Geological Quarterly, Vol. 37, No. 4, 1993, p. 501—536

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Upper Silurian and Lower Devonian in the western Holy Cross Mts.

Lithology of the Upper Silurian, Lower and Middle Devonian sediments exposed in northwestern part of Kielce are described. Nine lithostratigraphical units representing the six stages of the Silurian and Devonian are distinguished. Three of these units have been newly introduced i.e. Niewachlów Beds, Kielce Beds and Conglomerates from Gruchawka. Biostratigraphy of the Lower and Upper Silurian greywacke sediments and of a bottom of the Middle Devonian are defined. Lithostratigraphy and struetural setting of the Miedziana Góra Conglomerates and their relation to Klonów and Barcza Beds are presented.

INTRODUCTION

Two palaeogeographical-structural areas of the Paleozoic in the Holy Cross Mts. i.e. southern — Kielce Region, and northern — Łysogóry Region, are separated with the roughly west-east running Łysogóry Dislocation (Fig. 1). During the Paleozoic, but mainly in the interval Middle Cambrian–Middle Devonian, the southern region was uplifted whereas the northern one subsided. In the southern region a Caledonian folding was strong while in the north it is poorly expressed (Z. Kowalczewski, Z. Migaszewski, *in press*).

During the Upper Silurian claystones with graptolites of the Lower Ludlow are followed in the Holy Cross Mts. by deposition of greywackes. In the Kielce Region these sediments are defined as the Niewachlów Greywackes whereas in the Łysogóry Region a greywacke series is subdivided into the older — Wydryszów Beds, and the younger — Rzepin Beds (J. Czarnocki, 1950; H. Tomczyk, 1968; E. Tomczykowa, H. Tomczyk, 1981).

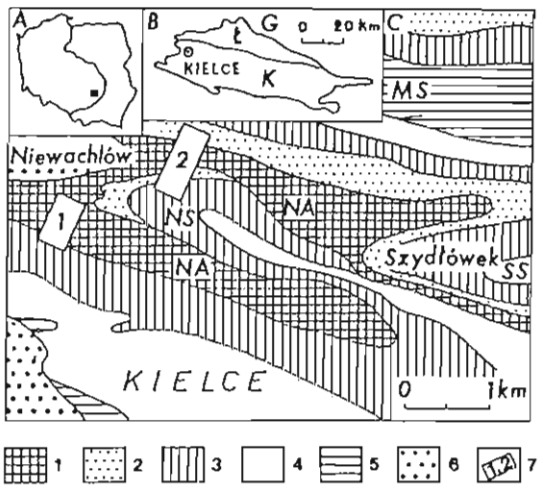

Fig. 1. Location of the studied area in Poland (A) against outcrops of the Paleozoic in the Holy Cross Mts. (B) and geological map (after J. Czarnocki, 1937) of the western Holy Cross Mts. (C)

1 — Silurian; 2 — Lower Devonian; 3 — Middle Devonian; 4 — Upper Devonian; 5 — Carboniferous; 6 — Permian; 7 — location of studied area; SS — Szydłówek Syncline; NS — Niewachlów Syncline; NA — Niewachlów Anticline; MS — Miedziana Góra Syncline; G — Grzegorzowice section; Ł — Łysogóry Region; K — Kielce Region

Lokalizacja obszaru badań w Polsce (A) na tle zarysu wychodni paleozoiku świętokrzyskiego (B) i mapy geologicznej (według J. Czarnockiego, 1937) zachodniej części Gór Świętokrzyskich (C)

1 — sylur; 2 — dewon dolny; 3 — dewon środkowy; 4 — dewon górny; 5 — karbon; 6 — perm; 7 — lokalizacja badanych obszarów; SS — synklina szydłówkowska; NS — synklina niewachlowska; NA — antyklina niewachlowska; MS — synklina miedzianogórska; G — profil Grzegorzowic; Ł — region łysogórski; K — region kielecki

Previous investigations indicated that the Niewachlów Greywackes of the Kielce Region correspond to the Wydryszów Beds (E. Tomczykowa, H. Tomczyk, 1981) or at most to the lowermost part of the Rzepin Beds of the Łysogóry Region (E. Tomczykowa, 1988). An opinion prevailed that deposition of the Niewachlów Greywackes was followed during the Upper Ludlow by uplifting and folding of the area in the Ardenian Phase of the Late Caledonian Orogeny (J. Samsonowicz, 1952; H. Tomczyk, 1974). In the Kielce Region the structural Variscan stage begins with terrigenous sediments of the Lower Devonian (Emsian) that overlie with huge stratigraphical gap and angular discontinuity a folded substrate composed of vari-aged rocks.

In the Łysogóry Region there is a continuous transition between the Silurian and the Devonian (H. Tomczyk et al., 1977). Greywackes of the Wydryszów and Rzepin Beds of the Upper Silurian are overlain by the Lower Devonian (Gedinnian) marine sediments of the Bostów Beds, and developed in shallow-water facies — the Klonów Beds (M. Pajchlowa, 1968; J. Malec et al., 1990). Late Caledonian deformations have been expressed by substrate uplifting only, fold deformations excluded. The Bostów and Klonów Beds are topped by sedimentary discordance by terrigenous sediments of

of the Barcza Beds of the lowermost Emsian probably (H. Łobanowski, 1981); they start deposition of a syn-Variscan complex (Z. Kowalczewski, 1971*a*).

New geological data collected recently for the Niewachlów Anticline and Syncline as well as the Miedziana Góra Syncline in the northwestern part of Kielce were found very important for reconstruction of sedimentary and tectonic processes in the Upper Silurian and Lower Devonian of the Kielce Region (Fig. 1). As a result of excavation, mainly at heat plant of the city of Kielce, previously unknown fragments of the Upper Silurian and the Lower Devonian sequence were examined (J. Malec, 1988, 1989, 1990, 1991*a*, *in press*). These are greywackes of the Upper Silurian, corresponding to the Wydryszów and Rzepin Beds of the Łysogóry Region, and their gradual transition into the sediments of the Klonów Beds and the Miedziana Góra Conglomerates, probably of the Lower Gedinnian age. Presence of these sediments indicates continuous greywacke deposition in the Upper Silurian of the Kielce Region. Deposition of the Miedziana Góra Conglomerates ends the Caledonian structural stage in the Kielce Region, which is followed by folding and uplifting of this area. The Variscan cycle starts with deposition of conglomerates that overlie with angular discordance the Miedziana Góra Conglomerates (or other Old Palcozoic rocks), covered with terrigenous sediments of the Lower Emsian.

A new lithostratigraphical subdivision within the Niewachlów Greywackes was introduced. Their lower part was distinguished as the Niewachlów Beds, corresponding to the Wydryszów Beds of the Łysogóry Region, and the upper — as the Kielce Beds, corresponding to the Rzepin Beds. A new lithostratigraphical member — the Conglomerates from Gruchawka — are distinguished in the bottom of the Variscan cycle (Fig. 12).

Lithological composition of exposed complexes of the Upper Silurian and the lowermost Devonian are described, and their stratigraphical location is presented.

I am indebted to Prof. H. Żakowa and Docent Z. Kowalczewski for a critical review of the manuscript. Special gratitude is given to Prof. L. Teller for remarks on stratigraphy of the Silurian and determination of graptolites. Acknowledgment is due to Doc. E. Borsuk-Białynicka for determination of vertebrates, to Dr. hab. E. Tomczykowa — of trilobites, to Dr. E. Głuchowski — of crinoids and to J. Studencka, M.Sc. — of brachiopods.

LITHOLOGICAL DESCRIPTION

Nine lithostratigraphical units of regional rank were distinguished within the Silurian and Devonian sediments exposed in northwestern part of Kielce. They belong to the Upper Silurian (Niewachlów Beds, Kielce Beds), Lower Devonian (Klonów Beds, Miedziana Góra Conglomerates, Conglomerates from Gruchawka, Barcza Beds, Beds from Winna) and Middle Devonian ("ore-bearing" clays, dolomites).

N i e w a c h l ó w B e d s occur in western part of the examined area in a southern limb of the Niewachlów Anticline (Fig. 1, study area 1) and in its eastern part — at border of the Niewachlów Syncline and northern limb of the Niewachlów

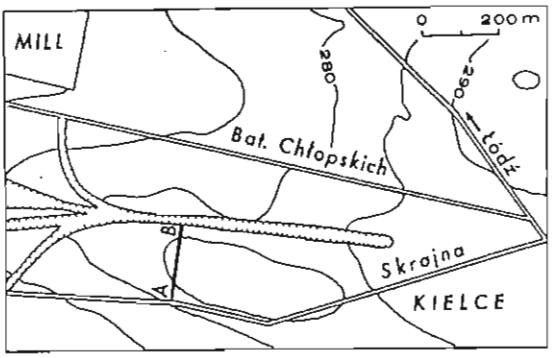

Fig. 2. Topographic map of the northwestern part of Kielce with location of the section AB presented in Fig. 4
Mapa topograficzna NW części Kielc z lokalizacją profilu AB przedstawionego na fig. 4

Anticline (Fig. 1, study area 2). They are composed of a greywacke-claystone sequence, in which the contents of beds of greywacke sandstones is about 30%.

In a 188 m long research trench and in exposures within a railway cut in southern limb of the Niewachlów Anticline (Figs. 2, 4), a lowerpart of the Niewachlów Beds with total thickness of over 300 m was examined. The section exposed in the trench is composed of greywacke sandstones in single beds or in bed sets of varying thickness, interbedded with claystone layers. Material of greywacke sandstones belongs usually to psammitic and more rarely, to psephitic fraction. Greywacke sandstones as well as claystones are of varying colour, from light gray through dark gray to brown. The greywacke section contains frequently intercalations of tuffites, 0.5 to 30 cm thick. In the lower part of the section there is a 4 m thick complex of brown clayey shales with abundant fauna (Fig. 4). Sedimentary structures of the greywacke sandstones are often expressed by single graded bedding with good separation of granular material which is typical for turbidites.

An uppermost fragment of the Niewachlów Beds was examined in pits at border of the Niewachlów Syncline and Anticline (Fig. 6). These sediments are composed of fine- and medium-grained brown greywacke medium- and coarse-bedded sandstones, with average thickness of about 15–20 cm and maximum thickness 37–50 cm. Within a compact, over 5 m thick complex of greywacke sandstones, there are five intercalations (10–20 cm thick) of green and green-brown siltstones and several thin (about 1 cm) layers of green clays, probably — pyroclastic rocks.

Greywackes of the Niewachlów Beds gradually pass upwards into claystones with intercalations of greywackes of the Kielce Beds (Fig. 6). A border between the Niewachlów and the Kielce Beds is arbitrarily accepted (similarly as in the Łysogóry Region between the Wydryszów and the Rzepin Beds — E. Tomczykowa, H. Tomczyk, 1981) at the top of a compact complex of greywacke sandstones (Fig. 6).

