Geological Quarterly, Vol. 40, No. 1, 1996, p. 1–22

Jerzy ZNOSKO

Tectonic style of the Early Palaeozoic sequences in the Holy Cross Mountains

Thirty two localities (outcrops and boreholes) have been described and analyzed from the structural point of view. The evidence is given that the structural style of folds, imbrications and overthrusts is similar in the both Early Palaeozoic units: southern (Dyminy–Klimontów) and northern (Łysogóry). A new overthrust (Bronkowice–Zawichost–Biłgoraj) has been indicated in the north. Holy Cross Fault is a result of thrusting of the Łysogóry Range over the Devonian of the Kielce–Łagów Synclinorium in the syn-Variscan and syn-Alpine epochs.

INTRODUCTION

Holy Cross Mountains (HCM) are a relatively small group of Palaeozoic exposures, 90 km long and 30 km wide, uplifted in the earliest Tertiary from beneath the Permian-Mesozoic cover. Palaeozoic strata are rather poorly exposed there. The outcrops, though numerous, are predominantly small and dispersed, particularly in the Early Palaeozoic rocks. In the eastern part of the area which is covered by thick veneer of Quaternary loesses the exposures are limited to stream beds. In spite of these disadvantages, the geological knowledge of the HCM is essential for the geology of Poland and of the entire Middle Europe since the nearest exposures of deformed Palaeozoic rocks (Sudetes, Dobrogea) and of Palaeozoic cratonic cover (Bornholm, Scania, Podolia) are hundreds of kilometres away.

The HCM are usually divided, after J. Czarnocki (1936) into two units (Fig.1): Łysogóry Unit in the north and Kielce Unit in the south, separated by a regional fault called the Holy Cross Fault (HCF) or the Holy Cross Overthrust. It is connected with a deep fracture in the Moho discontinuity. North of this fracture the crustal thickness is about 50 –52 km, south of it — about 43–45 km (A. Guterch *et al.*, 1984).

The tectonics of the HCM were interpreted in various ways. Some researchers accentuated the fundamental role of the Cadomian (W. Pożaryski, H. Tomczyk, 1968) or Early

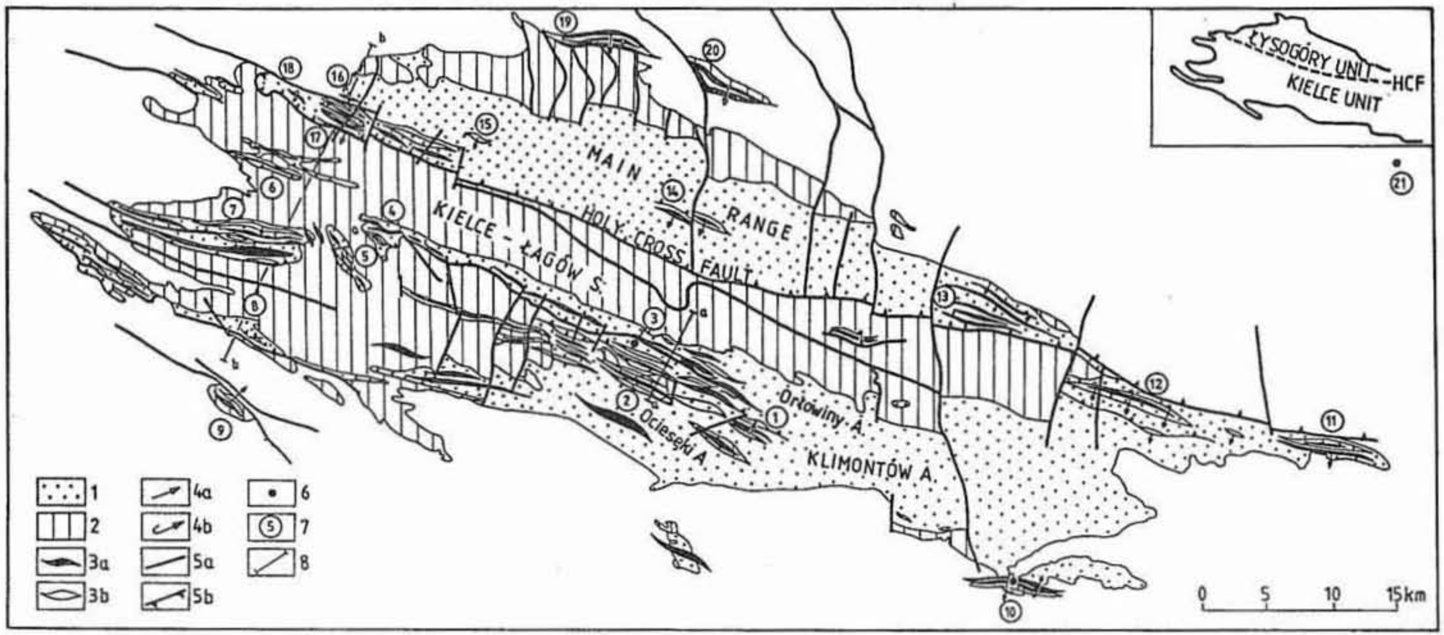


Fig. 1. Tectonic sketch of the Holy Cross Mts. with location of outcrops and boreholes described in the text

1 — Cambrian through Silurian, 2 — Devonian and Carboniferous, 3 — anticlines (a) and synclines (b), 4 — inclined (a) and overturned (b) folds, 5 — faults (a) and overthrusts (b), 6 — boreholes, 7 — number of structure described in the text, 8 — geological cross-sections in: Fig. 3 (a – a) and Fig. 5 (b – b)

Szkic tektoniczny Gór Świętokrzyskich z lokalizacją odsłonięć i otworów wiertniczych opisanych w tekście

1 — kambro-sylur, 2 — dewon i karbon, 3 — antykliny (a) i synkliny (b), 4 — fałdy pochylone (a) i obalone (b), 5 — uskoki (a) i nasunięcia (b), 6 — otwory wiertnicze, 7 — numer struktury opisanej w tekście, 8 — przekroje geologiczne na: fig. 3 (a – a) i fig. 5 (b – b)

Caledonian (W. Pożaryski, 1990) deformations while Variscan folding processes were preferred by others (e.g. W. Mizerski, 1979; E. Stupnicka, 1992). The present author has favoured since many years a major role of the Late Caledonian orogeny (e.g. J. Znosko, 1974, 1984).

Regional setting of the HCM area and some general tectonic considerations were presented recently (R. Dadlez *et al.*, 1994). Also some illustrations relevant to the present paper are included in the cited work. The following text is concentrated mainly on the fundamental evidence: the description and structural interpretation of the most important sites (outcrops and boreholes) with Early Palaeozoic sequences. The basis for this analysis were the old but excellent maps by J. Czarnocki (1938) and J. Samsonowicz (1934) as well as later papers by many authors, first of all by Z. Kowalczewski, H. Tomczyk and C. Żak (see references). More than twenty localities, shown on the map (Fig. 1), were selected from the greater number of investigated profiles.

LOWER PALAEOZOIC STRUCTURAL FEATURES

KIELCE UNIT

This unit is dominated in the eastern and central part by the Klimontów Anticlinorium built of Cambrian rocks and the Kielce–Łagów Synclinorium filled in with Devonian[1]. The former is divided by the Bardo Syncline with the Ordovician and Silurian rocks into two Cambrian anticlinorial units: the Orłowiny Anticlinorium in the north and the Ociesęki Anticlinorium in the south (Fig. 1). In the western part there occur again two anticlinorial units south of the Kielce–Łagów Synclinorium: the Dyminy Anticlinorium and the Brzeziny–Chęciny Anticlinorium. Their axes are shifted to the south relative, respectively, to the axes of the Orłowiny and Ociesęki Anticlinoria (Fig. 1).

Chojnów Dół (**1** — bold numbers refer to the numbers of sites in Fig. 1) is situated at the eastern pericline of the Bardo Syncline. Here, the bottom and the slopes of a narrow stream-valley were cleaned and investigated as early as in the thirties in connection with the exploration for mineralization in the Silurian diabases. A recumbent syncline built of the Lower Cambrian (with axial plane plunging northwestwards) and overlain by the Arenig commencing with basal conglomerate, is clearly visible (Fig. 2b). Ordovician and Silurian rocks with a diabase sill are also folded and thrust southwards over the Lower Cambrian fold. The structural pattern in the valley bottom suggests the existence of vertical, or at least reclined fold (Fig. 2a).

Similar structural relations are noted in the section across the middle part of the **Bardo** Syncline (**2**), with an angular unconformity between the Lower Cambrian and Arenig as well as between the entire folded Cambro-Silurian and the transgressive Lower and Middle Devonian (Fig. 3).

---

[1] The terms: "anticlinorium" and "synclinorium" are used here in a general but not hierarchical sense. They are also used in the geological literature and, particularly, on the tectonic maps for structures of higher order, e.g. Holy Cross Anticlinorium, Carpathian Anticlinorium, Alpine Anticlinorium.

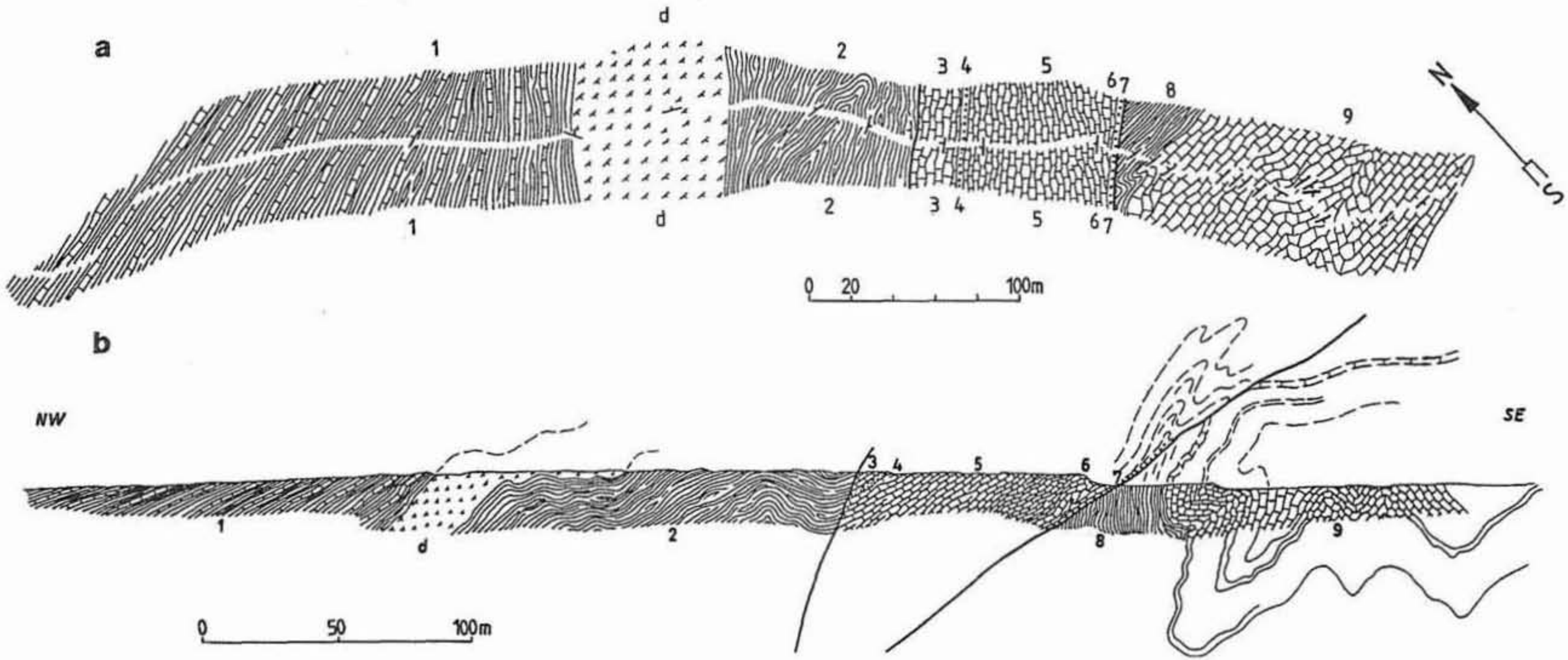


Fig. 2. Chojnów Dół ravine: a — geological plan of the bottom (after J. Czarnocki, 1939, slightly simplified), b — cross-section (after J. Czarnocki, 1939; tectonic interpretation by J. Znosko in 1978)

