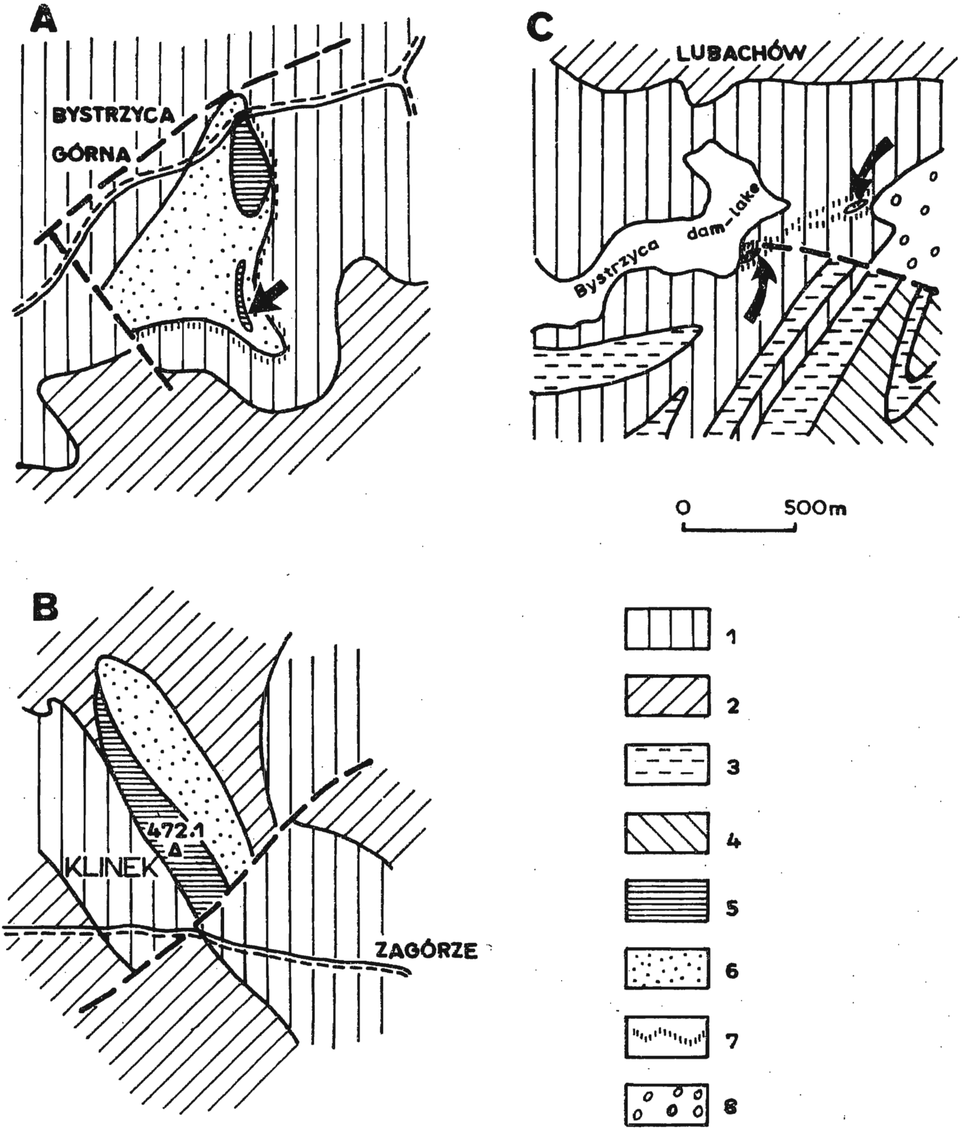

Fig. 2

Geological situation of the granulite occurrences in the Owl Mts

1 — coarse-layered migmatitic gneiss, 2 — flaser gneiss, 3 — fine-grained flaky gneiss, 4 — laminated flaky gneiss, 5 — serpentinized ultrabasites, 6 — granulite, 7 — blastomylonitic gneiss, 8 — Lower Carboniferous (Culm) deposits

zone by the strongly recrystallized blastomylonitic augen gneiss, occasional hornblende gneiss, and scarce amphibolites, all occurring in irregular 0.5—1.5 m thick layers (Text-figs 2—3). The blastomylonite and associated rocks were folded during the F_2 regional folding episode (*cf.* ŻELAŹNIEWICZ 1979).

