Microfossils from the high-grade metamorphic rocks in the Góry Sowie Mts. (Sudetes area) and their stratigraphical importance

Tadeusz GUNIA


Unconventional micropalaeontological methods have been employed in order to examine calcareous-silicic rocks and intercalations of crystalline limestones from 7 localities of “diabasic amphibolites”* in the gneissic Góry Sowie Block. Very poorly preserved microfossils and relics of skeletal fauna, i.e. fragments of radiolarians, calcareous shells of Hyolithes, problematic conoidal forms and minute brachiopod shells have been found for the first time in the investigated rocks. A few specimens belonging to Archaeogastropoda, Ostracoda and Vermes have been identified, too. The microfossil assemblage contains also problematic taxa. The discovery of microfossils including skeletal fauna in crystalline limestones (marbles) enclosed in “schistose diabasic amphibolites” of the Góry Sowie Block has an outstanding stratigraphical importance. It is possible now to accept that the rocks are undoubtedly younger than Precambrian. The most probable age would be Cambrian. There have been over 10 isotopic datings reported for the Góry Sowie Mts. Various methods have been used and different minerals examined. Most of the ages fall within the Ordovician. There are also rather extreme results pointing to the Proterozoic and Devonian, and even to the Early Carboniferous.

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INTRODUCTION

One of the difficult problems of geology of the Sudetes and their foreland is the age of metamorphic series. Lithological, petrological and tectonic criteria previously used have proved to be ambiguous. In course of time there arose a need to revise these criteria.

* The name “diabasic amphibolites” and its synonyms such as diabasic amphibolites with crystalline limestones intercalations, schistose diabasic amphibolites, calcareous-silicic rocks exist in some older geological maps of the Góry Sowie Block published by E. Dathe (1902), L. Finckh (1925) and others (scale 1:25000). Carbonate intercalations from these amphibolites have yielded palaeontological material cited in this paper. The name “diabasic amphibolites” is a traditional one. It has been accepted after earlier authors. In more recent literature the name diabase refers to a basic subvolcanic rock, whereas surface eruptions may result in a basalt rock. Tuffs and tuffites may be related to such eruptions (A. Philpotts, 1990).

This required arduous and time-consuming studies. The author has finally managed to work out new unconventional methods which enabled a discovery of organic origin relics of a stratigraphical importance in over 20 localities with the so-called “parametamorphites”. Such studies were also conducted earlier in the gneissic Góry Sowie area.

Acritarchs and filamentous microflora indicative of the Late Riphean age of the primary marine deposits which were metamorphosed later to form paragneisses were discovered by T. Gunia (1981a, b, 1984) in 2 paragneisses localities (Fig. 1, black squares).

The two localities with documented age appeared to be insufficient for a vast area occupied by the Góry Sowie paragneisses showing both a considerable thickness (a few thousand metres) and highly complex tectonics.

When looking for new fossil localities in metamorphic rocks a particular attention was paid to calcareous-silicic rocks and scarce carbonate intercalations accompanying “schistose diabasic amphibolites” marked in old geological maps of the Góry Sowie Block.
An additional impulse to undertake these studies was the information found in L. Finckh's papers (1923, 1925) that the calcareous-silicic rocks and crystalline limestones accompanying "schistose diabasic amphibolites" were formed out of "diabasic tuffites and calcareous tuffites", whereas gneisses of the Gory Sowie Block (according to that author) are a product of metamorphism of Cambro-Silurian sedimentary rocks.

Taking into account also this data, samples collected from carbonate rocks of paraamphibolites located in both the Fore-Sudetic (3 localities) and Sudetic (4 localities) parts of the Gory Sowie Block (Fig. 1) have been studied using traditional micropalaeontological-stratigraphical methods. Both high degree of metamorphism (amphibolite facies) and intense tectonic deformations have made it impossible to obtain well preserved specimens enabling precise identifications according to palaeontological rules.

The author realizes all these difficulties. These are, so far unknown from carbonate intercalations in paraamphibolites of the Sudetes and its foreland, organic origin forms of a great stratigraphic importance, whose localities were described (Fig. 1) and specimens labelled using modern methods (Tab. 1). Better preserved ones were photographed (Pl. II–VIII). Maybe in the future some others, more perfect research methods will be worked out and it will be possible to find in these carbonate intercalations better preserved specimens. So far, there have been found no reports in the available literature on organic microfossils in analogous rocks.

