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GEOMETRIC ANALYSIS OF STEEP-DIPPING DISLOCATIONS WITHIN THE GRANITOID CORE IN THE POLISH PART OF THE TATRA MTS

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Abstract: The paper is focused on steep dipping dislocations within the granitoid core of the Polish part of the Tatra Mts. Two groups of dislocations were distinguished: single faults with flat and smooth planes, and mylonitic and cataclastic zones. With the help of TectonicsFP software, the reconstruction of the stress pattern, responsible for the formation of single faults, is presented basing on slip structures on their planes. The structures can be linked with the Middle Miocene (Sarmatian) 106–120° extension; in effect a set of normal oblique-slip, ≈35/60N faults was formed with a horizontal sinistral component. The geometry of the system of mylonitic and cataclastic zones should be analysed after reversing them to positions prior to the post-Palaeogene rotational upheaval of the Tatra Mts. The orientation of some dislocation zones, described in literature, is revised.

Key words: Tatra Mts, faults, slickenside, stress axes, Middle Miocene extension.

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INTRODUCTION

The granitoids of the High Tatra Mts (Fig.1), the Rb-Sr age of which was determined at 290±15 Ma (Burchart, 1968), and the ^{40}Ar-^{39}Ar age at 305–327 Ma (Maluski *et al.*, 1993), were subject to many tectonic deformations taking place in different conditions (Grochocka-Piotrowska, 1970; Piotrowska, 1997; Żelaźniewicz, 1997). The age and character of the particular fault systems are difficult to determine due to the rotation of the Tatra Massif (Piotrowski, 1978; Kovač *et al.*, 1994). This event changed the position of the fault planes in relation to the stress axes, as well as influenced the relative isotropy of the rocks; thus the sense of movement and its magnitude are difficult to determine. In earlier papers (Jurewicz, 2000a), the author focused on the characteristic system of flat dipping faults (<45°), which were then used in the reconstruction of the stress pattern with help of TectonicsFP software. Such faults occurring within the crystalline rocks of the Wyspa Goryczkowa were previously analysed by Burchart (1963). The planes of these faults are typically flat, smooth, mineralised with epidote, quartz or chlorites, and possess well-preserved tectoglyphs. The interpretation of the slip structures points to their link with Alpine nappe thrusting. The direction of compression varied during the charge, probably due to the basement rotation (Jurewicz, 2000a). This was subsequently confirmed by structural analysis of the nappe units (Jurewicz, 2000b).

Apart from the analysed flat-dipping faults, steep dislocations (dip>45°) responsible for the formation of most rocky passes are also present in the granitoid core of the High Tatra Mts. During fieldwork the dislocations were initially subdivided into two groups:

a) steep dislocations comprising singular planes or systems of several parallel planes;

b) steep dislocations comprising mylonites or cataclasites, several tens of centimetres to approximately 2–3 m wide, or comprising a series of narrow zones from several to several tens of centimetres wide.

To a certain degree this subdivision corresponds to the subdivision applied by Grochocka-Piotrowska (1970) for dislocation zones into the so-called uniform slip zones, mylonite and cataclastic zones as well as dislocation zones with plastic deformations. The term "mylonitic zones", commonly applied in literature (Passendorfer, 1974; Piotrowska, 1997), is not precise, as it is also applied to zones macroscopically determined as cataclase zones. Determining the degree of metamorphism in tectonic zones requires a separate petrographic analysis, useful in specifying conditions, in which mylonites and cataclasites were formed in the Tatra Mts., and in comparing with conditions under which faults with flat and smooth planes were formed. Variable pressures and temperatures in the process of formation of mylonites and cataclasites were indicated by liquid-gaseous inclusions in quartz (Kozłowski & Jurewicz, 2001), what will probably lead to the revision of the presently accepted Alpine age of the mylonitic zones. The conditions