Upper Silurian: 1 — shales and greywackes — Upper Ludlow, 2 — graptolithic shales — Lower Ludlow; Lower Ordovician: 3 — dolomites, 4 — conglomerates, 5 — sandstones, 6 — chalcedonitic beds, 7 — basal conglomerate; upper part of Lower Cambrian: 8 — greywackes and shales, 9 — sandstones; d — diabases; bold lines — faults

Wąwóz Chojnów Dół: a — plan geologiczny dna (według J. Czarnockiego, 1939, nieco uproszczony), b — przekrój geologiczny (według J. Czarnockiego, 1939; interpretacja tektoniczna J. Znoski z 1978 r.)

Sylur górny: 1— łupki i szarogłazy — ludlow górny, 2 — łupki graptolitowe — ludlow dolny; ordowik dolny: 3 — dolomity, 4 — zlepieńce, 5 — piaskowce, 6 — warstwy chalcedonowe, 7 — zlepieniec podstawowy; kambr dolny część górna: 8 — łupki i szarogłazy, 9 — piaskowce; d — diabazy; linie grube — uskoki

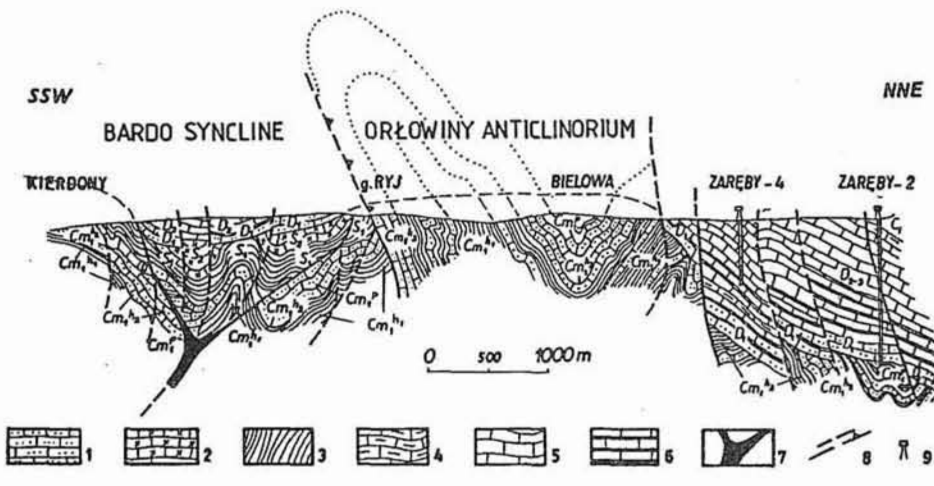


Fig. 3. Geological section across the Bardo Syncline, the Orłowiny Anticlinorium and southern part of the Kielce–Łagów Synclinorium (after Z. Kowalczewski *in*: Z. Kowalczewski, R. Lisik, 1974)

1 — sandstones and siltstones, 2 — greywackes and greywacke siltstones, 3 — claystones, 4 — marls and marly limestones, 5 — limestones, 6 — dolomites with clayey inserts in places, 7 — diabases, 8 — faults and overthrusts (ascertained and supposed), 9 — boreholes; Cm_1 — Lower Cambrian: Lower Holmia Beds (h_1), Upper Holmia Beds (h_2), Protolenus Beds (p); O — Ordovician; S_1 — Lower Silurian; S_2 — Upper Silurian; D_1 — Lower Devonian; D_{2-3} — Middle and Upper Devonian; C_1 — Lower Carboniferous

Przekrój geologiczny przez synklinę bardzką, antyklinorium orłowińskie i południową część synklinorium kielecko-łagowskiego (według Z. Kowalczewskiego w: Z. Kowalczewski, R. Lisik, 1974)

1 — piaskowce i mułowce, 2 — szarogłazy i mułowce szarogłazowe, 3 — iłowce, 4 — margle i wapienie margliste, 5 — wapienie, 6 — dolomity miejscami z wkładkami ilastymi, 7 — diabazy, 8 — uskoki i nasunięcia (pewne i przypuszczalne), 9 — otwory wiertnicze; Cm_1 — kambr dolny: warstwy holmiowe dolne (h_1), warstwy holmiowe górne (h_2), warstwy protolenusowe (p); O — ordowik; S_1— sylur dolny; S_2 — sylur górny; D_1 — dewon dolny; D_{2-3} — dewon środkowy i górny; C_1 — karbon dolny

In the northern limb of the Bardo Syncline the borehole at **Prągowiec** (**3**) revealed the Emsian, unconformably and transgressively overlying the almost vertically dipping Upper Silurian shales and greywackes (see fig. 3a in: R. Dadlez *et al.*, 1994). This borehole pierced also a diabase dike approximately concordant with Silurian strata.

In **Niestachów** and **Mójcza** (**4** and **5**), at the western pericline of the Orłowiny Anticlinorium (Fig. 4), the analysis of detailed maps, and of strike and dip values in outcrops reveal a very complicated picture of tight, bifurcating Cambro-Silurian folds which are unconformably overlain by isolated patches of the Emsian and are in fault contact with the surrounding Devonian. The Mójcza fold has been probably rotated clockwise around the vertical axis.

At the western periphery of the Kielce–Łagów Synclinorium a very complicated, bifurcated anticline of **Niewachlów–Szydłówek** (**6**) appears from beneath the Devonian strata (Fig. 4). It is built of flysch-like Upper Silurian greywackes. A syncline separating its both segments is filled in with the Emsian through Frasnian rocks. Structural style of this fold reveals much similarity to that of the Dyminy fold (see below), though its both segments did not come to direct contact as in that case.

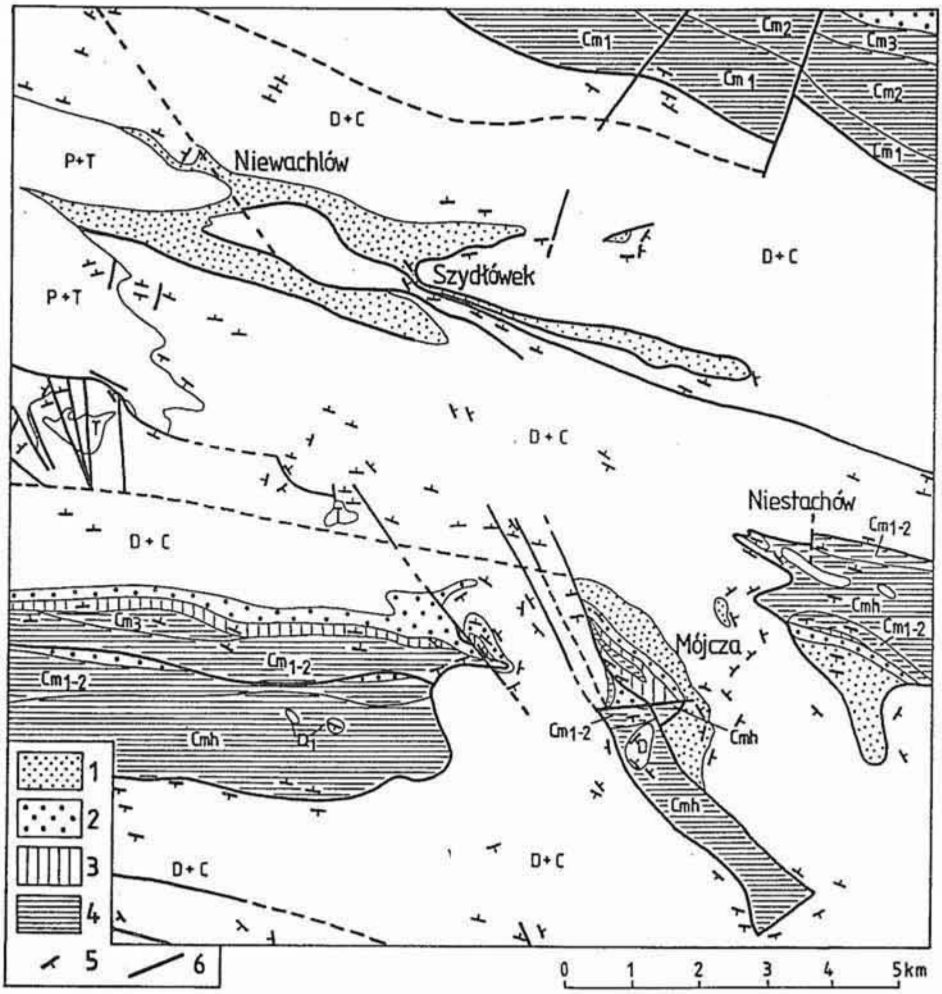


Fig. 4. Geological sketch of the western part of the Holy Cross Mts. (after J. Czarnocki, 1938)

1 — Upper Silurian, 2 — Lower Silurian, 3 — Ordovician, 4 — Cambrian, 5 — strike and dip of beds, 6 — faults; Cmh — Holmia Cambrian, Cm_1 — Lower Cambrian, Cm_2 — Middle Cambrian, Cm_3 — Upper Cambrian, D — Devonian, D_1 — Lower Devonian, C — Carboniferous, P — Permian, T — Triassic

Szkic geologiczny zachodniej części Gór Świętokrzyskich (według J. Czarnockiego, 1938)