The presence of the thin blastomylonitic gneiss horizon is characteristic of both the Bystrzyca Górna and Lubachów granulitic occurrences.

The Owl Mts granulites are represented mainly by light, quartzofeldspathic rocks with a high pressure mineral assemblage. They are composed of quartz, plagioclase, orthoclase, garnet, kyanite, accessoric rutile and zircon, with occasional biotite and sillimanite as a secondary phase.

The light granulites are subordinately accompanied by various pyribolitic rocks that generally consist of clinopyroxene, hornblende, garnet, quartz, and plagioclase in varying proportions. They are known but from two granulitic occurrences, at Bystrzyca Górna and at Zagórze (Klinek), though contacts between the light and dark granulites are nowhere exposed.

At a seasonally accessible bed of the river Bystrzyca in the village of Bystrzyca Górna, also is present pyroxene granulite, composed of quartz, plagioclase, orthoclase, garnet, and both pyroxenes (GROCHOLSKI 1967, ORŁOWSKI 1983). It occurs as a thin intercalation in the light quartzofeldspathic granulite.

The light, quartzofeldspathic granulite is the commonest and makes the bulk of each of the three recognized occurrences. More or less severely serpentinized ultrabasites have mostly been set in this variety. The present report deals with the light granulites as they are almost exclusively exposed in the studied outcrops, and they contain highly significant microstructures, absent from the dark granulitic rocks. There are three textural varieties of the light granulites studied.

The first variety is represented by an equigranular and massive, non-foliated and non-lineated rock, with randomly oriented garnet and kyanite.

The second variety is represented by a pretty well foliated and more or less banded rock. The banding, sometimes fairly irregular, results from alternation of whitish garnet-free and reddish garnet-rich layers, 0.5 to over 20 mm thick. In many cases there is also rough segregation of feldspathic and quartzic bands, seen under the microscope (Text-fig. 4). Quartz grains are frequently elongate, sometimes even ribboned.

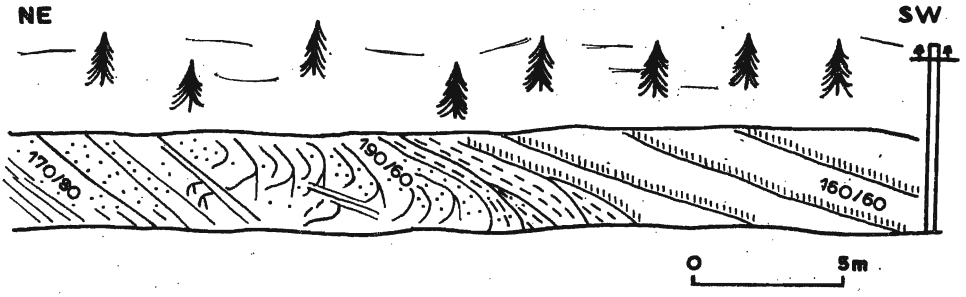

Fig. 3. A part of the granulite exposure in road-cutting, dam-lake side near Lubachów

Dotted — granular banded or massive granulite; *coarse dashed* — foliated granulite with quartz ribbons; *vertically dashed* — blastomylonitic gneiss

The third variety is perfectly foliated, mostly due to the highly extensive presence of quartz ribbons, with directionally oriented kyanite and garnet, being either concentrated into its own bands or not.

The equigranular and non-foliated granulite is composed of polygonal mosaic grains of quartz dominating over both feldspars (Plg > Ksp). In such a mosaic are set hypautomorphic garnet grains, practically free of any inclusions, as well as prismatic kyanite grains, usually few times larger than those of other minerals. The rock is almost untouched by any secondary mineral transformations, and this is one of its significant features. Only kyanite yielded to slight retrogressive alterations, being rimmed and locally replaced by white mica and biotite, or corroded by quartzofeldspathic groundmass.

The banded and foliated granulite, although apparently richer in garnet and kyanite, is composed of the same minerals as the massive one. Its compositional banding is likely of primary origin. However different grainsize of feldspathic and quartzic segregations bears also evidence for certain metamorphic differentiation (Text-fig. 4). Within the feldspathic layers several grains of plagioclase and orthoclase are usually in contact, making seeds for further recrystallization to produce larger blasts or to continue the differentiation, especially if favorable strain conditions would be imposed on the rock. Monomineral quartz segregations tend readily to yield to ductile deformation.