K i e l c e B e d s form a principal rock unit of a northern limb of the Niewachlów Anticline (Fig. 1, study area 2; Fig. 5). Near the bottom of the section they are composed of gray-green claystones, 1.5 m thick, that contain three layers (to 15 cm thick) of greywacke sandstones (Fig. 6). They are overlain by several hundred meter

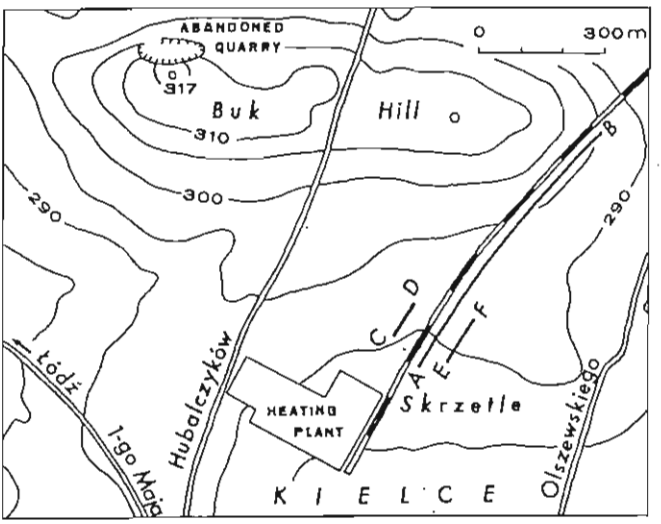

Fig. 3. Topographic map of the northwestern part of Kielce with location of sections AB, CD and EF presented in Figs. 5–8

Mapa topograficzna NW części Kielc z lokalizacją profili AB, CD i EF przedstawionych na fig. 5–8

thick series of dark gray claystones with rare, single and generally thin layers of greywacke sandstones (Fig. 5).

In several sections of the lower part of the Kielce Beds in a northern limb of the Niewachlów Anticline there are rafts of the Middle Devonian dolomites, located close to a strike-slip fault (Fig. 7).

Fine-grained greywacke sandstones located within claystones constitute only about 3–4% of the over 500 m thick sequence of the Kielce Beds. Layers of greywacke sandstones are from few to 50 cm thick (single layers), usually 8–15 cm, and commonly do not display any graded bedding. In the middle of the section there are wave ripples on surfaces of single beds of greywacke sandstones. Occasionally there are also single (5–10 cm) layers of medium-grained greywacke sandstones of varying mineral composition with abundant micas. Within claystone beds there is frequently a horizontal subtle lamination, accentuated by presence of darker laminae, presumably enriched in organic matter. Single layers of greywacke sandstones and claystones in the upper part of the Silurian contain abundant and diverse fauna. In the upper part of the Kielce Beds layers of fine-grained calcareous quartz sandstones with rich micro- and macrofauna are recorded. In shallower fragments of the section the weathered rocks are olive or gray-green whereas at depths of 7–10 cm beneath land surface there are non-weathered layers of dark gray or locally even black colour.

K l o n ó w B e d s are noted in a northern limb of the Niewachlów Anticline where they overlie with a sedimentary continuity dark gray claystones and greywackes of the Kielce Beds (Fig. 1, study area 2; Figs. 8, 10; Pl. I, Fig. 1). A lower part of the Klonów Beds is composed of cherry colour claystones with distinct horizontal lami-

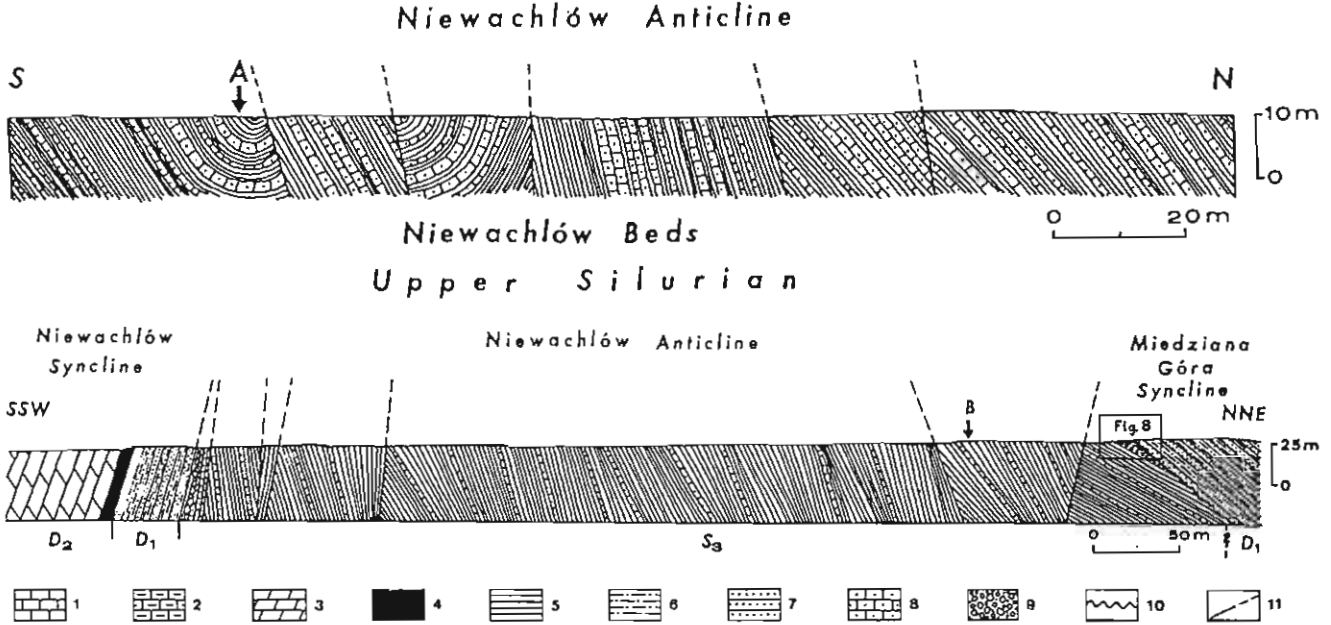

Fig. 4. Lithological section AB of the lower part of the Niewachlów Greywackes (Fig. 1 — study area 1; Fig. 2 — AB)

A — localization of occurrence of graptolites *scanicus* Zone

Profil litologiczny AB dolnego odcinka szarogłazów niewachlowskich (fig. 1 — obszar badań 1; fig. 2 — AB)

A — lokalizacja występowania graptolitów poziomu *scanicus*

Fig. 5. Geological section AB of the northwestern part of Kielce (Fig. 1 — study area 2; Fig. 3 — AB)

1 — limestones; 2 — marls; 3 — dolomites; 4 — clays; 5 — claystones; 6 — siltstones; 7 — sandstones; 8 — greywacke sandstones; 9 — conglomerates; 10 — erosional discordance; 11 — main tectonic zones; B — occurrence of graptolites *Monograptus transgrediens* Perner; S_3 — Upper Silurian; D_1 — Lower Devonian; D_2 — Middle Devonian

Przekrój geologiczny AB z NW części Kielc (fig. 1 — obszar badań 2; fig. 3 — AB)

1 — wapienie; 2 — margle; 3 — dolomity; 4 — iły; 5 — iłowce; 6 — mułowce; 7 — piaskowce; 8 — piaskowce szarogłazowe; 9 — zlepieńce; 10 — niezgodność erozyjna; 11 — główne strefy tektoniczne; B — lokalizacja występowania graptolitów *Monograptus transgrediens* Perner; S_3 — sylur górny; D_1 — dewon dolny; D_2 — dewon środkowy

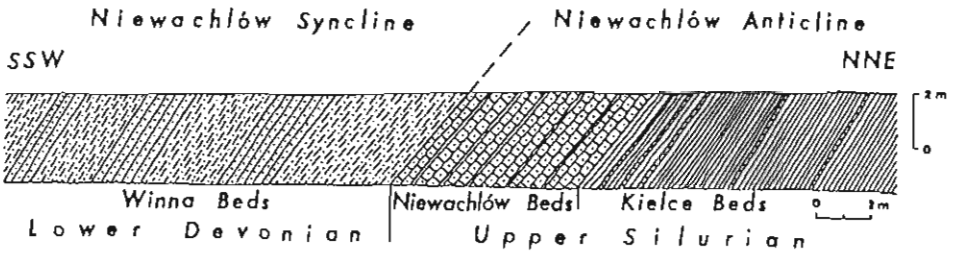

Fig. 6. Section CD of the Silurian and Devonian near the boundary between the Niewachlów Syncline and Anticline (Fig. 3 — CD)

Profil CD syluru i dewonu z pogranicza synkliny i antykliny niewachlowskiej (fig. 3 — CD)

nation, 6.5 m thick. Compact series of these claystones passes upwards into a continuous claystone-sandstone complex, about 1.4 m thick (Fig. 8). In its lower part — inside claystones and sandstones (quartz wackes) there are thin celadon-coloured layers (from 1 mm to 0.5–1.0 cm), separated with cherry colour layers. Participation (number and thickness) of celadon claystones and sandstones gradually increases upwards and completely predominates in upper part of the sequence. First layers of sandstones appear in its lower part. In general there are 6 sandstone layers, 4–17 cm thick. Within the Klonów Beds neither microspores nor faunistic remains have been found.

Miedziana Góra Conglomerates. Celadon-coloured claystones and sandstones of the Klonów Beds pass upwards continuously into a conglomerate complex (Figs. 5, 8, 10; Pl. I, Fig. 1). The conglomerates form two layers with well and very well rounded pebbles of Cambrian quartzitic sandstones. A lower bed, 5 to 180 cm thick, is of ortho-conglomerate type and is composed of poorly sorted and poorly cemented pebbles in fraction of 0.5–20 cm. On the other hand the upper layer is composed of para-conglomerates (in bottom — of ortho-conglomerates), including very poorly cemented (siltstone cement of celadon colour) larger pebbles — about 0.5–40 cm in diameter and 0.9–3.5 m thick. In both layers pebbles are usually isometric or of similar shape, more rarely they are irregular — elongated or disc-shaped. Pebbles are irregularly distributed. Mean size of pebbles is 10–15 cm. Maximum thickness of the Miedziana Góra Conglomerates exposed in northwestern part of Kielce is 4.5 m (Fig. 8). Previous studies indicate (J. Czarnocki, 1936; Z. Kowalczewski, 1968; J. Malec, 1990) that clastic material of the Miedziana Góra Conglomerates comes from the northwestern Łysogóry Region in the Holy Cross Mts.

