Geologia Sudetica, 2003, 35: 61–67.

The problem of "diastrophic" blocks in the marginal parts of the Late Cretaceous Nysa Kłodzka graben, the Sudetes, SW Poland

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Key words: tectonics, crystalline basement, fault, thrust, mapping, sedimentary cover.

Abstract In the marginal parts of the Nysa Kłodzka graben, the presence of "diastrophic" blocks sliding from the frames of the developing morphological depression were distinguished with the use of radar and remote sensing (J. Šebesta in: Batik *et al.*, 1996). The results of mapping and structural observations in the field surprisingly point to the subhorizontal displacement of Cretaceous beds to the outside of the graben, i.e. in the opposite direction to the slide of "diastrophic" blocks suggested by J. Šebesta. The process of subhorizontal overlapping of the Cretaceous beds onto the metamorphic framework may be related to the bursting action of the sediments filling the Nysa Kłodzka graben during the process of subsidence and their squeezing in a wedge-like style into the graben, which narrowed with depth (subhorizontal extensional faults).

Manuscript received 22 August 2003, accepted 17 October 2003

INTRODUCTION

The Nysa Kłodzka depression, clearly distinguishable in the landscape (Figs. 1 and 2), is filled with an approximately 900 metres thick sedimentary sequence, including clays, flysch-like sandstones and the Coniacian Idzików conglomerates (Don & Don, 1960; Jerzykiewicz, 1970, 1971; Radwański, 1975). They sedimented on marls and sandstones (thinning out towards the east) of the Cenomanian–Turonian sea, which was encroaching onto the then flat area of the Orlickie–Bystrzyckie Mts. metamorphic unit, the Śnieżnik metamorphic unit and the Permo-Carboniferous of the Kłodzko District (Don, 1996).

The exodynamic analysis of radar pictures, together with the interpretation of aerial photographs led J. Šebesta (in: Batik *et al.*, 1996) to distinguish sequences of numerous "diastrophic" blocks sliding from the margins of the surrounding metamorphic massifs into the Nysa Kłodzka depression in its post-tectonic period of evolution (Fig. 3). The blocks are also supposed to fill the whole open space of the graben, which is now for the most part covered with young Neogene and Quaternary sediments from fluvial fans (Leppla, 1900; Sroka & Kowalska, 1998). The existence of landslides from the graben edge had already been postulated by Jerzykiewicz (1970, 1971), albeit in relation to the concept of the flysch nature of the Idzików sediments, i.e. much older sediments than the "diastrophic" blocks suggested by J. Šebesta.

RESULTS OF GEOLOGICAL MAPPING AND FIELD OBSERVATIONS

I was not able to confirm Šebesta's hypothesis, neither by direct field observation nor by detailed mapping (on the scale of 1:10 000). Only along the marginal fault of the Góry Orlickie Mts., near Kamieńczyk, did I distinguish two allochthonous blocks (A: 200 x 1000 m; B: 300 x 600 m) that probably occur in superposition in relation to the underlying Cretaceous sediments (Fig. 4). They are composed of weathering-resistant marls and sandstones of the Cenomanian, underlain by the Coniacian Idzików clays, which on the SW side are again in tectonic contact with Cenomanian–Turonian sediments, dipping monoclinally 15 to 40° towards NE over the underlying metamorphic series of the Góry Orlickie Mts (Fig. 5). On the NE side, the allochthonus blocks are cut by a steep border fault of the Nysa Kłodzka graben. The tectonic planes mentioned above do not appear in any outcrops and were mapped on the basis of morphological observations, the presence of tectonic breccias in the weathered cover, line-

Fig. 1. A view of the Nysa Kłodzka graben with the boundary to the southern part of the Śnieżnik metamorphic unit (Góra Urwista Mt – 795 m a.s.l.) from the vicinity of Dolnik.

