Kwartalnik Geologiczny, 35, nr 4, 1991 r., str. 403–420

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Systems of main longitudinal strike-slip faults in the vicinity of the Góry Sowie Block (Sudetes)

The strike-slip character of the great Variscan faults was documented by the large-scale plumose systems. The main faults and the branching-off faults of lower order are prolonged upwards into the platform cover. The Main Sudetic Fault, the Tłumaczów – Sienna Fault, and Marginal Sudetic Fault were accepted as main faults. They all have dextral character. They mark-out three strike-slip blocks — the Fore-Sudetic Block, the Inter-Sudetic Block and the Outer-Sudetic Block; on the last formed the plumose system of faults and strike-slip blocks of lower order. The Outer-Sudetic Block forms the main tectonic graben of Sudetes. The forming of the system of strike-slip faults and posthumous faults was preceded by forming of the dextral strike-slip of Trójgarb – Borek Strzeliński Fault. The Cadomian movement along the fault had the character of the transpression of the Imbramowice metamorphic massif on the Góry Sowie Block. During these movements the Cadomian metamorphic massif of Wzgórza Niemczańskie was also folded.

INTRODUCTION

The geological investigations in Sudetes showed from the very beginning that the faults play here the major role. H. Cloos (1922), on the basis of the faults, denominated the structure of these mountains as mosaic. Many faults were determined or described in the geological bibliography: the Main Sudetic Fault (H.Cloos, 1922; Oberc, 1964), the Marginal Sudetic Fault (H.Cloos, 1922; E.Bederke, 1934; J.Oberc, 1955; J.Oberc, S.Dyjor, 1969), and its prolongation in Eastern Sudetes (Z.Pouba, Z.Misař, 1961) and the fault system between Tłumaczów and Sienna in the Śnieżnik Massif, not yet described as a whole.

The fragments of the dislocations named above and some others were given various names, such as Szczawienko Fault (E.Dathe, E. Zimmermann, 1912) or

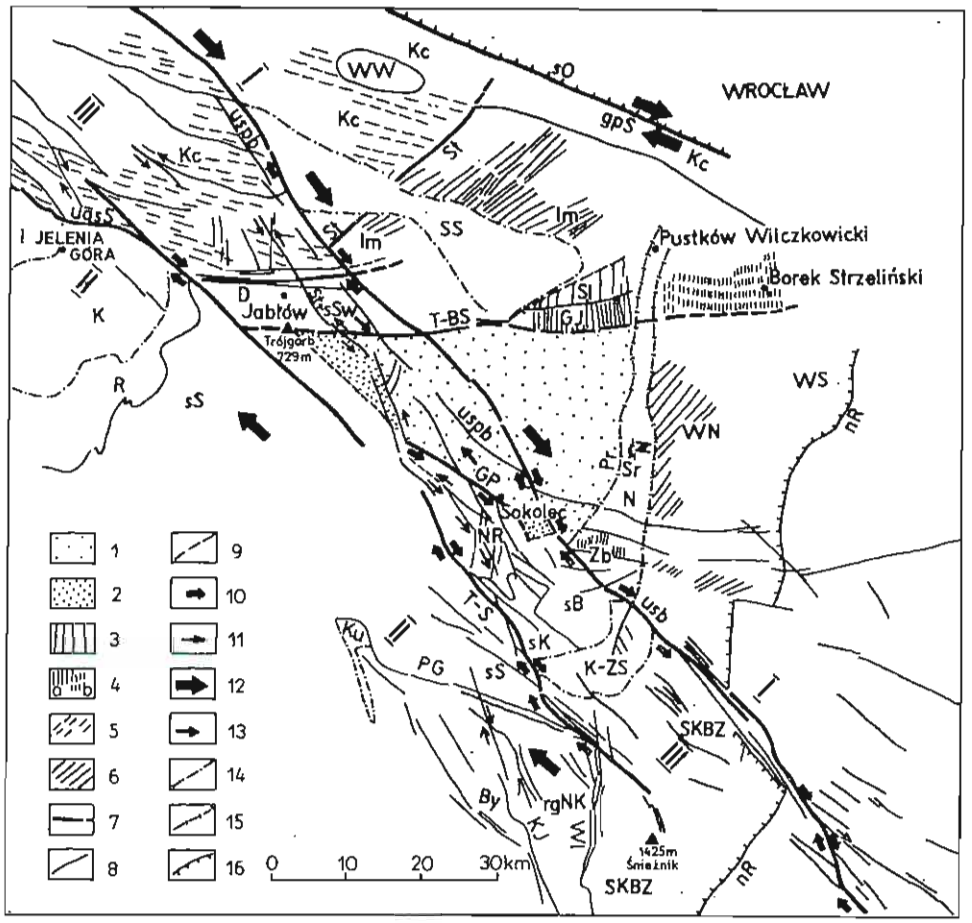

Fig. 1. Systems of main longitudinal strike-slip faults in the vicinity of the Góry Sowie Block
1 — Góry Sowie Block on the surface and under the cover rocks; 2 — fragments of the Góry Sowie Block under Palaeozoic formations; 3 — main outcrops of the basic rocks (NR – of Nowa Ruda, Sl – of Ślęża); 4 — main outcrops of ultrabasites: a — on the earth surface, b — under the surface (GJ — of Gogołów – Jordanów, Sr — of Szklary, Zb — of Ząbkowice Śląskie); 5 — Kaczawa Structure and the main (Variscan) lineation in its area; 6 — main lineation in the Cadomian metamorphic massif (Imbramowice metamorphic massif and Wzgórza Niemczańskie metamorphic massif); 7 — main faults (D — of Domanów, GP – of Głuszyca – Podlesie, T–S — of Tłumaczów – Sienna, T–BS — of Trójgarb – Borek Strzeliński, ugsS — Main Intra-Sudetic Fault, usb – Marginal Sudetic Fault); 8 — faults of lower order (PG — of Pstrążna – Gorzanów, Str — of Struga, St – of Strzegom, uspb – Near-marginal Sudetic Fault, Wl — of Wilkanów, KJ — of Kamieńczyk – Jagodna); 9 — marginal dislocations of the Niemcza Zone (N – of Niemcza, Pr — of Przystronie); 10 — strike-slip transport along the main faults; 11 — strike-slip transport along the faults of lower orders; 12 —transport of the strike-slip blocks of higher order; 13 — transport of some strike-slip blocks of lower order; 14 — boundaries of the granitoid intrusions; 15 — boundaries of the Niemcza Zone; 16 — Ramzova Overthrust (nR); Main Fore-Sudetic Overthrust (gpS); geological units: I — of Izera, Im — of Imbramowice, Kc — of Kaczawa, N — of Niemcza, R — of Rudawy Janowickie (Eastern Karkonosze), rgNK — Upper Nysa Kłodzka Graben, sS — Intra-Sudetic Synclinorium, WN — Wzgórza Niemczańskie Synclinorium; granitoids massifs: K — of Karkonosze , Ku