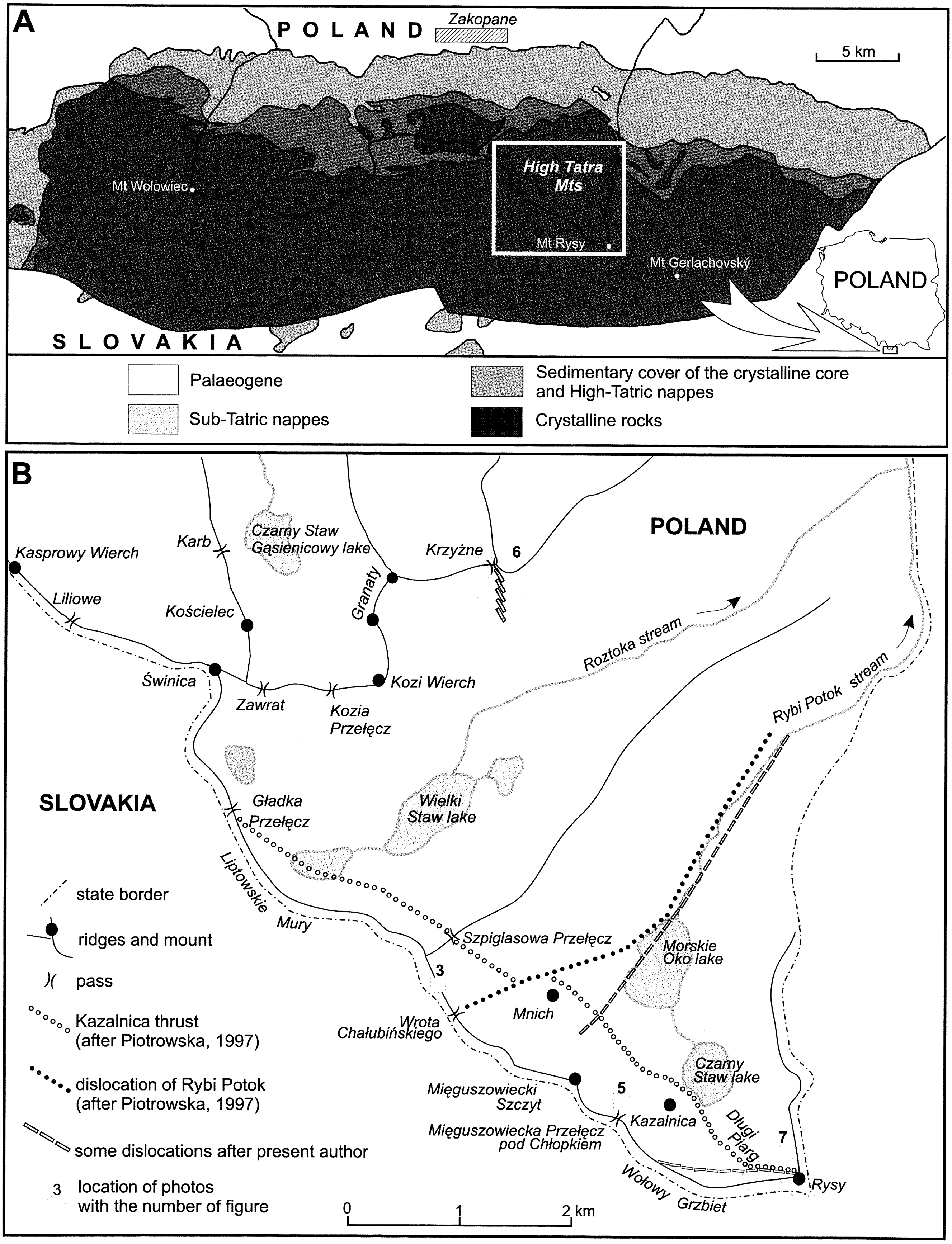


Fig. 1. **A.** Study area against the main geological tectonic structures of the Tatra Mts (geology after Bac-Moszaszwili *et al.*, 1979; simplified). **B.** Topographic sketch of the Polish part of the High Tatra Mts

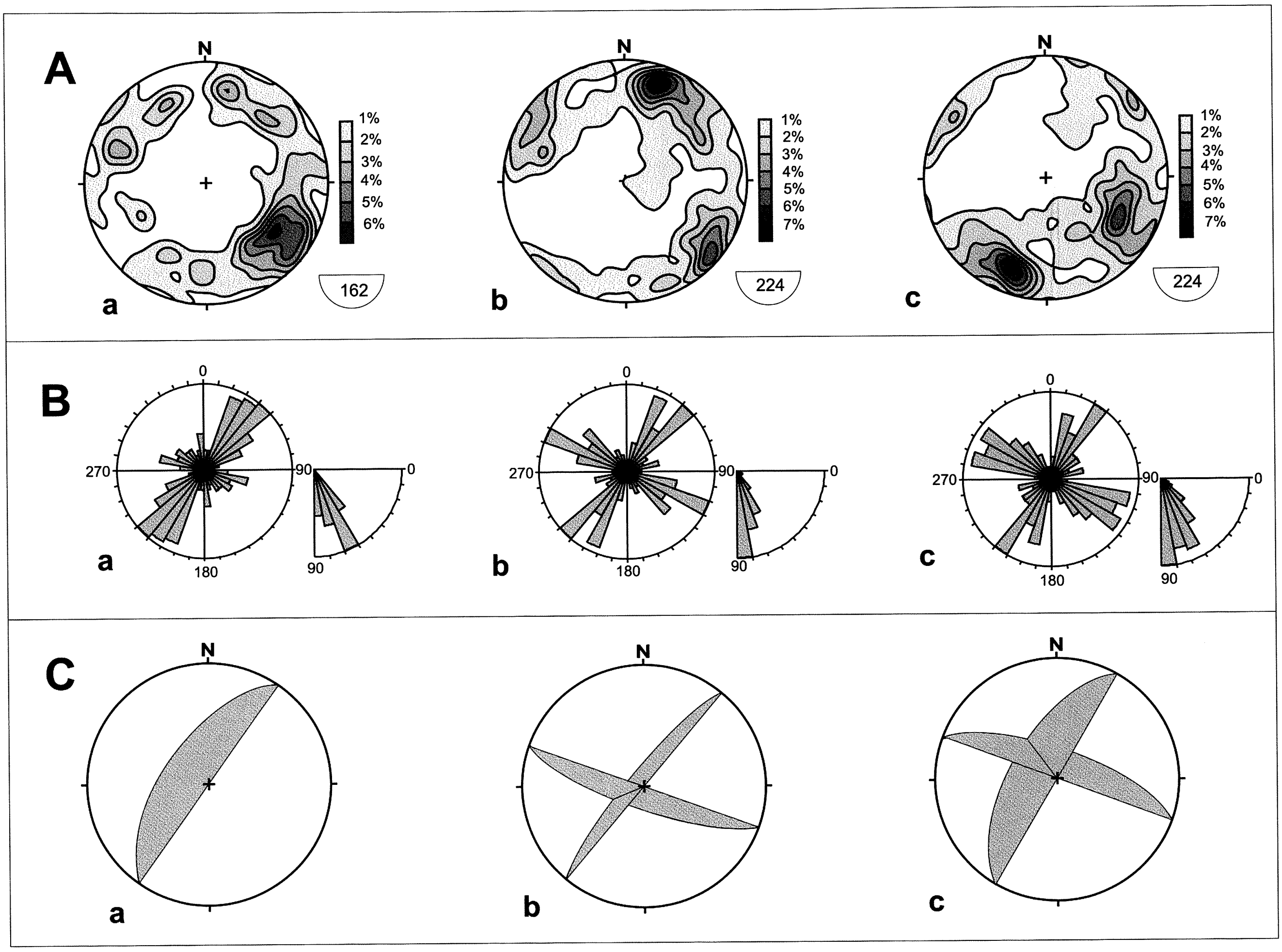


Fig. 2. Structural analysis of fault planes and the mylonite and cataclastic zones (basing on Stereonet software). **A.** Contour plots. **B.** Strike and dip rosettes. **C.** Typical orientation of the fault planes for: **a)** steep-dipping fault planes, **b)** mylonite and cataclastic zones in present-day position, **c)** mylonite and cataclastic zones after vertical rotation (40° southwards around the 90/0 axis)

under which mylonites and cataclasites were formed (pressure and temperature), as well as the diversity of mylonites and cataclasites and their relation to the fault planes with tectoglyphs will be studied in the future.