GEOLOGICAL POSITION OF MICROFOSSIL LOCALITIES

The outcrops which for the first time have yielded the microfossils are natural and artificial exposures and weathered in situ blocks. They have been found in places where E. Dathe (1902), L. Finckh (1925) and others marked in old detailed geological maps (1:25 000) a "small rock bodies" within paragneisses, calling them "schistose" or "bedded" diabasic amphibolites or "paraamphibolites" (black triangles in this paper — Fig. 1, labelled with Roman numerals: I–III in the Fore-Sudetic part and IV–VII in Sudetic part of the Góry Sowie Block).

The Góry Sowie Block, in which the "schistose diabasic amphibolites" occur, has a triangle-like shape and area of about 650 km² (Fig. 1). It is divided by the Marginal Sudetic Fault into the smaller Sudetic part and larger Fore-Sudetic one. This unit, sometimes being considered a part of the Bohemian Massif, is largely composed of gneisses and migmatites, within which very abundant "small metamorphic bodies" occur, including amphibolites of a different origin, granulites, hyperites, serpentinites and extremely rare crystalline limestones. Locally occurring unmetamorphosed rocks in this area include the Lower Carboniferous sedimentary series, gabbros, porphyries, porphyrites and kersantites (H. Żakowa, 1963; W. Grocholski, 1967).

This block, being one of major tectonic units in the Middle Sudetes, played the important role in the Palaeozoic tectonics and palaeogeography (T. Gunia, 1985).

Relatively greatest amount of publications have dealt with problems of its tectonics and tectono-metamorphic evolution. Only a few synthetic paper can be mentioned here, some synthetic ones should be including the aerial ones by E. Kalkowsky (1878) and E. Bederke (1929, 1934) and more recent by H. Teisseyre (1957), J. Oberc (1966), W. Grocholski (1967) and A. Żelaźniewicz (1987).

Stages of alterations of rocks in the Góry Sowie Block have been believed to depend on tectonics and in particular on tectono-metamorphic evolution. There were relatively few exclusively petrological works showing these complex problems synthetically. Of older ones a monograph by H. Hentschel (1943), devoted to petrology of calcareous-silicic rocks, should be mentioned. Of more recent works, that by K. Smulikowski (1952) on metamorphic complexes of the Sudetes including the Góry Sowie Block, and monographs by A. Polański (1955) and R. Kryza (1981) must be quoted. The latter explains petrology of gneisses and migmatites together with a reconstruction of premetamorphic series. The mono-
### Table 1

Microfossils from carbonate enclosures in “diabase amphibolites” of the Góry Sowie Mts.

<table>
<thead>
<tr>
<th>Microfossils</th>
<th>Outcrops</th>
<th>Precambrian</th>
<th>Cambrian</th>
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<tbody>
<tr>
<td></td>
<td>I Owiesno</td>
<td>II Gilów</td>
<td>III Pilawa</td>
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<tr>
<td><strong>Flora</strong></td>
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<tr>
<td>Baltisphaeridium sp.</td>
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<tr>
<td>Micrhystridium lanatum</td>
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<tr>
<td>Micrhystridium sp.</td>
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<tr>
<td>Micrhystridium cf. brevicornatum</td>
<td>x</td>
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<tr>
<td>Aranidium sp.</td>
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<tr>
<td>Asteridium cf. spinosum</td>
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<tr>
<td>Filamentous forms</td>
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<td>x</td>
<td>x</td>
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<tr>
<td>Algae indet.</td>
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<tr>
<td><strong>Radiolaria</strong></td>
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<tr>
<td>Liophsaeridium</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Ucolida sp.</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>?Radiolaria indet.</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td><strong>Hyolitha</strong></td>
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<tr>
<td>Cireothecidae</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>?Laratheca sp.</td>
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<tr>
<td>Turcatheca sp.</td>
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<tr>
<td>Allatecheidae</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Allatheca sp.</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Anabartidae</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>Cambrothubalas sp.</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Longiochrea sp.</td>
<td>x</td>
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<td><strong>Hyolithida indet.</strong></td>
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<td>Operculum from Hyolitha</td>
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<td>Hyolithellus cf. rectus</td>
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<tr>
<td>Pseudortheca cf. filosa</td>
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<td>Pseudortheca cf. perornata</td>
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<td>Pseudortheca cf. rotundicincta</td>
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<tr>
<td>Pseudortheca sp.</td>
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<tr>
<td>Lapworthellidae</td>
<td></td>
<td></td>
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<tr>
<td>?Tetratheca sp.</td>
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<tr>
<td>Cambroclaviidae</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>?Cambroclavus sp.</td>
<td>x</td>
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<tr>
<td>?Pseudoclavat sp.</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td><strong>?Polychaeta</strong></td>
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<tr>
<td>Coleoloides sp.</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>?Protoconodonts</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>?Fomitchella sp.</td>
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<tr>
<td><strong>?Brachiopoda</strong></td>
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<td></td>
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<tr>
<td>?Obolidae et Kutorginidae</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Brachiopoda indet.</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>Archaeogastropoda indet.</td>
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<tr>
<td><strong>Ostracoda</strong></td>
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<tr>
<td>?Bradovia sp.</td>
<td>x</td>
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<tr>
<td>?Vermes indet.</td>
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<tr>
<td>Microproblematica</td>
<td>x</td>
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DESCRIPTION OF LOCALITIES