Domanów Fault (E. Zimmermann, 1933; A.K.Teisseyre, 1968) and many others. The photogeological map appeared in 1986; the authors (J.Bażyński et al., 1986), grounding their opinion on the geologically acknowledged and photogeologically confirmed dislocations, identified several faults unknown till then, broadening in this way the knowledge of the faulting tectonics of the Sudetes. These materials among others were used in this work. The analysis of faults showed that, for the fault-structure of the Góry Sowie Block, most important are the main dislocations with the direction NW–SE parallel or almost parallel to the general trend of the mountains.

Author considers this problem in a general way. Therefore, he speaks about the faults west of the Niemcza Zone and the Upper Nysa Kłodzka Graben as if they were longitudinal faults in spite of the fact that some of them are diagonal, or even perpendicular to the direction of the folds. Because of the change in direction of the folds east of the line mentioned above, the diagonal faults in the west become transverse faults. Therefore, the great dislocations with direction perpendicular to the given direction will not be examined (Fig. 2).

The aim of this work is not the description of the dislocations, but the causational connections between the main dislocations mentioned and the faults of the lower order usually with similar direction. The main dislocations are of Variscan age and part them have older foundations. The less important faults cut through the post-Variscan series.

— of Kudowa, K–ZS — of Kłodzko – Złoty Stok, SS — of Strzegom – Sobótka; metamorphic massif: By — of Góry Bystrzyckie and Góry Orlickie, SKBZ — of Śnieżnik, Krowiarki, Góry Bialskie and Góry Złote, sO — of Middle Odra, WW — of Wądroże Wielkie; tectonic structures: sB — of Bardo, sK – of Kłodzko, SSw – of Świebodzice, WS — of Wzgórza Strzelińskie; main strike-slip blocks: I — Fore-Sudetic Block, II — Intra-Sudetic Block, III — Outer-Sudetic Block

Układy głównych podłużnych dyslokacji przesuwczych w sąsiedztwie bloku sowiogórskiego

1 — blok sowiogórski na powierzchni i pod utworami pokrywowymi; 2 — fragmenty bloku sowiogórskiego pod utworami paleozoiku; 3 — główne występownia bazytów (NR — Nowej Rudy; Śl – Ślęży); 4 — główne wystąpienia ultrabazytów: a — na powierzchni Ziemi, b — pod powierzchnią (GJ — Gogołowa – Jordanowa, Sr — Szklar, Zb — Ząbkowic Śląskich); 5 — struktura kaczawska i główna (waryscyjska) lineacja w jej obrębie; 6 — główna lineacja w matamorfiku kadomskim, Imbramowic i Wzgórz Niemczańskich; 7 — uskoki główne (D — Domanowa, GP — Głuszycy – Podlesia, T–S – Tłumaczowa – Siennej, T–BS – Trójgarbu– Borka Strzelińskiego , ugsS — główny uskok śródsudecki, usb — uskok sudecki brzeżny); 8 — uskoki niższych rzędów (PG – Pstrążnej – Gorzanowa, Str — Strugi, St — Strzegomia, uspb — uskok sudecki przybrzeżny, Wl — Wilkanowa, KJ — Kamieńczyka – Jagodnej); 9 — dyslokacje ograniczające strefę Niemczy (N — Niemczy, Pr — Przystronia); 10 — transport przesuwczy wzdłuż uskoków głównych; 11 — transport przesuwczy wzdłuż uskoków niższych rzędów; 12 — transport bloków przesuwczych wyższego rzędu; 13 — transport niektórych bloków przesuwczych niższego rzędu; 14 — granice intruzji granitoidowych; 15 — granice jednostki Niemczy; 16 — nasunięcie ramzowskie (nR); główne nasunięcie przedsudeckie (gpS); jednostki geologiczne: I — izerska, Im — Imbramowic, Kc — kaczawska, N — Niemczy, R — Rudaw Janowickich (Wschodnich Karkonoszy), rgNK — rów górnej Nysy Kłodzkiej, sS — synklinorium śródsudeckie, WN — synklinorium Wzgórz Niemczańskich; masywy granitoidowe: K — Karkonoszy, Ku — Kudowy, K – ZS — kłodzko-złotostocki, SS — Strzegomia – Sobótki; metamorfik: By — Gór Bystrzyckich i Gór Orlickich, SKBZ — Śnieżnika, Krowiarek, Gór Bialskich i Gór Złotych, sO — środkowej Odry, WW — Wądroża Wielkiego; struktury: sB — bardzka, sK — kłodzka, SSw — Świebodzic, WS — Wzgórz Strzelińskich; główne bloki przesuwcze: I — przedsudecki, II — sudecki wewnętrzny, III— sudecki zewnętrzny

THE BOUNDARIES OF THE GÓRY SOWIE BLOCK

Authors working-out the synthetical structure of Sudetes (E.Cloos, 1922; F.Kossmat, 1925) observed long ago that the Góry Sowie Block is an exotic element in these mountains. At the basis of the similarity to the core of Bohemian Massif some authors tried to lead it from there by the way of Variscan horizontal movement (F.Kossmat, 1925), what has not been acknowledged till now. E.Bederke (1934) showed that the Góry Sowie Block is autochtonous from Upper Devonian.