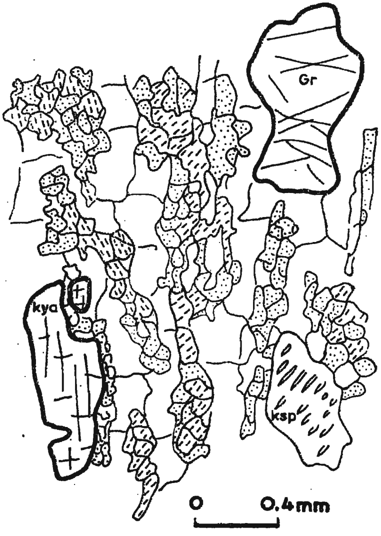

Fig. 4

Segregation of feldspathic and quartzic bands in a banded granulite (*stippled* — plagioclase; *dashed* — orthoclase; *blank* — quartz)

Undoubtedly highly ductile deformed are the excellently foliated granulites with lots of quartz ribbons. The knife-sharp bounded ribbons alternate with thinner feldspathic layers made of grains more or less flattened and deformed, or remaining still almost unstrained (Text-fig. 5). Nevertheless, the grainsize in underformed equigranular portions of the rock is too small and the ribbons themselves are often too thick and continuous to be produced exclusively by non-cataclastic ductile deformation. Obviously the actual compositional layering and ribbonning was introduced into the rock undergoing deformation, not only by plastic flow of the strained, highly ductile quartz grains, but also by some amount of the strain-promoted diffusional metasomatic differentiation and pressure solution. This is nicely proved by the presence of elongate pressure shadows made of quartz and orthoclase around more rigid crystals of garnet and kyanite (Text-fig. 5).

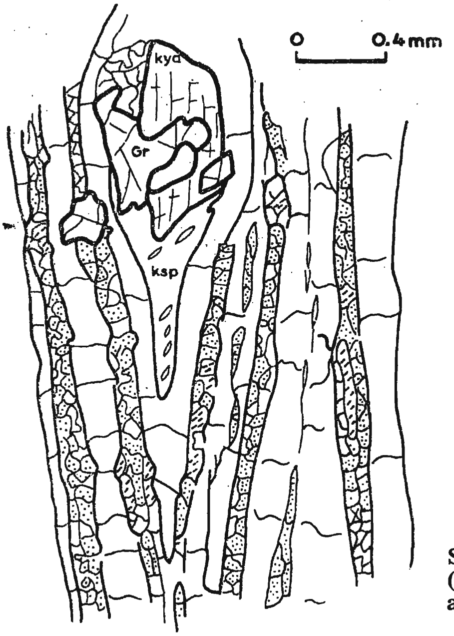

Fig. 5

Strongly foliated granulite with quartz ribbons (*blank*): perthitic orthoclase in pressure shadow at rigid association of garnet and kyanite crystals (*stippled* — plagioclase; *dashed* — orthoclase)

Accordingly, the feldspathic layers may be interpreted as a sort of leftover after once equant quartzofeldspathic mosaic, out of which more mobile quartz had migrated to form eventually its own monomineral bands. Within the feldspathic layers plagioclase is usually much more rigid than orthoclase. The latter has also ability to develop larger blasts or contribute to pressure shadows.

In general, the microstructural relationships imply marked ductility contrast between the minerals involved, operation of pressure solution and metamorphic differentiation as well as highly inhomogenous strain imposed on the granulites. The perfectly foliated, ribbonned granulites were produced by virtue of ductile deformation from originally granular, either massive or banded varieties.

The deformation must have naturally taken place under conditions allowing fairly free influx of H_2O, though it was not able to penetrate the granular granulitic bodies more deeply than their outer strongly sheared and highly foliated portions. As a matter of fact, all retrogressive transformations, even including biotite healings in rigid, fractured garnet and kyanite crystals, have been restricted to those marginal parts of the examined outcrops. Accordingly, the granulites, receiving water from their migmatitic surroundings, were deformed under „wet" conditions, thus different from those that controlled their origin.

THE GRANULITE/GNEISS TRANSITION

A gradual passage from the granulites to migmatitic gneisses was recognized by POLAŃSKI (1955). In the transitional rock garnet and orthoclase disappear in favor of biotite and plagioclase. Thus the granulitic paragenesis Q—Plg—Ksp—Gr—Kya+(Rut, Zr, Ap) is being replaced by the Q—Plg—Bio+Gr, Ksp, Kya—(Rut, Zr, Ap) gneissic one. Theoretically, the mineral transformation might go either way, prograde as suggested by ORŁOWSKI (1983), or retrograde as interpreted by POLAŃSKI (1955).