LOCALITY I: OWIESNO

This is a natural exposure in Owiesno village (Fore-Sudetic part of the Góry Sowie Block). The calcareous-silicic rocks are exposed in the western slope of the (unnamed) hill marked in the old geological map by an altitude of 375.5 m. Dimensions of this exposure are 5 x 3 m. The exposed rocks are dark steel-grey in colour with abundant light grey calcareous beds or laminae within dark-coloured amphibolite mass. Schistosity and tectonic deformations are distinct. Locally, the rock passes into a massive amphibolite.

In the old geological map (scale 1:25 000) by E. Meister (1925), sheet Gnadenfrei (= Piława Góra), the Owiesno exposure was marked within “schistose amphibolites” forming a small lens in sillimanite gneisses, stretching almost N-S and cut by a fault. These gneisses were petrologically studied by C. August and R. Kryza (1979). They estimated the palaeotemperature of their formation to be over 600°C.

A total amount of 35 samples have been collected from the calcareous-silicic rock exposed in Owiesno, out of which 15 petrographical sections and 220 powdered preparations have been prepared. These revealed fairly abundant but poorly preserved faunal relics, mainly of radiolarians, as well as a few specimens of microflora, among others acritarchs and filamentous forms (Tab. 1). Preliminary results of micropalaeontological and stratigraphical studies of the rocks have been published separately (T. Gunia, 1997a, b).

LOCALITY II: GILÓW

It is also located in the Fore-Sudetic part of the gneiss Góry Sowie Block, and comprises a crystalline limestone lense occurring between diabasic amphibolites and paragneisses. It is situated about 1 km south of Gilów village, on the southern slope of an unnamed hill. The limestone is not exposed at the surface. Basing on investigations conducted by P. Raczyński (pers. comm.) in a shaft, a photograph of wall fragment, and megascopical studies in cross-cut samples, it may be assumed that the rocks are represented by fine- and middle-grained crystalline limestones with numerous amphibolitic laminae, dark in colour. According to P. Raczyński (pers. comm.) there is a tectonic breccia composed of angular blocks of amphibolites and limestones in the lower part of the pit. The shaft is located within the above-mentioned crystalline limestone lense marked on a detailed geological map (scale 1:25 000), sheet Lauterbach (= Sieniawka), compiled by O. Barsch and L. Finckh (1921). Text explanations to this map were written by L. Finckh (1925). 25 samples have been collected from the shaft wall. 10 thin sections and 90 microscopic preparations have been prepared. Poorly preserved microflora, small fragments of fauna and microproblematics have been found (Tab. 1).