The exotic elements ought to show the same age all boundaries. Probably, it was so during the time of occupying its position by the Góry Sowie Block, but during many movements with different directions the character and the course of its boundaries was changed. Author acknowledges as primary boundaries these, which are characterized by the intensive cataclasis and mylonitization of the rocks, and as secondary those boundaries in which this phenomena do not take part at large scale.

THE EASTERN BOUNDARY (THE PRZYSTRONIE FAULT) [1]

Even on the schemes given by E.Bederke (1934), repeated later in the geological bibliography, the contorsion of the surface of foliation is evident in the vicinity of Przystronie Fault in the direction of NE with the tendency to be parallel to this fault. K. H. Scheumann (1937) acknowledged the high degree of mylonitization of the rocks; because of this the term of the mylonitic Niemcza Zone is often used. These are undoubtedly the aspects of the intensive, probably many-phased movements along the Przystronie Fault. The surface of foliation in the Niemcza Zone and in the areas lying farther to the east shows the runs approximate to meridional, what probably shows that this position is connected with the movement of the Góry Sowie Block to the east. Somewhat farther the foliation has the direction SSW–NNE just as in the Imbramowice metamorphic massif north of the Góry Sowie Block.

THE SOUTHERN BOUNDARY (BEYOND THE BARDO STRUCTURE)

The small, isolated fragment of the Góry Sowie Block in the vicinity of Mikołajów, as E.Bederke (1929) showed is impressed in the direction of WSW in the series of the Góry Bardzkie. This phenomenon is connected with Asturian Phase (E.Bederke, *l.c.*; J.Oberc, 1953).

At the remaining section of the southern slope of Góry Sowie formations of Lower Carboniferous, lying discordantly on the Góry Sowie gneisses, are dipping to the south (E.Dathe, 1904) and are here cataclased. According to A.Pacholska (1978) the boundary between the gneisses and Lower Carboniferous of Bardo Structure is along

[1] J.Oberc (1972).

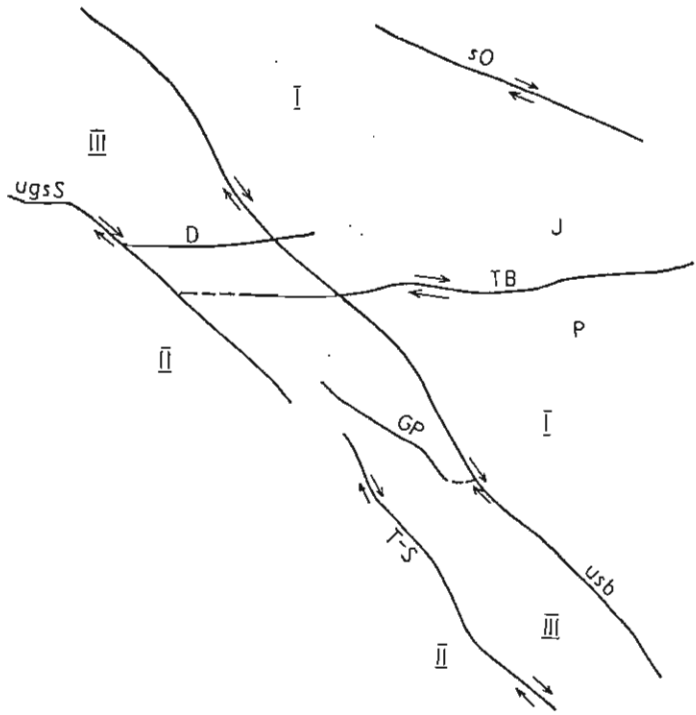

Fig. 2. Scheme of main strike-slip dislocations and blocks in the Góry Sowie Block zone
Dislocations: ugsS — Main Intra-Sudetic Fault, D — Domanów Fault, TB — Trójgarb – Borek Strzeliński Fault, GP — Głuszyca – Podlesie Fault, T–S — Tłumaczów – Sienna Fault, usb — Marginal Sudetic Fault; sO — Middle Odra Fault; Variscan strike-slip blocks: I — Fore-Sudetic Block, II — Intra-Sudetic Block, III — Outer-Sudetic Block; Cadomian strike-slip blocks: J — Imbramowice Block, P — southern block
Schemat głównych dyslokacji i bloków przesuwczych w sąsiedztwie bloku sowiogórskiego
Dyslokacje: ugsS — uskok główny śródsudecki, D — uskok Domanowa, TB — uskok Trójgarbu – Borka Strzelińskiego, GP — uskok Głuszycy – Podlesia, T–S – uskok Tłumaczowa – Siennej, usb — sudecki uskok brzeżny, sO — uskok środkowej Odry; bloki przesuwcze waryscyjskie: I — przedsudecki, II — sudecki wewnętrzny, III — sudecki zewnętrzny; bloki przesuwcze kadomskie: J — Imbramowic, P — południowy

the fault. In the light of the results of the investigations of the borehole Zdanów IG 1 it is probably the inverse fault.

In the borehole Zdanów IG 1 (M.Chorowska et al., 1987) it was acknowledged that the perforated formations of Devonian, Silurian and again Devonian were thrusted to the north during Sudetic Phase (J.Oberc, 1987) on the formations of Lower Carboniferous overlying the Góry Sowie gneisses (depth 1908.6 m). These gneisses reach not much further to the south what witnesses the tectonic situation between Zdanów and Nowa Wieś Kłodzka. The profile Zdanów IG 1 shows that the Góry

Sowie gneisses slope to the south in at least two steps running along the parallel of the latitude. These steps correspond to the inverse faults with vergency towards S.

THE SOUTH-WESTERN BOUNDARY (THE PODLESIE – GŁUSZYCA FAULT)

This dislocation is the fragment of the Main Sudetic Fault (J.Oberc, 1964). The margin of the Góry Sowie Block between Podlesie and Głuszyca is formed from strongly cataclased gneisses; it is then the primary margin. Characteristic for this section is the narrow (probably inverse) gneissic horst separating Carboniferous of Intra-Sudetic Synclinorium from Lower Carboniferous of Góry Sowie Mts in the vicinity of Sokolec. This horst was discovered by W.E.Petrascheck (1939). The margin mentioned was for many times engaged in the tectonic movements what show the intrusions of serpentinites (Przygórze), of gabbro (Sokolec), and the breccias, ore veins and kersantite veins (E.Dathe, 1904). Along the margin of gneisses runs the tectonic graben consisting of Žacleř Beds.

