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FAULTS IN THE CONTACT AREA OF THE ĎUMBIER AND KRAKLOVÁ CRYSTALLINE COMPLEXES (WEST CARPATHIANS)

(Fig. 1—5)

Abstract: Three Alpine fault systems occur in the investigated area. They differ by fault type, orientation and relative age. The imbricate structure of metamorphites is built up by the northeast striking systems of reverse faults and overthrusts. Thrusting of the Kraklová over the Ďumbier crystalline has been confirmed in the northeast contact section only. Fault geometry in the studied cases depends on the lithology and orientation of main compressive stresses, varying with a structural level.

Резюме: В изучаемой зоне встречаются три альпийских систем сбросов. Они отличаются по типу сброса, ориентировке и относительному возрасту. Имбрикационная текстура метаморфитов построена направленной к северовостоку системой обратных сбросов и взбросов. Надвигание краклевского на дюмбиерский кристаллический комплекс подтверждено только в северовосточном участке контакта. Сбросовая геометрия в изучаемых случаях зависит от литологии и ориентировки главных сжимающих напряжений, изменяющихся в зависимости от уровня текстуры.

Introduction

The interpretation of the West Carpathian crystalline structure formulated by M. Máška and V. Zoubek (1961) emphasizes the significance of the marginal faults of Alpine macrostructural units. The Čertovica fault at the contact of the Ďumbier and Kraklová crystallines is held for one of the most important. Following some views (V. Zoubek 1935, A. Biely — O. Fusán 1967) the decollement of Mesozoic sediments and the formation of the Krížna nappe is due to the reduction on this fault.

The contact of the Ďumbier and Kraklová crystallines is marked by the Mesozoic envelope of the Ďumbier crystalline in the foot wall of the Čertovica fault, by the dislocation metamorphism zone and by mineral water springs (maps in V. Zoubek 1935, D. Andrusov — J. Koutek — V. Zoubek 1951). The Čertovica fault is depicted on schematic cross sections as a medium steep reverse fault to horizontal overthrust with the horizontal component of separation several up to tens of kilometers (A. Biely — O. Fusán 1967, A. Biely 1955 in M. Mahel' 1974).

Lack of structural information concerning the Čertovica fault and the whole contact area of the Ďumbier and Kraklová crystallines renders it difficult to correlate their metamorphic grade, their absolute and palinologic ages. For this reason structural mapping has been performed, the results concerning the most important macrostructures-faults, being presented in this paper.