LOCALITY III: PILAWA

This locality comprises weathered in situ blocks. It is located at the place where an exposure of “diabasic para-amphibolites” is marked on the old geological map by a letter “a”. This is a small unnamed hill, marked on the E. Meister’s map (1925) by an altitude of 334.5 m, situated near Piława Dolna (sheet Gnadenfrei = Piława Góra) in the Fore-Sudetic Block. 6 samples of white and brown-grey crystalline limestones have been collected from the blocks. Very fine, light in colour carbonate laminae and dark amphibolitic ones are visible on weathered surfaces. 4 petrographical sections and 40 microscopic preparations have been prepared. Relicts of microflora and fauna have been found (Tab. 1).

LOCALITY IV: BŁYSZCZ-KAMIONKI HILL

This locality consists of weathered blocks in situ situated on a steep slope of the Błyszczyk Hill with altitude 637 m at the place where a branching amphibolite lense with enclosed two smaller crystalline limestone lenses is marked within biotitic paragneisses on the old geological map on scale 1:25 000 (E. Dathe, 1902, sheet Langenbielau = Bielawa). Isolated small rocks and outcrops marked on that map do not exist at present. Their remains are weathered blocks in which small fragments of crystalline limestones and amphibolites can be recognized. The limestones are light in colour, most frequently coarsely and medium crystalline with numerous intergrowths and lenticular laminae of amphibolite. 20 samples have been collected from here. 7 thin sections and 110 microscopic preparations have been prepared. Scarce and very small fragments of fauna and microproblematics have been found (mainly in preparations) (Tab. 1).

LOCALITY V: CZYZYK-KAMIONKI HILL

It is situated 1 km east of the previous one, on the slope of the Czyżyk Hill with marked altitude of 555 m. Here, amongst numerous amphibolite lenses marked by letters “ag”, and enclosed in biotitic paragneisses as shown on the E. Dathe’s map (1902), there is one slightly larger lense of “diabasic amphibolites” with three small intercalations of crystalline limestones within it.

The outcrops do not exist any more and there are only weathered blocks at that site. 15 samples have been collected from the blocks for laboratory analyses.

A total amount of 80 preparations have been prepared. Cut sections of particular samples have shown laminae of white coarsely and medium crystalline limestones within amphibolites. In some samples laminae of dark-coloured amphibolite pass into light-coloured limestone.

LOCALITY VI: BIELAWA-KAMIONKI

This is a small quarry, marked on the old detailed geological map by E. Dathe (1902), as comprising “diabasic para-amphibolites” with intercalations of crystalline limestones. It
is located close to a topographic edge of the Góry Sowie Mts. in the outskirts of the town of Bielawa called "Kamienicek". The limestone has been completely mined out here. In one of the quarry walls, in the area of a few square metres, numerous laminae and lenses (up to 5 cm thick) of light-coloured crystalline limestones can be seen on the background of darker amphibolite. From 15 samples collected from the locality, 5 limestones in the outskirts of the town of Bielawa called "Kamieniczki". laminae and lenses (up to 5 cm thick) of light-coloured crystalline limestones can be seen on the background of darker amphibolite. From 15 samples collected from the locality, 5 petrographical sections and 80 microscopic preparations have been prepared. Relicts of microfauna have been found in the limestones.

LOCALITY VII: KAMIONKI-SMOCZA JAMA

This is a former adit in Kamionki (probably after limestone exploitation) situated on the western slope of the unnamed hill, at the place where E. Dathe (1902) marked an intercalation of crystalline limestones within one of diabasic amphibolite lenses. This adit is now called "Smocza Jama". Inside, very numerous, fine and irregular carbonate laminae within amphibolites are visible on the walls. 25 samples have been collected from the rock out of which 7 sections (4 petrographical and 4 palaeontological) as well as 120 microscopic preparations have been prepared.

METHODS OF STUDY

Some unconventional micropalaeontological methods have been employed in order to examine carbonate rocks, i.e. crystalline limestones and dolomites forming a single larger "rock body", as well as irregular, fine laminae, intergrowths and lenses within the so-called "schistose diabasic amphibolites" (sensu E. Dathe, 1902; L. Finckh, 1925).

There were no previous attempts to investigate microfossils in such highly metamorphosed (amphibolite facies) and tectonically deformed rocks. Thus it has been difficult to apply methods worked out earlier. The present micropalaeontological and stratigraphical studies were conducted during several stages.