In the vicinity of Głuszyca the SW margin turns distinctly to NNW. Because of this, the zone of the cataclased gneisses, disappearing under the Wałbrzych Synclinorium, is cut-off, and the margin (at the surface) has secondary character. The Struga Fault having the character of the inverse fault of Asturian age (J.Oberc, 1972) forms the ENE margin of Intra-Sudetic Synclinorium on which the Góry Sowie gneisses in the south and Świebodzice Structure to the north are overthrust.

The Main Sudetic Fault (NW of Głuszyca to the vicinity of Ciechanowice) along the margin of Rudawy Janowickie Mts cuts the formations of Carboniferous of Intra-Sudetic Synclinorium and is known in two versions. According to the classical mapping it forms the prolongation of the Podlesie – Głuszyca Fault and so it was described by H.Cloos (1922) and J.Oberc (1964). However, according to the photogeological interpretation (J.Bażyński et al., 1986), the Main Sudetic Fault slipped for about 3 km SW from Głuszyca. The rhyolites of Upper Carboniferous are connected with it to the south and west of Wałbrzych (the Chełmiec laccolith with the Sobięcin rhyolite vein). J.Oberc (1964, 1972) accepted the suggestion of E.Bederke (1929) and of E.Bederke and K.Fricke (1943) that the Wałbrzych Synclinorium is underlaid by the Góry Sowie gneisses and its western boundary is formed by the Jabłów Anticline, which seems lying over the Main Sudetic Fault as the anticline overlying the fault.

THE NORTHERN MARGIN OF THE GÓRY SOWIE BLOCK

The northern margin of the Góry Sowie Block as a whole has never been described till now, or even denominated.

E.Dathe and E.Zimmermann (1912), drawing the boundary between the Góry Sowie Block and the Świebodzice Structure in the map sheet of Świebodzice (Freiburg) and writing about the Szczawienko Fault (H.Teisseyre, 1956), speak about the northern marginal fissure of Góry Sowie Mts (nördliche

Eulengebirge-Randspalte). This notion seems to correspond to the northern margin of the Góry Sowie Block. The data obtained till now indicate, that the northern margin of the Góry Sowie Block has secondary character. With this margin are connected the biggest outcrops of the ultrabasic rocks, beginning from Gogołów to at least Borek Strzeliński, where the ultrabasites were bored (J. Jerzmański, 1989). It shows that this dislocation, for which the name the Trójgarb (729 m a.s.l.) – Borek Strzeliński Fault is proposed. reaches beyond NE angles of the Góry Sowie Block. To the west it is probably connected with the Main Sudetic Fault.

The middle section of the Trójgarb – Borek Strzeliński Fault was described as the Szczawienko Fault (H.Teysseyre, 1956) separating the Świebodzice Structure from the Góry Sowie Block. This fact shows that the Trójgarb – Borek Strzeliński Fault was active during the Nassau Phase, when the Świebodzice Structure was folded.

Farther to the east, the northern margin of Góry Sowie Block consists of the boundary with serpentinites, precised by Z.Gajewski (1970). The intrusive contact between the ultrabasites and gneisses may be accepted as a sort of fault, which could be earlier used by the ultrabasites.

The foundations of the Trójgarb – Borek Strzeliński Fault seem to be with the period of folding of the formations of shists of the Imbramowice Unit. These shists reached earlier much farther to the south and were washed away in the area over the later gabbros and serpentinites. The metamorphic lineation in the Imbramowice Unit has the regular direction SW–NE, such as in the series of shists east of the Niemcza Zone and in the Wzgórza Strzelińskie Hills. The Imbramowice and Wzgórza Niemczańskie units are separated by the northern prolongation of the tectonic graben of the Niemcza Zone in which the formations of Sylurian were preserved near Pustków Wilczkowski (J.Oberc, 1987). This graben separates both crystalline areas. Its younger structural horizon corresponds to the Bardo Structure.

The fundamental outline of the tectonics of the Imbramowice metamorphic massif, given above, could form during the tectonic transport directed to SE before the sedimentation and folding of the Kaczawa series west from the Strzegom Fault (J.Oberc, 1980). The Kaczawa Structure did not take part in the main folding of the shists of Imbramowice Unit, it is younger and the direction of the tectonic transport during the Sudetic Phase was directed to SSW. Its narrow band (from Legnica to Kąty Wrocławskie) — built of the greenshists and found under the Tertiary formations by J.Jerzmański (1989) — is impressed between the Imbramowice metamorphic massif and the central part Middle Odra metamorphic massif and probably overthrust on the Imbramowice metamorphic massif.

Old-Cadomian folding movements of Western Sudetes seem to be responsible for the direction of the Imbramowice Structure. They are in part hidden under the Kaczawa series where, as in the of Karkonosze – Góry Izerskie Block, exist the primary directions of folds WNW–ESE (J.Oberc, 1967 *a, b*). The Wądroże Wielkie gneisses, in which reign the directions of folds (metamorphic lineation) WNW–ESE (J.Oberc, 1960 *a*), are the fragments of this basement. Similarly oriented is the metamorphic lineation in the surrounding shists. This structure during the deformation of the Imbramowice Unit and the eastern branch of Cadomian tectogene (Wzgórza

Niemczańskie Hills) moved to SE or ESE what caused the forming of the lineation with the direction SW–NE.

It results from the image given, that:

— the direction of the northern margin of the Góry Sowie Block is oblique to the directions of the lineation in the Imbramowice Unit and the eastern branch of Cadomian tectogene; the angle between them equals to 30–60°;

— the Trójgarb – Borek Strzeliński Fault during the deformation of the Imbramowice Unit and its movement towards SE had the strike-slip character; the transpression of the shists series on the Góry Sowie Block was marked at the boundary of these units.