Conglomerates from Gruchawka occur at the border of the Niewachlów Anticline and the Miedziana Góra Syncline (Fig, 1, study area 2) where they overlie with erosive and angular discordance the Miedziana Góra Conglomerates (Figs. 8, 10). They are formed of a layer 5–6 cm thick, composed of poorly rounded pebbles of quartzic sandstones, 0.5–4.5 cm (on the average 1–2 cm) in diameter, strongly cemented with fine-grained sandstone material. Around pebbles and within a cement there are numerous voids, surfaces of which are covered with imprinted fragments of ostracoderms and placoderms(?).

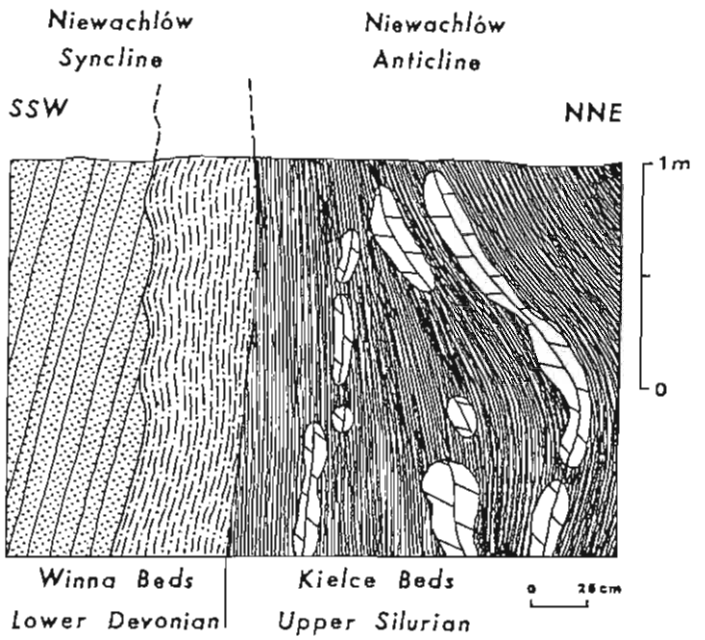

Fig. 7. Fragment of section EF of the Silurian and Devonian near the boundary between the Niewachlów Syncline and Anticline (Fig. 3 — EF)
Fragment profilu EF syluru i dewonu z pogranicza synkliny i antykliny niewachlowskiej (fig. 3 — EF)

B a r c z a B e d s are exposed in a southern limb of the Miedziana Góra Syncline (Fig. 1, study area 2). They are composed of mutually interbedding siltstones and sandstones, visible thickness of which is over 31 m (Figs. 8–10). Directly above the Conglomerates from Gruchawka there is a thick (about 3.3 m) uniform complex of fine-grained quartzic light gray, medium- and coarse-bedded arenites that form a principal core of a small ridge Buk, running westwards to Niewachlów. Above, there is 4 m thick complex of light gray siltstones, in a lower part of which there is an interval 20 cm with very abundant and partly crushed but relatively well preserved fragments of psylophytes.

Upper part of the Barcza Beds is composed of alternating siltstone and sandstone beds of varying thickness, from several dozen centimetres to several metres. In lower part of the section the siltstones are light gray or gray-green, are distinctly stratified and display a subtle horizontal lamination. In the centre of the exposure, at distance of 8.5 m, siltstones are cherry-brown, do not show bedding and are structureless resembling irregular pseudolumps with indistinct borders. Above — to the top of the exposed section (about 6 m) — siltstones are gray-green and do not show distinct sedimentary structures.

Sandstones of the exposed Barcza Beds are composed generally of compact fine--grained arenites, more rarely of quartzic wackes, and they are usually light gray or

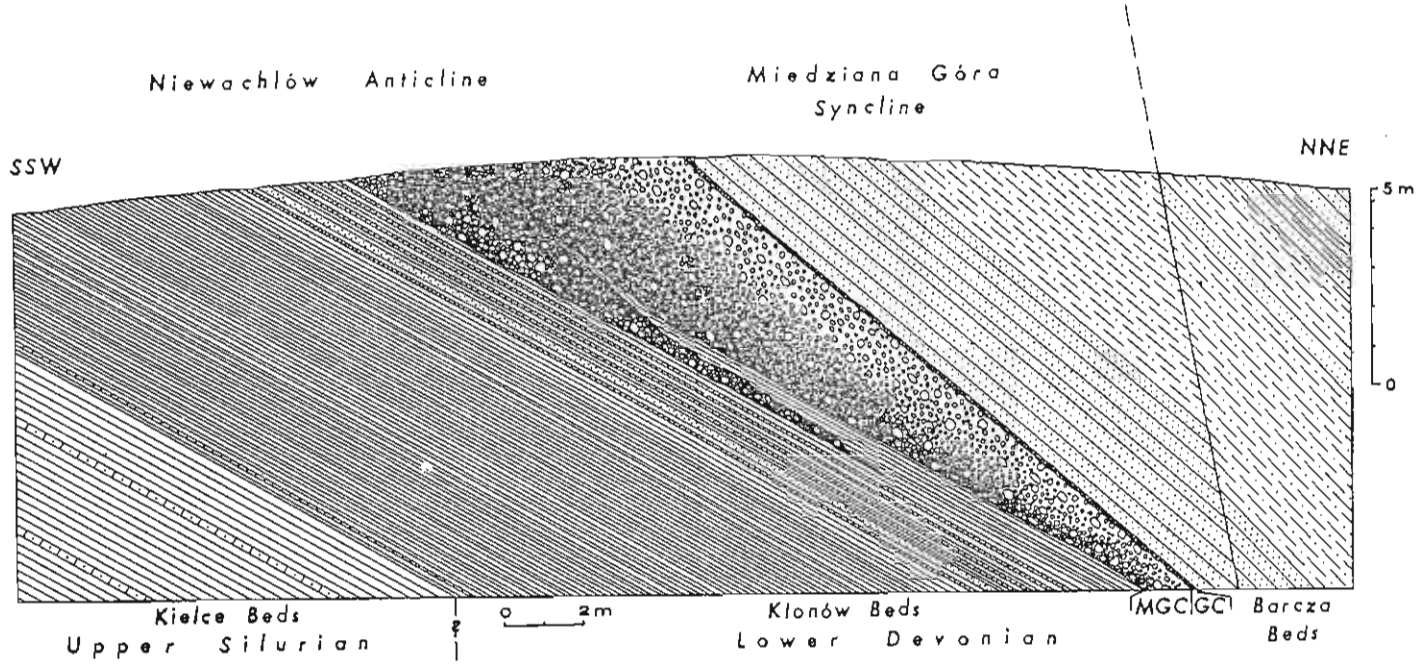

Fig. 8. Fragment of section AB of the Silurian and Devonian near the boundary between the Niewachlów Antieline and Miedziana Góra Syncline (Fig. 5 — eastern part of the section)

MGC — Miedziana Góra Conglomerates; GC — Conglomerates from Gruchawka

Fragment profilu AB utworów syluru i dewonu z pogranicza antykliny niewaehlowskiej i synkliny miedzianogórskiej (fig. 5 — wschodnia część przekroju)

MGC — zlepieńce miedzianogórskie; GC — zlepieńce z Gruchawki

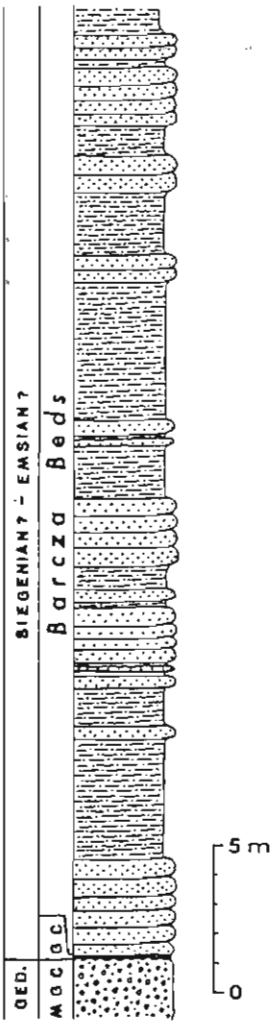

Fig. 9. Lithology of the lower Barcza Beds in the northwestern part of Kielce

GED. — Gedinnian; other explanations as in Fig. 8

Profil litologiczny dolnego odcinka warstw barczańskich z NW części Kielc

GED. — żedyn; pozostałe objaśnienia jak na fig. 8

locally — dark gray. Only directly near the bottom of cherry colour siltstones they are pink and poorly cemented. Thicker complexes of sandstones are medium- and thick-layered (15–53 cm thick), thinner are composed of layers to a dozen or so centimetres thick.

Beds from Winna occur in a northern limb of the Niewachlów Anticline (Fig. 1, study area 2). In the lower part they contact along dislocation with the Silurian claystones and greywacke sandstones of the Niewachlów or the Kielce Beds of the Niewachlów Anticline (Figs. 5–7; Pl. I, Fig. 2) whereas towards the top they pass concordantly into clayey sediments of the Middle Devonian (Figs. 10, 11; Pl. II, Figs. 1, 2; Pl. III, Fig. 1). An exposed fragment of the Beds from Winna (without a bottom part) is about 33.5 m thick.

Principal part of these sediments over the Silurian, about 29 m thick, is composed of mutually interbedded siltstones and sandstones. Besides thin claystone beds there are 6 compact siltstone layers from 1 to 3.3 m thick. Their general thickness is over 18 m. In a lower part of siltstones gray-brown and brown colours predominate whereas in the middle — dark violet, secondarily gray-green and celadon ones. Within some layers there are claystone hard balls, 0.5–2 cm in diameter. Siltstone layers are separated with fine-grained sandstones, mainly of arenites and more rarely of quartzic wackes. In a lower part the sandstones are gray-green and above — gray-brown. Besides single (from several to 55 cm thick) sandstone layers, there are 6 compact sandstone complexes 1–1.9 m thick. Sedimentary structures within sandstones are composed mainly of flat parallel lamination, accentuated by presence of dark minerals.

Upper part of the Beds from Winna is composed of 4.5 m thick, homogeneous complex of fine-grained compact light gray quartzic arenites (Pl. II, Figs. 1, 2; Pl. III, Fig. 1). Sedimentary structures are represented by flat parallel lamination, accentuated by the presence of micas and dark minerals.