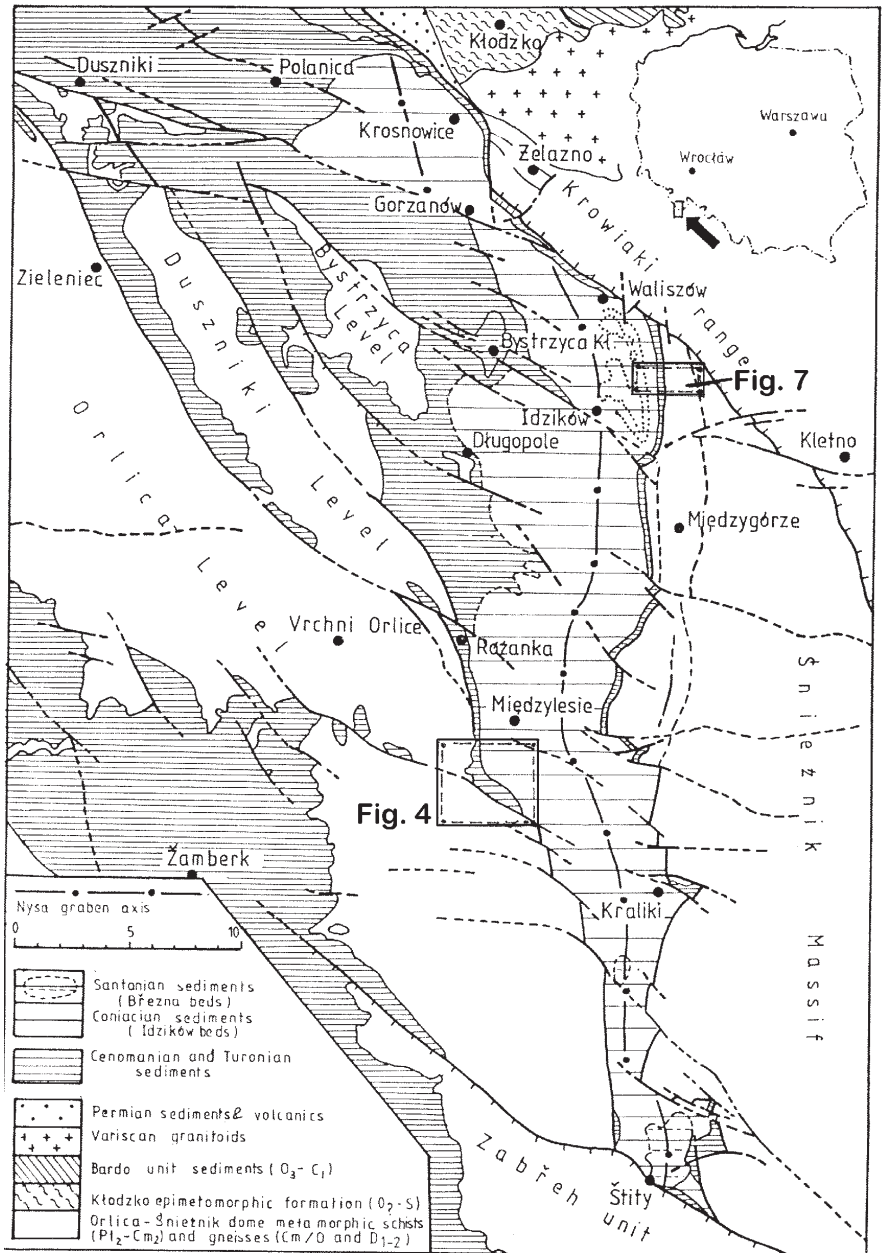

Fig. 2. Geological sketch map of the upper Cretaceous Nysa Kłodzka graben (together with its Czech part) after Don (1996).