METHODOLOGY

Fieldwork carried out in the Polish part of the High Tatra Mts (Fig. 1) included ca. 400 measurements of the fault plane orientation, and in those cases where it was possible, also the orientation of the slip structures on the fault planes. Tectoglyphs from the mylonitic and cataclastic zones were not measured due to the ductile character of the accompanying slickensides (bent surfaces, bending striae, different directions of striae, etc.). Data of the orientation of dislocations from the two groups (single fault planes as well as mylonitic and cataclastic zones) were initially analysed geometrically on contour diagrams (Fig. 2A-a, b) and dip and strike rosette diagrams (Fig. 2B-a, b). The results are rather univocal (Fig. 2C-a, b); single fault planes have the typical orientation 35/60N, and the mylonitic zones – 110/75S (much seldom 40/80N and 40/80S). These two tectonic orientations, with strikes of 25–45° and 115–145°, respectively, were earlier documented in analyses of discontinuous structures based on photointerpretations (Grochocka-Piotrowska, 1970).

The single fault zones

The single fault zones are typically characterised by planes mineralised with quartz, chlorites, rarely haematite or epidote (Fig. 3). In some cases slip structures are observed directly on the rock, along with different slip orientations on the subsequent mineral covers. Further analysis was focused on 162 fault measurements of the orientation of slip striae to reconstruct the stress pattern with the help of TectonicsFP software (Fig. 4). At first the P-B-T method was applied (Fig. 4A), in which the reconstruction of the stress axis is made separately for each fault, thus it is not a mean value as in other methods (Fig. 4B-D). In this case it is possible to estimate the range of results, and to determine whether or not the analysed set of data contains faults from different tectonic phases. Apparently, the obtained orientations of the compression axis seem to be scattered. In order to distinguish relatively homogenous faults from the data set, a selection was made to exclude strike-slip faults, re-