"Ore-bearing" Clays occur in a northern limb of the Niewachlów Syncline (Fig. 1, study area 2). Within this complex that directly overlies the Beds from

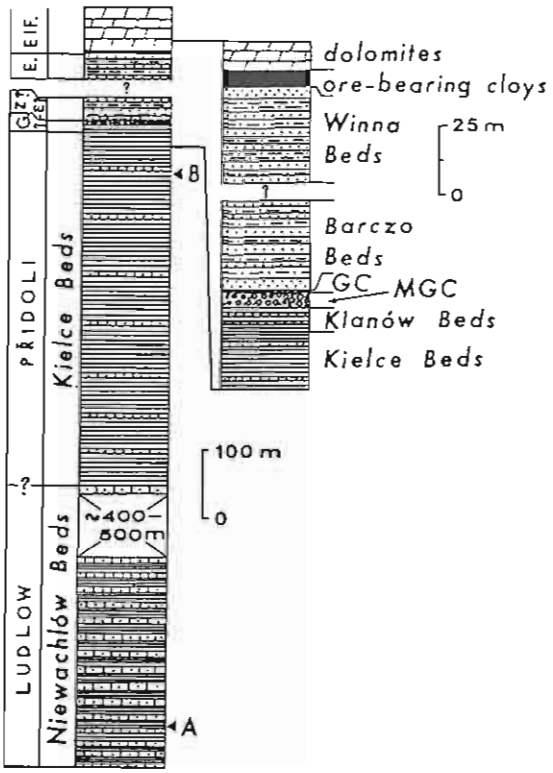

Fig. 10. Synthetic section of the Upper Silurian and Lower Devonian in the northwestern part of Kielce

A — location of graptolites from the *scanicus* Zone; B — location of graptolites *Monograptus transgrediens* Perner; G.? — Gedinnian?; Z.?–E.? — Siegenian?–Emsian?; E. — Emsian; EIF. — Eifelian; other explanations as in Fig. 8

Zbiorczy profil litologiczny osadów górnego syluru i niższego dewonu z NW części Kielc

A — lokalizacja graptolitów z poziomu *scanicus*; B — lokalizacja graptolitów *Monograptus transgrediens* Perner; G.? — żedyn?; Z.?–E? — zigen?–ems?; E. — ems; EIF. — eifel; pozostałe objaśnienia jak na fig. 8

Winna (Figs. 5, 10, 11; Pl. II, Figs. 1, 2; Pl. III, Figs. 1, 2), there are three characteristic rock units:

A. Plastic (at the bottom sandy) yellow clays with subtle horizontal lamination and several layers (3–4 cm thick) of beige-brown clays (Pl. III, Fig. 2 — C_1). Numerous crinoid ossicles are present. Thickness 1.2 m.

B. Sandy clays, very ferruginous, poorly cemented, with brown colour, no distinct sedimentary structures are noted (Pl. III, Fig. 2 — C_2). They contain several thin (to 1 cm) laminae of plastic dark pink clays and two layers (in middle and top parts) of compact and hard dark pink fine-grained sandstones, 2.5 cm thick. Thickness 1.3 m.

C. Brown-red-beige plastic clays with strongly increased content of Fe compounds. At the bottom there are single small (from several to 10 cm in diameter) nests of pink and poorly cemented sandstones. There are also irregular discontinuous and thin

(0.5–1 cm) laminae of plastic green, beige and brown clays. The series contains conodonts, foraminifers and scolecodonts. Thickness 3.2 m.

D o l o m i t e s . Within the northern limb of the Niewachlów Syncline (Fig. 1, study area 2) a complex of "orc-bearing" clays passes upwards with a sedimentary concordance into a thick series of dolomites (Figs. 5, 10, 11). The exposed lower part contains three various rock units:

A. Fine-crystalline dolomites with fauna, thin- and medium-bedded, dark gray and gray-beige, partly marly. They contain dispersed fauna of small solitary tetracorals, thin-branched tabulates, crinoids and brachiopods. Locally there are nesty concentrations of corals, a dozen or so centimetres thick. Thickness about 28 m.

B. Fine-crystalline dolomites with bioturbation, medium-bedded, gray-beige. Bioturbation structures are represented by numerous tubes, 2–3 mm in diameter, filled with microcrystalline lighter dolomite. Thickness about 8 m.

C. Fine-crystalline dolomites medium- and thick-bedded and without macroscopic organic remains. A lower part of the series is exposed and is over 22 m thick.

STRATIGRAPHY

SILURIAN

L u d l o w . There is a palaeontological documentation of lower part of the Niewachlów Beds from a southern limb of the Niewachlów Anticline (Fig. 1, study area 1). Within greywackes exposed in a research trench (Figs. 2, 4), fossils were found in three fragments of the section. In bottom and middle part there are rare graptolites and pelecypods, and in brown claystones — abundant graptolites, nautiloids, pelecypods (*Cardiola* sp., *Slava* sp.), ostracods (entomozoids) and rare crinoids. Amongst the graptolites present in brown claystones, L. Teller determined preliminarily the following taxons: *Lobograptus* cf. *amphirostris* Urbanek, *L.* cf. *expectatus* Urbanek, *L.* cf. *scanicus* (Tullberg), *Monograptus chimaera chimaera* (Barrande), *M. chimaera* cf. *salweyi* (Hophinson), *M. uncinatus* Tullberg, *M. dubius* (Suess) and *Bohemograptus bohemicus* (Barrande). According to L. Teller the mentioned assemblage of graptolites indicates the *scanicus* Zone of the Lower Ludlow.

Presence of greywacke sediments beneath the *scanicus* Zone at the bottom of the Niewachlów Beds from northwestern part of Kielce can indicate its deposition at the *progenitor* or *nilssoni* Zones. This fact is supported by previous reports from some sections of the Silurian in the southern and northern Holy Cross Mts. where greywacke deposition was noted at the *nilssoni* and *scanicus* Zones (J. Czarnocki, 1950; H. Tomczyk, 1954; E. Tomczykowa, 1959; Z. Kowalczewski, H. Tomczyk, 1981). These data demand revision of the previous opinion on beginning of greywacke deposition in the Holy Cross Mts. at the *leintwardinensis* Zone (E. Tomczykowa, H. Tomczyk, 1981).

Greywackes of the Niewachlów Beds, 400–500 m thick, not exposed in the central part of the Niewachlów Anticline (Fig. 1) can be only generally referred to the Ludlow.

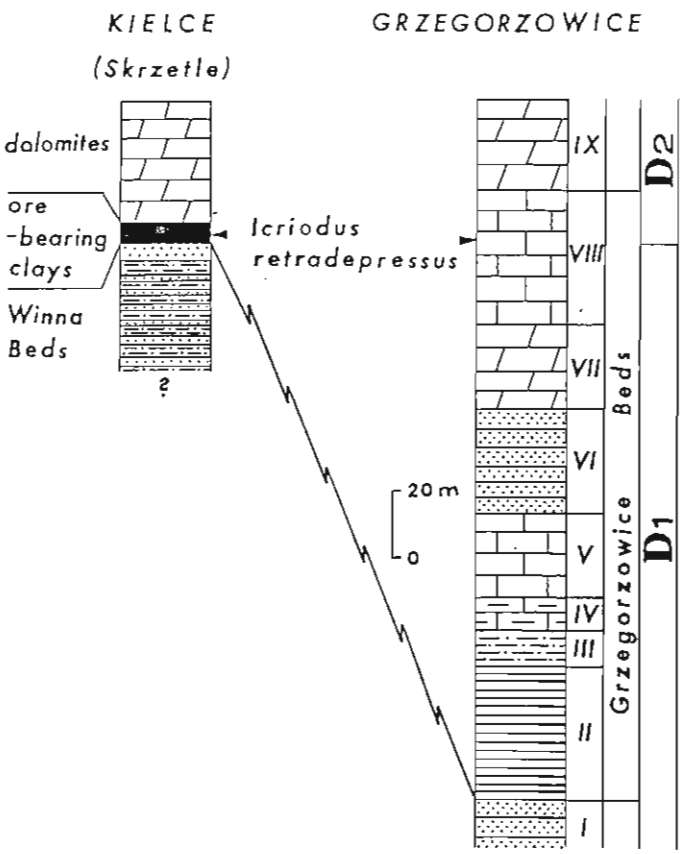

Fig. 11. Correlation of sections near the boundary between the Lower and Middle Devonian in the northwestern part of Kielce and at Grzegorzowice

Lithological complexes (I–IX) in the section Grzegorzowice after M. Pajchlowa (1957)

Korelacja profilów z pogranicza dewonu dolnego i środkowego z NW części Kielc i Grzegorzowic

Kompleksy litologiczne (I–IX) profilu Grzegorzowic według M. Pajchlowej (1957)

The Upper Ludlow includes arbitrarily an insignificant part of the Silurian from western part of a northern limb of the Niewachlów Anticline that represents a top of the Niewachlów Beds (Fig. 6). These sediments contain no organic remains. Similar lithology and probably of the same age are sediments at the top of the Wydryszów Beds from the Łysogóry Region; they are also dated as the Upper Ludlow (E. Tomczykowa, 1988).

The Ludlow/Přidoli boundary is placed arbitrarily (due to absence of fossils) between the Niewachlów and Kielce Beds (Figs. 6, 10).

P ř i d o l i . In the lower part of the Kielce Beds no macrofossils have been noted. Not before their upper fragment, starting from about 250 m beneath a top, there is

locally abundant micro- and microfauna, noted most frequently in layers of fine-grained greywacke sandstones and rarely in claystones. Most numerous are brachiopods and ostracods, frequent crinoids, trilobites, corals and pelecypods. On the other hand rare graptolites occur in single layers only. Scolecodonts, *Chitinozoa* and *Acritarcha* also have been documented.

Amongst brachiopods that occur about 104 m below the Klonów Beds, the following were identified: *Atrypa* sp. (Pl. V, Figs. 7, 10), *Delthyris*? *elevata* (Dalman) (Pl. V, Fig. 3), *Lancemyonia* cf. *tarda* (Barrande) (Pl. V, Figs. 1, 2), *Leptostrophia* cf. *cuspidata* (Barrande) (Pl. V, Figs. 8, 9), *Protochonetes* sp. (Pl. V, Fig. 4), *Strophodonta*? sp. (Pl. V, Figs. 5, 6) and *Hebetoechia* sp.

Ostracods belong decidedly to the genus *Neobeyrichia* (Pl. IV, Figs. 4–9). Present are also large (to 1 cm long) specimens from the family Leperditiidae of the genus *Herrmannina*. Less numerous are pelecypods. Amongst trilobites there are: *Helokybe* cf. *spio* Thomas (Pl. VI, Fig. 4), *Balizoma* sp. (Pl. VI, Fig. 7) *Dalmanites nexilis* (Salter) (Pl. VI, Figs. 5, 6, 8, 9), *Richterarges kielcensis* Tomczykowa (Pl. VI, Figs. 1–3) and *Harpidella* sp.