At the first stage some of the old detailed geological maps (70 or even 100 years old) of the gneissic Góry Sowie Block were analysed. Basing on the maps (and taking into account also text explanations), larger exposures of the above-mentioned "schistose diabasic amphibolites" with intercalations and lenses of crystalline limestones were selected.

The second stage started with field work in order to find the exposures and collect samples for laboratory analyses. This appeared to be a difficult task as both topography and state of preservation of rocks have changed after such a long time between the recent studies and cartographic works completed tens of years ago. Only some of the natural and artificial exposures, that existed at those times and were marked on geological maps, have been preserved. Unfortunately, in many places, instead of isolated rocks or natural exposures, weathered blocks are now present. Samples for further investigations were collected from both exposures and blocks.

During the third stage the samples were cut into thin slabs (3 cm thick). Weathered coatings were removed from them. Surfaces of the thin-sections were macerated cold and heated in 10% HCl in order to recognize larger biogenic structures as well as carbonate intergrowths, irregular laminae and lenses within the amphibolitic background. No fossils have been found using this method in both megascopic and binocular studies.

Slightly better results were archived when studying the so-called "palaeontological sections", i.e. large (5 x 7 cm) and uncovered thin-sections, thicker than petrographical ones. Some of them revealed fragments of extremely strongly recrystallized algal structures.

As it was mentioned above, petrographical thin-sections have also been prepared to find better preserved specimens. These sections were analysed using a polarizing microscope without analyser and with crossed nicks. In a few cases siliceous (Radiolaria) and carbonate (relicts of algae) structures have been recognized.

The studied rocks were probably subjected to a repeated and complex metamorphic alterations. This is, however, a separate petrological problem beyond the scope of this work.

The next stage of experimental researches was to prepare microscopic powdered preparations. Limestones and carbonaceous-silicic rocks containing numerous carbonate intergrowths, laminae and lenses, collected from each exposure were crushed separately.

Samples were mechanically crushed into two fractions: finer-grained (< 0.10 mm) and coarser-grained (0.10-0.50 mm). Both fractions were separately treated with cold HCl for 5-10 minutes. The powder residue, washed with distilled water and then dried up, was a material for microscopic preparations impregnated with Canada balm. 10 preparations for each grain fraction were preliminarily studied, separately for each stand. It has appeared that the relicts of microflora, and in particular of fauna, are the most abundant among very fine grains, i.e. within the fraction less than 0.10 mm, whereas among coarser-grains (i.e. 0.10-0.50 mm) they are very rare or lacking. Basing upon these preliminary results next preparations were prepared, from 40 to 220 for each stand. A total amount of 730 preparations have been prepared and examined. Microfossil specimens were analysed and photographed in transmitted light, without analyser and with crossed nicks using a polarizing mineralogical microscope, as well as in reflected light using the fibre optics. The obtained palaeontological "material" is exceptionally poorly preserved and extremely difficult to identify.

Acritarchs and filamentous microflora are usually carbonized, whereas calcareous algae show a strongly recrystallized structure. Fauna is also poorly preserved. These are very small, deformed or strongly recrystallized, siliceous and calcareous relicts. In many cases it was possible to determine their affiliation only to a family, subfamily or genus, rare instances and with reservations to a species. The microfossil assemblage also contains forms whose identification is impossible. These were ascribed to "Problematica".
GENERAL CHARACTERISTICS OF MICROFOSSILS

Microfossils are carbonized relics of microflora, fragments of carbonate algal structures of microscopic sizes as well as siliceous and carbonate relics of various faunal groups exhibiting very poor state of preservation. This work presents only their tabulated determinations (Tab. 1) with age of appearance given for a particular group, as well as localities in which they have been found. Literature used for identifications is also cited.

Among microflora there are some genera of Acritarcha, carbonized filamentous structures (Pl. II) and relics of carbonate algal structures labelled as Algae indet. They have been recognized using the following literature: N. Wolkowa (1969), T. Jankauskas (1979), T. Gunia (1981a, b), C. Downie (1982) and M. Moczyczkowska (1991).