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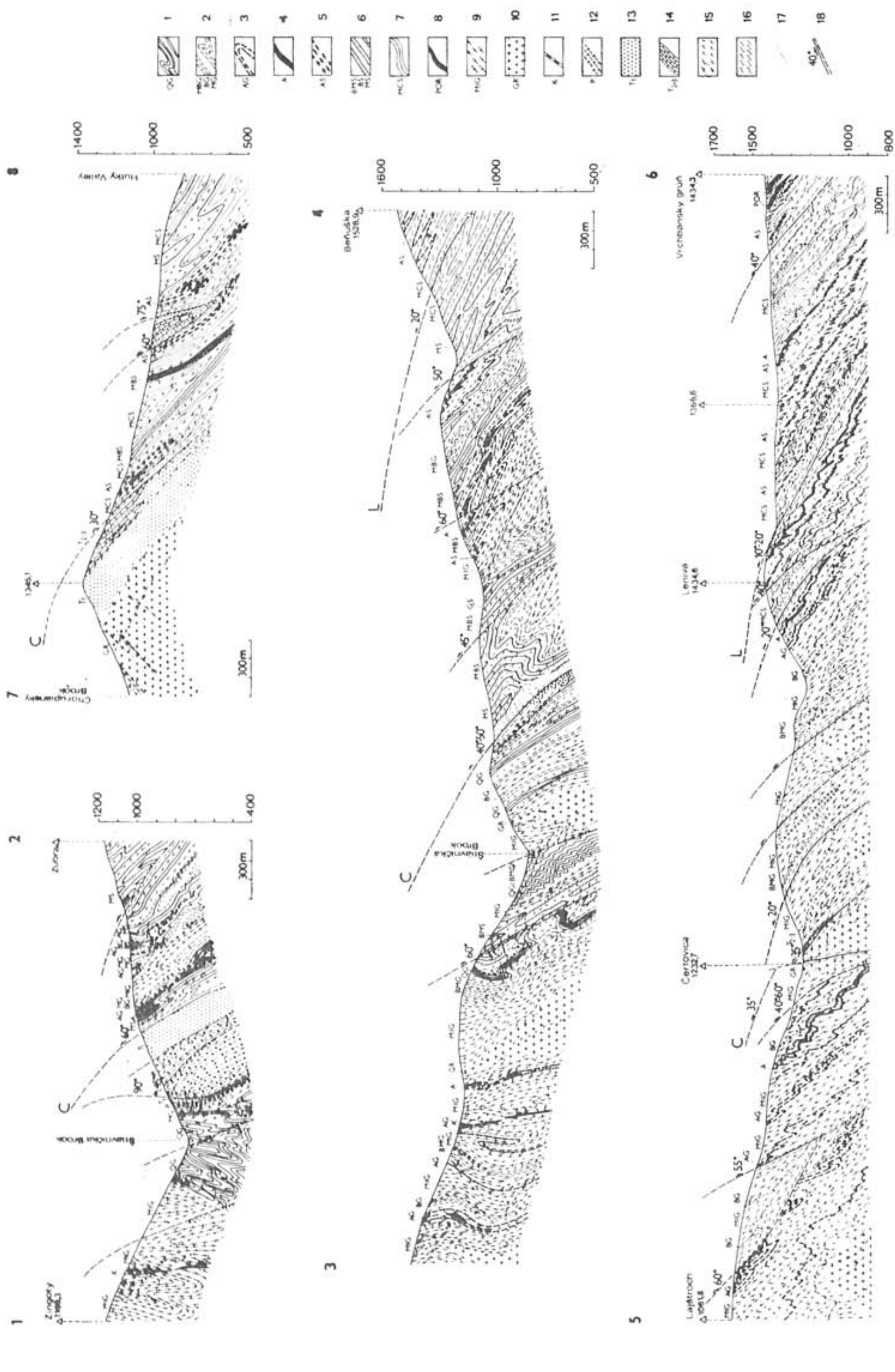
Lithology of the crystalline in the contact area

In order to evaluate the thrusting on the Čertovica fault an attempt was made to find out the lithologic marker on both its sides. Geological mapping (1 : 25 000) was unefficient. One third of the contact on the Ďumbier crystalline side (leaving the envelope Mesozoic out of consideration) is built by granitoids and two thirds by metamorphic rocks. The metamorphic grade increases towards the granitoids, the gneisses pass over gradually into migmatites and these into granitoids. Migmatites, two-mica and quartzitic gneisses (in places mica schists) predominate in metamorphites over amphibolites and amphibole biotite gneisses. On the Kraklová crystalline side only metamorphites occur. Mapping in strips across the contact (1 : 10 000) showed that the differences in metamorphites lithology of both crystalline complexes do not begin at the Čertovica fault. Similar migmatites, gneisses and amphibolites may be found on several sites on both sides of the fault (e. g. cross-section 5–6 in fig. 1). With increasing distance from the fault the different nature of the Kraklová metamorphites becomes more striking. The metamorphic grade decreases up to the medium and low grade. At a distance of 2–3 km from the central part of the fault to SE, a change may be recognized in the so far coherent character of the terrigenous formation. Acid magmatites and their low grade metatuffs or metatuffites appear. The portion of metabasites gets higher. The clastic component portion of the formation is lower than northwestward.