The Trójgarb – Borek Strzeliński Fault was followed by the ultrabasites of the Gogołów – Jordanów – Borek Strzeliński serpentinite massif, and then by the intrusions of gabbro. In the Lower Carboniferous of the Świebodzice Structure (E.Dathe, E.Zimmermann, 1912) and in the conglomerates of Lower Carboniferous in the north-western part of the Intra-Sudetic Synclinorium exist the gabbro — pebbles. The last outcrops of ultrabasites in the zone spoken about are the ultramaphic rocks from the vicinity of Janowice Wielkie (G.Berg, 1912; J.Teisseyre, 1965). They are connected with the Main Sudetic Fault; the Karkonosze – Góry Izerskie section of this fault investigated G.Berg (1912) and called the Main Intra-Sudetic Fault.

The Trójgarb – Borek Strzeliński Fault of the section the Gogołów – Jordanów serpentinite massif forms the secondary margin of the Góry Sowie Block.

THE DOMAŃÓW FAULT

The Domanów Fault was already known to E. Zimmermann (1933) and is bran-ching in the vicinity of Ciechanowice from the Main Intra-Sudetic Fault, separating the Kaczawa Structure from the Intra-Sudetic Synclinorium in the west and from the Świebodzice Structure to the east. It was possible to confirm photogeologically (J.Bażyński et al., 1986), that the fault consists of the set of 3–4 parallel faults (fault zone of Domanów), which are prolonged to the area of Fore-Sudetic Block. At the section of Intra-Sudetic Synclinorium A.K.Teisseyre (1968) found that the fault was active in Lower Carboniferous. The north upthrown side of fault supplied the mate-rial to the synsedimentary breccia forming beside of the fault. The greenstone material of this upthrown block is not such in reality, treated as belonging to Góry Kaczawskie Mts (H.Teisseyre et al., 1957; A.K.Teisseyre, 1968). The Kaczawa series were deposited in this time far to the north (J.Oberc, 1980). The greenshists belong to other Sudetic units deformed before the Sudetic Phase, and are cut through in the early Lower Carboniferous by the Domanów Fault. The movement along the Domanów Fault was repeated (or is active till now) after the overthrusts of the Kaczawa nappes. They are preserved on (this time downfaulted) the northern footwall of the Domanów Fault.

The eastern prolongation of the Domanów Fault is difficult to identify on the geological maps, drawn till now.

THE MAIN SUDETIC FAULT AND THE SET OF FAULTS BETWEEN GŁUSZYCA AND ŚNIEŻNIK MT.

J.Oberc (1964) denominated the Main Sudetic Fault of as a clipper fault. At the Karkonosze – Góry Izerskie section its southern side block is raised; the Góry Izerskie gneisses border along the dislocation with the Kaczawa Structure. At the eastern section — between Głuszyca and Podlesie — northern block (the side of Góry Sowie Mts) is raised, while the southern block is downthrown (Intra-Sudetic Synclinorium). The axis of rotation occurs in the formations of Lower Carboniferous of Intra-Sudetic Synclinorium (in the vicinity of Marciszów and Ciechanowice). According to this rule two synclinoria of Sudetes (Intra-Sudetic Synclinorium and North-Sudetic Synclinorium), lie as the downthrown blocks at the opposite sides of the dislocation.

The strike-slip component of this dislocation (probably multiphased) is difficult to denominate, because it is approximately parallel to the foliation surface in the gneisses or parallel deposition surfaces in Palaeozoic of Góry Kaczawskie Mts. The map in the paper of S.Radwański (1954) shows in the formations of Lower Carboniferous the contact at right angle of the surfaces of deposition NNE–SSW, typical for the flexural zone of Eastern Karkonosze, with the direction WNW–ESE typical for the great areas of Intra-Sudetic Synclinorium and Góry Kaczawskie Mts. The flexure mentioned formed under the influence of Asturian movement of the Karkonosze Block in the direction ESE (J.Oberc, 1980). The direction of the movement deduced in this way is not in concordance with the dislocational movement founded on the criterion of the plumose system of faults (see below).

Many dislocations, in part of first-rate importance, such as the fault bundle of Domanów Fault and the Trójgarb – Borek Strzeliński Fault, branch from the Main Sudetic Fault towards E, forming sharp angles. Such arrangement, typical for the plumose system of strike-slip faults, showed that movement of the northern side of dislocation was in the direction ESE.

The arrangement of main faults exists in the vicinity of Tłumaczów at the prolongation of the Main Sudetic Fault towards SE the area of Intra-Sudetic Synclinorium. Part of them forms the boundary between the synclinorium and crystalline basement, especially with Nowa Ruda gabbros and the metamorphic area of the Kłodzko Structure, and Krowiarki. The main dislocation found using carthographic methods and in part using photogeological methods runs between Tłumaczów – Radków and Sienna (near Śnieżnik Mt.). The intrusive boundary of the Kłodzko – Złoty Stok Massif and the Wilkanów Fault confining from the west Upper Nysa Kłodzka Graben seem to be the branches of this dislocation. Several smaller faults branch from it at both sides, forming sharp angles. The Pstrążna – Gorzanów Fault, bordering from the north the Kudowa granites, is the longest. The Stary Waliszów Fault, marking out at the certain section the boundary between the crystalline area of Krowiarki and Cretaceous rocks of the Upper Nysa Kłodzka Graben part of the Tłumaczów – Sienna Fault.

The complex of faults and flexures, forming the western boundary of the Upper Nysa Kłodzka Graben, disappearing in the area of Intra-Sudetic Cretaceous region in

the vicinity of Polanica Zdrój, seems to approach the Pstrążna – Gorzanów Fault from the south.