1 — sylur górny, 2 — sylur dolny, 3 — ordowik, 4 — kambr, 5 — biegi i upady warstw, 6 — uskoki; Cmh — kambr holmiowy, Cm_1 — kambr dolny, Cm_2 — kambr środkowy, Cm_3 — kambr górny, D — dewon, D_1 — dewon dolny, C — karbon, P — perm, T — trias

The **Dyminy** fold (7) is distinctive by: angular unconformities between the Ordovician and Cambrian; at places a discordant structural relation of the Silurian to Ordovician and Cambrian; pre-Emsian very strong folding of the Cambro-Silurian leading to slicing and

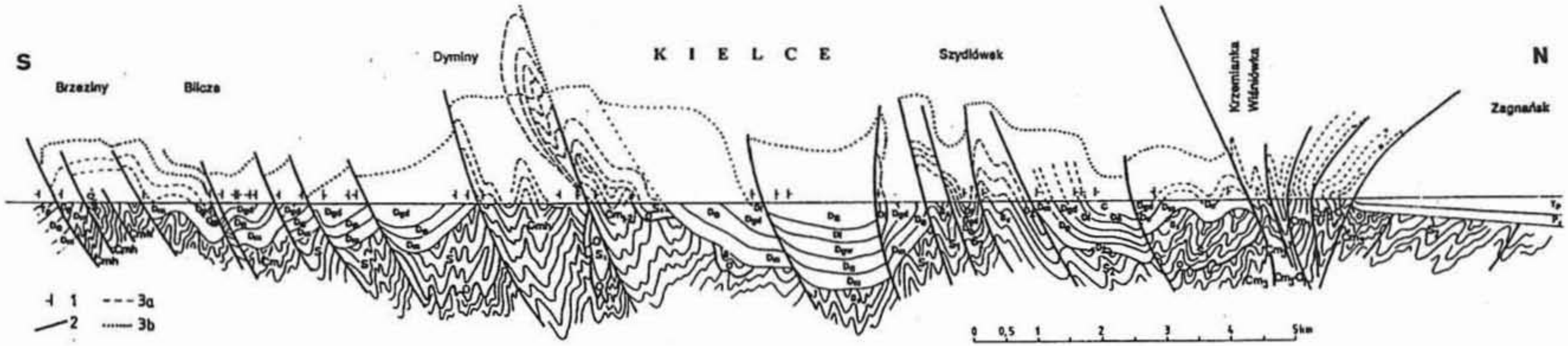


Fig. 5. Cross-section of the Holy Cross Mts. between Brzeziny and Zagnańsk (after the map by J. Czarnocki, 1938)

1 — dips, 2 — faults, overthrusts, 3 — aerial interpretation: a — of Cambro-Silurian structures, b — of Devonian box-fold structures; T_p — Lower Triassic, P_2 — Zechstein, C — Carboniferous, D_a — Famennian, D_f — Frasnian, D_{gw} — Givetian (limestones), D_{gd} — Givetian (dolomites), D_e — Eifelian, D_m — Emsian, $D_ż$ — Gedinnian, S — Silurian, S_2 — Upper Silurian (greywackes), S_1 — Lower Silurian (graptolithic shales), O — Ordovician, O_1 — Lower Ordovician, Cm — Cambrian, Cm_3 — Upper Cambrian, Cm_2 — Middle Cambrian, Cm_1 — Lower Cambrian, Cmh — Holmia-Cambrian

Przekrój geologiczny przez Góry Świętokrzyskie między Brzezinami a Zagnańskiem (według mapy J. Czarnockiego, 1938)

1 — upad warstw, 2 — uskoki i nasunięcia, 3 — interpretacja powietrzna: a — struktur kambro-sylurskich, b — struktur skrzynkowych dewońskich; T_p — trias dolny, P_2 — cechsztyn, C — karbon, D_a — famen, D_f — fran, D_{gw} — żywet (wapienie), D_{gd} — żywet (dolomity), D_e — eifel, D_m — ems, $D_ż$ — żedyn, S — sylur, S_2 — sylur górny (szarogłazy), S_1 — sylur dolny (łupki graptolitowe), O — ordowik, O_1 — ordowik dolny, Cm — kambr, Cm_3 — kambr górny, Cm_2 — kambr środkowy, Cm_1 — kambr dolny, Cmh — kambr holmiowy

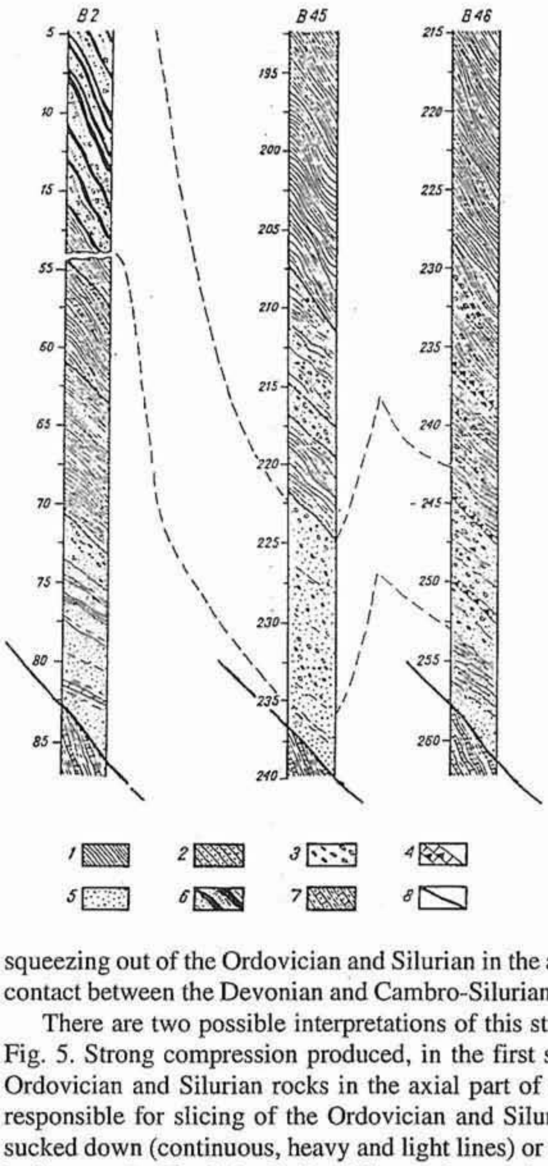


Fig. 6. Fragments of borehole profiles from Brzeziny (after H. Tomczyk and M. Turnau-Morawska, 1964; tectonic interpretation by J. Znosko in 1994)

Ordovician: 1 — shales with graptolites, 2 — siltstones with glauconite, 3 — chamosite, 4 — sideritic limestones, 5 — glauconitic sandstones, 6 — hematite; Lower Cambrian: 7 — claystones and siltstones with quartzitic interlayers; 8 — thrust fault

Fragmenty profilów otworów wiertniczych z Brzezin (według H. Tomczyka i M. Turnau-Morawskiej, 1964; interpretacja tektoniczna J. Znoski z 1994 r.)

Ordowik: 1 — iłowce z graptolitami, 2 — mułowce z glaukonitem, 3 — szamozyt, 4 — wapienie syderytowe, 5 — piaskowce glaukonitowe, 6 — hematyt; kambr dolny: 7 — iłowce i mułowce z wkładkami kwarcytów; 8 — nasunięcie

squeezing out of the Ordovician and Silurian in the axial part of the fold; finally, by a fault contact between the Devonian and Cambro-Silurian in the south and east (Fig. 5).

There are two possible interpretations of this structure, both versions being shown in Fig. 5. Strong compression produced, in the first stage of evolution, a syncline built of Ordovician and Silurian rocks in the axial part of the fold. Continued compression was responsible for slicing of the Ordovician and Silurian which, subsequently, were either sucked down (continuous, heavy and light lines) or extruded into the air (dashed lines). In both cases the Cambrian beds of the northern and southern anticlines must have come to direct contact. Angular unconformity below the Devonian and differences of structural style between the Devonian and Cambro-Silurian are again noticeable in this cross-section.

The Ordovician slice of **Brzeziny (8)** was described by H. Tomczyk (H. Tomczyk, M. Turnau-Morawska, 1964). Structural interpretation indicates a tectonic style similar to that in the Dyminy fold (Fig. 6). The dips of beds — steep to vertical in the upper part and more gentle in the lower part — imply slicing of the Ordovician and its thrusting over the Cambrian. In the Brzeziny fold there is also a fault contact between the Emsian or Eifelian (or, possibly, Givetian) and the Cambro-Silurian core in the north as well in the south of the fold.

The **Zbrza** Anticline (**9**) is situated beyond the main Palaeozoic core of the HCM. It is the southernmost exposure of the Palaeozoic emerging from beneath the Mesozoic cover. It is fairly well known from the studies by Z. Deczkowski and H. Tomczyk (1969*a*). Structural reinterpretation (Fig. 7) shows that the steeply inclined Lower Cambrian rocks are unconformably overlain by the reduced Ordovician and Silurian sequences with numerous slickensides as well as depositional and structural discontinuities. These formations in turn build an imbricated anticline/syncline couple. The entire Lower Palaeozoic is thrust northwards over the Oxfordian which resulted from the Early Tertiary horst-like uplift of the HCF block as a whole. In this area the difference between the more brittle, cratonic type of deformations of the Devonian and Oxfordian, and the more ductile (plastic) style of the Lower Palaeozoic is particularly clearly recognisable.

The structural arrangement of the Lower Cambrian rocks is known also from the **Bazów** borehole (**10**). A relatively good stratigraphic record reveals the existence of several faulted and imbricated folds, overlying each other, the entire stack being of probably northern vergence (Fig. 8). At least three hinges of overturned or even recumbent major folds were observed in this sequence, and the reversed stratigraphic order of strata was noted in several places. The intensity of tectonic deformations is identical with that in Dyminy, Zbrza and Brzeziny Anticlines.

The Cambrian in **Góry Pieprzowe** (**11**), at the eastern end of the HCM was studied in detail by C. Żak (1962). Apart from identification of several well pronounced imbricated folds, some very significant mesostructures were recorded, among them the boudinage in quartzite interbeds and drag folds at places (see figs. 4–12 in: C. Żak, 1962). Observed dips vary from 10–35° (rarely) to 40–90° (most frequently). C. Żak suggested a probable succession of two stages of tectonic development: an older one with stresses from the north and a younger one with stresses from the opposite direction. This sequence of events led to a very complicated structural pattern.

The **Międzygórze** Syncline (**12**), built of the Ordovician and Silurian is a recumbent syncline (Fig. 9), thrusted northwards over the Cambrian. In the northern borderland of the Międzygórze Syncline the Cambro-Silurian strata are in turn thrusted southwards over the Kielce–Łagów Synclinorium along the HCF.

ŁYSOGÓRY UNIT

The major structural element in this unit is the Łysogóry Main Range bounded from the south by the HCF. The range is built of the erosion resistant Cambrian sandstones, mainly quartzitic, which results in the maximum elevation of the hills, exceeding 600 m a.s.l. A depression filled in with Ordovician and Silurian rocks (mainly shales) adjoins the Main Range from the north.