There is no doubt, however, that the actual transformations were really retrogressive. This can be proved on several lines of evidence. Highly significant here is the presence of atoll garnet, embayed or overgrown by quartz, biotite, and eventually replaced by the dark mica (Text-fig. 6). Garnet grains are subjected also to brittle fragmentation into tiny pieces along the cleavage planes and occasional fractures. The new minute particles become linearly dispersed throughout the rock.

Biotite replacing garnet forms at first partly pseudomorphic aggregates of randomly oriented flakes which are subjected to steady reorientation until they reach parallelism with the main foliation planes (Text-fig. 6).

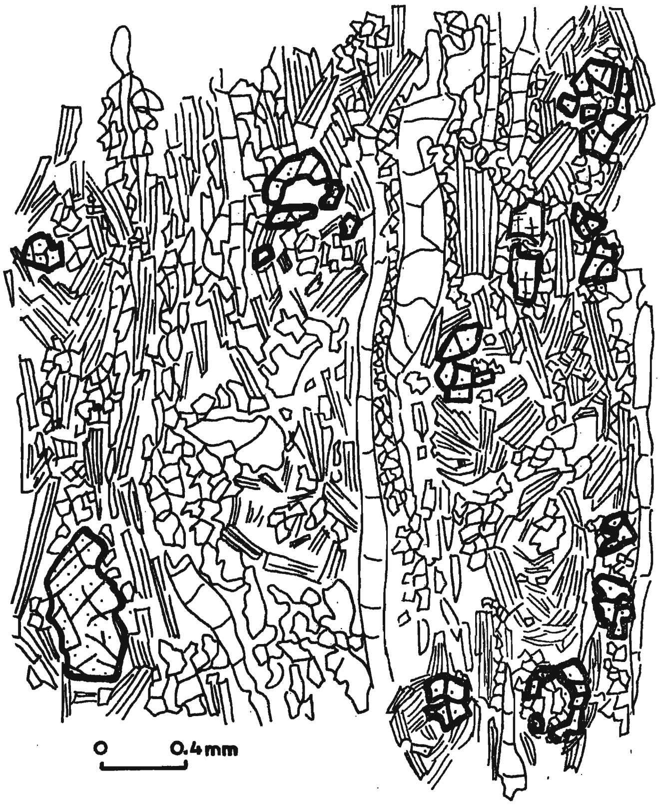

Fig. 6. Sheared granulite passing retrogressively into gneiss at the margin of granulitic inlier: garnet (*high relief*) replaced by biotite (*flakes*); quartz ribbons still present

The garnet grains of both the granulites and transitional gneisses are almost devoid of any inclusions. If the garnet were prograde mineral, then it would likely contain at least some inclusions as a record of its earlier developmental stages.

To some extent the same refers, though not so clearly, to kyanite which is also replaced by micas, growing at first as random aggregates and then becoming well preferably oriented flakes.

Highly characteristic is the presence of quartz ribbons, evidencing that the rock underwent ductile deformation syn- or prior to the retrogressive transformations and it must have come from the deformed, foliated granulite containing abundant quartz ribbons.

Microstructures of the transitional rock show that its former, highly planar fabric is obliterated by an overall recrystallization (Text-fig. 6), which relates to the M_2 episode experienced by the Owl Mts gneisses. At that time was also recrystallized blastomylonitic gneiss, following the granulite/gneiss contact, as both the rock had been involved in F_2 folding which slightly preceded the M_2 thermal episode. Accordingly, the contact may be interpreted as a strongly obliterated shear zone.