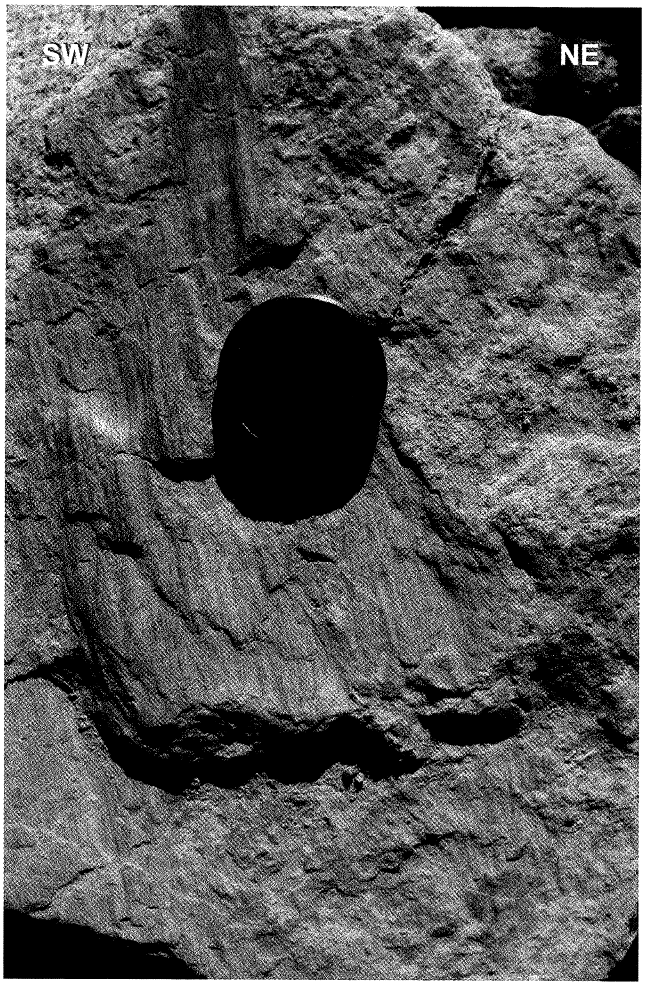


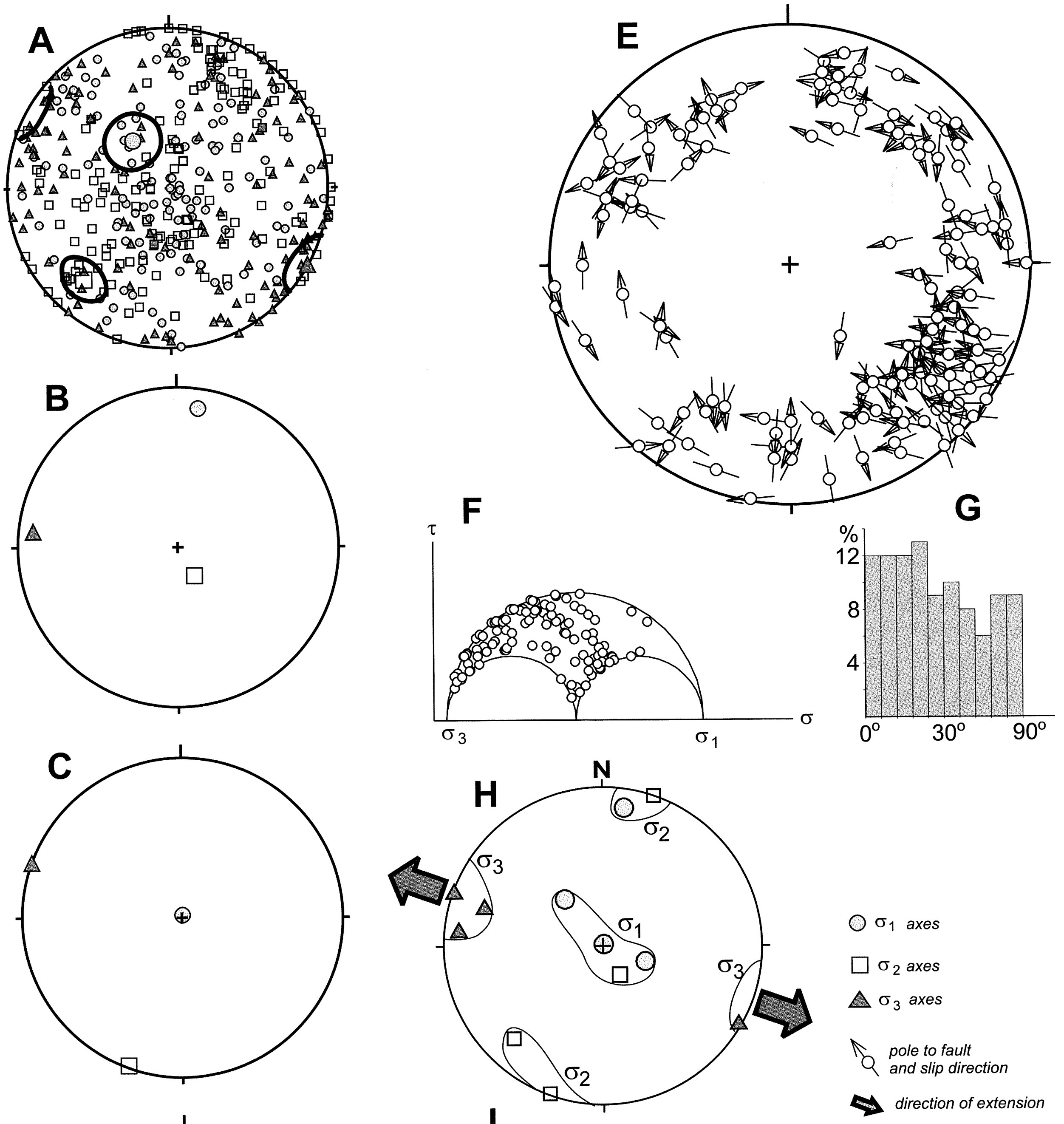
Fig. 3. Slickenside fault surface coated with epidote and quartz; Liptowskie Mury ridge, westward from the Wrota Chałubińskiego pass (location – see Fig.1). Diameter of lens cap – 5.5 cm

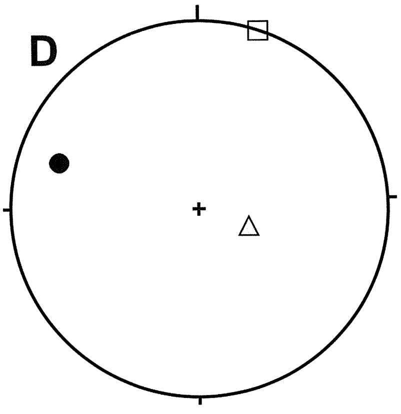
verse faults and faults with strikes different from the most common values. It is assumed that the remaining dominating set of 35/60N faults allows obtaining a relatively univocal result. This data set, comprising 92 measurements, was also applied in reconstructions of the stress pattern in the four methods used by TectonicsFP software. The results are presented on Fig. 4I; the selection did not cause a larger convergence of the orientations of the stress axis obtained through different methods. Therefore the entire data set, without selection, is a subject to graphic presentation. On the Hoepner plot (Fig. 4E), presenting the orientation of the fault planes and the sense of movement of the upper fault wall, the dominating 35/60N set includes normal oblique-slip faults, developed at an almost vertical orientation of the axis of the largest stress (Fig. 4H). The fluctuation plot drawn for the numeric-dynamic method indicates (Fig. 4G) that the data set analysed is not entirely homogenous, as only 60% measurements are concordant with the calculated mean orientation of the compression axis. The Mohr plot and the coefficient $R \approx 0.5$ indicate (Fig. 4F) that the fault set analysed developed in a triaxial stress field of the $\sigma_1 > \sigma_2 > \sigma_3$ type. Such stress pattern, where σ_1 is almost vertical, and which results in normal faults, is typical for horizontal extension with orientations normal to the fault strikes (ca. 125°). The extension responsible for the formation of normal faults, as plotted from reconstructions in TectonicsFP, has orientations of 106–120°. Worth noting is the fact that this simple interpretation is obtained without reversing to the position prior to the post-Palaeogene rotational upheaval of the Tatra Mts (Piotrowski, 1978; Burchart, 1972; Král, 1977). It can be thus assumed that the analysed population of slip structures on the planes of slickensides is relatively young. The surfaces of steep slickensides as well as the mylonitic zones may have very old, Variscan foundations and could have been activated several times (what is testified by different orientations of the slip striae on the same planes). Therefore the data sets analysed are not bound to be homogenous, and the reconstruction of the stress field based on the above results would not be univocal and precise. The stress axes were rather easy to determine for the flat dipping faults (Jurewicz, 2000a). This results from the fact that the data set analysed was initial and rather young (of Alpine age). Besides, due to their particular orientation (shears formed by horizontal compression) the faults were not reactivated during younger tectonic phases (their positions were different from the orientation of the planes of the largest shear).