At the eastern end of the Main Range an extremely complicated structural pattern was revealed in the **Opatów** area (**13**). Structural data indicate that in a 1–4 km wide zone at least seven folds occur built of very markedly compressed and partly imbricated Cambro-Silurian rocks (see fig. 4b and c in: R. Dadlez *et al.*, 1994). The folds are variable: upright, inclined, or even overturned (which is indicated by the reverse position of hieroglyphs),

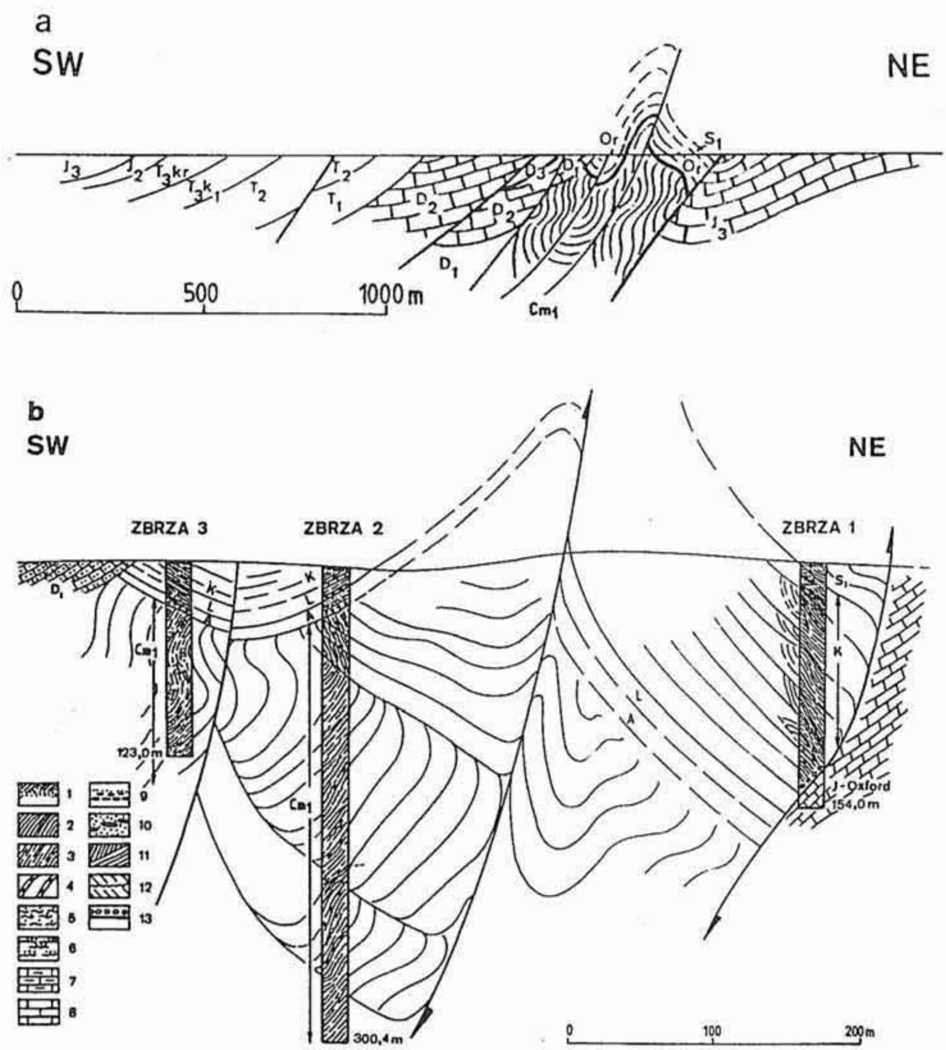


Fig. 7. Geological sections across the Zbrza Anticline: a — general, b — detailed with borehole columns (after Z. Deczkowski, H. Tomczyk, 1969*a*; tectonic interpretation by J. Znosko in 1994)

1 — Quaternary clays, loams, sands and gravels, 2 — shales with graptolites, 3 — dark grey claystones with graptolites (Caradoc) or grey-greenish claystones, strongly fractured (Cambrian), 4 — intercalations of dolomitic and sideritic limestones, 5 — sandy siltstones, locally calcareous, 6 — grey-greenish siltstones, with convolute bedding, 7 — calcareous claystones, locally marly, with abundant trilobites, 8 — limestones, 9 — conglomerates, 10 — glauconitic sandstones with intercalations of chalcedonite, 11 — tectonic disconformities, mainly overthrusts, 12 — transgressive and erosional unconformity, 13 — tectonic breccia; J_3 — Upper Jurassic; J_2 — Middle Jurassic; T_3kr — Upper Keuper; T_3k_1 — Lower Keuper; T_2 — Muschelkalk; T_1 — Buntsandstein; D_3 — Upper Devonian; D_2 — Middle Devonian; D_1 — Lower Devonian; S_1 — Lower Silurian; O_r — Ordovician: A — Arenig, L — Llandeilo, K — Caradoc; Cm_1 — Lower Cambrian

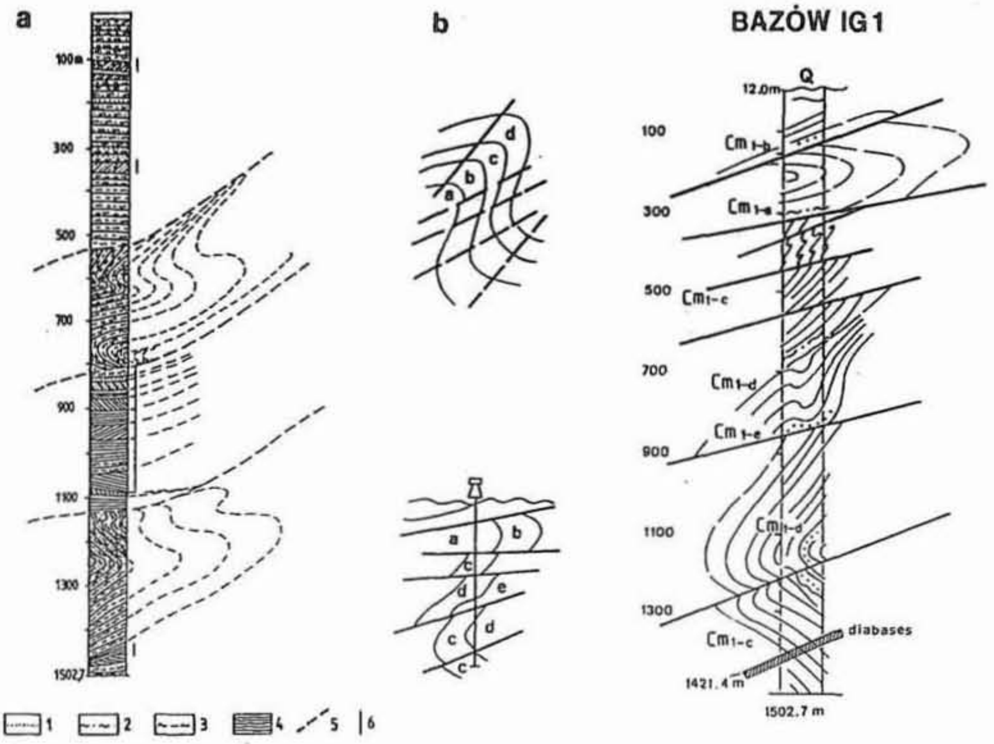


Fig. 8. Simplified columns of the Cambrian in the Bazów IG 1 borehole: a — compiled by H. Żakowa in: K. Lendzion *et al.* (1982); tectonic interpretation by J. Znosko in 1993; b — after Z. Kowalczewski (1993)

1 — quartz sandstones, 2 — sandy-silty rocks, 3 — silty-clayey, laminated rocks, 4 — laminated claystones, 5 — tectonic shear zones inferred from strong fracturing, brecciation and slickensides, 6 — thrust slices; Q — Quaternary; Cm_1 — a–e — Lower Cambrian, Holmia stage, lithologic units arranged stratigraphically (a–e) in ascending order

Uproszczone profile kambru w otworze wiertniczym Bazów IG 1: a — zestawiony przez H. Żakową w: K. Lendzion i in. (1982); interpretacja tektoniczna J. Znoski z 1993 r.; b — według Z. Kowalczewskiego (1993)

1 — piaskowce kwarcowe, 2 — skały piaszczysto-mułowcowe, 3 — skały mułowcowo-ilaste, laminowane, 4 — iłowce laminowane, 5 — tektoniczne strefy ścięć na podstawie silnego spękania, zbrekcjowania i ślizgów, 6 — łuski nasunięciowe; Q — czwartorzęd; Cm_1 — a–e — kambr dolny piętro holmiowe, kompleksy litologiczne uporządkowane stratygraficznie (a–e) w porządku wstępującym

---

Przekroje geologiczne przez antyklinę Zbrzy: a — ogólny, b — szczegółowy z profilami otworów wiertniczych (według Z. Deczkowskiego i H. Tomczyka, 1969*a*; interpretacja tektoniczna J. Znoski z 1994 r.)

1 — iły, gliny, piaski i żwiry czwartorzędowe, 2 — łupki ilaste z graptolitami, 3 — iłowce ciemnoszare z graptolitami (karadok) lub szarozielonawe silnie spękane (kambr), 4 — wkładki wapieni dolomitycznych i syderytycznych, 5 — mułowce piaszczyste lokalnie wapniste, 6 — mułowce szarozielonawe, laminowane konwolutnie, 7 — iłowce wapniste, lokalnie margliste z licznymi trylobitami, 8 — wapienie, 9 — zlepieńce, 10 — piaskowce glaukonitowe z wkładkami chalcedonitu, 11 — niezgodności tektoniczne (głównie nasunięcia), 12 — niezgodność transgresywna i erozyjna, 13 — brekcja tektoniczna; J_3 — jura górna; J_2 — jura środkowa; T_3kr — kajper górny; T_3k_1 — kajper dolny; T_2 — wapień muszlowy; T_1 — pstry piaskowiec; D_3 — dewon górny; D_2 — dewon środkowy; D_1 — dewon dolny; S_1 — sylur dolny; Or — ordowik: A — arenig, L — landeil, K — karadok; Cm_1 — kambr dolny