Microscopic faunal relics are represented by very poorly preserved siliceous specimens, belonging to Radiolaria. The external sculpture makes some of them alike to Lissospaeidae (Pl. III), others to Polyentactiniinae (Pl. IV), ?Plegmosphaerinae or to the genus ?Astroentactinia. This assemblage also contains forms similar to the genus ?Ulcundia or to spicules of undefined radiolarians. Forms difficult to identify are described as ?Radiolaria indet. Radiolaria are identified basing on: A. Campbell (1964) and B. Nazarov (1974, 1975). The above-mentioned siliceous specimens are most common in calcareous-silicic rocks in Owiesno (locality I), whereas in other localities only small fragments, difficult for identification, have been encountered.

Abundant and more diversified with respect to both sculpture and mineral composition (calcium carbonate or magnesium carbonate) are other faunal relics belonging to Hyolitha. They show a characteristic sculpture, different sections and variable width of angle in apical part of shells. A similarity to some of genera of Cicrothecidae, Allathecidae and Anabaritidae (Pl. V) is apparent amongst them. They are accompanied by similar carbonate specimens, resembling some of the genera (Tab. 1) of Hyolithellidae (Pl. V) (order Hyolithellinae) and Lapworthellidae (order Tommotiidae).

Within this group there are also fairly abundant small fragments of shells resembling Hyolitha in shape and sculpture. Their closer identification has been impossible. They are distinguished separately as Hyolitha indet. Oval and subtrigonal carbonate forms are also impossible to identify. They are similar to operculum of some hyoliths genera.


Apart from the small tube-shaped forms, small oval or subtrigonal specimens being a single unsculptured shells of ?Microbrachiopods, have also been found. Some of them resemble specimens of ?Obolidae, others — ?Kutorginidae (Pl. VII).

There are also unidentifiable specimens most probably belonging to "?Microbrachiopods" as well. They are separately distinguished as Brachiopoda indet. (Pl. VIII, Figs. 1-12) basing on: Ch. Walcott (1889), Ch. Poulsen (1932), W. Goryanski (1969) and A. Williams, A. Rowel (1965).

Carbonate specimens are also represented by those which may be comparable with Archaeogastropoda (Pl. VIII, Figs. 13-15), some of the genera belonging to Ostracoda and ?Vermes. Microproblems are present here, too.

DISCUSSION AND CONCLUSIONS

The discovery of organic origin relics in crystalline limestones (marbles) occurring as a larger "rock body" (vide Gilów-locality II) or in a form of irregular laminae (2-5 cm thick), intergrowths or lenses within calcareous-silicic rocks and "diabasic amphibolites" (sensu L. Finckh, 1925) has an outstanding stratigraphical importance.

In the former literature (E. Kalkowsky, 1878; E. Dathe, 1902; L. Finckh, 1923; K. Smulikowski, 1952; H. Teisseire, 1957; W. Grocholski, 1967 and others) the Gory Sowie Block was believed to be composed of gneisses and migmatites of the Archaean age.

Later on, it appeared that some of the paragneisses contain Late Riphean microflora (T. Gunia, 1981a, b, 1984). Therefore, their age determination changed from the Archaean to Late PreProtozoic.

However, the problem of biostratigraphical data in the Gory Sowie Mt. has not been ultimately solved this way. Still unsolved among others is the problem of age of the "small pararapamphibolite bodies" occurring within the gneisses and migmatites. There is a comprehensive petrological literature on orthoamphibolites (J. A. Winchester et al., 1998), while pararapamphibolites did not receive similar attention so far. Their origin is merely a matter of suppositions. On the older geological maps and in text explanations (E. Dathe, 1902; L. Finckh, 1925) pararapamphibolites were generally distinguished as "diabasic amphibolites with limestone lenses" or as "calcareous-silicic rocks" whose praeecursors were "diabasic tuffites rich in calcium carbonate or calcareous tuffites". In more recent papers the pararapamphibolites are also supposed to have originated from dolomitie-marly intercalations occurring within the primary sedimentary sequence (K. Smulikowski, 1952; A. Polański, 1955; T. Morawski, 1973).