THE MARGINAL SUDETIC FAULT

The Marginal Sudetic Fault, on which the orographic margin of Sudetes was founded, is running from Bolesławiec to Jesenik at the length of about 150 km with the prolongation towards west in the direction of Döbern (J. Sokołowski, 1967). It was described by H. Cloos (1922), W. Thust (1927), E. Bederke (1929), J.Oberc (1955, 1960 *a,b*) and J.Oberc, S.Dyjor (1969). Authors attribute to this fault in most cases Tertiary or Neogene age. According to J.Oberc and S. Dyjor (*l.c.*) this fault cuts through the formations of Upper Miocene and the peneplain earlier than Upper Miocene. H.Cloos (1922) noticed as the first that the erosion of the Fore-Sudetic Block — separated from Sudetes by the Marginal Sudetic Fault — is deeper than the erosion of the Sudetes. J. Oberc (1968) estimated the difference in the erosion depth of the Fore-Sudetic Block in the relation to Sudetes at about 2500 m, because Bardo and Świebodzice structures are not present, as they were here eroded. Along the VII-th profile GSS the Moho surface in Sudetes lies at the depth of 36 km; under the Fore-Sudetic Block it lies at the depth of 30 km (A. Guterch et al., 1975). The erosion of the Fore-Sudetic Block lasted during uppermost Palaeozoic, Mesozoic till the Middle Miocene. It results from above, that the Marginal Sudetic Fault was formed on the Late Variscan dislocation, the downthrown of which was opposite then in the time of the Tertiary renewing of the marginal fault (H.Cloos, 1922; J.Oberc, 1968, 1987).

Many faults are approaching the Marginal Sudetic Fault at sharp angles. The last stage of development of these faults took part in various periods of the geological time. In the north-west these faults are the Laramide inverse fault (Góry Kaczawskie Mts). We do not know, whether these faults are prolonged to the Fore-Sudetic Block because of the broad spreading of Neogene formation. In the middle section, in the area of southern part of Góry Sowie Block, the marginal fault is approached from the east by the early Tertiary faults running along the parallel of the latitude; at the East-Sudetic section the angle between the marginal fault and the approaching faults diminishes, and sometime they are parallel. In the case of many existing faults, parallel or nearly parallel, we can speak about the marginal fault zone of Sudetes. The Near-marginal Sudetic Fault (J.Bażyński et al., 1986) shows great regularity and is precisely parallel at the section of Góry Sowie Mts.

METHODS OF INTERPRETATION

The use of the methods of measurement in the investigation of faults, especially multiphased faults and great faults, is very difficult. The tectonization of rocks causes the diminishing of their resistance to the weathering and erosion. As a result, the

valleys are formed with slopes covered by the mantle of waste. Hence the difficulties with the observation and collection of measurement data. Author adapted the cartographic image of the faults and used two methods. The first is applied to the proofs on the strike-slip character of the faults, the second is applied to the development of great faults during the geological time.

The starting point of the first method is so called plumose fault (W. Jaroszewski, 1981). It consists of two elements: the fault itself and the accompanying oblique, thickly lying fractures or cleavage. The sharp angle between the fault and the cleavage is in shadow of the movement of the block moved horizontally. It would be proper to speak about "the criterion of the sharp angle".

In the interpretation used in this paper, the role of the model fault plays the great fault, and the role of cleavage — the smaller faults branching from it. Such arrangement consists then of three blocks (and not two) separated by two faults. It is then reasonable to speak about the plumose system of faults (Fig. 1).

The second criterion pertains to the development of the great, manyphased faults. The great dislocations change the character of the movement in the structural horizons existing one over the other in dependence from the changes of the structural plans of the deformations existing one after the other. The strike-slip fault, the inverse fault and the normal fault can be stages of the development. The succession of the stages may be different. The great dislocations develop beginning from the lower to the higher structural horizons (stages; postume faults). Because of this in Sudetes, we can extend the considerations on the strike-slip faults, to the strike-slip faults in the platform-socle and in the platform-cover, and even to the normal faults, and in the end to young faults marked in the morphology of the terrain; the best example may be the Marginal Sudetic Fault, developed on the strike-slip fault.

Additionally, during the movements, especially strike-slip movements, the local fields of force and connected with them systems of faults of lower order are forming. The interpretation of the "prolonging of faults upwards", that is in the higher structural stages in Upper Silesian Basin was used by E.Herbich (1981).

THE SYSTEM OF MAIN SUDETIC FAULT AND THE FAULT COMPLEX BETWEEN TŁUMACZÓW AND ŚNIEŻNIK MT.

The bundle of faults of Domanów, running along the parallel of the latitude, branches from the north-western section of the Main Sudetic Fault. It is more than certain, that the Trójgarb – Borek Strzeliński Fault branches from the prolongation in the west of the main dislocation. Although the geological mapping and photogeological investigations did not show it, there are here two possibilities: a — the dislocation is impalpable in the monotonous Lower Carboniferous formations; b — the dislocation does not appear in the Lower Carboniferous formations, but is covered by them. It is very not probable, that such great dislocation are extinct already in the Trójgarb Massif.

The situation of the faults of lower order, branching in the directlon SW in the vicinity of Jelenia Góra, is nor clear in the regional image of the Main Intra-Sudetic

Fault. Author is inclined to accept, that this phenomenon is connected with the movement of the eastern part of the granitic intrusion of Karkonosze Mts towards ESE. At the opposite side of the Main Intra-Sudetic Fault the dislocations branching to NW could form.

Between Tłumaczów and the slopes of Śnieżnik Mt. (Sienna), several faults are branching to the east from the Main Sudetic Fault; only one fault branches to the west. It is the great Pstrążna – Gorzanów Fault, which ended its forming during Laramide Phase. This dislocation cuts the Kudowa granite from the north, and in the direction NE from Zabłocie it connects with the Tłumaczów – Sienna Fault. The position of the Wilkanów Fault in the system of Tłumaczów – Sienna faults is not clear; the fault is branching from the main dislocation to the south, and its prolongation to the north is disappearing in the crystalline area of Krowiarki. Speaking about the Głuszyca – Podlesie Fault it must be mentioned that several faults are branching from it towards SE. The Głuszyca – Polesie Fault shows in turn the tendency to approaching the Marginal Sudetic Fault (see above). Nevertheless, the connection between these two dislocations (if it exists) is masked by the very complicated Bardo Structure.