Crinoids occur as dispersed fragments but frequently there are longer fragments of their stems. Preliminarily identified were: *Asperocrinus* sp. (Pl. IV, Fig. 3), *Formosocrinus* sp. (Pl. IV, Fig. 1) and *Mediocrinus* sp. (Pl. IV, Fig. 2). About 120 m below the Klonów Beds there are rich concentrations of tetracorals and more rarely, of tabulates *Favosites* sp. In the upper part of the Silurian sediments, at distance of about 65 m below a top of the Kielce Beds, dark gray claystones contain rare graptolites of the species *Monograptus transgrediens* Perner and brachiopods *Lingula* sp. (Fig. 5). Single non-identified fragments of graptolites were also noted in claystones, 104 m below a top of the Kielce Beds. Abundant pelecypods, tetracorals, brachiopods, ostracods and crinoids are noted in dark gray claystones whereas poorly limy greywacke sandstones — about 20 m below a bottom of the Klonów Beds.

Graptolites *Monograptus transgrediens* Perner, present at the top of the Kielce Beds, indicate age of this part of the Silurian — presumably the *transgrediens* Zone i.e. the uppermost graptolite biozone of the Silurian (J. Kriż et al., 1986; L. Teller, 1987; J. Kriż, 1989; R.B. Rickards, 1989). In correlation with the Łysogóry Region, the Kielce Beds correspond to the Rzepin Beds (Fig. 12). If referred to the Silurian of the East European Platform, they are synchronous with the upper part of the regional stage Podlasie whereas in a standard subdivision they belong to Přidoli.

DEVONIAN

LOWER DEVONIAN

G e d i n n i a n ? In northwestern part of Kielce the Gedinnian is probably represented by the Klonów Beds and the Miedziana Góra Conglomerates (Fig. 10). Cherry colour claystones and sandstones in the Niewachlów Anticline above claystones and greywackes of the Kielce Beds can be considered (in context of facies change in a sedimentary regime) as equivalents of bottom part of siltstones and sandstones of the Klonów Beds from the Łysogóry Region (Fig. 12). According to J. Czarnocki

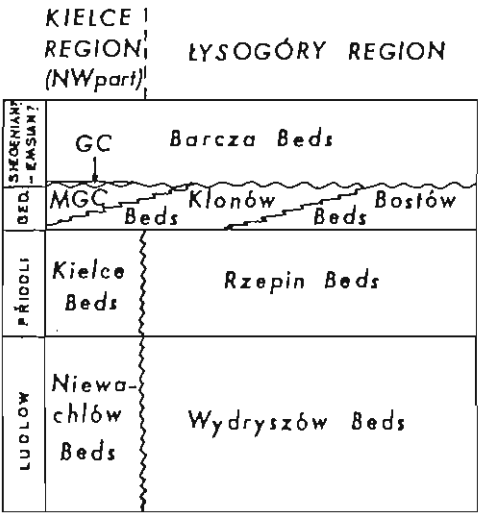

Fig. 12. Stratigraphical scheme of the Upper Silurian and Lower Devonian in the northwestern part of the Holy Cross Mts.

Explanations as in Figs. 8 and 9

Schemat stratygrafii górnego syluru i dolnego dewonu w NW części Gór Świętokrzyskich

Objaśnienia jak na fig. 8 i 9

(1936), P. Filonowicz (1965, 1969) and Z. Kowalczewski et al. (1989) these sediments are located in western part of the Łysogóry Region directly above the Rzepin Beds of the Upper Silurian. The Klonów Beds have been considered almost up to the present as terrigenous sediments of the Old Red facies (M. Pajchlowa, 1968; E. Tomczykowa, H. Tomczyk, 1981; E. Stupnicka, 1989). Recent studies indicate (J. Malec et al., 1990) that at least a considerable part of the Klonów Beds is represented by shallow-marine sediments. They constitute presumably a variant, equivalent of the Bostów Beds that represent a more deep-marine facies (Fig. 12).

Age of the Miedziana Góra Conglomerates has been arbitrarily defined within a broad stratigraphical interval from the Upper Ludlow (H. Tomczyk, 1968) through Gedinnian (J. Czarnocki, 1936; Z. Kotański, 1959; K. Pawłowska, 1961; M. Pajchlowa, 1962; P. Filonowicz, 1971, 1973; J. Malec, 1990; Z. Kowalczewski, Z. Migaszewski, *in press*) to the boundary of the Siegenian and the Emsian (Z. Kowalczewski, 1966, 1968, 1971*b*). Well exposed section of the Miedziana Góra Conglomerates in Kielce proves that the conglomerates, being a regressive sequence, overlie in a stratigraphical concordance the top of the Klonów Beds (Fig. 8). Until the present their age has not been more accurately precised and recent microspore examination of samples from these sediments, carried through by E. Turnau, gave negative results. Basing on biostratigraphy of sediments from top of underlying claystones and greywackes of the Kielce Beds, their age can be only approximately defined as the boundary between the Silurian and Devonian or as the Lower Gedinnian(?).

S i e g e n i a n ? – E m s i a n ? . Organic remains in the Conglomerates from Gruchawka are represented by ostracoderms and placoderms(?). Examination of the Devonian placoderms proved (L. B. H. Tarlo, 1964) that in the Gedinnian they are known from fluvial-deltaic environments only whereas in the Siegenian and Emsian — from marine ones. Transgressive character of the Conglomerates from Gruchawka and stratigraphical gap expressed by angular discordance between them and the Miedziana Góra Conglomerates of the Gedinnian? indicates their Siegenian? or the Emsian? age, most probably, however, near the boundary between these two stages.

Lithostratigraphical and structural equivalents of the Conglomerates from Gruchawka (previously identified with the Miedziana Góra Conglomerates) are known from many areas of a southern region in the Holy Cross Mts. (M. Tarnowska, 1988; Z. Kowalczewski, Z. Migaszewski, *in press*). They have erosive contact and usually great angular discordance with underlying rocks of the older Palcozoic, and are to 4 m thick (M. Tarnowska, 1987). They are formed of variable clastic material, a composition of which depends on lithological composition of a substrate. These features make them decidedly different from the older Miedziana Góra Conglomerates that are almost exclusively composed of quartzic sandstones of the Middle and Upper? Cambrian, coming from the Łysogóry Region; they occur in sedimentary continuity with the Klonów Beds (J. Malec, 1990).

Sediments above the Conglomerates from Gruchawka in the northwestern part of Kielce which are correlated with the Lower Devonian of the Łysogóry Region, correspond to a lower part of the Barcza Beds (Fig. 12). According to P. Filonowicz (1969) the Barcza Beds in the western Łysogóry Region occur with a sedimentary discordance (perhaps with a stratigraphical gap) above the Klonów Beds. Z. Kowalczewski et al. (1989) however speak for occurrence between the Klonów and the Barcza Beds of the sediments that could correspond to the Bostów Beds. In the Łysogóry Region a bottom of the Barcza Beds is dated as the boundary between the Siegenian and Emsian (H. Łobanowski, 1971, 1981). The oldest sediments of the Barcza Beds in the northern part of Kielce can be of similar age. Stratigraphical gap that exists between the Miedziana Góra Conglomerates and the Conglomerates from Gruchawka occurs most probably between the Lower Gedinnian? and the upper part of the Siegenian?

E m s i a n . No organic remains have been found in sediments of the Lower Devonian from a northern limb of the Niewachlów Syncline. Lithology of exposed terrigenous sediments, passing continuously into sediments of the Middle Devonian, enables their direct correlation with the Lower Devonian of a southern region in the Holy Cross Mts. The whole Lower Devonian sequence can be correlated with sediments of the siltstone-sandstone Beds from Winna, distinguished by M. Tarnowska (1983) in the upper part of the Lower Devonian in this area. The lower siltstone-sandstone fragment of the exposed section can be correlated with their lower part i.e. with the upper siltstone complex whereas sandstones in their top are equivalents of the upper part of the Beds from Winna, distinguished as the upper sandstone complex (M. Tarnowska, 1976). A thick bed of celadon-coloured siltstones at the top of siltstone-sandstone series can correspond to the tephra horizon T_4, noted by M. Tarnowska (1983) in the Upper Emsian of a southern region in the Holy Cross Mts.

MIDDLE DEVONIAN

E i f e l i a n . Sediments of the Middle Devonian — Lower Eifelian are represented in northern part of the Niewachlów Syncline by "ore-bearing" clays and by dolomites (Figs. 5, 10, 11).

A complex of "ore-bearing" clays in the Niewachlów Syncline contains agglutinated foraminifers, crinoids, scolecodonts and conodonts (J. Malec, 1988). Conodonts are represented by *Icriodus retrodepressus* Bultynck, *I. corniger corniger* Wittekindt and *I. corniger* cf. *leptus* Weddige. Foraminifers belong to the species *Webbinelloidea similis* Stewart et Lampe, in which three morphotypes (IB, IIB, IIIB) were identified in agreement with the scheme of J. E. Conkin and B. M. Conkin (1970). *Icriodus retrodepressus* Bultynck indicates the Lower Eifelian age of the "ore-bearing" clays, corresponding to a lower part of the conodont *partitus* Zone (K. Weddige, 1977, 1982; R. Feist et al., 1985).

In fossiliferous dolomites that directly overlie the "ore-bearing" clays, there are brachiopods, crinoids, tabulates and tetracorals. From a stratigraphical point of view the most significant fossils were found near the bottom of the clays. Noted brachiopods *Chimaerothyris dombrowiensis* (Gürich) are common in limestones and dolomites of the so-called "Dąbrowa Zone" of the Devonian in the Holy Cross Mts. (G. Gürich, 1896; J. Czarnocki, 1951; J. Samsonowicz, 1934; P. Filonowicz, 1973). Basing on vertical range of this taxon J. Studencka (1983) distinguished a biostratigraphical unit — the *Chimaerothyris dombrowiensis* Zone — of a local correlative significance. Conodont studies by the author prove (J. Malec, 1991*b*) that sediments with this species belong to the lowest Eifelian. If referred to the Devonian sediments of the Łysogóry Region in the Holy Cross Mts., they correspond in age to the complex VIII in the section Grzegorzowice (Fig. 11).

In overlying dolomites with bioturbation and dolomites without fauna no stratigraphically significant fossils have been found. Similar sediments in a southern region of the Holy Cross Mts. are generally included into the Lower Eifelian (J. Samsonowicz, 1934; M. Tarnowska et al., 1981; M. Narkiewicz, I. Olkowicz-Paprocka, 1983; A. Romanek, M. Rup, 1990).

CONCLUSIONS

Studies of the Silurian and Devonian sediments in northwestern part of Kielce provied new information on lithology, stratigraphy and tectonics of the rocks in this area. Results threw a new light on deposition and tectonics in the Upper Silurian and near the Silurian/Devonian boundary in a southern region of the Holy Cross Mts. and in Małopolska. General results and conclusions drawn from the carried studies can be presented as follows:

1. Beginning of deposition of the greywacke sediments of the Upper Silurian in the southern region of the Holy Cross Mts. (defined in this area as the Niewachlów Greywackes) and presumably in southern Małopolska was diachronous. According to the previous (J. Czarnocki, 1950; H. Tomczyk, 1954, 1968; Z. Kowalczewski, H.