GRANULITES *VERSUS* ULTRABASITES

According to BAKUN-CZUBAROW (1981), the ultrabasites are represented by periodotites and pyroxenites, mostly harzburgites and lherzolites, with occasional wehrlites and websterites. Particularly important is that lherzolites and websterites of both the Bystrzyca Górna and Zagórze occurrences are garnet-bearing, with 72% and 62% of pyrope molecule respectively. More details about these interesting rocks were given by SMULIKOWSKI (1973), SMULIKOWSKI & BAKUN-CZUBAROW (1973), and BAKUN-CZUBAROW (1980, 1981). The lherzolites of Bystrzyca Górna are generally massive with some porphyroclastic and sheared textures, while the lherzolites of Zagórze are usually banded owing to the presence of light clinopyroxenic or both pyroxenic laminae. BAKUN-CZUBAROW (1981) stated that the ultrabasites encountered in the Owl Gts granulites represent "a fairly differentiated material of the top part of upper mantle, originated under conditions of primary phase equilibria, distinctly differing from those of blastesis in surrounding granulites". In case of the pyrope-bearing lherzolite of Bystrzyca Górna it was around 1 100°C and 2 GPa, and in case of websterite nearly 1 000°C and 3 GPa. The P-T consitions of the granulites BAKUN-CZUBAROW (1981) estimated at *ca.* 650°C and less than 1 GPa, while ORŁOWSKI (1983) at 750°—850°C range.

A contact between ultrabasite and granulite can be directly observed in an abandoned quarry, some 600 m south of the railway-station at Bystrzyca Górna. In northern face of the quarry there is well exposed an irregular interface of the two rocks. The pyrope-bearing peridotite cuts across the banded granulite (Text-fig. 7). The contact surface is independent of foliation planes in granulite and serpentinized periodite, in which only thin rim of densely packed serpentine minerals follows mimetically this contact.

Within the serpentinite, close to its border with granulite, were encountered two small oval bodies of equigranular and poorly foliated rock built of quartz, plagioclase, garnet, biotite, and kyanite. Its composition and texture resemble that of banded granulite. The bodies might represent xenoliths of the actually retrogressed granulite once captured and taken over by the peridotite during its emplacement.

Accordingly, the highly irregular interface between ultrabasite and granulite, independent of their foliation planes, and an occasional presence of granulitic xenoliths inside peridotite make interpret the granulite/ultrabasite boundary as an originally intrusive, non-tectonic contact. Thus the ultrabasites must have, as a matter of fact, been intruded, or otherwise, but not tectonically, pressed into their actual granulitic surroundings. Details of the emplacing mechanism remain however unclear (mantle diapirism?).

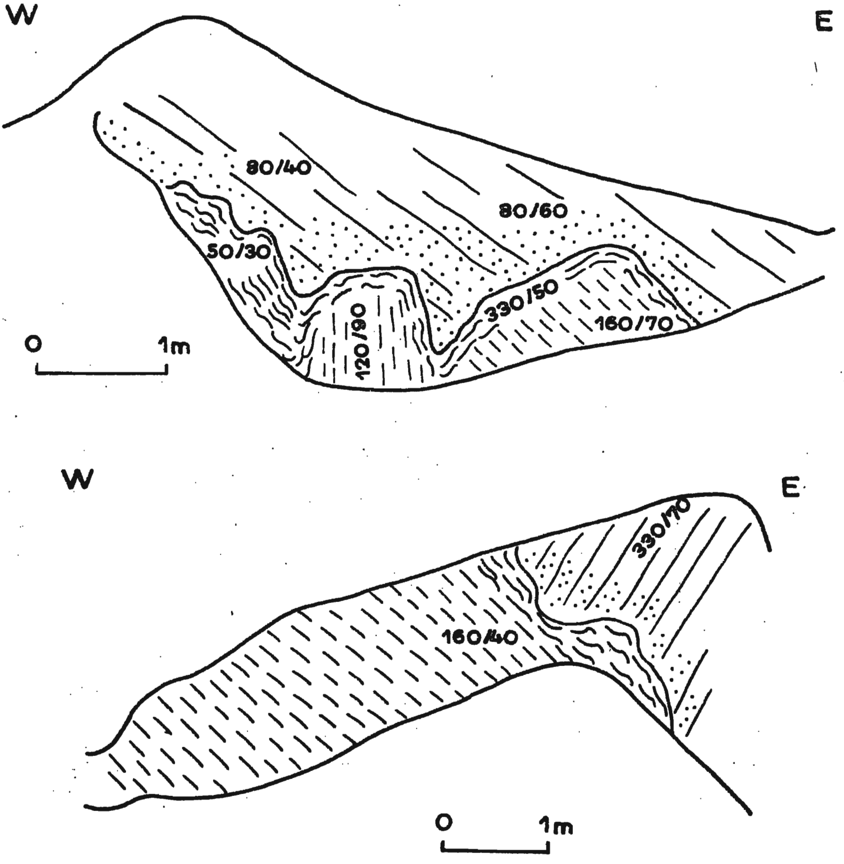

Fig. 7. Sketches showing contact of granulite (*lined*) with serpentinized ultrabasite (*dashed*) exposed in northern part of quarry near Bystrzyca Górna (*arrowed* in Text-fig. 2*A*)