According to A. Żelaźniewicz (1995) who gave an incomplete description of lithologies of "...the Fore-Sudetic part of the Gory Sowie Block...", "...quartz-bearing amphibolites forming discordant interbeds in gneisses..." are probably of a volcanic origin, i.e. secondary after tuffites (compare earlier opinion of L. Finckh, 1925). A part of them, according to A. Żelaźniewicz (op. cit.), "...is of a sedimentary origin..." (compare earlier views of K. Smulikowski, 1952; A. Polański, 1955 and T. Morawski, 1973). Although I object to the lack of references to earlier literature and concepts in the paper by A. Żelaźniewicz (op. cit.), but I share his opinion of that the pararapamphibolites "...are not quite well studied yet..." with
It is not clear whether the primary sediments (protolith) were marine flysch-like series effusive basic rocks rich in calcium carbonate, calcareous rocks or intercalations of marly-calcareous series. It may be assumed that they probably contained tufts of effusive basic rocks in carbonates, calcareous rocks, calcareous tuffs and intercalations of marly-calcareous rocks. Such origin of the paraamphibolites will remain hypothetical until detailed petrological investigations are made.

The analysis of old geological maps mentioned in the above chapter describing the localities indicates that all the studied finds of paraamphibolites with carbonate intercalations occur within paragneisses, both in the Sudetic and Fore-Sudetic parts of the Gory Sowie Block. It may be presumed that they are coeval. The presence of microfossils, in particular skeletal fauna in carbonates enclosed in paraamphibolites, shows that these rocks cannot be older than Cambrian.

The present-day state of knowledge on biostatigraphy of the Gory Sowie Block with regard to the paragneisses and paraamphibolites can be summarized as follows: a thick (estimated at several thousand metres) primary sedimentary series, i.e. marine flysch-like series and related carbonate-rich tufts or tufts of basic rocks (basalt type) or containing marly-dolomitic interbeds, were deposited in the Late Riphean–Cambrian. They might have been metamorphosed after the Cambrian and before Late Devonian.

Lowermost Upper Devonian (Lower and Middle Frasnian) sediments were partly deposited already upon a metamorphosed basement of an undefined and unknown pre-Gory Sowie area. Limestone pebbles containing fauna of the lowermost Upper Devonian (T. Gunia, 1962) occurring together with pebbles of metamorphic rocks, among others the Góry Sowie gneisses (T. Gunia, 1962; Porębski, 1981), and known from the Lower Famennian conglomerates of the neighboring Świebodzice Depression area (Fig. 1), are indicative of sediment transport from that area.

A separate problem for further studies is a similarity in terms of biostratigraphy between the Cambrian age of the carbonates in paraamphibolites of the Góry Sowie Block and the same age of marbles connected with amphibolites in amphibolitic shales in another part of the Sudetes, i.e. within the Łędzki–Śnieżnik metamorphic complex.

The attempts to determine an isotopic age of metamorphic rocks in the Góry Sowie Block were undertaken many times. They have brought very different results leading to various interpretations. Recently, they have been summarized by Z. Cymerman (1998). That author (pers. comm.) is preparing a paper containing geochronological interpretation of these results. Here, only selected results are presented basing on the IUGS geochronological table compiled by J. Cowie and M. Basset (1989). According to O. van Breemen et al. (1988) the datings fall between 381 and 369 Ma, i.e. Middle and Late Devonian. Other authors, among others A. Kröner and E. Hegner (1998) have obtained the age of 482–472 Ma, i.e. Early Ordovician. The same authors have determined the age of detrital zircons to span younger Archean to Proterozoic. Single datings (G. Olivier, S. Kelley, 1993) even point to the Early Carboniferous.

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nie, lecz wyraża się prawdopodobieństwo, że prototytem tych amfiboliów mogły być wkładki dolomityczno-marglisty w pierwotnym osadzie.

W wyniku przeprowadzonych badań udało się w siedmiu miejscach (fog. I) znaleźć we wtrącaniach weglandowych tkwiących w „amfiboliach diabazowych” mikroskopowej wielkości fragmenty flor i fauny, którą zestawiono tablicarzcznie (tab. 1) i udokumentowano fotograficznie (tab. II–VIII), podając „czas geologiczny” pojawienia się poszczególnych grup. Zacytowano również literaturę, na podstawie której dokonano oznaczeń. Do mikrofory należą niektóre rodzaje akrystalikatów, uwzględnionych (tab. II) oraz relikty glonowych struktur weglanowych, które oznaczono jako Algae indet.