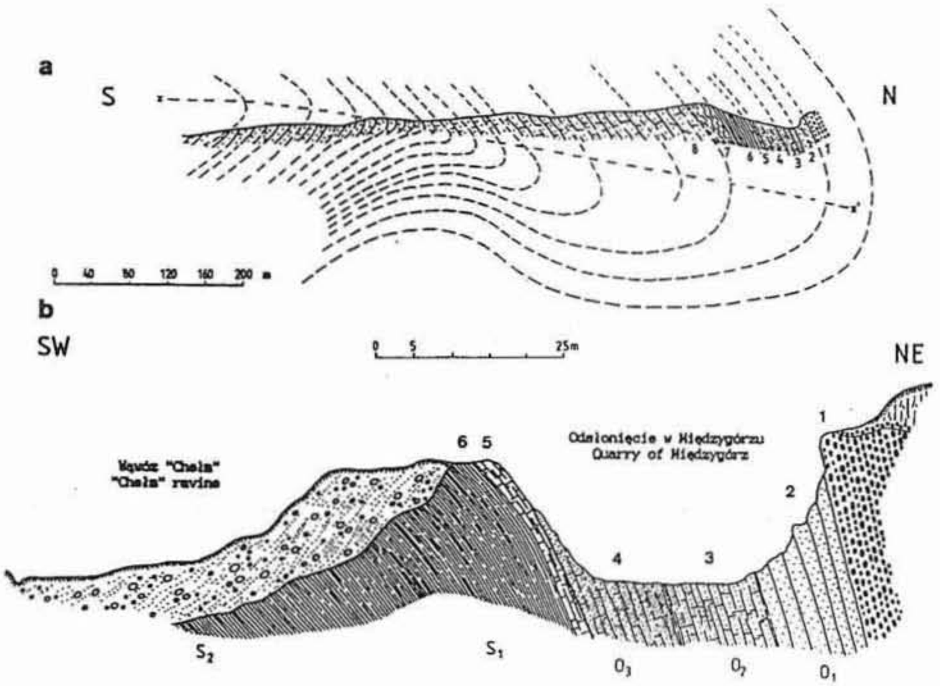


Fig. 9. Geological sections across the Międzygórz Syncline: a — general (after H. Tomczyk, 1954; tectonic interpretation completed by J. Znosko in 1993), b — detailed section of the Międzygórz quarry and Chełm ravine (after H. Tomczyk, 1954)

Ordovician: 1 — conglomerates, 2 — quartzitic sandstones, 3 — glauconitic sandstones, 4 — sandstones with Orthidae, 5 — limestones and marls; Silurian: 6–7 — shales, 8 — greywackes; x – x' — axis of Międzygórz Syncline

Przekroje geologiczne przez synklinę międzygórską: a — ogólny (według H. Tomczyka, 1954; interpretacja tektoniczna uzupełniona przez J. Znoskę w 1993 r.), b — przekrój szczegółowy przez kamieniołom Międzygórz i wąwóz Chełm (według H. Tomczyka, 1954)

Ordowik: 1 — zlepieńce, 2 — piaskowce kwarcytowe, 3 — piaskowce glaukonitowe, 4 — piaskowce ortidowe, 5 — wapienie i margle; sylur: 6–7 — łupki ilaste, 8 — szarogłazy; x – x' — oś synkliny międzygórskiej

with dominant southern vergence towards the HCF. Fan-like pattern is locally expressed by slicing and thrust surfaces which are inclined both to the south and to the north.

In **Wólka (14)** the Middle Cambrian strata in the southern segment of cross-section (Fig. 10) are intensely folded, folds being inclined to the south-west. They are composed of shales with thin quartzitic interlayers, partly with distinct boudinage. Cambrian is overthrust by black Ashgill shales, also strongly folded, containing — especially in the neighbourhood of thrust surfaces — the mesostructures resembling the crenulation in metamorphic rocks. The great stratigraphic gap (Upper Cambrian through Caradoc) at the thrust contact must be a result of significant tectonic shortening and squeezing out of the lacking strata which are known elsewhere in the Łysogóry Unit in full development. In the northern part of cross-section an asymmetric, relatively flat syncline occurs, built also of the Upper Ordovician shales.

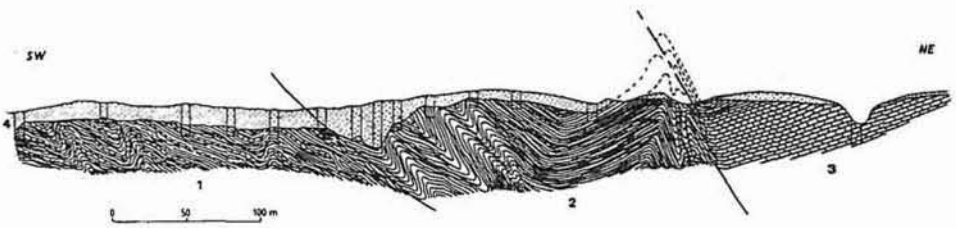


Fig. 10. Cross-section of the Middle Cambrian and Ordovician at Wólka (after J. Czarnocki, 1939)
1 — dark shales with thin interbeds of quartzite — Middle Cambrian, 2 — black siliceous shales with *Dicellograptus* sp. — Upper Ordovician (lower part), 3 — light-coloured shales with *Trinucleus* sp. — Upper Ordovician (upper part), 4 — weathered rock and talus; prospection pits and trenches indicated

Profil kambru środkowego i ordowiku w Wólce (według J. Czarnockiego, 1939)
1 — łupki ciemne z cienkimi wkładkami kwarcytów — kambr środkowy, 2 — łupki czarne krzemionkowe z *Dicellograptus* sp. — ordowik górny (część dolna), 3 — łupki ilaste jasne, trynukleusowe — ordowik górny (część górna), 4 — wietrzeliny i osuwiska zboczowe; oznaczone miejsca szybików i przekopów

The **Wilków** sequence (**15**) was recognised in a borehole and described in detail by H. Tomczyk (Z. Deczkowski, H. Tomczyk, 1969*b*). According to my interpretation (Fig. 11) it is a stack of imbricated, overturned folds with squeezed out lower limbs. The gap existing between the Upper Cambrian and the Caradoc is most probably due to the tectonic removal of the Tremadoc-Llandeilo sediments since they are known in the close vicinity. As proved by the presence of slickensides, two levels of tectonic breccia and many discordant dips, the Upper Cambrian strata are folded and imbricated, and the Caradoc should be interpreted as an assemblage of tectonic slices. The tectonic breccias below and above the Llandovery delimit the imbricated anticline with the bottom limb being tectonically removed. The Wenlock and Lower Ludlow shales and siltstones are also imbricated, and the lack of bottom limbs of slices automatically results in non-repetition of the faunistic sequences. Also the Upper Ludlow greywackes show numerous slickensides; some parts of the sequence are distinctly sliced although folding and tectonic removal may have been less intensive in this portion than in the lower parts of the nearly 1000 m thick sequence.

In **Kajetanów** (**16**) the stratigraphic contents is similar to that in Wólka but the tectonic involvement is greater since the strata are arranged in reverse order. Upper Cambrian sediments rest upon Lower Ashgill shales and these in turn are underlain by Upper Ashgill shales. Thus, the structural transformation lead here to the detachment and overturning of the entire Upper Cambrian and Upper Ordovician sequence. The squeezing out of the Tremadoc to Llandeilo beds must have occurred during folding and slicing, like in Wólka and Wilków.

The Wólka–Wilków–Kajetanów sequences give convincing arguments against the current allegations about the weak tectonic involvement of the Łysogóry Ordovician and Silurian. The presence in the nearest boreholes of the continuous sequence from the Upper Cambrian through Llandeilo (E. Tomczykowa, 1968 — boreholes Brzezinki 17 and Jeleniów 2) is the best proof that the gaps in the Wólka and Wilków profiles are purely tectonic.

Wiśniówka (**17**) is an excellent example of the Łysogóry Cambrian tectonics. In the pre-war period extensive exploratory works (exploratory pits, shallow boreholes) have been

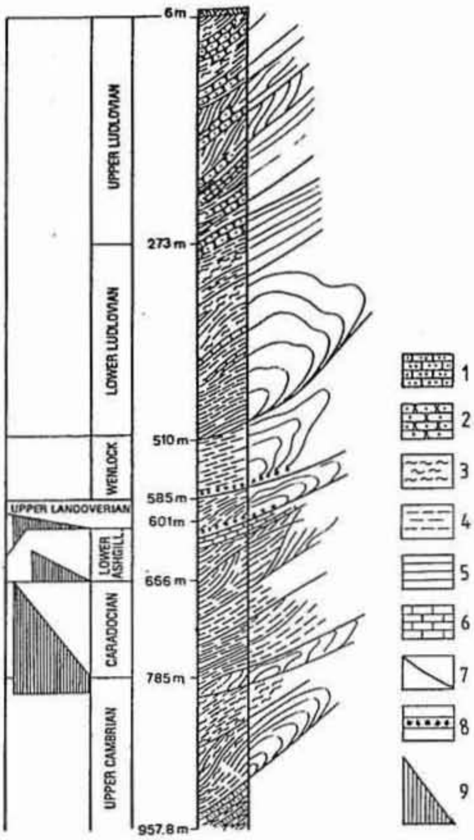


Fig. 11. Lithologic-stratigraphical column of the Early Palaeozoic in the borehole Wilków (after H. Tomczyk in: H. Tomczyk, Z. Deczkowski, 1969*b*; tectonic interpretation by J. Znosko in 1994)

1 — quartzitic sandstones, 2 — greywackes, 3 — sandy siltstones partly calcareous, 4 — calcareous shales, 5 — shales, 6 — limestones, 7 — tectonic slickensides, 8 — tectonic breccia, 9 — tectonic gaps

Profil litologiczno-stratygraficzny starszego paleozoiku z otworu wiertniczego Wilków (według H. Tomczyka w: H. Tomczyk, Z. Deczkowski, 1969*b*; interpretacja tektoniczna J. Znoski z 1994 r.)

1 — piaskowce kwarcytowe, 2 — szarogłazy, 3 — mułowce piaszczyste lub wapniste, 4 — iłowce wapniste łupkowate, 5 — łupki, 6 — wapienie, 7 — ślizgi tektoniczne, 8 — brekcje tektoniczne, 9 — luki tektoniczne

made aiming at the exploration of the Cambrian quartzites (J. Czarnocki, 1958). Afterwards, three quarries — two of them presently at work, the third abandoned — enabled detailed investigations: precise definition of rock types, strike and dip measurements as well as mesostructural observations such as of boudinage in quartzites. These problems are presented separately by Z. Kowalczewski and R. Dadlez (1996); I give here only a general overwiev.

In cross-section through Mount Wiśniówka, based on the above mentioned exploratory pits (Fig. 12), several steep, detached folds occur which are arranged in a fan-like pattern, i.e. they are inclined southwards in the south and northwards in the north. Deeper down these folds must be compressed stronger and, in the merging shear zones, they should acquire an oblique or vertical position, with bottom limbs removed and missing in all the fold units.