Dotted is retrograde biotite gneiss after granulite; in serpentinite, a narrow band with dense foliation follows the contact surface (mesurements show orientation of foliation planes, discordant near the contact and getting concordant further away)

Boundaries between the ultrabasites and granulites are generally sharp and quite distinct. Nevertheless, at the contacts, there are developed some tens of centimetres wide zones, in which banded or massive granulite is turned retrogressively into evenly-grained gneiss, with almost all garnet being altered to biotite. Ultrabasite is changed to very fine-grained, densely schistous rock composed of serpentine minerals, following the contact at a distance of some centimetres to some tens of centimetres.

In the quarry near Bystrzyca Górna, there is an abrupt change in position of foliation planes in serpentinite outside such a narrow densely foliated zone near the immediate contact with granulite (Text-fig. 7). The serpentinized rock is generally well foliated over here, especially conspicuous being the closely spaced parallel veinlets consisting of various serpentine group minerals (mostly fibrous chrisotile and whitish lizardite). In more intensely deformed portions of the serpentinites, especially in the vicinity of granulite/gneiss boundary (quarry and railway-cutting at Bystrzyca Górna), the foliation is mostly marked by parallel arrangement of scaly serpentine minerals, accompanied frequently by biotite. Such foliation planes are also distinctly lineated owing to their fine corrugations and directional orientations of those minerals. In general this foliation, besides some minor deviations, is spatially concordant with that of the granulites and in turn with that of the surrounding migmatitic gneisses. The discrete lineation in serpentinitic rocks conforms with L_2 lineation and F_2 fold axes recognized in the gneissic complex, and conformable L_3 lineations being also in evidence.

All these observations are of paramount importance as they inform that the garnetiferous ultrabasite must have been emplaced into the granulite before these rocks became foliated and lineated. Foliation and lineation developed in these rocks later, concurrently with F_2+M_2 regional episode recorded by the gneissic/migmatitic complex, when the ultramafites experienced serpentinization. Since the very episode the gneisses, granulites, and ultrabasites have shared a common tectonometamorphic history.

The above mentioned transformations of rocks on either side of the ultrabasite/ /granulite interface are clearly retrogressive, controlled by a good amount of water available from the gneisses undergoing regional metamorphism and migmatization. There is no evidence of any thermal aureole whenever present. Thus the ultrabasites must have most likely been emplaced into already hot and dry rocks, which the granulites were at the moment of intrusion, and not into a cold and wet sedimentary pile with thin arkosic or acid tuffitic intercalations.

PROVENANCE OF THE GRANULITES

Three minute occurrences of granulitic rocks, of which two are accompanied by garnetiferous peridotite and pyroxenite, are pretty peculiar within the huge gneissic/ /migmatitic complex. Both mineralogical and chemical composition of the granulites allowed to interpret them as metamorphosed arkosic (POLAŃSKI 1955, MORA-

WSKI 1973, KRYZA 1981, ORŁOWSKI 1983), or acid tuffitic (KRYZA 1981) intercalations within the primary graywacke pile. Undoubtedly critical for all these interpretations was the recognition of gradual passages from meta-graywacke gneisses to granulites or vice versa. Nevertheless, it must be clearly stated that the so far published results of chemical analyses of the granulites are not clearly and absolutely decisive as to the origin of a pre-granulitic parent rock.

Because of the ascertained passage from granulite to gneiss, apparently the most justified interpretation seems that one assuming the presence of arkosic intercalations within the primary graywacke series. It rises however a couple of important objections.

How it had happened that the garnet-bearing ultrabasites of mantle origin became emplaced just into the granulites, occupying less than 0.1% of a total area of the entire Owl Mts block, that is *ca.* 0.6 km^2 versus 650 km (0.4 km at Bystrzyca Górna and 0.2 km^2 at Zagórze)? As there is no other locality known throughout the block with garnetiferous peridotite, except those under investigation, the association of the two contrasting lithologies can by no means be explained as a haphazardous feature. It would be a highly inconceivable idea that upper mantle rocks piercing intrusively upwards (no matter what the actual cause was) just selected and hit but granulites. Such precise shots, at *ca.* 1/1600 probability in one case and *ca.* 1/3200 probability in the other, would have been geologically very odd and it sounds rather improbably.