Trudne do oznaczenia były również reureczkowane formy Cambroclavidae, a także okazy należące, być może, do ?Polycysta oraz do protokonodontów. Znaleziono też bardzo małe okazy owalne lub subtrzygoanalne formy weglanowe, zbliżone do wieczek niektórych hioleów.


W dawniej literaturze (E. Kalkowsky, 1878; E. Dathe, 1902), a także w powojennej (K. Smulikowski, 1952; H. Teisseyre, 1957; W. Grocholski, 1956; S. Porebska, 1981) znane z dolnofamenskich zlepienców sąsiedniego obszaru depresji Świębodziń (fig. 1).

Porównawczym zagadnieniem jest „czasowa” (w sensie biostratigrafiennym) zbieżność między kambryjskim wiekiem wapieni krystalicznych w „amfiboliach diabazowych” na bloku sudetyjskim a takim samym wiekiem większych wystąpień marmurów związanych z amfiboliom i lupańami amfibolitowymi innej części Sudetów, a także w niektórych obszarach depresji Świębodziń (fig. 1).

Dotychczasowe dataowanie wieku izotopowego Górz Sowich w zależności od autorów, metody badań i wybranych mineralów nie przyniosły rozstrzygających wyjaśnień. Oznaczony wiek wydaje się być gorny. Stan badan próbuje się poprawić w przyszłości, a także w podanym czasie.

EXPLANATIONS OF PLATES

PLATE I

Fig. 1. Outcrop of calc-silicate rocks with microfossils (Owiesno); photo J. Stachowiak

PLATE II

Figs. 1–7. Baltisphaeridium sp. Owiesno 31 and 87; powder samples

Figs. 8–10. Microhystridium lanatum Owiesno 20 and 30; powder samples

Figs. 11–14. Microhystridium cf. brevicornatum Owiesno 22–24; powder samples

Figs. 15–17. Microhystridium sp. Owiesno 60; powder samples

Figs. 18, 19. Aranidium sp. Owiesno 80; powder samples

Figs. 20. Aranidium cf. spinosum Owiesno 22; powder samples

Figs. 21–24. Filamenous forms Owiesno 27–36; powder samples

PLATE III

Figs. 1–7. Siliceous, oval, elliptical and polygonal forms with sculpture resembling ?Liosphaeridae (radiolarian); Owiesno 35–95; powder samples

PLATE IV

Figs. 1–6. Siliceous forms with spongy-like sculpture resembling radiolarian (subfam. ?Polyentactiniinae); Owiesno 35–95; thin-section

PLATE V

Hyolitha (Anabaritidae)

Figs. 8, 9. Cambrostubulus sp. Pława 21/4, 661/2, 271/1; powder samples

Figs. 4–7. Longiochrea sp. Gilów 56/1, Pława 81, Błyszek Hill 82/4, 73/1; powder samples

Hyolithelminthes (Hyolithellidae)

Figs. 8, 9. Hyolithelminthes cf. rectus Owiesno 158/2, 191/2; powder samples

Figs. 10–12. Pseudortheca cf. filosa Czyżów Hill 39/1, 45/1, 38/1; powder samples
PLATE VI

Figs. 1–3. *Pseudortheca cf. perornata*
Gilów 1/4, Czyżyk Hill 33/3, Pilawa 33/1; powder samples

Figs. 4–9. *Pseudortheca cf. rotundicincta*
Czyżyk Hill 34/3, Gilów 82/2, 1/3, 76/2, 18/2; powder samples

PLATE VII

Figs. 1–11. Kutorginidae-like forms

PLATE VIII

Pilawa 4/2, 45/2, 64/2, Błyszcz Hill 46/1, 106/1, 105/2, 39/1, 40/2, Gilów Hill 1/2, Czyżyk Hill 25/1, 32/1; powder samples

Figs. 1–12. Brachiopoda indet.
Pilawa 21/1, 41/2, 61/3, 47/2, 42/1, 61/2, Błyszcz Hill 45/1, 106/2, 15/1, 109/6, Czyżyk Hill 28/4; powder samples

Pilawa 13/1, Czyżyk Hill 24/2, Qwiesno 18/2; powder samples
Tadeusz GUNIA — Microfossils from the high-grade metamorphic rocks in the Góry Sowie Mts. (Sudetes area) and their stratigraphical importance
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