Tomczyk, 1981) and present data from northwestern part of Kielce, the *nilssoni–leintwardinensis* Zones have been dominated by deposition of graptolite shales as well as greywackes. Not before the *leintwardinensis* Zone, a whole area of the Holy Cross Mts. was characterized by a deposition of greywacke sediments (H. Tomczyk, 1968; E. Tomczykowa, H. Tomczyk, 1981).

Greywacke deposition in a southern region of the Holy Cross Mts. has been previously ascribed to the *leintwardinensis–formosus* Zones (E. Tomczykowa, H. Tomczyk, 1981; E. Tomczykowa, 1988) or even to the *Bohemograptus bohemicus* Zone only (E. Stupnicka et al., 1991). Studies of greywacke sediments from the northwestern part of Kielce indicate that greywacke deposition in the southern region of the Holy Cross Mts. occurred most probably within *nilssoni–transgrediens* Zones.

2. Thickness of claystones and greywackes of the Kielce Beds in the Niewachlów Anticline is about 500 m. Total thickness of greywacke and clay sediments of the Upper Silurian, including the Niewachlów and the Kielce Beds in the northwestern part of Kielce, is about 1200–1300 m (J. Malec, 1991*a*, *in press*). Maximum thickness of greywacke sediments in a southern region of the Holy Cross Mts. seems to be several times greater than the recently presented values (A. Romanek, M. Rup, 1989; T. Przybyłowicz, E. Stupnicka, 1989, 1991).

3. Studies of greywacke and clay sediments from the Niewachlów Anticline indicate that up the section of the Upper Silurian in this area and presumably in remaining part of a southern region of the Holy Cross Mts., a number of greywacke intercalations and size of clastic material decreases whereas a content of pelitic fraction and of claystone layers is greater. Until recently there was a common opinion that upwards the Silurian section in the Kielce Region a participation of greywacke beds and mean grain size increase (A. Romanek, M. Rup, 1989).

4. Continuity of greywacke-claystone deposition in the Niewachlów and Kielce Beds in the northwestern part of Kielce indicates that the southern region of the Holy Cross Mts. probably has not been emerged during the Upper Silurian. A principal source area for greywacke sediments was located outside the Holy Cross Mts. and presumably, outside a southern part of Małopolska. One can only assume that it could comprise also a substrate of the Carpathians, Gemera Zone in Slovakia, Upper Silesian Massif or area to the west of the Holy Cross Mts. (K. Jaworowski, 1971; Z. Kowalczewski, 1979; J. Znosko, 1983; A. Romanek, M. Rup, 1989; W. Pożaryski, 1990). Recently an opinion has been presented that alimentary area for the Niewachlów Greywackes occurred in a southern region of the Holy Cross Mts. (T. Przybyłowicz, E. Stupnicka, 1989, 1991).

5. Continuous deposition of greywacke sediments of the Upper Silurian in a southern region of the Holy Cross Mts. (and undoubtedly in a whole area of Małopolska) lasted uninterruptedly from the *leintwardinensis* Zone (H. Tomczyk, 1968; E. Tomczykowa, H. Tomczyk, 1981) to the *transgrediens* Zone i.e. at the boundary between the Silurian and Devonian (J. Malec, 1989). Beginning of uplift did not occur before deposition of the Klonów Beds and the Miedziana Góra Conglomerates. According to J. Znosko (1970, 1988) the latter can be considered, together with greywacke sediments, as an older molasse. The area northwest of Kielce — in a region to the north and northeast of Miedziana Góra i.e. in northwestern part of the Łysogóry

Region, was uplifted during deposition of the Klonów Beds and Miedziana Góra Conglomerates (J. Malec, 1990).

6. Recent investigations by the author (J. Malec, 1990) indicate that during deposition of greywacke sediments of the Upper Silurian and the lowermost Devonian there were only two Late Caledonian orogenic phases, instead of three (Cracovian, Ardenian, Erian) as previously accepted (K. Łydka et al., 1963; H. Tomczyk, 1974; Z. Kowalczewski, 1974; E. Tomczykowa, H. Tomczyk, 1981; J. Znosko, 1983; E. Tomczykowa, 1988). The first one (Ardenian Phase) should be connected with the beginning of deposition of greywacke sediments whereas the second (Erian Phase) — with the end of marine deposition at the turn of the Silurian and Devonian as well as with uplift and folding (after deposition of the Klonów Beds, Miedziana Góra Conglomerates and Bostów Beds) of a southern region of the Holy Cross Mts. and of Małopolska. The Cracovian Phase would be a younger synonym of the Ardenian Phase only.

7. Lack of greywacke sediments of the uppermost Silurian, corresponding to claystones and greywackes of the Kielce Beds in the southern part of the Kielce Region and in Małopolska, can indicate intensity of uplift and folding at the boundary between the Silurian and Devonian and a deep erosional truncation of the area before deposition of sediments of upper part (Emsian) of the Lower Devonian (J. Malec, 1990). Equivalents of the Kielce Beds are present only in peripheral, less uplifted zones of the described area.

8. According to the previous opinions the Miedziana Góra Conglomerates were considered as regressive sediments lying on eroded surface of the Niewachlów Greywackes of the Upper Ludlow (J. Czarnocki, 1936; J. Samsonowicz, 1952; H. Tomczyk, 1968, 1974) or as transgressive sediments that overlie discordantly the folded graywackes of the Silurian — at base of the Devonian — in the Upper Gedinnian (Z. Kowalczewski, Z. Migaszewski, *in press*) or near the Siegenian/Emsian boundary (Z. Kowalczewski, 1968, 1971*b*).

Present studies indicate (J. Malec, 1990) that in the northwestern part of Kielce city the Miedziana Góra Conglomerates were deposited most probably as submarine fans in a declining Silurian basin with claystone-siltstone sediments. Present observations support a previous opinion (J. Czarnocki, 1936; Z. Kowalczewski, 1968) that source area of clastic material (quartzic sandstones of the Middle and Upper? Cambrian) of the Miedziana Góra Conglomerates was located in the Łysogóry Region. Source area for the Miedziana Góra Conglomerates in northwestern part of Kielce occurred most probably to the north or northeast from Miedziana Góra (J. Malec, 1990). It is indicated by preliminary measurements of transport directions of pebbles in the Miedziana Góra Conglomerates in northwestern part of Kielce and also, by increased size of clastic material in conglomerates towards Miedziana Góra.

Results of present studies indicate that the Miedziana Góra Conglomerates are structurally related to a spatial pattern of the Silurian instead of a Variscan pattern of the Devonian as considered previously (Z. Kowalczewski, 1968).

9. In the northwestern part of Kielce a structural discordance between the Miedziana Góra Conglomerates and the Conglomerates from Gruchawka is of angular type and at the same time it is a boundary between two orogenic cycles of the Paleozoic: Caledonian and Variscan. Further to the south of the outcrops of the Miedziana Góra

Conglomerates the Caledonian–Variscan structural discordance runs between equivalents of the Conglomerates from Gruchawka and stronger tilted rocks of the Early Paleozoic.

10. Recent studies proved that conglomerates at base of the Lower Devonian in the northwestern part of the southern region of the Holy Cross Mts. are bipartite (J. Malec, 1990, *in press*). Older — "regressive" conglomerates — that occur in sedimentary continuity with the Klonów Beds, are represented by the Miedziana Góra Conglomerates. On the other hand, younger — "transgressive" conglomerates are distinguished as a new lithostratigraphical unit of the Conglomerates from Gruchawka. In the northwestern part of the described area the Conglomerates from Gruchawka occur with a slight angular discordance and with a stratigraphical gap on eroded surface of the Miedziana Góra Conglomerates. In remaining part of the southern region these conglomerates overlie commonly with great angular discordance various rocks of the older Paleozoic age.

Translated by Leszek Marks

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Received: 8.12.1992

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Jan MALEC

GÓRNY SYLUR I NIŻSZY DEWON W ZACHODNIEJ CZĘŚCI GÓR ŚWIĘTOKRZYSKICH

Streszczenie

W NW części Kielc, w głębokich wykopach usytuowanych w obrębie antykliny i synkliny niewachlowskiej oraz synkliny miedzianogórskiej, odsłonięto skały górnego syluru oraz dolnego i środkowego dewonu (fig. 1–3).

Utwory górnego syluru, określane na badanym obszarze, a także w regionie południowym Gór Świętokrzyskich jako szaroglazy niewachlowskie, rozdzielono na dwie nowe jednostki litostratygraficzne: warstwy niewachlowskie, stanowiące dolną część sekwencji szarogłazowej, oraz warstwy kieleckie, występujące w jej górnej części. Warstwy niewachlowskie — z dużym udziałem piaskowców szarogłazowych — odpowiadają warstwom wydryszowskim, natomiast warstwy kieleckie — utworzone głównie z iłowców z nielicznymi wkładkami szarogłazów — warstwom rzepińskim z regionu łysogórskiego Gór Świętokrzyskich (fig. 12). Zespół graptolitów, obecny w dolnej części warstw niewachlowskich, datuje najstarsze utwory szarogłazowe w NW części Kielc co najmniej na poziom *scanicus*. W wyższej części warstw kieleckich występuje lokalnie liczna i urozmaicona taksonomicznie fauna. Graptolity *Monograptus transgrediens* Perner, obecne w stropowej części warstw kieleckich, datują te utwory na poziom *transgrediens* górnego syluru.

Miąższość utworów szarogłazowych górnego syluru w NW części Kielc wynosi ok. 1200–1300 m, w tym warstw niewachlowskich 700–800 m, a warstw kieleckich ok. 500 m.

W północnej części antykliny niewachlowskiej stwierdzono ciągłość sedymentacji między warstwami kieleckimi a leżącymi wyżej warstwami kłonowskimi i zlepieńcem miedzianogórskim (fig. 8). Na zerodowanej powierzchni zlepieńców miedzianogórskich, z luką stratygraficzną i dyskordancją kątową, leży warstwa zlepieńców, którą wyróżniono jako nową jednostkę litostratygraficzną — zlepieńce z Gruchawki (fig. 8, 10). Między zlepieńcem miedzianogórskim i zlepieńcem z Gruchawki przebiega granica oddzielająca kaledoński i waryscyjski kompleks strukturalny.

W synklinie niewachlowskiej udokumentowano wyższą część warstw z Winnej górnego emsu oraz dolnoeifelskie iły „rudonośne", dolomity z fauną, dolomity z bioturbacją i dolomity bez fauny.