Another situation reveals on the northeastern tract of the contact (SE and E of Vyšná Boca in fig. 2), where different rocks appear on both sides of the envelope Mesozoic in the foot wall of the Čertovica fault. The Ďumbier crystalline is there made up of two-mica and biotite granodiorites, tonalite and muscovite granite, the Kraklová crystalline is built by mica schists, in places by gneisses. Acid metamagmatites occur in close proximity of the Čertovica fault (fig. 1, cross-section 7–8). The thrusting of the Kraklová on the Ďumbier crystalline is evident from both geological and structural relations. In the basement of the gently dipping (35 °) fault zone the envelope Mezosoic of the Ďumbier crystalline appears.

The age of the terrigenous formation has not been investigated in the study area. The nearest palinologic determinations from the Ďumbier metamorphites are of Devonian – Carboniferous age (O. Čorná – L. Kamenický 1976), those from Kraklová of Silurian-Lower Devonian age (A. Klinec – E. Planderová – O. Miko 1975). The absolute age of the quartz diorite from Nižná Boca is 305 m. y. (J. Kantor 1959).

Fig. 1. Geological cross sections through the contact area of the Ďumbier and Kraklová crystalline complexes. Localization in fig. 2. 1 – quartzitic gneisses and metaquartzites, 2 – muscovite-biotite (MBG), biotite (BG) and muscovite (MG) gneisses, 3 – hornblende gneisses, 4 – amphibolites, 5 – hornblende-mica schists, 6 – biotite-muscovite (BMS), biotite (BS) and muscovite (MS) mica schists, 7 – muscovite-chlorite schists, 8 – porphyroids (meta-porphyries), 9 – migmatites, 10 – granitoids, 11 – lamprophyres (kersantites), 12 – Permian arkoses and shales, 13 – Lower Triassic conglomerates and quartzites, 14 – Middle to Upper Triassic limestones and dolomites, 15 – low-grade dislocation metamorphism and shearing, 16 – medium grade dislocation metamorphism (tectonic brecciae, mylonites, phylonites), 17 – geological boundaries, 18 – faults (dashed where inferred; displacement of the hanging wall marked by arrow).



The stratigraphic range of the slightly metamorphosed envelope sediments is Permian to Upper Triassic. Lightgreen and brownishgreen arkoses with green slate patches and grey sandstones intercalations are regarded for Permian and have not been described so far from the investigated region. They are overlying rocks of muscovite gneisses and the basement of Werfenian conglomerates. Their thickness at the locality SW of Jarabá is 50 to 100 m. Lower Triassic conglomerates and quartzites occur more frequently than Middle to Upper Triassic carbonates. They resisted better to tectonic "squeezing" in folds and fault zones.

The fault macrofabric

Numerous faults were found by mapping of the contact area (fig. 2). They are usually marked by zones of tectonic brecciae, phyllonites and mylonites of several to several tens meter thicknesses. Selective weathering of these rocks causes negative relief (saddles and walleys) and indicates some of the faults. On several of them cold ferric mineral water springs. Fault density varies considerably. Apart from the factor of reduced exposure (mainly in NE of the area) in metamorphites it depends on the grade of metamorphism. Far less faults were mapped in migmatites than in paragneisses and micaschists. The dependance of fault density on rheologic properties is evident also from comparison of metamorphites with granitoids. In the granitoids is the lowest. In the densely faulted Kraklová metamorphites 3 to 4 faults may be found on 1 km^2.