The mylonitic and cataclastic zones

The mylonitic and cataclastic zones represent zones of ductile deformations associated with numerous slip planes; small folds (Fig. 5), often of a drag-fold character, S-C structures and elongation lineation can be distinguished there. Despite the fact that tectoglyphs in mylonitic zones are very numerous, and can supply a large data set, their ductile character does not allow their geometric analysis and, consequently, reconstruction of the stress field. The analysis is also hampered by their geometry, as they are not rectilinear and do not possess a wide range, as assumed from the photointerpretation sketch by Grochocka-Piotrowska (1970). Typically the zones are oriented irregularly, and are of varying thickness, because products of these zones were moved along the zones and inserted within the adjacent fractures. Generally these zones have orientations of 110/75S, rarely 40/80N (Fig. 2B). They are probably older than the fault planes. During interpretation they should be reversed to position prior to the post-Palaeogene rotational upheaval of the Tatra Mts. After rotation around the horizontal 90/0 axis southwards by the angle of 40° (Fig. 2C), the mylonitic and cataclastic zones attain orientations of 110/70N and (rarely) 30/60N.

Field observations of slip zones on surfaces surrounding the mylonitic and cataclastic zones indicate that most of them are normal oblique-slip sinistral faults. It can be assumed that these slips register the last phase movement. Therefore, it is difficult to determine initial conditions of the development of mylonitic and cataclastic zones. Their multiple reactivation is testified by the presence of older mineral veins, crushed and deformed in the subsequent movement phases, as well as by orientation of structures, being indicators of the orientation and sense of movement, different from the orientation of younger slip structures.





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	Steep dipping faults (all datasets = 162)				Steep dipping faults after selection (97 datasets)			
Method (after TectonicsFP software)	σ_1	σ_2	σ_3	R	σ_1	σ_2	σ_3	R
P-B-T **(A)**	321/59	224/20	120/2		16/78	227/2	127/6	
NDA **(B)**	21/89	200/1	290/0	0.53	30/72	210/18	300/0	0.62
direct inversion **(C)**	9/13	150/73	276/10	0.50	16/31	151/51	273/2	0.37
dihedra **(D)**	110/67	19/0	288/23		116/64	23/2	292/26	

Fig. 4. Reconstruction of the stress pattern for steep dipping fault planes on the basis of slip structures. Methods: **A.** P-B-T axis, **B.** Numerical dynamical analysis (NDA), **C.** Direct inversion, **D.** Dihedral calculation, **E.** Hoepner plot, **F.** Mohr plot, **G.** Fluctuation histogram. Reconstruction of stress pattern after four analyses in TectonicFP software: **H.** Graphic, **I.** Tabular (for the entire population of faults and after selection)

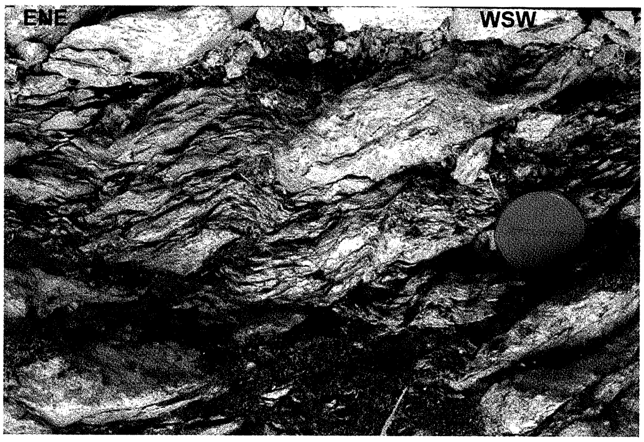

Fig. 5. Small folds in the mylonitic zone; Mięguszowiecka Przełęcz pod Chłopkiem pass (location – see Fig. 1). Diameter of lens cap – 5.5 cm

REMARKS ON ORIENTATION OF SOME DISLOCATION ZONES

Direct field observations, analysis of topographic and geological maps (Fig. 1) and a statistical analysis of the orientations of faults and mylonite zones are at variance with data presented in the literature. The obtained results are best compared with those of Grochocka-Piotrowska (1970), whose paper presents a complete structural analysis of the crystalline core, and a photointerpretation sketch of the fault zones in the High Tatra Mts. The differences refer to orientation of the dislocations and their mutual relations. This results mainly from the fact that air images show intersection of the fault plane with morphology (steep, ca. 60–70° fault dips versus gentle slopes), as well as the surface features related both to tectonics, and those produced by erosional processes and gravity slips. For example, orientation of the Rybi Potok stream dislocation which terminates at the Wrota Chałubińskiego pass is problematic. Due to its a rather rectilinear course, assuming a steep southern dip, it should rather reach the Mnichowy Żleb chute or Hińczowa Przełęcz pass.

An example of discordance in the orientation of dislocations, and chutes which accentuate them, which are better recognisable on air photos than the dislocations, is represented by the Krzyżne pass. At geological map, 1:10 000 scale (Guzik & Jaczynowska, 1978), the Krzyżne mylonitic zone is the largest and widest zone in the Polish part of the High Tatra Mts. On the contrary, the associated pass is