Przeprowadzone badania oraz dotychczasowe dane wskazują, że sedymentacja utworów szarogłazowych górnego syluru w Górach Świętokrzyskich była diachroniczna i rozpoczęła się wcześniej (w poziomie *nilssoni* i *scanicus*) niż powszechnie przyjmowano (w poziomie *leinwardinensis*) i trwała nieprzerwanie do pogranicza syluru i dewonu. Ruchy wznoszące zaczęły się dopiero w momencie sedymentacji warstw klonowskich i zlepieńców miedzianogórskich, których materiał okruchowy pochodzi z NW części regionu łysogórskiego. Brak utworów szarogłazowych najwyższego syluru w południowej części regionu kieleckiego Gór Świętokrzyskich i na obszarze Małopolski wskazuje najprawdopodobniej na intensywność ruchów wznoszących i fałdowych z pogranicza syluru i dewonu oraz na głębokie ścięcie erozyjne tego obszaru przed sedymentacją utworów dolnego dewonu.

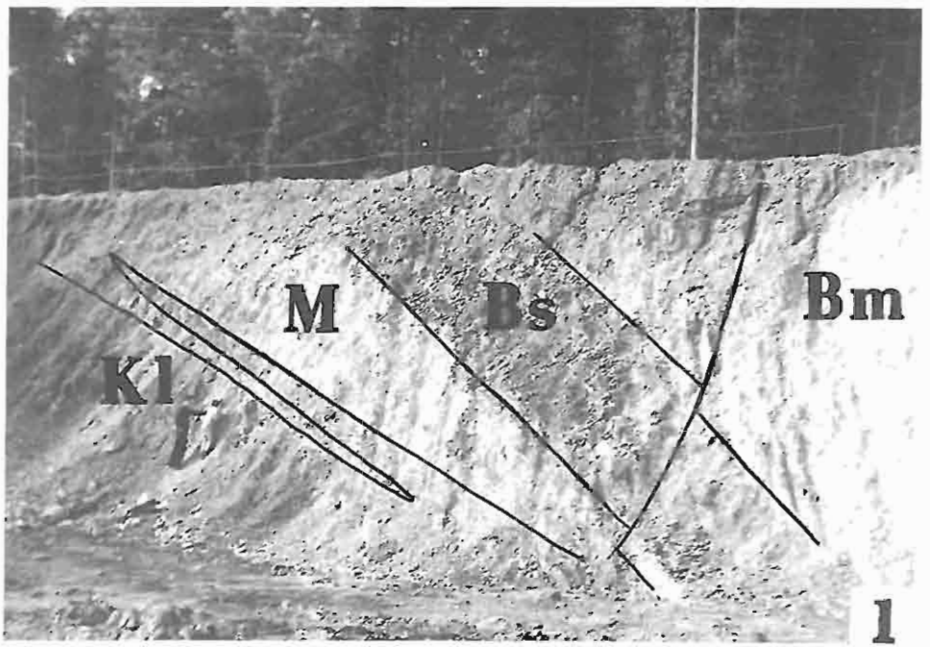
PLATE I

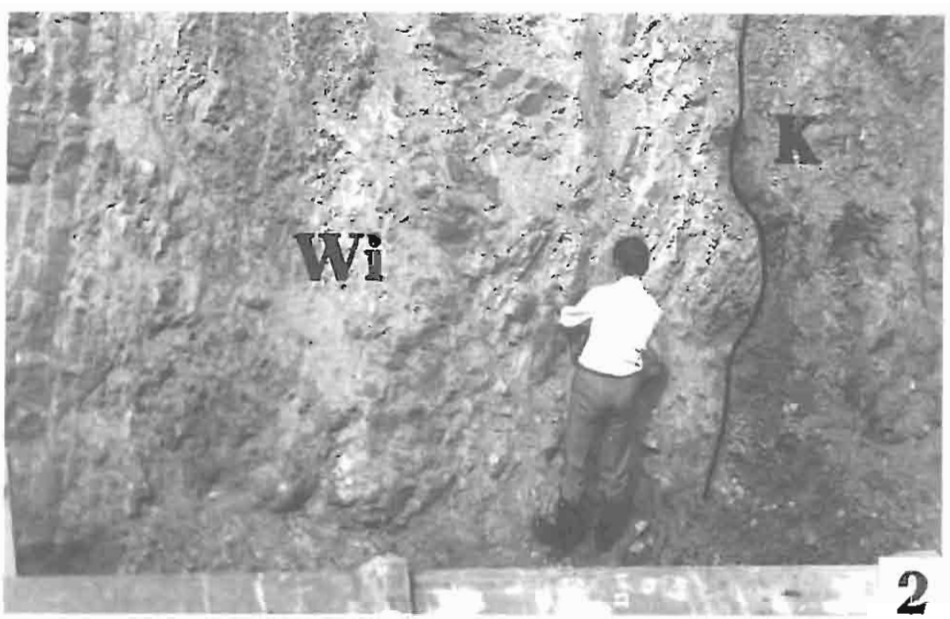
Fig. 1. Exposure of sediments near the boundary between the Niewachlów Anticline and the Miedziana Góra Syncline in the northwestern part of Kielce; Kl — Klonów Beds (Lower Devonian? — Gedinnian?); M — Miedziana Góra Conglomerates (Lower Devonian? — Gedinnian?); Barcza Beds (Lower Devonian — Siegenian? — Emsian?): Bs — sandstone complex, Bm — siltstone complex

Odsłonięcie utworów z pogranicza antykliny niewachlowskiej i synkliny miedzianogórskiej w NW części Kielc; Kl — warstwy klonowskie (dewon dolny? — żedyn?); M — zlepieńce miedzianogórskie (dewon dolny? — żedyn?); warstwy barczańskie (dewon dolny — zigen? — ems?): Bs — kompleks piaskowcowy, Bm — kompleks mułowcowy

Fig. 2. Exposure of sediments near the boundary between the Niewaehlów Syncline and Anticline in the north-western part of Kielce; K — Kielce Beds (Upper Silurian — Přidoli); Wi — Beds from Winna (Lower Devonian — Upper Emsian)

Odsłonięcie utworów z pogranicza synkliny i antykliny niewaehlowskiej w NW części Kielc; K — warstwy kieleckie (sylur górny — přidoli); Wi — warstwy z Winnej (dewon dolny — ems górny)



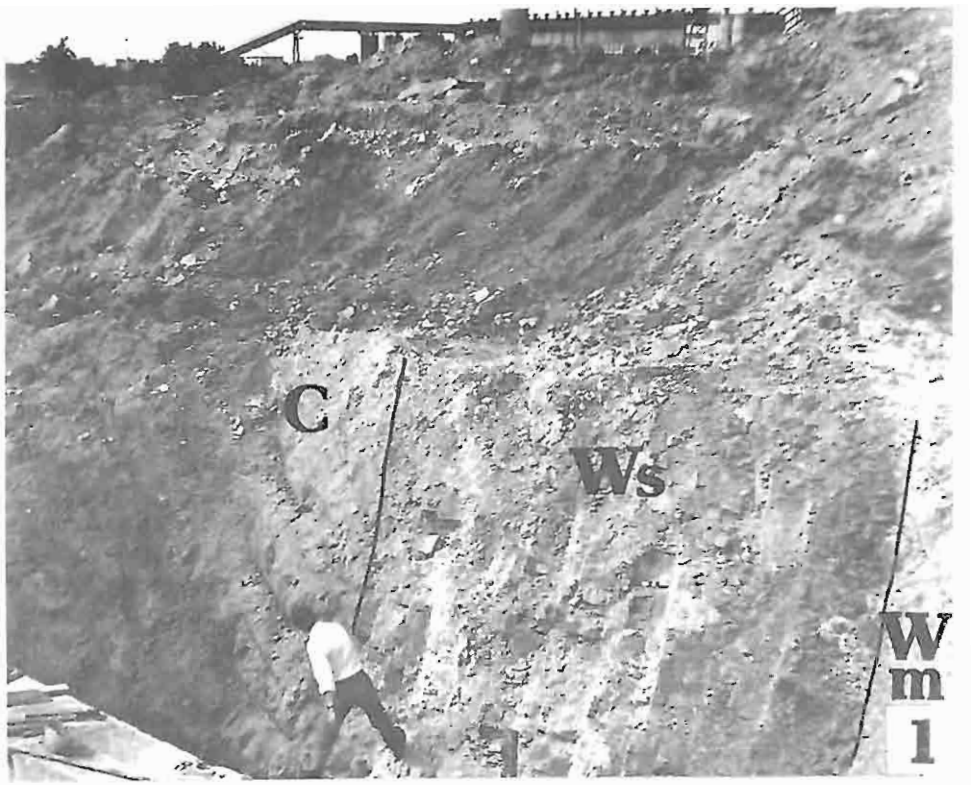


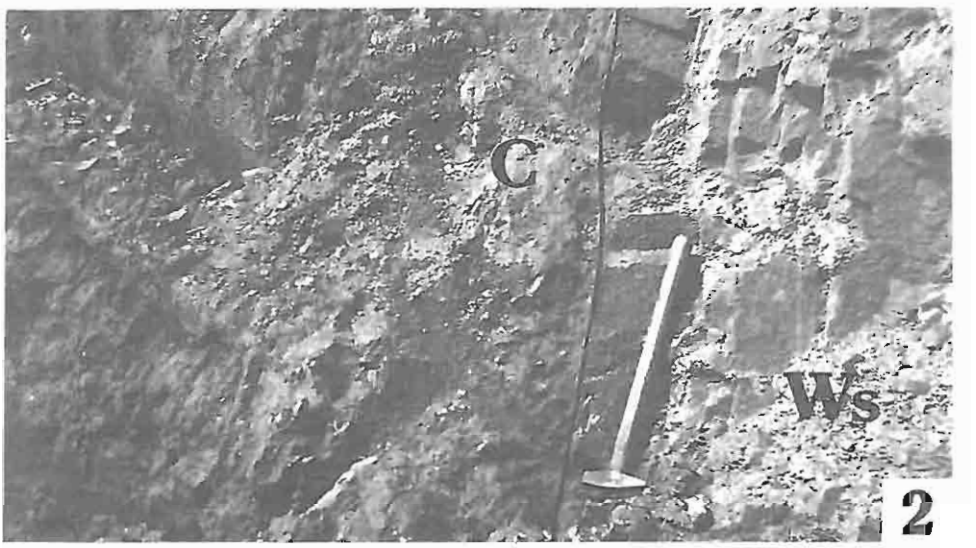
Jan MALEC — Upper Silurian and Lower Devonian in the western Holy Cross Mts.