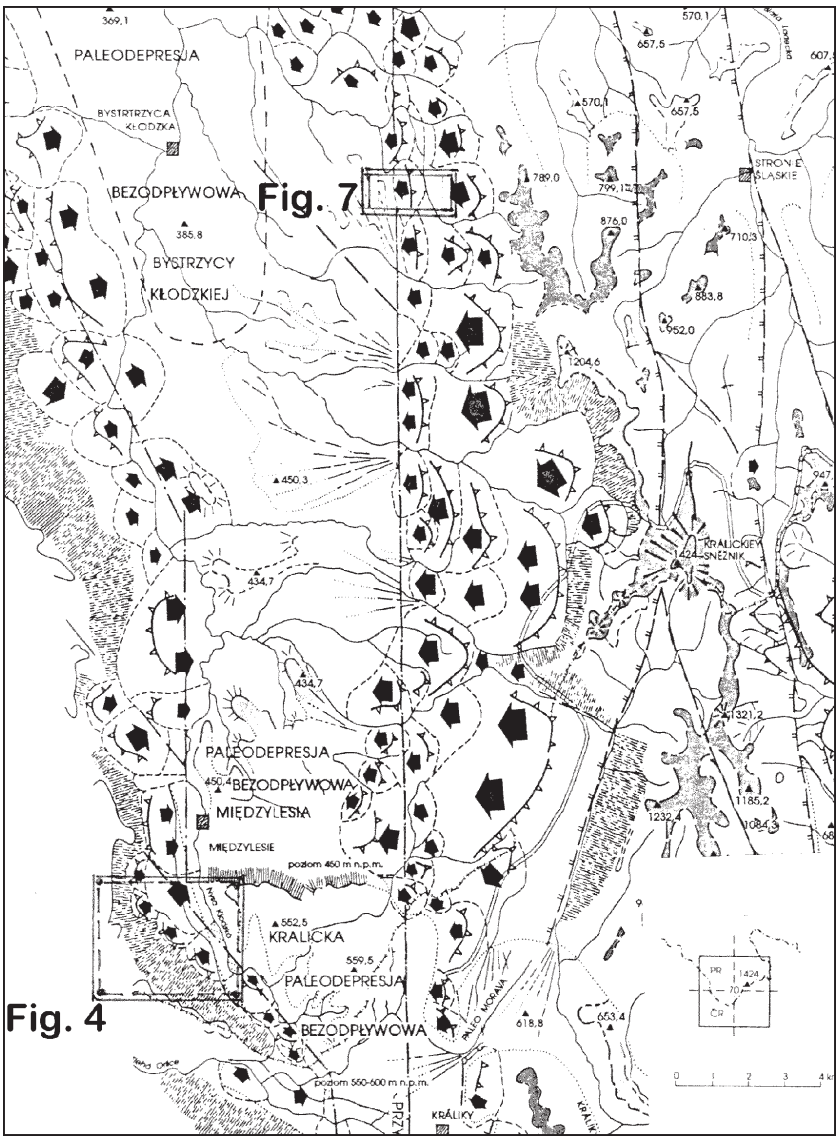

Fig. 3. The Polish part of the Nysa Kłodzka graben after J. Šebesta (in: Batik *et al.* 1996 – Fig. 2–4)

arly distribution of springs and seepages, and mostly on the basis of the interpretation of the compiled geological map (Fig. 4). It turns out from the intersection relationships that the plane underlying the blocks dips to the NE at an angle of 20–30°. The direction of their displacement on this plane cannot be directly determined. At first, these blocks seemed to me to be a confirmation of Šebesta's conclusion, particularly since they could have slid on the bottom plane of the Cretaceous rocks inclined in the neighbouring part of the Góry Orlickie Mts. towards the Nysa Kłodzka graben (see the geological cross-section in Fig. 4). However, this conclusion was difficult to accept, due to the lack of tectonic disturbances and the traces of disruption of the Cretaceous cover sediments along the said plane; this is easy to map on the slopes of the valleys incised cross-wise relative to the tectonic structures of the Góry Orlickie Mts. Moreover, in the adjacent part of the Nysa graben, blocks of Cenomanian–Turonian rocks are present in structurally higher positions than their corresponding parts on the metamorphic series of the marginal zone of these mountains (Fig. 5).

Observations made along the eastern rim of the graben led me to interpret the evolution of the structures described in a different way than that proposed by J. Šebesta. From Pisary in the south, as far as Nowy Waliszów in the north, the Upper Cretaceous beds were flexurally dragged up to the vertical position, thinned out and in places disrupted along an also vertical marginal fault of the Śnieżnik metamorphic unit (Fig. 6 & 7). In numerous places, the marginal flexure is diagonally cut by younger faults of the Sudetic direction (NW–SE) with vertical planes (the Pisary-Heřmanice fault and the Stroma-Potoczek fault), or faults with dips to the NE at angles of up to 40° near Nowa Wieś (Frąckiewicz, 1965), and the regionally important marginal Krowiarki fault (Don, 1996 and Fig. 2).