How it had happened that merely several meters thick arkosic intercalations, as at the Lubachów occurrence, managed to escape a „wet" regional metamorphism and migmatization affecting so profusely the gneissic and migmatitic neighbourhood?

How it had happened that the granulite occurrences do not conform at all with the existing pattern of regional metamorphic zonation in the Owl Mts (e.g., granulite of Bystrzyca Górna appears merely in a Gr/Kya zone)?

KRYZA (1981) tried to cope with the problems arguing that the Owl Mts complex underwent shortly a HP metamorphism, producing granulitic parageneses in originally water-deficient rocks, and then the P-T conditions were quickly set back to those of the long lasting amphibolitic facies. The HP stage was to be proved by the relic presence of kyanite in gneisses. This interpretation is, however, rather inconsistent with the observable data. As a matter of fact, there is no evidence at all for the operation of HP metamorphism in the Owl Mts. By no means as such can be treated the kyanite of gneisses. Sillimanite in the Owl Mts gneisses and migmatites was developed mostly through a fibrolitization of biotite. Polymorphic transformation kyanite/sillimanite was of no significance over there (ŻELAŹNIEWICZ 1984). Sillimanite pseudomorphs after kyanite are exceedingly rare. Thus, the actual low amount of kyanite in gneisses is the original feature of those rocks, the mineral being of primary and not of relic nature, and practically having nothing in common with a widespread production of sillimanite. Rocks below the sillimanite zone are by no means richer in kyanite than those containing sillimanite.

ORŁOWSKI (1983), admitting that any abrupt change between „wet" and „dry" conditions at depth are hardly conceivable, and that pre-granulitic rocks had no special reason to become just granulities, came out with another idea. According to him, the granulites were effected not by HP metamorphism, but by differential migmatization, understood by him as the extremal metamorphism. The granulites were born in deeper parts of the rock complex, with CO_2 dominating over H_2O, while in a bit shallower levels, with H_2O prevailing upon CO_2, went on the differential migmatization and sillimanite gneisses were produced. Also this point of view is hardly acceptable. There is a very little probability that the actual, small granulitic occurrences could be once sites of suddenly increased CO contents, with respect to that of the gneissic surroundings. And, there is no good reason for envisaging such abrupt changes in H_2O/CO_2 ratio either.

Any attempt to explain position of the granulites within the gneissic/migmatitic complex of the Owl Mts must take into account several key items, as follows:

(*1*) intrusive character of the granulite/ultrabasite interface;
(*2*) clearly retrograde and secondary tectonic character of the granulite/gneiss passage (not being of a primary sedimentary nature);
(*3*) perfectly foliated granulite with abundant quartz ribbons at the granulitic outcrop margins;
(*4*) strongly recrystallized blastomylonitic rocks along the granulite/migmatite contact;

(*5*) foliation and lineation in the serpentinized pyrope-bearing peridotite of upper mantle provenance, conforming with those produced in the surrounding migmatitic gneisses by F_2+M_2 regional tectonometamorphic episode;
(*6*) spatial accordance of foliation planes in migmatitic gneisses, granulites, and serpentinites;
(*7*) migmatization effects exerted on granulites and ultrabasites (serpentinites);
(*8*) unique, throughout the Owl Mts block, tiny associations of granulite with mantle-derived ultrabasite set in the gneissic/migmatitic complex.

Accordingly, garnetiferous peridotites and pyroxenites, coming from the differentiated upper mantle material, were intrusively, and forcefully emplaced into the varied granulitic domain. The domain consisted mostly of light quartzofeldspathic granulites in massive and banded varieties, accompanied by various pyribolitic rocks of crustal origin, and eclogites. Neither timing of the intrusion nor its primary geological setting can be yet reconstructed. Ultrabasites intruded hot, *ca.* 800°C, and dry rocks. That is why whatever thermal contact effects between the intrusives and country granulites are lacking.

Next, due to some unspecified geodynamic reasons, the granulite domain was subjected to intense inhomogenous shearing, which generated a number of tectonic slices. Some of the slices became cut off from the parent domain and upthrust, or otherwise inlaid, along the ductile shear zones into their actual gneissic surroundings. Both direction and distance (vertical, lateral, or whatever) the slices travelled remain unknown. The granulite domain must have been localized either outside or roughly beneath the Owl Mts gneissic/migmatitc complex.