According to orientation three main fault systems may be distinguished. The first system build NE to E trending faults of medium to steep dip (50°—80°) towards SE to SSE. The second system is made up of similar trending but moderate dipping (20°—45°) faults. The third NW to N trending system shows steep up to vertical dip. The first and the third system appear in both the Ďumbier and in the Kraklová crystalline. The second system was found to be present only in the Kraklová crystalline. An exception of the classified systems are the faults accompanying structures of the infolded envelope Mesozoic W of Vyšná Boca and the NE part of the Čertovica fault. The relative age of the fault systems may be suggested from the continuity disruption of older by younger systems. In most cases the first system is older than the second, nevertheless the contrary relation was found too. The third system is always the youngest. This scheme cannot be absolutized. From mesoscopic observations in fault zones it follows, that one part of the older shear planes may be reused. Steeply dipping fractures are particularly suitable for repeated movement. In some casses age differences between the NE and E trending faults of the same system (e. g. S of Zingoty and N of Beňuška, fig. 2) were found. Eastward trending faults are older than those directed northeastward. The presence of envelope Mesozoic in the fault zone might be another criterion for the division of faults. Owing

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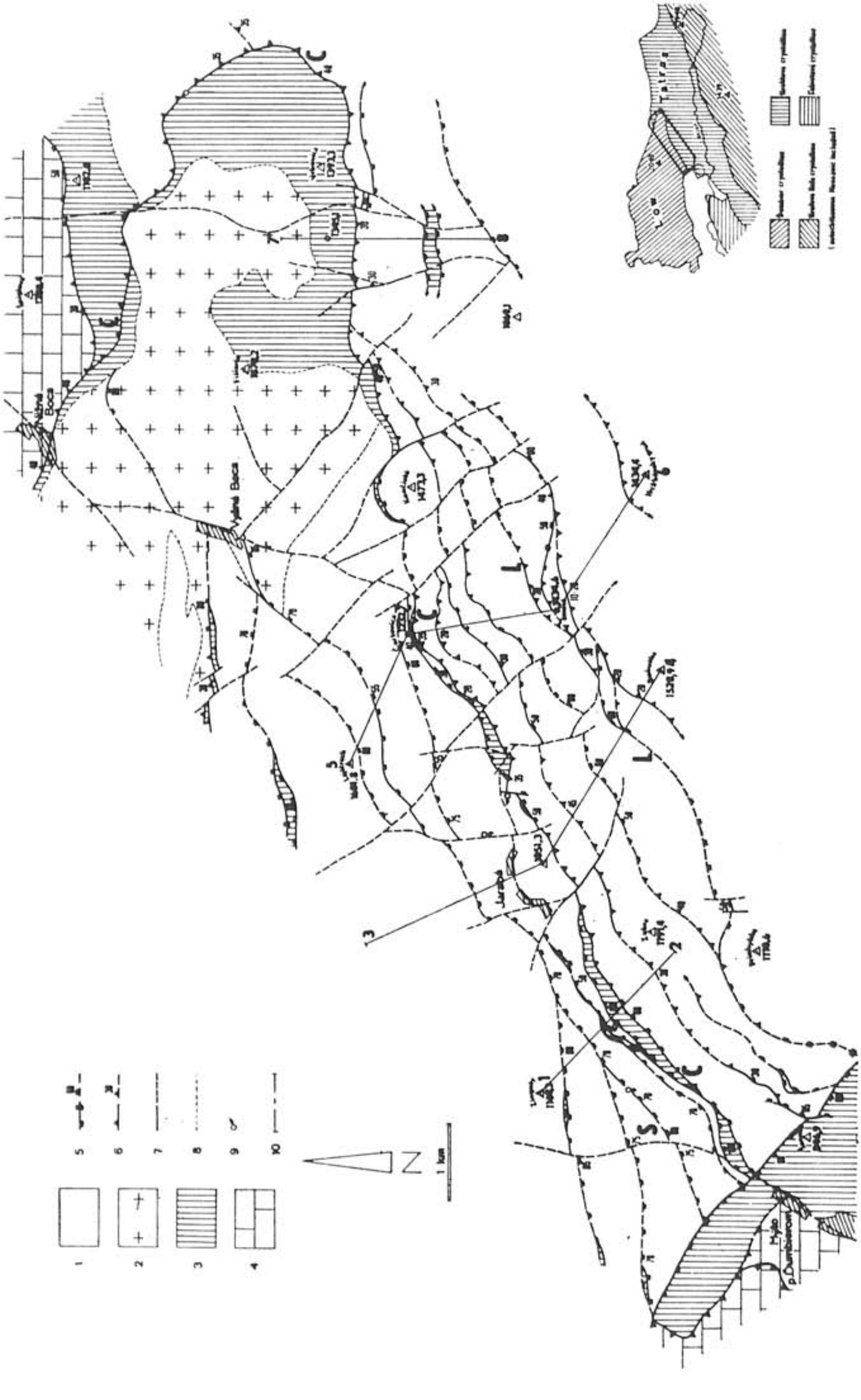
Fig. 2. Faults in the contact area of the Ďumbier and Kraklová crystalline complexes. 1 — metamorphic rocks, 2 — granitoids, 3 — envelope Mesozoic, 4 — nappes, 5 — faults with dip more than 45° (dashed where inferred), 6 — faults with dip less than 45°, 7 — normal faults and faults without established dip, 8 — geological boundaries, 9 — mineral water springs, 10 — line of the cross section (in fig. 1), C — Čertovica fault, L — Lenivá fault, S — Štiavnička fault. Situation sketch in the lower right corner.