Along the eastern marginal fault, I did not find any structures similar to those occurring in the vicinity of Ka-

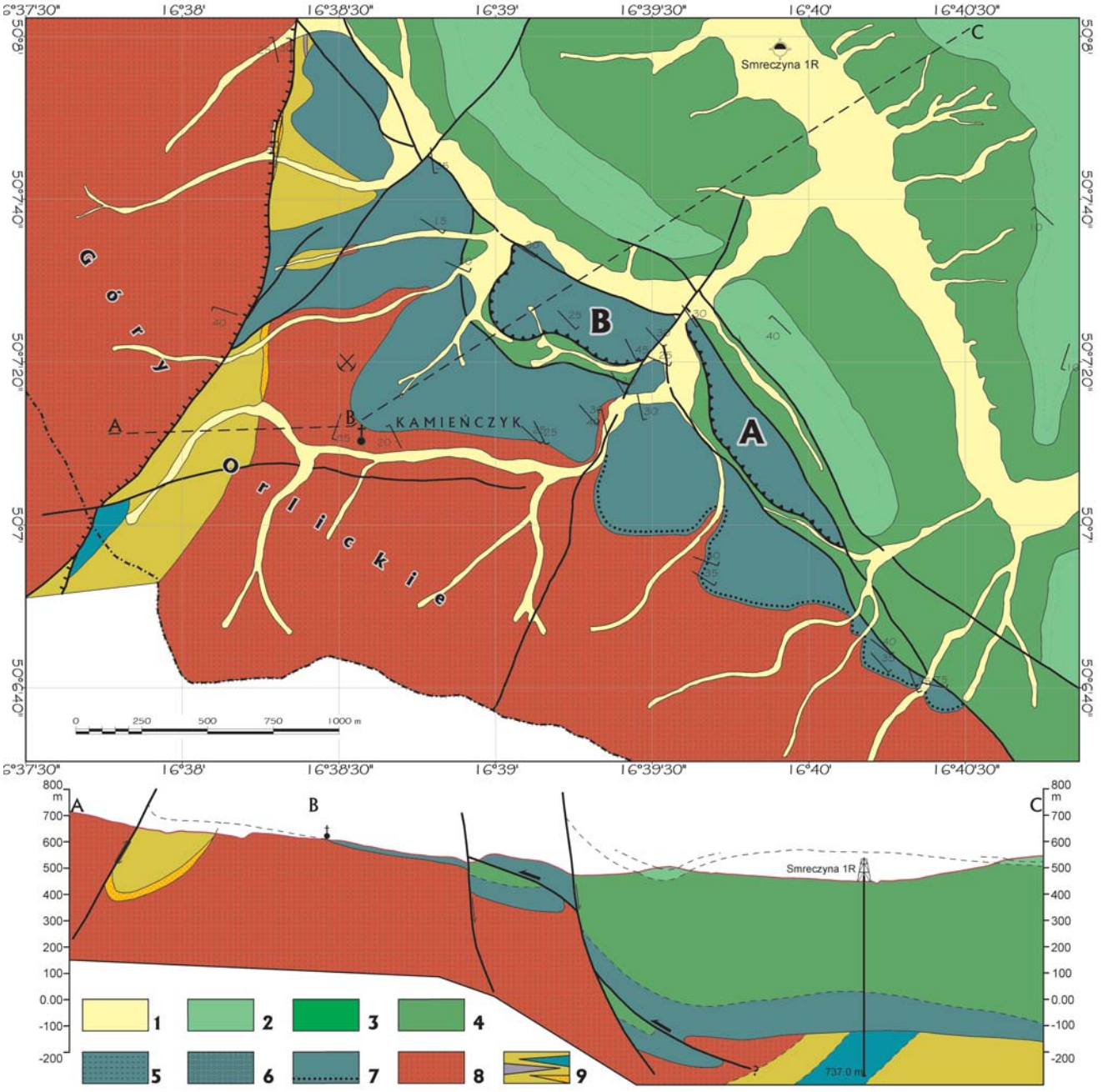

Fig. 4. Fragment of the 1:10 000 geological map of the Kamieńczyk area, with a geological cross-section (preliminary draft of the field data). *1* – Quaternary sediments; *2* – the Upper Coniacian Idzików sandstones (Fig. 4); *3* – the Upper Coniacian Idzików conglomerates (Fig. 7); *4* – the Coniacian Idzików shales; *5* – upper Turonian upper 'ringing' marls (Fig. 7); *6* – quartz conglomerates (Fig. 7); *7* – lower Turonian lower 'ringing' marls (Fig. 4 and 7) with Cenomanian–Turonian glauconite sandstones at the bottom (Fig. 4); *8* – augen gneisses the Śnieżnik type (Cm/O); *9* – schists of the Stronie supracrustal series with intercalations of light quartzites, crystalline limestones, amphibolites and graphite schists (Pt_3–Cm_2).