PLATE II

Figs. 1, 2. Exposures of sediments near the boundary between the Lower and Middle Devonian in the northern wall of a deep trench in the Niewachlów Syncline; Beds from Winna (Lower Devonian — Upper Emsian): Wm — upper siltstone complex, Ws — upper sandstone complex; C — "ore-bearing" clays (Middle Devonian — Lower Eifelian)

Odsłonięcia utworów z pogranicza dewonu dolnego i środkowego w północnej ścianie głębokiego wykopu w obrębie synkliny niewachlowskiej; warstwy z Winnej (dewon dolny — ems górny): Wm — górny kompleks mułowcowy, Ws — górny kompleks piaskowcowy; C — iły „rudonośne" (dewon środkowy — eifel dolny)



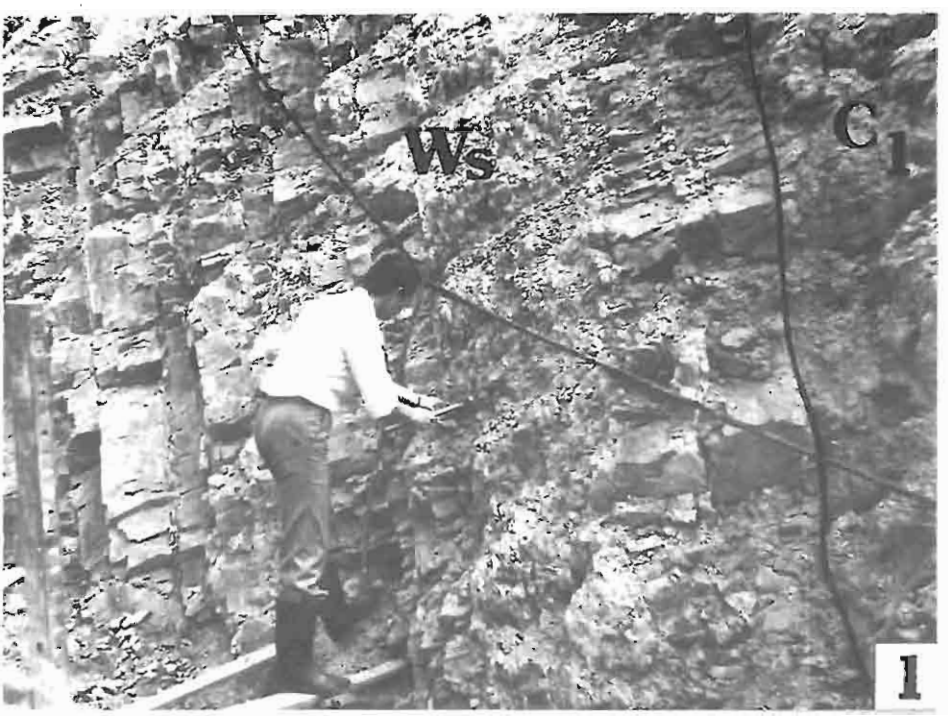


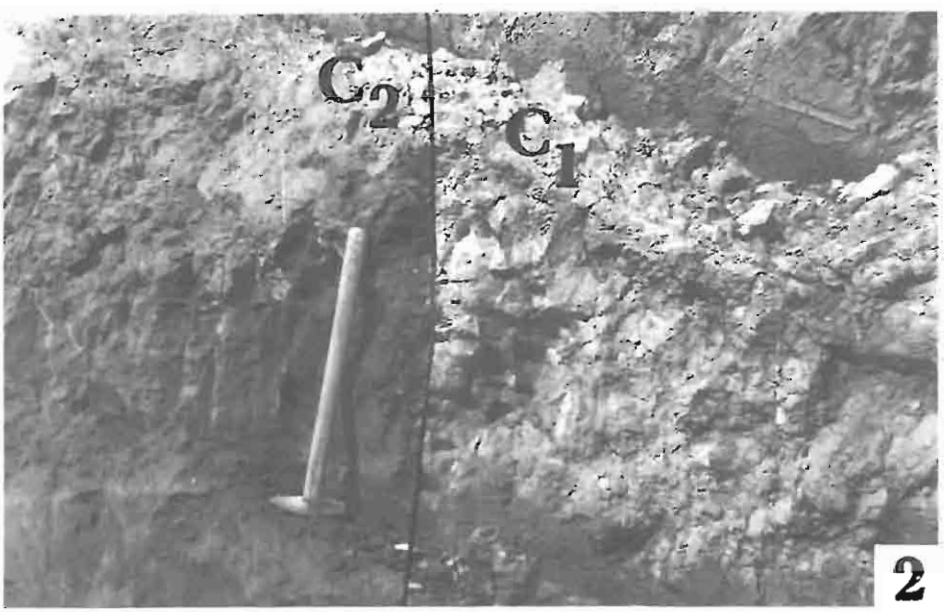
Jan MALEC — Upper Silurian and Lower Devonian in the western Holy Cross Mts.

PLATE III

Figs. 1, 2. Exposures of sediments near the boundary between the Lower and Middle Devonian in a deep trench in the Niewachlów Syncline (Fig. 1 — southern wall, Fig. 2 — northern wall); Ws — Beds from Winna, upper sandstone complex (Lower Devonian — Upper Emsian); "ore-bearing" clays (Middle Devonian — Lower Eifelian): C_1 — yellow clays, C_2 — brown clays

Odsłonięcia utworów z pogranicza dewonu dolnego i środkowego w głębokim wykopie w obrębie synkliny niewachłowskiej (fig. 1 — ściana południowa, fig. 2 — ściana północna); Ws — warstwy z Winnej, górny kompleks piaskowcowy (dewon dolny — ems górny); iły „rudonośne" (dewon środkowy — eifel dolny): C_1 — iły żółte, C_2 — iły brunatne





Jan MALEC — Upper Silurian and Lower Devonian in the western Holy Cross Mts.

PLATE IV

Fig. 1. *Formosocrinus* sp.
Fig. 2. *Mediocrinus* sp.
Fig. 3. *Asperocrinus* sp.,
Figs. 4–9. *Neobeyrichia* sp.

Figs. 1–3 — about 104 m below Miedziana Góra Conglomerates: Figs. 1, 3 — x 10, Fig. 2 — x 4; Figs. 4–9 — about 224 m below the Miedziana Góra Conglomerates, x 10

Fig. 1–3 — ok. 104 m poniżej zlepieńców miedzianogórskich: fig. 1–3 — 10 x, fig. 2 — 4 x; fig. 4–9 — ok. 224 m poniżej zlepieńców miedzianogórskich, 10 x

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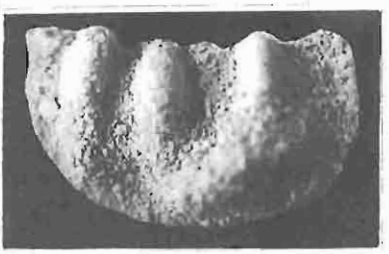

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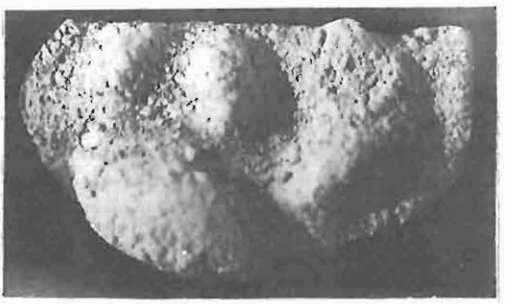

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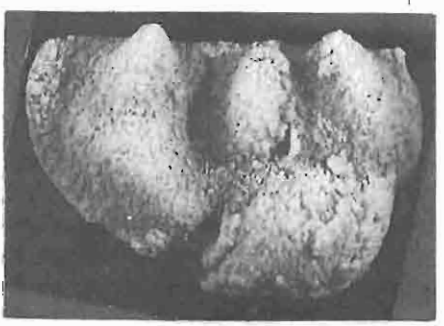

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Jan MALEC — Upper Silurian and Lower Devonian in the western Holy Cross Mts.

PLATE V

Figs. 1, 2. *Lancemyonia* cf. *tarda* (Barrande)
About 104 m below the Miedziana Góra Conglomerates; x 3
Ok. 104 m poniżej zlepieńców miedzianogórskich; 3 x
Fig. 3. *Delthyris*? *elevata* Dalman
About 224 m below the Miedziana Góra Conglomerates; x 3
Ok. 224 m poniżej zlepieńców miedzianogórskich; 3 x
Fig. 4. *Protochonetes* sp.
About 224 m below the Miedziana Góra Conglomerates; x 2
Ok. 224 m poniżej zlepieńców miedzianogórskich; 2 x
Figs. 5, 6. *Strophodonta*? sp.
About 224 m below the Miedziana Góra Conglomerates; x 2
Ok. 224 m poniżej zlepieńców miedzianogórskich; 2 x
Figs. 7, 10. *Atrypa* sp.
About 104 m below the Miedziana Góra Conglomerates; x 2
Ok. 104 m poniżej zlepieńców miedzianogórskich; 2 x
Figs. 8, 9. *Leptostrophia* cf. *cuspidata* (Barrande)
Fig. 8 — about 104 m below the Miedziana Góra Conglomerates, Fig. 9 — about 224 m below the Miedziana Góra Conglomerates; x 2
Fig. 8 — ok. 104 m poniżej zlepieńców miedzianogórskich, fig. 9 — ok. 224 m poniżej zlepieńców miedzianogórskich; 2 x

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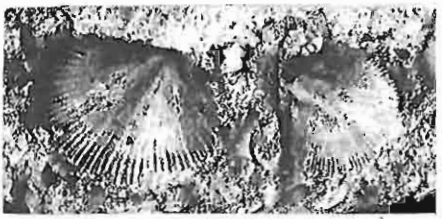

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Jan MALEC — Upper Silurian and Lower Devonian in the western Holy Cross Mts.

PLATE VI

Figs. 1–3. *Richterarges kielcensis* Tomczykowa
Fig. 4. *Helokybe* cf. *spio* Thomas
Figs. 5, 6, 8, 9. *Dalmanites nexilis* (Salter)
Fig. 7. *Balizoma* sp.

Figs. 1–4, 7 — about 104 m below the Miedziana Góra Conglomerates, x 4.5; Figs. 5, 6, 8, 9 — about 224 m below the Miedziana Góra Conglomerates, x 2; specimens of fauna presented in Plates IV–VI come from the Kielce Beds of the Upper Silurian — Přidoli

Fig. 1–4, 7 — ok. 104 m poniżej zlepieńcow miedzianogórskich, 4.5 x; fig. 5, 6, 8, 9 — ok. 224 m poniżej zlepieńców miedzianogórskich, 2 x; okazy zilustrowane na tabl. IV–VI pochodzą z warstw kieleckich górnego syluru — přidoli

1

2

3

4

5

6

7

8

9

Jan MALEC — Upper Silurian and Lower Devonian in the western Holy Cross Mts.