THE SYSTEM OF MARGINAL SUDETIC FAULT

In the map enclosed two sections are visible. At the north-western section exist several smaller faults, branching to the west in the direction of Sudetes, forming sharp angles. Similarly behaving is the Głuszyca – Podlesie Fault. In the southern zone of the section of Góry Sowie Mts and Góry Bardzkie Mts many neotectonic faults (J.Oberc, S.Dyjor, 1969) are approaching the marginal fault from the east, forming sharp angles with the marginal fault. At the south-eastern section the branches directed towards Sudetes, that is to SE, in part towards Fore-Sudetic Block, that is to E, are prevailing. At the section of Góry Bardzkie Mts and of the Kłodzko – Złoty Stok Massif the branches away from the marginal fault are lacking. It seems, as if it were the area, away from which the strike-slip dislocations in the Sudetic Block were directed in the opposite sides, that is to NW and SE. The section makes part of the border zone between the directions of fold structures typical for the Western Sudetes — NW–SE, WNW–ESE — and for the Eastern Sudetes — directions of folds NNE–SSW (J.Oberc, 1991). However, the relation of the marginal fault to the fold structures is different. At the section NW it is diagonal; at the section SE — transversal.

THE SCALE OF THE STRIKE-SLIP MOVEMENTS

The qualification of the strike-slip faults (longitudinal or nearly longitudinal) is very difficult. Because of this, the determination of the amplitude is difficult also. Such a situation takes place along the north-western section of the Main Sudetic Fault. The scale of movements along the Marginal Sudetic Fault, with the exception of the section of Góry Sowie Mts where the strike-slip movements are lacking, cannot be determined because of the deep erosion of the Fore-Sudetic Block; already before

Tertiary Bardo and Świebodzice structures were eroded. The bend towards NW (at the length of about 20 km) cannot be explained by the strike-slip movement of Ramzova Overthrust on the Fore-Sudetic Block (E.Bederke, 1931, 1934; J.Oberc, 1968).This bend has the direction contrary to the movement of the Fore-Sudetic Block along the Marginal Sudetic Fault (Fig. 1).

THE SYSTEMS OF STRIKE-SLIP BLOCKS IN THE AREA OF THE GÓRY SOWIE BLOCK

Two systems of strike-slip blocks of different ages exist in the Góry Sowie Block zone: the older and the younger system. The older system is determined by the forming of the Trójgarb – Borek Strzeliński Fault. The formed strike-slip blocks can be named as the northern block (of Imbramowice) and the southern block.

In the younger system of strike-slip blocks the blocks of lower and higher order can be separated. The blocks of higher order are: the Fore-Sudetic Block, the Outer-Sudetic Block (up till the Main Sudetic Fault in the north-west) and assemblage of dislocations between Tłumaczów and Śnieżnik Mt. (Sienna) in the south-east. The Outer-Sudetic Block splits into two segments separated by the diagonal Głuszyca – Podlesie Fault: the north-western and the south-eastern segment. Farther to SW is the Intra-Sudetic Block, which is not interesting to us. The boundary between two Sudetic blocks is not marked in the Moho surface (36 km), while in the case of the Marginal Sudetic Fault is raised to 30 km (A.Guterch et al., 1975), as it was mentioned before. This difference shows the greater role of the vertical movements of Sudetes, beginning as a whole from the Variscan time, rather then the movements along the Main Sudetic Fault.

The general image (Fig. 2) shows, that the main faults have the dextral character in Paleozoides (systems NW–SE) just as in the Cadomian structure — Trójgarb – Borek Strzeliński Fault. However, the set of the strike-slip faults of the lower orders shows sinistral features as well (Fig. 1).

The Outer-Sudetic Block is the most varied in the aspect of strike-slip faults. At its north-western section the great faults with pre-Variscan foundations are bran-ching (with the direction inside), but at the south-eastern section, especially along the system Tłumaczów – Sienna (Śnieżnik Mt.) the branches are sometimes marked and have the direction to the outside of the Outer-Sudetic Block.

At the margin of the introduced term "the Outer-Sudetic Block", author gives some remarks touching its regional position. Generally speaking, this block has the character of the complicated post-orogenic tectonic graben, which it is proposed by author to call the main tectonic graben of Sudetes. Deep Caledonian synclinoria (the Kłodzko Structure), Variscan (the Świebodzice and Bardo structures, the mountainous part of the Kaczawa Structure), old-Alpine North-Sudetic Synclinorium and the Kłodzko – Złoty Stok granitoid massif, together with the strongly elevated mountainous massif of the Góry Sowie Block with some traces of Lower Carboniferous cover belong to it. The main tectonic graben of Sudetes is

limited from SE by the outcrops of the Góry Złote metamorphic massif. From NW the boundary of the graben is not so sharp and can be observed in Łużyce.

The main tectonic graben of Sudetes in the cross-section shows the prominent asymmetry. It has the greatest depth along the Marginal Sudetic Fault, beyond which the Bardo and Świebodzice structures, and the part of the Kłodzko — Złoty Stok granitoid massif were eroded in the uppermost Palaeozoic and Mesozoic periods (see higher). The Moho surface in the south-western block of the Marginal Sudetic Fault lies at the depth of 36 km, while on the Fore-Sudetic Block at the depth of 30 km (A.Guterch et al., 1975). Late Tertiary uplifting movement of Sudetes as a tectonic horst diminished the depth of the graben in the vicinity of Marginal Sudetic Fault not more than about 400 km (J.Oberc, S.Dyjor, 1969). The outher zone of Sudetes is them a tectonic graben and escarpment horst as well.

The boundary of the main tectonic graben of Sudetes in distinct at the section of the Karkonosze – Góry Izerskie Block. The rest of the south-western boundary runs trough the Intra-Sudetic Synclinorium.

THE MOVEMENTS OF THE STRIKE-SLIP BLOCKS

The confirmation of the dextral character of the movements along the main Palaeozoic faults of the Sudetic Structure leaves some problems to solve, especially touching the Middle Odra Fault, along which the dextral movement took also place. In case of taking into account of the boundaries of strike-slip blocks, then along their edges the sinistral movement takes part, adverse of lower order to the movement along the main faults. The explanation of this fact in the Outer-Sudetic Block is rather simple; the adverse movement of the Fore-Sudetic Block and Inter-Sudetic Block caused the formation of the great amount of faults of lower orders because of the local fields of forces. However, the adverse movement of the Outer-Sudetic Block and the block existing in the north-east of the Middle Odra Fault (Fore-Sudetic Monocline-Block — A.Guterch et al., 1975) did not cause the existence of the phenomenon of this type in the Outer-Sudetic Block.