Vyšná Boca
1 km
N

to easy overlooking of small lenses of Mesozoics in the scanty exposed terrain and their localization beyond of the erosion plane the reliability of this criterion is however low. In faults of the third system the envelope Mesozoic was not found. By inspection of the map (fig. 2) the different fault pattern in granitoids and metamorphites is evident. In the granitoids the fault macrofabric is blocky, in the metamorphites it is imbricated.

The Čertovica fault belongs to the most important faults of the investigated area. It may be traced directly in the fault zone outcrops in the section Mýto p. Ďumbierom-Čertovica and following the occurence of the envelope Mesozonic margin and the morphology in the section Čertovica–Nižná Boca (fig. 2) continuation of the fault is covered by the envelope Mesozoic, which is faulted lower the crystalline complex (and the underlying envelope Mesozoic in the Čertovica fault zone) on the steeply dipping and NW trending third system fault. It is evident from field relations that the envelope Mesozoic in the nappe base in the environment of Mýto p. Ďumbierom cannot be strictly autochthonous, likewise the adjacent envelope Mesozoic of the fault zone, being the comparatively oldest and lowermost Mesozoic structural unit. The SW part of the Čertovica fault is complicated by subparallel and diagonal faults of lower order. The fault zones are recognizable at the contact of Lower Triassic quartzites and conglomerates with metamorphites as well as in Permian arkoses (fig. 1, cross-section 1–2). At these sites the fault in the contact of the Lower Triassic with the overlying southwestern metamorphites is conventionally designated as Čertovica fault. From the fault zone dip (60°–90°) it is evident, that the horizontal component of the thrusting towards NW is small. The maximum stress direction (chapter 6) is almost vertical at these sites. This part of the fault does not furnish a striking thrust of the Kraklová on the Ďumbier crystalline.

The fault zone dip decreases northeastward. In the Čertovica saddle and eastward it is 20° to 30°. The maximum stress in the fault zone dips in average 25° to SSE and E. Small Mesozoic occurences within metamorphites of the fault zone are not autochthonous. The granitoids overlying Mesozoics are regarded for autochthonuos on the base of outcropping at Nižná Boca only, since the exposure is generally unsufficient. The detachment of Lower Triassic envelope quartzites from the crystalline mass depends on the competence contrast which is higher for metamorphic rocks than for granitoids. East of Vrbovica the direction of the fault line alters from E to N and NW resembling a parable. The fault morphology may be compared with a part of a circular cone surface with eastward trending axis. Faults of the second systems in the overlying Kraklová metamorphites are of unchanged NE and E strike. In the vicinity of Nižná Boca the fault is covered by the comparatively steep dipping (30°–50°) Choč nappe. On both sides of the fault the foliation and lineation in the envelope Mesozoic is discordant. The overpriting of the northern part of the Čertovica fault by a younger fault (third system) cannot be excluded, the fault zone being unsufficiently exposed. The dips of the nappe and the Čertovica fault are unproportional for this type of structures and are probably increased owing to the uplift of the axial part of the mountains, which might have induced normal faulting. Mezoscopic structures in the SW part of the fault account for this interpretation. In this view the Čertovica fault is a composite, dynamically and kinematically unhomogenous structure.