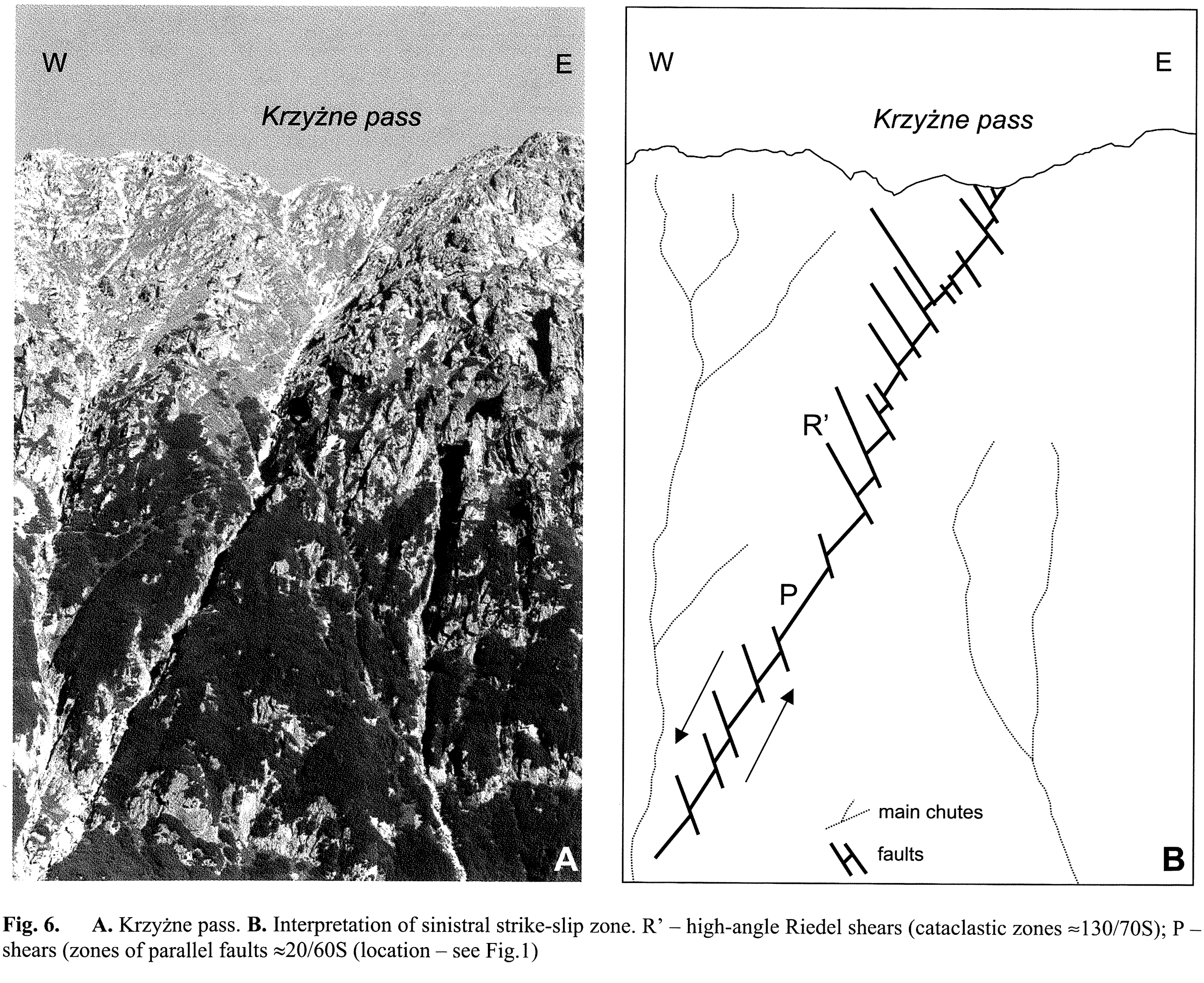

Fig. 6. **A.** Krzyżne pass. **B.** Interpretation of sinistral strike-slip zone. R' – high-angle Riedel shears (cataclastic zones ≈130/70S); P – shears (zones of parallel faults ≈20/60S (location – see Fig.1)

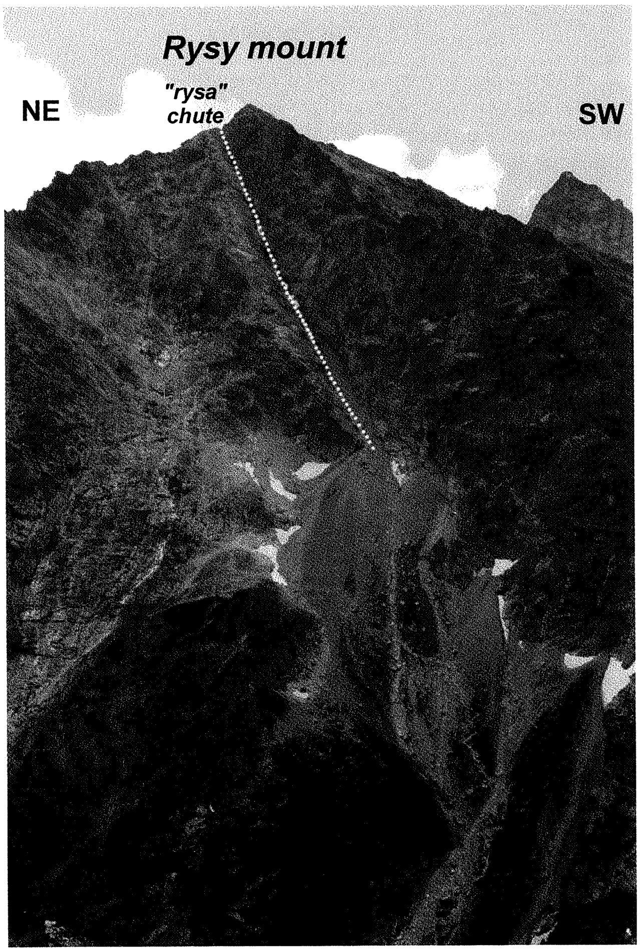

Fig. 7. View of Rysy mount. Dotted line – "rysa" chute (location – see Fig.1)

rather indistinct, and cuts in the ridge at a much smaller degree than in the case of other mylonitic zones. Clusters of small, few to several tens of centimetres wide cataclastic and mylonitic zones, with 130–150° strikes and southern dips, and parallel faults (in some cases also cataclase zones), with orientations of 10–30° and southern dips, were observed during fieldwork on the southern slope of the Krzyżne pass (Fig. 6). This is a system of en echelon faults: the first is much older than the second one (see Woodcock & Schubert, 1994). An almost southern chute (170°) adapted the system of dislocations; a several tens on meters wide mylonitic zone parallel to the chute is shown on the map of Guzik and Jaczynowska (1978).