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Received: 8.05.1990

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UKŁADY GŁÓWNYCH PODŁUŻNYCH DYSLOKACJI PRZESUWCZYCH W SĄSIEDZTWIE BLOKU SOWIOGÓRSKIEGO (SUDETY)

Streszczenie

Blok sowiogórski, zbudowany z gnejsów moldanubskich, położony jest w tej części Sudetów Zachodnich, w której panują fałdy o kierunkach WNW–ESE lub NW–SE. Jedynie w położonym na północ od niego kadomskim epi- i mezozonalnym metamorfiku Imbramowic fałdy (lineacja metamorficzna) mają kierunki SW–NE, jak w krystaliniku Wzgórz Niemczańskich. W czasie dźwigania się bloku sowiogórskiego z głębokiego podłoża do poziomu zajmowanego dzisiaj w waryscyjskiej (w zasadzie) strukturze Sudetów Zachodnich gnejsy na jego brzegach zostały skataklazowane bądź zmylonityzowane. W ślad za pionowymi ruchami bloku sowiogórskiego przemieszczały się ku górze w czasach waryscyjskich początkowo magmy ultrazasadowe (serpentynity), później zasadowe (gabra) dzisiaj podścielające i okalające na powierzchni blok sowiogórski. Najbardziej południowa i zachodnia część bloku sowiogórskiego ukryta jest pod utworami paleozoiku. Wzdłuż uskokowych granic z tymi utworami nie występują na powierzchni większe masy kataklazytów ani mylonitów.

Północną równoleżnikową krawędź bloku sowiogórskiego, na której nie została zachowana strefa mylonitów i kataklazytów, stanowi przedłużająca się w obu kierunkach dyslokacja (uskok) Trójgarbu – Borka Strzelińskiego. Zachodnie jej zakończenie przykryte jest zlepieńcami turneju. Na sąsiednim odcinku występuje tu, już na powierzchni, blok sowiogórski graniczący ze strukturą Świebodzic (D3–C1 gatt.) fałdowaną w czasie ruchów nassauskich. Wzdłuż pozostałych odcinków dyslokacji Trójgarbu – Borka Strzelińskiego występują serpentynity wychodzące na powierzchnię w masywie Gogołowa – Jordanowa. Na północ od serpentynitów znajduje sie strefa gabr. Nad tymi skałami została zerodowana część krystaliniku Imbramowic, który przed zajęciem przestrzeni przez skały zasadowe i ultrazasadowe

graniczył z blokiem sowiogórskim. Kąt między wspomnianą już lineacją w metamorfiku Imbramowic a brzegiem bloku sowiogórskiego wynosi 30–60°, co autor tłumaczy jako wynik transpresji. Dekstralny transpresyjno-przesuwczy ruch metamorfiku Imbramowic wzdłuż dyslokacji Trójgarbu – Borka Strzelińskiego uformował w tej części budowli sudeckiej kadomskie bloki przesuwcze.

Równoległa do dyslokacji Trójgarbu – Borka Strzelińskiego jest dyslokacja Domanowa ograniczająca od południa strukturę kaczawską (Cm1–C1) fałdowaną w czasie fazy sudeckiej.

Głównymi podłużnymi dyslokacjami w sąsiedztwie bloku sowiogórskiego są:

— rozpoznana przez H.Cloosa (1922) główna dyslokacja Sudetów (J.Oberc, 1964), oddzielająca strukturę Gór Kaczawskich od bloku karkonosko-izerskiego; ku ESE wchodzi w obręb synklinorium śródsudeckiego (C1–T1, K2), po czym ogranicza od SW blok sowiogórski jako dyslokacja Głuszycy – Podlesia.

— dyslokacja Tłumaczowa – Siennej, której końcowy odcinek wchodzi w strefę kierunków wschodniosudeckich (N–S lub NNE–SSW); nie zmieniając kierunku zachodniosudeckiego staje się dyslokacją poprzeczną;

— uskok sudecki brzeżny, neotektoniczny rozwinięty jest na dyslokacji waryscyjskiej, której podniesione skrzydło stanowi blok przedsudecki; był on erodowany od schyłku paleozoiku do starszego trzeciorzędu włącznie (J.Oberc, 1968);

— dyslokacje Domanowa i Trójgarbu – Borka Strzelińskiego należą do dyslokacji głównych; chociaż nie są podłużne odgałęziają się od głównej dyslokacji Sudetów.

Od głównych dyslokacji sudeckich odchodzą pod kątem ostrym liczne mniejsze dyslokacje tworzące wielkoskalowe systemy pierzaste. Systemy te dowodzą przesuwczego charakteru dyslokacji głównych. Kierunek ruchu przesuwczego skrzydeł uskoków głównych zaznaczony jest na fig. 1 odpowiednimi strzałkami. Ruchy wzdłuż uskoków głównych są dekstralne. Amplitudy przemieszczeń przesuwczych nie zostały określone. Autor przyjmuje, że są one małe.

Systemy pierzaste uskoków wyznaczają waryscyjskie bloki przesuwcze różnych rzędów. Najważniejsze z nich to bloki: przedsudecki, sudecki wewnętrzny i sudecki zewnętrzny. Ten ostatni jest silnie zdyslokowany. W stosunku do bloków sąsiednich stanowi on rów tektoniczny o bardzo złożonej budowie. Jest to główny rów tektoniczny Sudetów.

Autor włączając do systemów pierzastych również uskoki powaryscyjskie (z neotektonicznymi włącznie) przyjął tezę, że uskoki te są odnowione (wtórne — postumne). Uskoki główne i pierzaste ich odgałęzienia w pokrywach platformowych stanowią przedłużenie ku górze uskoków przesuwczych z cokołu waryscyjskiego budowli sudeckiej.

Powaryscyjskie ruchy wzdłuż uskoków waryscyjskich, a nawet starszych, nie mają na ogół charakteru przesuwczego. Dla waryscydów środkowej Europy autor przyjął tezę, że charakter ruchu wzdłuż uskoków starszych zmieniał się (J.Oberc, 1987). Poszczególne uskoki w różnych etapach miały charakter bądź to przesuwczy, inwersyjny, bądź też grawitacyjny.