The horizontal component of separation, discussed in some former studies cannot be evaluated quantitatively on the basis of found data. Only the estimation of A. Biely and O. Fusán (1967) according to the distance of the envelope Mesozoic of the Veľký Bok unit near Mýto p. Ďumbierom and east of Nižná Boca may be corrigated. The join of these occurrences regarded as thrusting distance lies in direction of medium compressive stress in the Čertovica fault zone and in the whole region and not in maximum stress direction in which the thrusting took place. In this direction the occurences of the Kraklová crystalline envelope Mesozoic are substantially nearer.

The Lenivá fault (denominated according the elev. point Lenivá 1434,6) south of the Čertovica saddle, appears 1,5 to 2 km south of the Čertovica fault and is mostly subparallel with it. It is covered by the envelope Mesozoic on SW and terminated east of Končisté. The fault zone dip varies similarly as that of the Čertovica fault. In the topographically lower SW part it makes 50° to 90° to SE, in the higher central and NE part it is 20° to 30° to SE. According to maximum stress orientation in the fault zone it is a normal fault in the first part and a thrust in the second. one. The fault separates metamorphites devoid of and with substantial representation of acid metamagmatites and metatuffites present in the southernmore hanging wall. The metamorphic grade is in average lower in the hanging wall than in the foot wall. The fault however is not a sharp boundary in lithologic view. It is placed in the less competent well schistose muscovite-chlorite phyllites and mica schist of the metavolcanoclastic formation (fig. 1, cross-section 5—6 and 3—4). The central fault section in the highest altitude N and NE of Beňuška indicates overprinting of different structural level faults. In fault doublings the southern eastward trending branches are always with smaller dip and in higher altitude. Different orientation of maximum stress in doublings proves for the heterogenous origin of such a pattern. The formation of the Čertovica fault east of the connection with the Lenivá fault might be affected by similar factors. At both faults "etage effect" displays in fault zone orientation in the macrodomain as well as in overprinting by younger faults of different orientation and size.

The Štivnička fault (V. Zoubek 1935) occurs in the Ďumbier crystalline N of the Čertovica fault. The fault zone dip is steep (85°—55° to SE), at higher sites 20° lower. In addition to dislocation metamorphism it is marked by mineral water springs and by morphology. The fault penetrates through metamorphites as well as granitoids. Three older eastward striking faults with the envelope Mesozoic in the fault zone terminate on it.

The structures of the fault zones

None of the found faults can be characterized in mezoscopic domains by a single shear plane. The shear planes generated by faulting form one or several sets. Their increased density marks the fault zone. The width of the fault zone depends on deformation intensity, as well as on rheologic properties of the faulted rocks. Based on width the order of the fault cannot be stated definitely. The thickest fault zones (100 to 300 m) appear in micaschists and phyllites of the Kraklová crystalline, the narrowest (10 to 50 m) occur in migmatites and granitoids of the Ďumbier crystalline. That is why the fault zone varies often. The shear planes of the fault zone are often penetrative in the adjacent wall rocks. Quantitative criteria of density had been thus adopted for limitation of the fault zone. The number of shear planes in the fault zone is usually 10 to 100 on 10 cm (measured in direction normal to the dominant set of planes). In the envelope Mesozoic the shear zones are as a rule localized in slates and on contact of conglomerates and quartzites with metamorphites. While slates use to be squeezed out, quartzites are slightly sheared. From carbonates brecciae generated devoid of conspicuous shear planes and known as "rauhwacks".