Another dislocation, the orientation of which requires correction, is the so-called Kazalnica overthrust (Piotrowska, 1997). It is supposed to run from the summit of Mt Rysy (downwards the chute called in Polish "rysa"; Fig. 7) to the base of Mt Kazalnica, through the tower of Mięguszowiecki Szczyt mount, base of Mt Mnich, Szpiglasowa Przełęcz pass, to the Gładka Przełęcz pass. On the geological map, 1:10 000 scale (Jaczynowska, 1980), from the orientation of the "rysa" chute apparently runs parallel to the dislocation. In reality, however, its course on the map is an effect of intersection of the 120/60S dislocation plane with the northward inclined surface. Lower down the slope, the intersection line diverts from the 120° strike southwards, passes across the western part of Długi Piarg slope and then ascends the Wołowy Grzbiet ridge, turning in this case northwards. Along the intersection line of the 120/60S plane, mylonites are marked on the geological map of Jaczynowska (1980). This plane is, however, difficult to trace at the base of Mt Kazalnica. The "rysa" chute should not be connected with the tectonical structures occurring at the base of Mt Kazalnica. In the opposite case this would be inconsistent with geometry rules; at decreasing morphological gradient the intersection line of a southwards dipping plane should be oriented southwards, and not northwards as on the Piotrowska's (1997) map. Furthermore, there is a lack of lithological equivalents of the mylonites within the "rysa" chute. Due to development in various conditions and at different intervals they should not be linked with the system of dense slickensides in the Czarny Staw ridge (Grochocka-Piotrowska, 1970). The further course of the Kazalnica overthrust is also problematic. According to Piotrowska (1997), this thrust runs across the tower of the Mięguszowiecki Szczyt mout, where it forms a 100-m thick wide zone; but zone like this should be more prominent in the morphology. Westwards, this zone is supposed to continue from the Szpiglasowa Przełęcz pass to the Gładka Przełęcz pass; its width decreasing from several metres to over a dozen centimetres above the Dolina Pięciu Stawów valley.

DISCUSSION

There is a distinct diversity in the orientation of steep fault zones and the mylonitic and cataclastic zones, probably resulting from diversified origin and age. Steep faults are typically 35/60N oriented. Their origin, basing on their present-day position, can be explained assuming their Late Tertiary age. They belong to the set of normal faults striking 35°. Such faults occur in the nappe zones and pass into the Oligocene deposits (Gedl, 1999) of the Podhale basin, e.g. in the region of the Dolina Chochołowska valley (see Passendorfer, 1974), the Dolina Małej Łąki valley (see Bac, 1971), and the Dolina Olczyska valley (see Sokołowski, 1959). According to Mastella *et al.* (1988), the faults should be linked with the Mid-Miocene compression of the Styrian phase, whereas Birkenmajer (1999) basing on investigations in the Dolina Białej Wody valley and by analogy to the Pieniny Klippen Belt, specifies their age at the Sarmatian.

Analyses of contour plot and rosette diagram of the fault strikes (Fig. 2A-a, B-a) indicate that their development was probably linked with an extension trending 125°. The orientation of the extension axis interpreted from the Stereonet is 122°, whereas the reconstruction of the stress pattern in TectonicsFP indicates extension between 106° and 120°. Presence of a horizontal component on the faults planes (in most cases sinistral faults) may be linked with the post-Palaeogene clockwise rotation of Sub-Tatric blocks postulated e.g. by Bac-Moszaszwili (1998).

The mylonitic and cataclastic zones are most probably older than the single fault zones and were formed in different, more ductile conditions. To recognise their origin they should be assembled at positions prior to the pre-Late Tertiary rotational upheaval of the Tatra Mts, e.g. 40° southwards around the 90/0 axis (see Jurewicz, 2000a). After rotation, the most common orientations would be 110/65N and 30/60N (Fig. 2A-c, B-c). The fact that one (although poorly marked) set of mylonitic and cataclastic zones attains orientations close to strikes of single steep-dipping dislocations, may indicate that this set underwent reactivation during the formation of these dislocations. This is testified by orientations of slip striae pointing to the oblique-slip character of the latest movement, taking place along the planes bordering the mylonitic and cataclastic zones.

The mylonitic and cataclastic zones in the Tatra Mts are difficult to date. Besides radiometric dating, petrotectonic analyses performed in order to determine pressure and temperature condition during formation of the tectonic zones, may help in this matter. Till now, only the mylonites from the Western Tatra Mts were subject to such investigations. There, gently dipping zones, up to 100 m thick, were considered Variscan in age, basing on their contact with Werfenian deposits. These zones were reactivated during the Alpine folding (Żelaźniewicz, 1996). Maluski *et al.* (1993) consider the mylonites from the Western Tatra Mts as Alpine in age (67 my – Maastrichtian). Dallmeyer *et al.* (1993), basing on Ar/Ar age determinations, generally consider them as Variscan (333 my) structures, formed at temperatures reaching 400–500°C, poorly reactivated at ca. 100–80 my. According to Putiš (1992), the low-temperature (below 300°C) mylonites resulted from Alpine sinistral transpression. According to Janák (1994), the maximal temperature affecting the crystalline core of Tatra Mts during the Alpine cycle did not exceed 300–350°C. Kovač *et al.* (1994) determined it at maximally 250°C, whereas Lefeld (1997) calculated the temperatures at ca. 200°C, and the pressure at ca. 1 kbar.

Investigations of liquid-gaseous inclusions in quartz (Kozłowski & Jurewicz, 2001) indicate that the quartz veins mineralising the mylonitic zones were formed at temperatures of 264–316°C and at pressures 1.5–1.7 kbar. Results from a mylonitic zone at Granaty are particularly interesting. The orientation of the zone is similar to that of steep slickensides, its quartz vein was formed at low pressures (0.85 kbar); this could indicate extensional conditions, which were responsible for the formation of a set of normal faults of the same orientations.

CONCLUSIONS

Dislocations comprising faults with steep and flat planes generally show orientations of 35/60N, being normal sinistral oblique-slip faults. Their formation is linked with the Middle Miocene (Sarmatian) 106–120° extension.