mieńczyk. However, in two places, I did observe overthrusts of vertically arranged Cretaceous beds along subhorizontal planes towards the east, i.e. in the direction opposite to the one suggested by J. Šebesta. The first of these observations concerns a mesostructure in a dormant quarry of middle Turonian marls and sandstones, on the northern escarpment of the Wilczka river valley, at its outlet in direct contact with the marginal fault of the Nysa graben, west of Międzygórze. Along a plane inclined at an angle of 25–30° to the graben, the Cretaceous beds that overlie it were shifted towards the east (Fig. 6). As a rule, such mesostructures are accompanied by similar macrostructures. And indeed, I found a much larger shift – of over 60 m – of such kind on the eastern side of the marginal fault of the Nysa graben between Nowy Waliszów and Kamienna. On the western slopes of Mt. Modrzeńce (630 m asl), above the outcrops of the Śnieżnik augen gneisses, folded together with the Stronie

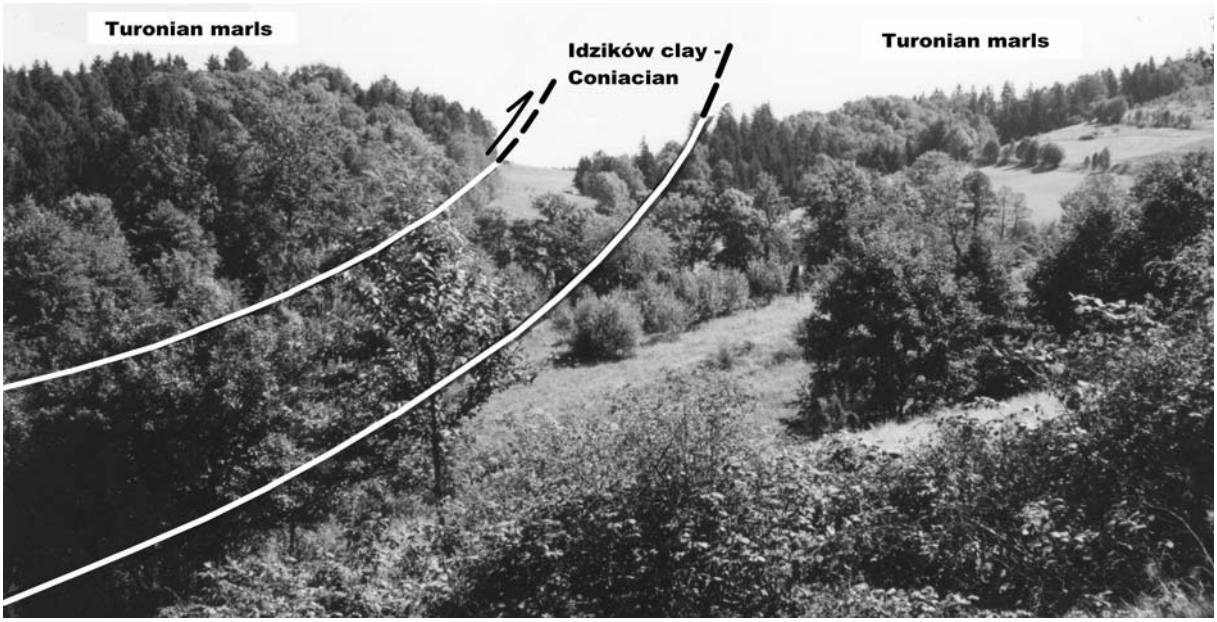

Fig. 5. A view of the western contact of the Turonian 'ringing' marls with the under lying Lower Coniacian Idzików shales near Kamieńczyk (block A – Fig. 4).

series schists, there is a 'fragment' of subhorizontally shifted middle Turonian marls (Fig. 7). The trace of this overthrust outside of the Cretaceous sediments is hard to track in the weathered cover, as the planes are not accompanied by tectonic breccias (compare Fig. 6).

The observations of subhorizontal shifts of the Cretaceous beds outside of the Nysa Kłodzka graben are related to a disrupting action on its frames exercised by sediments wedged during the subsidence of the sediments filling the depression (subhorizontal extensional faults – see Fig. 8). I would connect the mapped tectonic blocks from the vicinity of Kamieńczyk with this type of thrust (Fig. 4). The process of the pushing out of the Cretaceous beds from the Nysa Kłodzka graben is spatially related to its meridi-

Fig. 6. Flexure of the Turonian beds cut by a subhorizontal fault in the contact zone with the Śnieżnk metamorphic unit gneisses (abandoned quarry on the N slope of the Wilczka gorge, approximately 300 m to the west of the dam in Międzygórze).