Another possible interpretation — similar but somewhat different — is given by Z. Kowalczewski (see fig. 4a in: R. Dadlez *et al.*, 1994). There is a recumbent syncline in the north and a recumbent anticline in the south, the hinges of both elements opposing each other. Between them there lies the compressed and steep fragment of the central syncline

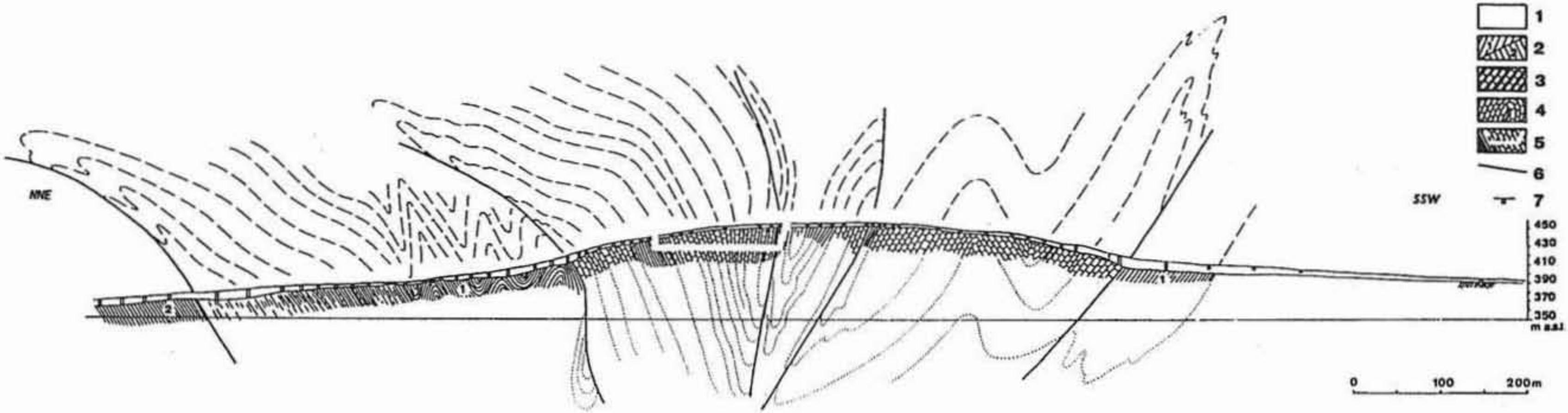
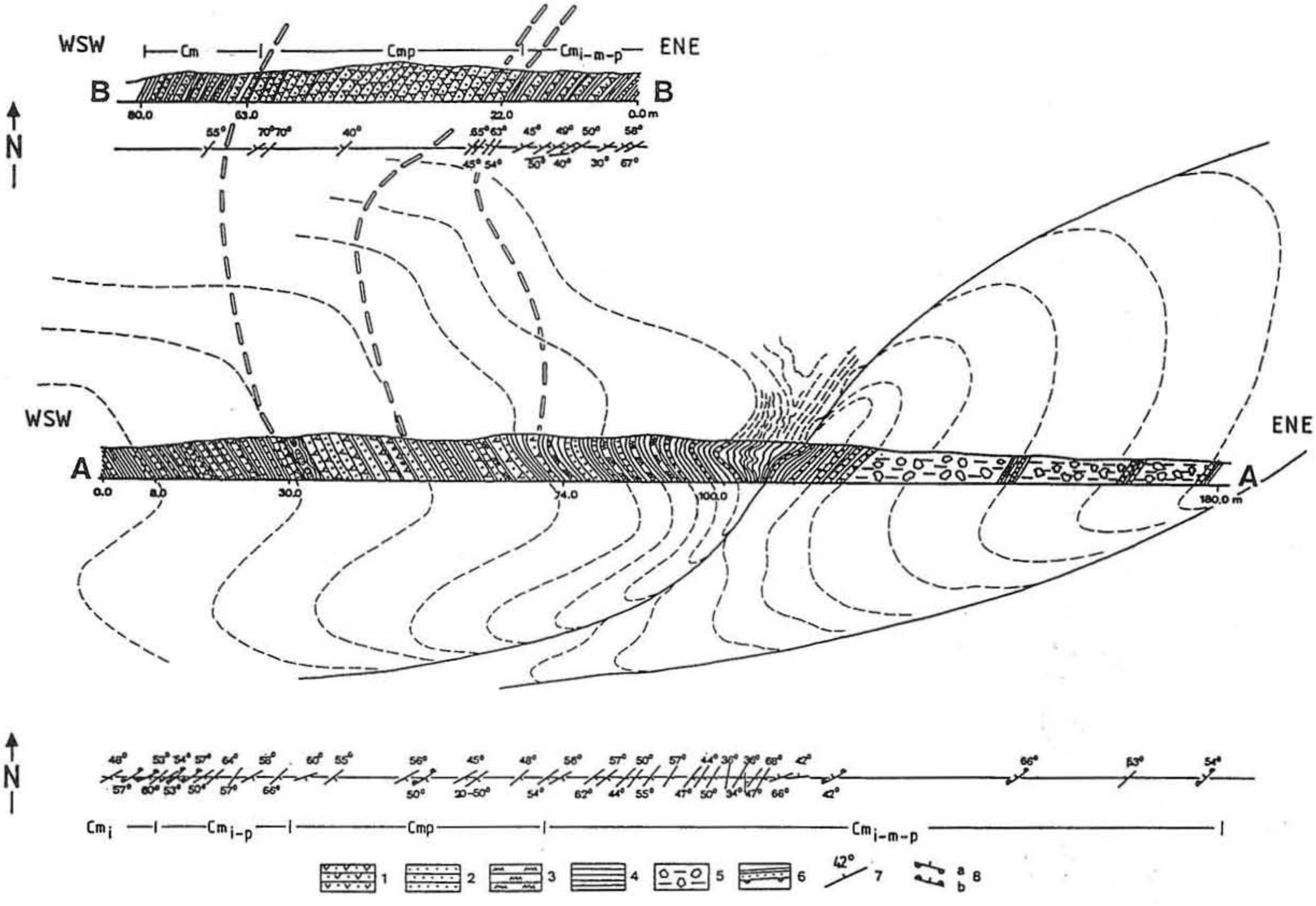


Fig. 12. Geological cross-section of Mount Great Wiśniówka (after J. Czarnocki, 1958; tectonic interpretation by J. Znosko in 1978)

1 — quartzite debris and weathered rock, 2 — shales (1 — Cambrian, 2 — Ordovician), 3 — quartzites with interbeds of shales (Cambrian), 4 — thick-beded quartzites (Cambrian), 5 — boundary of quarry, 6 — faults and overthrusts, 7 — prospection pits

Przekrój geologiczny przez górę Wiśniówkę Wielką (według J. Czarnockiego, 1958; interpretacja tektoniczna J. Znoski z 1978 r.)

1 — rumowiska kwarcytowe i wietrzeliny, 2 — łupki (1 — kambr, 2 — ordowik), 3 — kwarcyty z wkładkami łupków (kambr), 4 — kwarcyty gruboławicowe (kambr), 5 — granice kamieniołomu, 6 — uskoki i nasunięcia, 7 — szybiki


WSW
Cm
Cmp
Cmi-m-p
ENE
B
B
80.0
63.0
22.0
0.0 m
N
WSW
ENE
A
A
0.0
8.0
30.0
74.0
100.0
180.0 m
N
Cmi
Cmi-p
Cmp
Cmi-m-p
1
2
3
4
5
6
42°
7
a
b
8

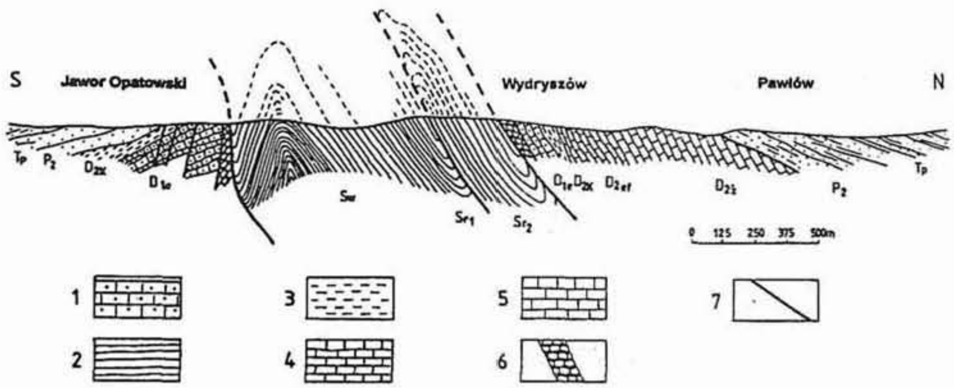


Fig. 14. Cross-section through the Wydryszów fold (middle part) (after J. Czarnocki, 1957; reinterpreted by J. Znosko in 1994)

1 — sandstones, 2 — shales, 3 — flaky, black shales, 4 — limestones and dolomitic marls, 5 — dolomites, 6 — tectonic breccia, 7 — faults and overthrusts; Upper Silurian: Sw — Wydryszów Beds, Sr_1 — Lower Rzepin Beds, Sr_2 — Upper Rzepin Beds; Lower Devonian: D_{1e}— Emsian; Middle Devonian:D_{2K} — Couvinian, D2ef — Eifelian, $D_{2ż}$ — Givetian; Permian: P_2 — Zechstein; Triassic: T_p — Buntsandstein

Przekrój przez fałd wydryszowski (część środkowa) (według J. Czarnockiego, 1957; reinterpretacja J. Znoski z 1994 r.)

1 — piaskowce, 2 — łupki ilaste, 3 — łupki ilaste czarne, blaszkowe, 4 — wapienie i margle dolomityczne, 5 — dolomity, 6 — brekcje tektoniczne, 7 — uskoki i nasunięcia; sylur górny: Sw — warstwy wydryszowskie, Sr_1 — warstwy rzepińskie dolne, Sr_2 — warstwy rzepińskie górne; dewon dolny: D_{1e} — ems; dewon środkowy: D_{2K} — kuwin, D2ef — eifel, $D_{2ż}$ — żywet; perm: P_2 — cechsztyn; trias: T_p — pstry piaskowiec

developed upwards into a now non-existent, eroded anticline, squeezed out at the contact of both synclines.

In the neighbouring **Krzemianka (18)**, exposed recently in a road-cut (Z. Kowalczewski, M. Studencki, 1983), two anticlines (southwestern recumbent and northeastern overturned) of northern vergence are observed. A syncline separating them — due to strong compression — was clenched and detached along its bottom limb while slicing proceeded along the anticlinal axial plane (Fig. 13). It resulted in the tectonic removal of the northeastern limb of southern syncline and the southwestern limb of northern anticline. The

Fig. 13. Geological sections of the Cambrian of Mount Krzemianka exposed in road-cut (A – A) and in prospection trench (B – B) (after Z. Kowalczewski and M. Studencki, 1983; tectonic interpretation by J. Znosko in 1994)

1 — quartzitic sandstones, 2 — quartz sandstones, 3 — quartz siltstones, 4 — claystones and silty claystones, 5 — waste of quartzites and shales, 6 — hieroglyphs on bedding planes, 7 — strike and dip, 8 — hieroglyphs: a — in normal position, b — in inverse position; Cm — Cambrian, Cm_{i-m-p} — claystone-siltstone-sandstone complex, Cm_p — complex of quartzitic sandstones, Cm_i+Cm_{i-p} — claystone and claystone-sandstone complexes

Przekroje geologiczne kambru góry Krzemianki odsłonięte w przekopie drogowym (A – A) i rowie badawczym (B – B) (według Z. Kowalczewskiego i M. Studenckiego, 1983; interpretacja tektoniczna J. Znoski z 1994 r.)