The dislocations represented as mylonitic and cataclastic zones generally show orientations of 110/75S and 40/80N. They are older than the single fault zones, and bear evidences of frequent reactivation (also of Late Tertiary age). To recognise the conditions of their formation they should be reversed to positions prior to the rotational upheaval of the Tatra Mts, that is 110/70N and 30/60N.

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Streszczenie

ANALIZA GEOMETRYCZNA STROMYCH DYSLOKACJI W TRZONIE GRANITOIDOWYM POLSKIEJ CZĘŚCI TATR WYSOKICH

Edyta Jurewicz

W trzonie granitoidowym Tatr Wysokich (Fig. 1) można wydzielić kilka charakterystycznych zespołów uskoków. Jeden z nich stanowią uskoki połogie o płaskich i gładkich powierzchniach, zmineralizowane epidotem, kwarcem lub chlorytami, z dobrze czytelnymi tektoglifami. Analiza struktur ślizgowych z powierzchni tych uskoków przeprowadzona we wcześniejszym opracowaniu autorki (Jurewicz, 2000a) pozwoliła na rekonstrukcję układu naprężeń i powiązanie ich z alpejskim etapem nasunięć płaszczowinowych. Przedmiotem niniejszego opracowania były stromo nachylone dyslokacje w granitoidach polskiej części Tatr Wysokich. Podzielone zostały one na: (a) dyslokacje strome złożone z płaszczyzn występujących pojedynczo lub w zespołach liczących po kilka równoległych powierzchni, które przez Grochocką-Piotrowską (1970) były określane jako strefy ślizgów jednorodnych; (b) dyslokacje strome złożone z mylonitów lub kataklazytów o szerokości od kilkudziesięciu centymetrów do średnio 2–3 m, lub złożone z serii wąskich, kilku-, kilkudziesięciocentymetrowych stref.

Pojedyncze płaszczyzny uskokowe wykazują najczęściej położenia ≈35/60N (Fig. 2A) i mają powierzchnie zmineralizowane kwarcem, chlorytami, rzadziej hematytem lub epidotem. Niekiedy obserwuje się struktury ślizgowe rozwinięte bezpośrednio na skale (Fig. 3) oraz po kilka kierunków ślizgów na różnych pod względem składu powłokach mineralnych. W oparciu o struktury ślizgowe na powierzchniach pojedynczych uskoków została przeprowadzona z użyciem programu TectonicsFP rekonstrukcja układu naprężeń, odpowiedzialnego za ich powstanie (Fig. 4), która pozwoliła na określenie kierunku ekstensji na ok. 106–120°. Jej efektem było powstanie zespołu uskoków normalnych, zrzutowo-przesuwczych, z lewoskrętną składową poziomą. Przez analogię do pienińskiego pasa skałkowego można je powiązać ze środkowomioceńską ekstensją (Birkenmajer, 1999). Obecność składowej poziomej na powierzchniach tych uskoków może wynikać z popaleogeńskiej prawoskrętnej blokowej rotacji postulowanej m.in. przez Bac-Moszaszwili (1998) dla regli Tatr Zachodnich.

Strefy mylonityczne i kataklastyczne są strefami deformacji podatnych; można w nich obserwować drobne zafałdowania (Fig. 5), struktury typu S-C itp., którym często towarzyszą powierzchnie ślizgów. Choć tektoglify w tych strefach są licznie reprezentowane, to ich podatny charakter sprawia, że nie nadają się one do geometrycznej analizy i rekonstrukcji pola naprężeń. Strefy te noszą ślady wielokrotnej aktywności tektonicznej, o czym świadczy obecność starszych żył mineralnych (pokruszonych i zdeformowanych w kolejnych fazach ruchu) oraz niezgodność orientacji struktur, będących wskaźnikami kierunku i zwrotu przemieszczenia z orientacją młodszych struktur ślizgowych. Strefy te wykazują najczęściej orientację 110/75S (rzadziej – 40/80N). Są one starsze od wyżej opisywanych płaszczyzn uskokowych. W celu ich interpretacji należy przywrócić im położenia sprzed poeoceńskiego rotacyjnego wypiętrzenia Tatr (por. Piotrowski, 1978). Po rotacji wokół poziomej osi o orientacji 90/0 ku południowi o kąt 40° (Jurewicz, 2000a) strefy mylonityczne i kataklastyczne przyjmują położenia 110/70N (rzadziej – 30/60N).

W opracowaniu uściślono przebieg niektórych dyslokacji, np. opisywanego w pracy Piotrowskiej (1997) nasunięcia Kazalnicy, które miałoby przebiegać od wierzchołka Rysów przez filar Mięguszowieckiego Szczytu, podstawę Mnicha, Szpiglasową Przełęcz, do Gładkiej Przełęczy (Fig. 1). Przebieg tzw. "rysy" (Fig. 7) jest efektem intersekcji płaszczyzny (strefy mylonitycznej) 120/60S i powierzchni terenu nachylonej ku północy. Linia intersekcyjna powierzchni zapadającej na południe nie może w miarę obniżania się terenu zmierzać ku północy (taki jej przebieg byłby sprzeczny z zasadami geometrii), lecz w miarę obniżania się morfologii linia ta odchyla się od biegu 120° ku południowi, przechodzi na zachodnią stronę Długiego Piargu i ponownie zaczyna się wspinać na stoki Wołowego Grzbietu, skręcając tym razem ku północy. Zgodnie z tą linią na mapie geologicznej (Jaczynowska, 1980) znaczone jest występowanie mylonitów i taki jej przebieg jest dobrze czytelny w terenie.

W opracowaniu dokonano korekty przebiegu uskoku Rybiego Potoku (Fig. 1) opisywanego przez Piotrowską (1997) oraz reinterpretacji strefy mylonitycznej Krzyżnego (Guzik & Jaczynowska, 1978) jako systemu uskoków kulisowych związanych ze strefą ścinania (Fig. 6).