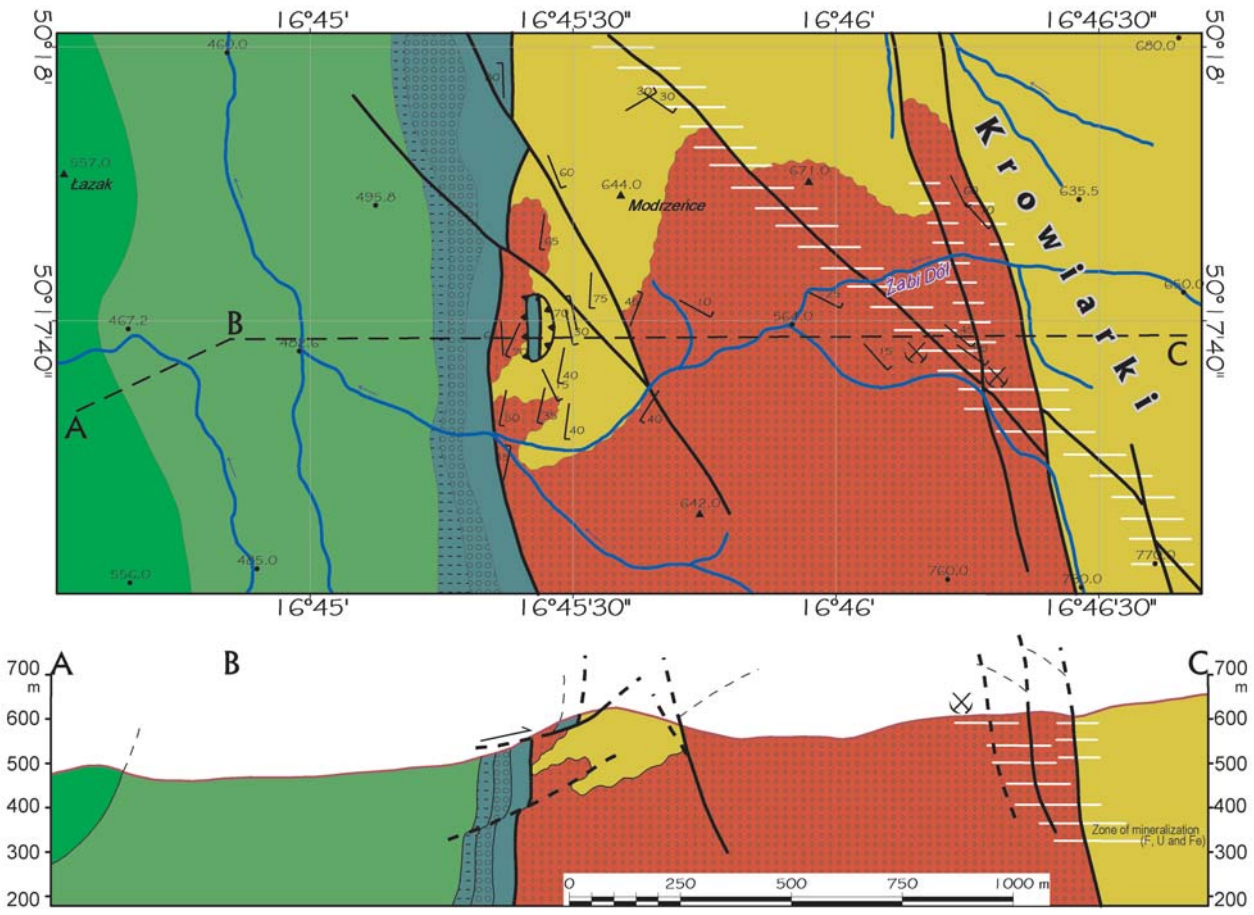

Fig. 7. A fragment of the 1:10 000 geological map of the marginal zone of the Nysa Kłodzka graben with a periclinal part of the Międzygórze anticlinorium to the SE of Nowy Waliszów (between the Skowronek Mt – 653 m a.s.l. and the Górzyca Mt – 815 m asl), together with a geological cross-section (preliminary draft of the field data). Legend as in Fig. 4.

onally stretched marginal faults, the evolution of which took place in the Coniacian in a tensional setting (Cloos, 1922; Don & Don, 1960) and preceded the evolution of the vertical and inversional diagonal NW–SE faults probably representing the Laramian age (Don, 1996). Subhorizontal thrusts of a similar origin were found in a horizon of black copper shales in the Polkowice mine on the Fore-Sudetic Block (Dumicz & Don, 1977). The local horsts, uplifted above this surface, were cut along it and moved at a distance of over 50 m to the SW, i.e. away of the Szczecin-Łódź-Miechów depression.