1 — piaskowce kwarcytowe, 2 — piaskowce kwarcowe, 3 — mułowce kwarcowe, 4 — iłowce i iłowce mułowcowe, 5 — zwietrzelina kwarcytów i iłów, 6 — hieroglify na powierzchniach warstw, 7 — bieg i upad warstw, 8 — hieroglify: a — w pozycji normalnej, b — w pozycji odwróconej; Cm — kambr, Cm_{i-m-p} — kompleks iłowcowo-mułowcowo-piaskowcowy, Cm_p — kompleks piaskowców kwarcytowych, Cm_i+Cm_{i-p} — kompleks iłowcowy i iłowcowo-piaskowcowy

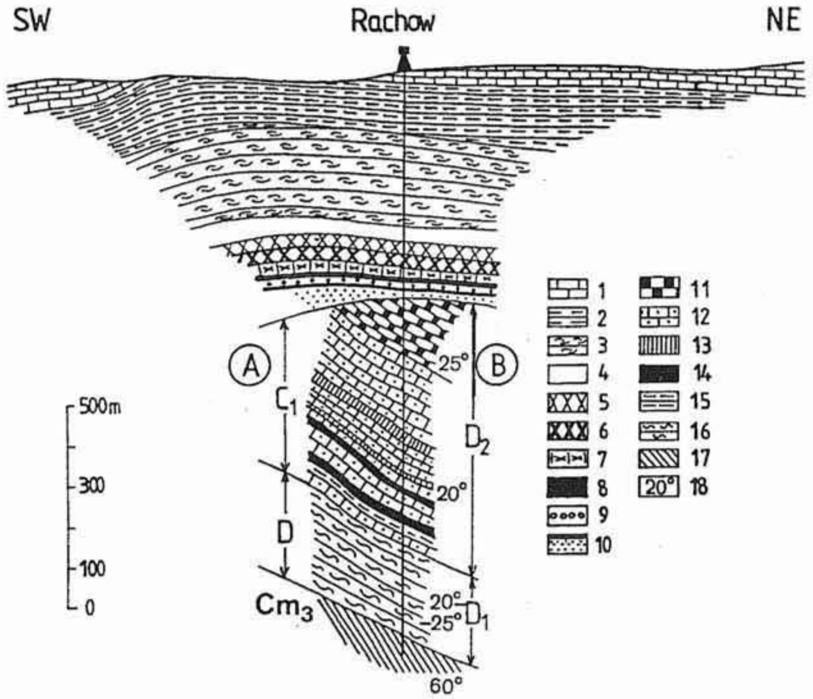


Fig. 15. Deep-seated structure of Rachów (after A. Tokarski, 1958, simplified)

1 — Upper Cretaceous; 2–8 — Upper Jurassic: marls, limestones and dolomites; 9–10 — Middle Jurassic: sandstones and shales; Devonian: 11 — dolomites and dolomitic limestones, 12 — quartzitic sandstones, 13 — green shales, 14 — vari-coloured shales, 15 — grey shales, 16 — vari-coloured siltstones with interlayers of quartzite, 17 — Upper Cambrian: quartzites and sandy shales, 18 — dips; C_1 — Lower Carboniferous, D — Devonian, D_2 — Middle Devonian, D_1 — Lower Devonian, Cm_3 — Upper Cambrian; Palaeozoic stratigraphy: A — after J. Samsonowicz in: A. Tokarski (1958); B — after J. Znosko (1962)

Wgłębna struktura Rachowa (według A. Tokarskiego, 1958, uproszczona)

1 — kreda górna; 2–8 — margle, wapienie i dolomity jury górnej; 9–10 — piaskowce i łupki jury środkowej; dewon: 11 — dolomity i wapienie dolomityczne, 12 — piaskowce kwarcytowe, 13 — zielone łupki, 14 — pstre łupki, 15 — szare łupki, 16 — pstre mułowce z wkładkami kwarcytów, 17 — kwarcyty i łupki piaszczyste kambru górnego, 18 — upady; C_1 — karbon dolny, D — dewon, D_2 — dewon środkowy, D_1 — dewon dolny, Cm_3 — kambr górny; stratygrafia paleozoiku: A — według J. Samsonowicza w: A. Tokarski (1958); B — według J. Znoski (1962)

situation is like that in the Dyminy fold: due to strong compression two overthrust anticlines come to almost direct contact. Such an interpretation was not only possible but simply forced by the observation of hieroglyphs.

The **Bronkowice** fold (**19**), situated farther north, is built of the Upper Silurian rocks. It was previously described by J. Czarnocki (1957) as an intensely folded structure with two internal detachment surfaces, thrust over the bordering Devonian in the south but conformable with the Devonian along the northern limb. Later geological interpretation and the results of pits studied by E. Mariańczyk (1973) revealed the Lower Devonian conglomerates in the southern limb — they rest with the angular unconformity on the Silurian.

Presently, the Bronkowice fold is believed to be composed of several folds repeatedly imbricated and unconformably overlain by the Devonian conglomerates and sandstones (see fig. 3b in: R. Dadlez *et al.*, 1994).

North of the main Palaeozoic core of the HCM — exactly like the Zbrza Anticline in the south — is situated the **Wydryszów** fold **(20)** emerging from beneath the Mesozoic cover. It was interpreted by J. Czarnocki (1957) as an asymmetric anticline with axis veering from the NW to WNW trend, and with steep southern limb and fault contact with the Devonian along this limb. Thorough analysis of J. Czarnocki's map (where dip values are given) and of the accompanying text (with remarks concerning the unconformities and detachments) leads to conclusion that there are at least 4–5 folds within this structure (Fig. 14). Its northern and southern part must be treated separately and at least two thrust surfaces — like in Bronkowice — must be accepted. Both folds: Bronkowice and Wydryszów, reveal the southern vergence and are thrusted over a wide and gentle Bodzentyn Syncline filled in with the Devonian. This overthrust is parallel to the HCF and can be traced far to the east because it influenced the development of the Mesozoic cover. Moreover, looking at the gravity maps, we can see — east of Vistula river — its possible connection with a narrow gravity high of Biłgoraj which is caused by strongly deformed Cambrian-Silurian sequences lying near the Earth's surface.

The last example is the **Rachów** borehole **(21)**, located some twenty kilometres north of the Palaeozoic core, where a distinct angular unconformity has been found between the Upper Cambrian and the Lower Devonian (A. Tokarski, 1958, see also Fig. 15).

CONCLUSIONS

1. The tectonic involvement of the Early Palaeozoic rocks in the HCM points — as a rule — to their ductile (plastic) deformation and to strong horizontal compression. This is indicated both by macrostructural and mesostructural observations made in various sites in the entire area.

2. These compressional events occurred at least twice in the Kielce Unit: before the Arenig and after the Silurian. In the Łysogóry Unit only the latter event has been recorded. There is no substantial difference in the tectonic involvement of both units as well as in the tectonic style within each unit (e.g. the deformations in the Łysogóry Unit from Opatów in the east to Krzemianka in the west).

3. The influence of the Variscan (syn-Variscan) deformations is undoubtful and expressed mainly by the rejuvenation of earlier faults. This is clearly visible, first of all, along the HCF and at the southern limb of the Bronkowice–Wydryszów fold system.

4. The Devonian strata, however, are characterized by a brittle style of deformations expressed by horsts and grabens, as well as half-horsts and half-grabens. Rocks of this age are steeply inclined or even folded near the faults, including reverse faults, flexural bends and box folds. However, in vast areas they lie horizontally or subhorizontally (see e.g. Figs. 3, 5, 7 and 14). These deformations are typical of intracratonic tectonics and result from weaker compression combined with vertical movements.

5. Another rejuvenation took place during the Early Tertiary uplift of the HCM block. It is well expressed along the southwestern edge of the Palaeozoic core (see Fig. 7). The

separation of effects of the four stages of tectonic evolution is the most important task for future research.

Translated by Grażyna Burchart and Ryszard Dadlez

Zakład Geologii Regionalnej i Naftowej
Państwowego Instytutu Geologicznego
Warszawa, ul. Rakowiecka 4
Received: 15.11.1995

REFERENCES

CZARNOCKI J. (1936) — Überblick der Stratigraphie und Paläogeographie des Unterdevons im polnischen Mittelgebirge (in Polish and German). Spraw. Państw. Inst. Geol., **8**, p. 163–200, no. 4.
CZARNOCKI J. (1938) — Carte géologique générale de la Pologne 1:100 000, Feuille 4: Kielce (in Polish and French). Państw. Inst. Geol. Warszawa.
CZARNOCKI J. (1939) — Field work in the Święty Krzyż Mountains in 1938 (in Polish with English summary). Biul. Państ. Inst. Geol., **15**, p. 1–42.
CZARNOCKI J. (1957) — Tectonics of the Święty Krzyż Mountains. Geology of the Łysogóry region (in Polish with English summary). Pr. Inst. Geol., **18**, p. 11–138, vol. 2, no. 3.
CZARNOCKI J. (1958) — W sprawie rozbudowy kamieniołomów państwowych w Zagnańsku. Pr. Inst. Geol., **21**, p. 122–159, no. 3.
DADLEZ R., KOWALCZEWSKI Z., ZNOSKO J. (1994) — Some key problems of the pre-Permian tectonics of Poland. Geol. Quart., **38**, p. 169–190, no. 2.
DECZKOWSKI Z., TOMCZYK H. (1969*a*) — Geological structure of the Zbrza Anticline in the south-western part of the Góry Świętokrzyskie (in Polish with English summary). Biul. Inst. Geol., **236**, p. 143–175.
DECZKOWSKI Z., TOMCZYK H. (1969*b*) — Older Palaeozoic in bore hole Wilków (northern part of the Świętokrzyskie Mountains) (in Polish with English summary). Kwart. Geol., **13**, p. 14–24, no. 1.
GUTERCH A., GRAD M., MATERZOK R., PAJCHEL J., PERCHUĆ E., TOPORKIEWICZ S. (1984) — Deep structure of the Earth's crust in the contact zone of the Paleozoic and Precambrian Platforms and the Carpathian Mts in Poland. Acta Geophys. Pol., **32**, p. 25–41, no. 1.
KOWALCZEWSKI Z. (1993) — Coarse grained Cambrian deposits in the mid-southern Poland. Biul. Państ. Inst. Geol., **366**, p. 5–37.
KOWALCZEWSKI Z., LISIK R. (1974) — New data on diabases and geological structure of the Prągowiec area in the Góry Świętokrzyskie (in Polish with English summary). Biul. Inst. Geol., **275**, p. 113–152.
KOWALCZEWSKI Z., STUDENCKI M. (1983) — Geological structure of the Krzemianka Hill near Kielce (in Polish with English summary). Kwart. Geol., **27**, p. 695–708, no. 4.
KOWALCZEWSKI Z., DADLEZ R. (1996) — Tectonics of the Cambrian the Wiśniówka area (Holy Cross Mts., central Poland). Geol. Quart., **40** (this volume), p. 23–46, no. 1.
LENDZION K., MOCZYDŁOWSKA M., ŻAKOWA H. (1982) — A new look at the Bazów Cambrian sequence (southern Holy Cross Mts). Bull. Acad. Pol. Sc. Sér. Sc. Terre, **30**, p. 67–75, no. 1–2.
MARIAŃCZYK E. (1973) — New data on geology of the Bronkowice region (in Polish with English summary). Prz. Geol., **21**, p. 158–160, no. 3.
MIZERSKI W. (1979) — Tectonics of the Łysogóry Unit in the Holy Cross Mts. Acta Geol. Pol., **29**, p. 3–37, no. 1.
POŻARYSKI W. (1990) — The Middle European Caledonides — wrenching orogen composed of terranes (in Polish with English summary). Prz. Geol., **38**, p. 1–9, no. 1.
POŻARYSKI W., TOMCZYK H. (1968) — Assyntian orogen in south-east Poland. Biul. Inst. Geol., **237**.
SAMSONOWICZ J. (1934) — Carte géologique générale de la Pologne 1:100 000, Feuille Opatów (in Polish and French). Państw. Inst. Geol. Warszawa.
STUPNICKA E. (1992) — The significance of the Variscan orogeny in the Świętokrzyskie Mountains (Mid Polish Uplands). Geol. Rdsch., **81**, p. 561–570, no. 2.