The granulitic slices, frequently charged with ultrabasites, had been set in the complex before, or at the beginning of, the regional F_2+M_2 tectonothermal episode took place. At that time the gneisses remained under garnet-kyanite metamorphic zone conditions. Close to the newly tectonically introduced granulite/gneiss contact, margins of the granulitic slices and their immediate gneissic neighbourhood experienced intense ductile shearing and mylonitization, the granulites being mostly sheared and gneisses mainly mylonitized.

Regional deformational phase F_2 gave rise to tight folds in both gneisses, granulites and mylonites. An accompanying metamorphic recrystallization M_2 caused retrogressive reactions to occur in the highly deformed marginal granulite, turning it into the transitional gneiss, provided the strongly recrystallized blastomylonitic gneisses, and promoted serpentinization of the ultrabasites. Thus much of the former cataclastic features became healed and obliterated by the M_2 and subsequent episodes of metamorphism and migmatization. Since F_2+M_2 episode the granulites and associated ultramafites have had their further tectonothermal history in common with the gneisses and migmatites. Accordingly, the granulites and ultrabasites are viewed upon as inliers of foreign rocks once picked up from outside during intense ductile shearing movements and tectonically set in their present Moldanubian surroundings.

Quite recently, PIN & VIELZEUF (1983) subdivided the granulites of Variscan Europe into two groups. It must be noted that the Owl Mts granulites conform perfectly with their group *I*, as they are associated with eclogites and mantle-derived garnetiferous peridotites, composed of HP mineral assemblage, and occur in lenses with retrograde rims of amphibolitic facies essemblages. The group *I* granulites, being of 450—400 Ms old, are related to subduction of the Moldanubian crustal segment, subsequent continental collision (380—340 Ma), and early thrust napping within the Variscan tectogene.

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WYSTĄPIENIA GRANULIÓW WŚRÓD GNEJSÓW SOWIOGÓRSKICH

(Streszczenie)

Przedmiotem pracy* jest analiza sposobu powstawania trzech małych wystąpień kwarcowo-skaleniowych granulitów, z wysokociśnieniowym zespołem minerałów, znanych od dawna wśród migmatycznych gnejsów NW części Gór Sowich (fig. 1—6). W ich obrębie pojawiają się zserpentynizowane ultrazasadowe skały, z pyropowym granatem i spinelem, pochodzące ze zdyferencjonowanego górnego płaszcza. Skały te kontaktują intruzywnie z granulitami (fig. 7), które diaftorycznie przechodzą w otaczające gnejsy migmatyczne. Przejście to stanowi znacznie rekrystalizacyjnie zatartą strefę intensywnego ścinania. Dokonuje się tu retrogresywne zastępowanie granatu i ortoklazu granulitów przez biotyt i plagioklaz dominujące w gnejsach (fig. 6). W brzeżnych partiach wystąpień, budowanych głównie przez granulity równoziarniste, masywne lub smugowane (smugi bogatsze w granat), pojawiają się granulity z wybitnie rozwiniętą foliacją (fig. 5). Znaczy ją przede wszystkim powszechna obecność wstęgowych ziarn kwarcu, będących świadectwem silnej deformacji ciągliwej (ang. *ductile*). Zarówno granulity jak i serpentynity są skałami posiadającymi foliację i lineację, zgodną z foliacją S_2 i lineacją L_2 otaczających gnejsów. W gnejsie blastomylonitycznym widoczne są także fałdy F_1. Interpretacja dostrzeżonych faktów zakłada, że ultrabazyty z górnego płaszcza intrudowały w znajdujący się głęboko kompleks granulitów, położony poza gnejsowym kompleksem dzisiejszych Gór Sowich, w innym poziomie lub części skorupy ziemskiej. Następnie, w czasie ruchów sprzed fazy F_2, lub też syntektonicznie z początkiem tej fazy, tektoniczne plastry wycięte z granulitowego otoczenia zostały wzdłuż stref ciągliwego ścinania wtłoczone w moldanubskie gnejsy poddawane regionalnemu fałdowaniu, progresywnemu metamorfizmowi i migmatytyzacji. Począwszy od epizodu F_2+M_2 granulity, ultrabazyty i gnejsy miały wspólną już historię tektonometamorficzną.

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