CONCLUSION

Finally, I would like to state that the conclusions drawn on the basis of the analysis of radar pictures or the interpretation of aerial photographs should be verified in the field. They have not confirmed the widespread presence of "diastrophic" blocks that slid from the frames into the morphologic depression of the upper Cretaceous Nysa Kłodzka graben postulated by Šebesta (in: Batik *et al.*, 1996).

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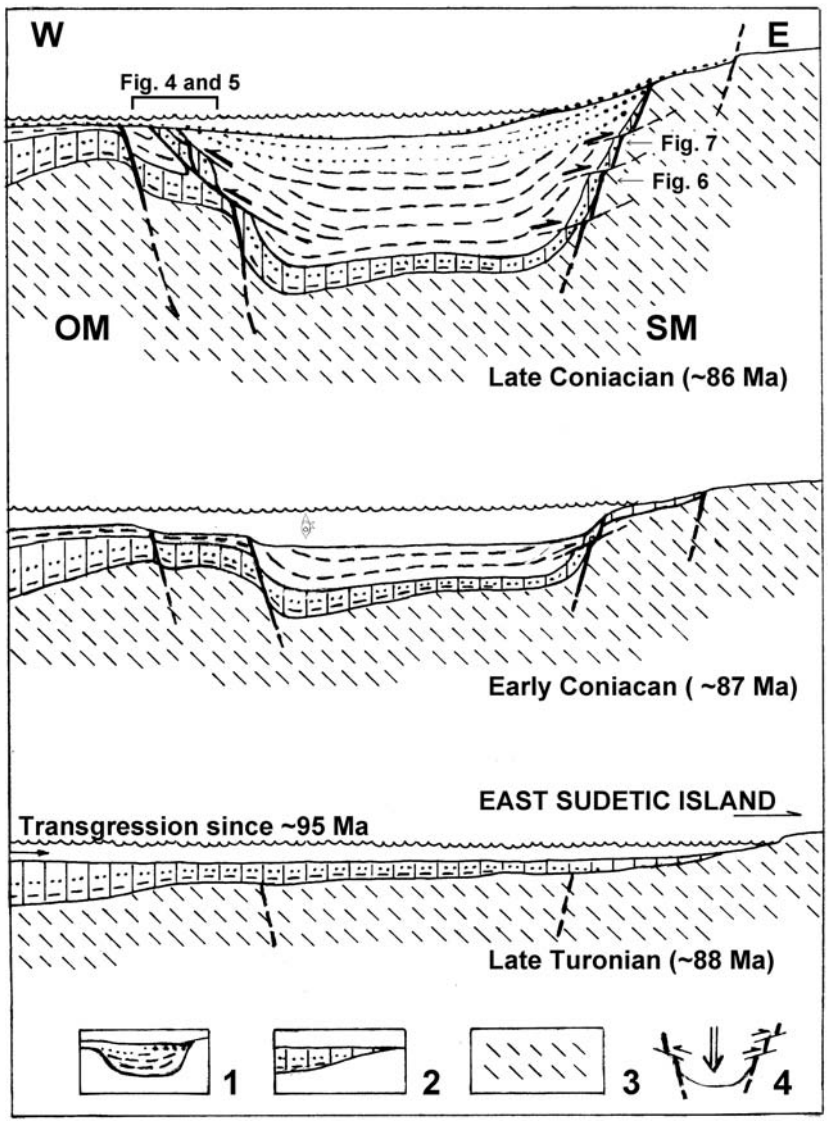

Fig. 8. Schematic profiles explaining the evolution of the Nysa Kłodzka graben during the Late Cretaceous (not to scale). *1* – Idzików beds (Coniacian clays, flysch-like sandstones and polymictic conglomerates); *2* – Turonian "ringing" marls and monomictic quartz sandstone, in the west part spread over Cenomanian glauconite sandstone; *3* – crystalline basement (~500 to ~340 Ma); *4* – subhorizontal extensional faults.

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