TOKARSKI A. (1958) — Notes on structure types in the Meta-carpathian arch (in Polish with English summary). Kwart. Geol., **2**, p. 807–824, no. 4.
TOMCZYK H. (1954) — Stratigraphy of the Gothlandian of the Międzygórz Basin — Święty Krzyż Mts on the basis of the fauna from graptolitic shales (in Polish with English summary). Biul. Inst. Geol., **93**.
TOMCZYK H., TURNAU-MORAWSKA M. (1964) — Stratigraphy and petrography of the Ordovician in Brzeziny near Morawica (Holy Cross Mts.) (in Polish with English summary). Acta Geol. Pol., **14**, p. 501–543, no. 4.
TOMCZYKOWA E. (1968) — Stratigraphy of the uppermost Cambrian deposits in the Świętokrzyskie Mountains (in Polish with English summary). Pr. Inst. Geol., **54**.
ZNOSKO J. (1962) — Present status of knowledge of geological structure of deep substratum of Poland beyond the Carpathians (in Polish with English summary). Kwart. Geol., **6**, p. 485–511, no. 3.
ZNOSKO J. (1974) — Outline of the tectonics of Poland and the problems of the Vistulicum and Variscicum against the tectonics of Europe. Biul. Inst. Geol., **274**, p. 7–47.
ZNOSKO J. (1984) — Tectonics of southern part of Middle Poland (beyond the Carpathians). Z. Dtsch. Geol. Ges., **135**, p. 585–602, no. 2.
ŻAK C. (1962) — Preliminary study of the tectonics of the Middle Cambrian in the Góry Pieprzowe Mts. (in Polish with English summary). Biul. Inst. Geol., **174**, p. 9–50.

Jerzy ZNOSKO

STYL TEKTONICZNY KOMPLEKSÓW STAROPALEOZOICZNYCH W GÓRACH ŚWIĘTOKRZYSKICH

Streszczenie

W artykule poddano analizie tektonicznej 32 struktury oraz profil otworu wiertniczego Rachów, które zostały opisane przez wielu autorów m. in.: J. Czarnockiego, J. Samsonowicza, H. Tomczyka, C. Żaka, Z. Kowalczewskiego i in. Prawie w cały materiał źródłowy autor niniejszego artykułu nie ingerował. Uzupełnił go jedynie interpretacją w głąb i w powietrze, aby unaocznić styl deformacji tektonicznych.

Spośród 32 przeanalizowanych struktur szczególnie uwypuklono fałdy, które obrazują najlepiej styl strukturalny skał starszego paleozoiku Gór Świętokrzyskich. Profil w Chojnowym Dole ujawnia nurzający się(!) fałd skał dolnokambryjskich. Jest on ścięty niezgodnie i transgresywnie przez nasunięte skały ordowiku i syluru, które są przefałdowane i odkłute. W utworach kambru i syluru widoczne są fałdy pionowe(!), na co nie zwracano dotychczas uwagi.

Fałd dymiński stanowią dwie antykliny kambryjskie, które rozdziela zaciśnięta (lub wytłoczona w powietrze) synklinalna łuska ordowicko-sylurska. Piaskowce emsu ścinają utwory kambro-syluru i leżą na nich z dyskordancją kątową.

Fałd Zbrzy tworzą stromo ustawione skały kambru dolnego, na których z dużą niezgodnością kątową leży złuskowana synklina i antyklina utworów ordowicko-sylurskich. Tektonika nakrywającego dewonu oraz mezozoiku wykazuje platformowy styl odkształceń.

W Bazowie profil kambru dolnego o miąższości 1500 m ujawnia leżący i złuskowany co najmniej 3-krotnie fałd.

W Górach Pieprzowych C. Żak zbadał odsłaniające się utwory kambru środkowego. Są one silnie przefałdowane, złuskowane i zawierają bardzo liczne budiny kwarcytowe. Według C. Żaka zaznaczają się co najmniej 3 synkliny i 7 antyklin oraz zapewne jeszcze 3 synkliny zupełnie wyprasowane.

Skomplikowany układ przefałdowanych i złuskowanych struktur znany jest z okolic Opatowa. W strefie o szerokości 1–4 km zaznacza się 5 antyklin i 4 synkliny skał kambro-sylurskich. Fałdy są stojące, pochylone, obalone, a nawet nurzające się — podobnie jak w Chojnowym Dole. Płaszczyzny złuskowań i nasunięć są rozbieżne, pionowe oraz nachylone ku N i S.

W Wólce k. Nowej Słupi na sfałdowane skały kambru środkowego nasunięte są sfałdowane łupki dolnego aszgilu, a na nie z kolei złuskowana, asymetryczna synklina jasnych łupków górnego aszgilu. Luka obejmująca kambr górny oraz dolny i środkowy ordowik mogła się utworzyć przy wielkich przemieszczeniach i wyprasowaniu utworów, które znane są na obszarach sąsiednich.

Wytłoczenia i złuskowania prezentuje profil Wilkowa, również ujawniający liczne i poważne luki kompleksów, które są znane w bliskim otoczeniu. Tektonikę fałdowo-łuskową z licznymi wytłoczeniami różnych kompleksów stratygraficznych dokumentuje zestawienie profili E. Tomczykowej.

Opisany w 1939 r. profil Kajetanowa doskonale potwierdza dotychczasowe ustalenia. Jest on prawie analogiczny do profilu kambru i ordowiku w Wólce k. Nowej Słupi. Stosunek skał aszgilu dolnego i górnego do skał kambru górnego w Kajetanowie jest taki sam jak w Wólce — ale cały profil jest odwrócony o 180°. Zaznacza się więc zdumiewająca regularność tektoniki fałdowo-łuskowej na obu krańcach pasma łysogórskiego.

Wiśniówka jest klasycznym przykładem tektoniki fałdowo-łuskowej. Stwierdzono tu ogromną kompresję skał i skrócenie w przekroju poprzecznym. Doprowadziło to do sfałdowania, złuskowania i zbudinowania kwarcytów kambryjskich. Na Wiśniówce można ustalić według danych J. Czarnockiego 6 wystromionych antyklin i synklin, ułożonych wachlarzowato. Zwraca uwagę obecność fałdu pionowego. Według interpretacji Z. Kowalczewskiego mamy tu powtórzony plan z fałdu dymińskiego. Dwie czołowo stykające się synkliny rozdziela wytłoczona w powietrze i zerodowana antyklina.

Uwiarygodnieniem jest odsłonięty przy budowie obwodnicy drogowej i znakomicie udokumentowany fałd Krzemianki. Ustala on modelowy styl strukturalny dla kambru całego pasma łysogórskiego. Są to dwie leżące antykliny z zaciśniętą i wytłoczoną ku górze synkliną, która rozdziela obie antykliny. NE skrzydło synkliny jest na płaszczyźnie odkłucia prawie w całości wyprasowane. Zaobserwowane i pomierzone hieroglify w obu antyklinach nie dają innej możliwości interpretacyjnej.

Opisane fałdy obalają mit o różnym stylu strukturalnym kambro-syluru w północnej i południowej jednostce Gór Świętokrzyskich. Styl strukturalny jest taki sam.

W północnym obrzeżeniu trzonu paleozoicznego Gór Świętokrzyskich zaznaczają się fałdy Bronkowic i Wydryszowa. Fałd Bronkowic jest intensywnie przefałdowaną strukturą o 4 antyklinach i 5 synklinach oraz z trzema płaszczyznami odkłuć. E. Mariańczyk (1973) odkryła robotami ziemnymi w południowym skrzydle zlepieniec miedzianogórski leżący niezgodnie na utworach górnego syluru. Jest to bardzo ważne odkrycie. Fałd Wydryszowa według danych J. Czarnockiego kontaktuje z utworami dewonu diagonalnie niezgodnie i składa się co najmniej z 2 antyklin i 3 synklin. Oba fałdy Bronkowic i Wydryszowa mają wergencję południową i nasunięte są na płaską synklinę dewońską Bodzentyna. Jest to zatem nasunięcie równoległe do łysogórskiego. Jest to konstatacja nowa. Łysogórski kierunek tego nasunięcia załamuje się, przesuwa się w okolicy Szwarszowic i znajduje przedłużenie w wydłużonej, wąskiej anomalii grawimetrycznej Biłgoraja, którą wywołują silnie zdyslokowane i wyniesione skały kambru.

Otwór wiertniczy Rachów ujawnił dużą, do 40°, dyskordancję między dewonem dolnym a kambrem.

Fałd Bronkowic, Wydryszowa i ich biłgorajskie przedłużenie oraz profil w Rachowie wyznaczają zatem drugi, po dymińsko-klimontowskim, grzbiet tektoniczno-morfologiczny: bronkowicko-zawichojsko-biłgorajski. Pomiędzy tymi pasmami tektoniczno-morfologicznymi istniała ciągłość sedymentacyjna i zgodność strukturalna między sylurem a dewonem.

Odkłucie „pasma" łysogórskiego i nasunięcie go na dewon pola centralnego zostało spowodowane sumą ruchów synwaryscyjskich i synalpejskich.