In rare autcrops of the dislocation zones usually one set of subparallel shear planes may be found crossed by sporadic younger fractures. Sometimes in a part of the zone two conjugate sets are present. One set is usually dominant, it penetrates often beyond the fault zone and might be the site of later movements. The accute angle included by conjugated shear planes is not constant. The smallest is in the most sheared part of the zone. Slickensides were found only in migmatites and granitoids. They do not appear in fault zones but on mezoscopic shear planes in their vicinity. The attempt of their utilization for the determination of macrofaults slip showed as unsuccessful (K. Siegl, 1970). Striations have great dispersion not only on various slickensides, but even on a single one.

In thick fault zones the fabric of the shear planes is more complicated. The central part of the Čertovica fault (1,5 km SW of the Čertovica saddle) may serve as example. The fault zone is there limited by the most competent rocks (quartzites and amphibolites) and its thickness reaches 300 m. At the contact with the foot and hanging wall narrow gouge zones appear, indicating intensive deformation. Lenticular bodies of sheared migmatites and gneisses of 1—100 m size appear irregularily in the fault zone. In places planes of primary schistosity (p_1) are preserved. However penetrative structure is more often secondary shearing schistosity (p_2). The main part of the fault zone is filled with a tectonic breccia building the matrix of less deformed rock bodies. The general arrangement reminds a melange. Petrographic composition of the matrix varies considerably. In addition to tectonic brecciae (s. s.) also mylonites and phyllonites are present, differing in thin section by content of the matrix and micaceous minerals. Besides secondary schistosity planes building the dominant set in the matrix, three other types of shear planes were found. Two of them form a conjugated pair (p_3 and p_4), where one set overprints the older secondary schistosity planes (p_2). The young shear planes (p_5) are not penetrative, they are steeply dipping and bordered by gouge. They often overprint steeply dipping older planes (e. g. p_2 and p_4). The described shear planes pattern is presented in fig. 3. From the relation of numerous shear planes it is evident, that they are result of repeated faulting in the Čertovica fault zone. With regard to lack of slickensides and the key horizon, the slip in the fault zone cannot be determined. Insofar conjugate shear planes are present, maximum stress direction may be stated approximately. According to this criterion reverse faulting towards NW and later normal faulting set in within investigated section of the Čertovica fault. Repeated faulting is indicated also by mezoscopic fabrics of the mylonites.

Faults and the host rocks structure

The macrostructure of the investigated Ďumbier crystalline is in addition to faulting the result of Alpine foldings (K. Siegl 1976, 1976a). Isoclinal folds with gently eastward plunging axes had generated by older Alpine folding. By younger Alpine folding these folds were superposed by curvilinear folds with steeply northward dipping axes. In the Ďumbier metamorphites of the contact area (domain 1 in the centre of fig. 4) these foldings are reflected in the macrofabric of primary schistosity planes. In the orientation diagram indications of two large girdles appear (fig. 4, diagram 1a). Alpine foldings transformed also the pre-Alpine fabric, minor folds of which had been reoriented into the new Alpine position. In the contact area of the Kraklová metamorphites Alpine macrofolds are rare. They are destructed by superposed imbricate structure. The orientation diagram of rarely preserved primary schistosity planes displays a pattern similar to that of the Ďumbier metamorphites (fig. 4, diagram 2a). Differences appear in the position of large girdles and in the angle they are including. Pre-Alpine minor folds were not found in this region.

Comparing the fold macrostructure with that of the faults in the Ďumbier metamorphites it results that the faults of the first system are slightly declined from the steeply dipping ab-plane of older Alpine macrofolds. In the Kraklová metamorphites in found (but rare) cases faults of the first and second system

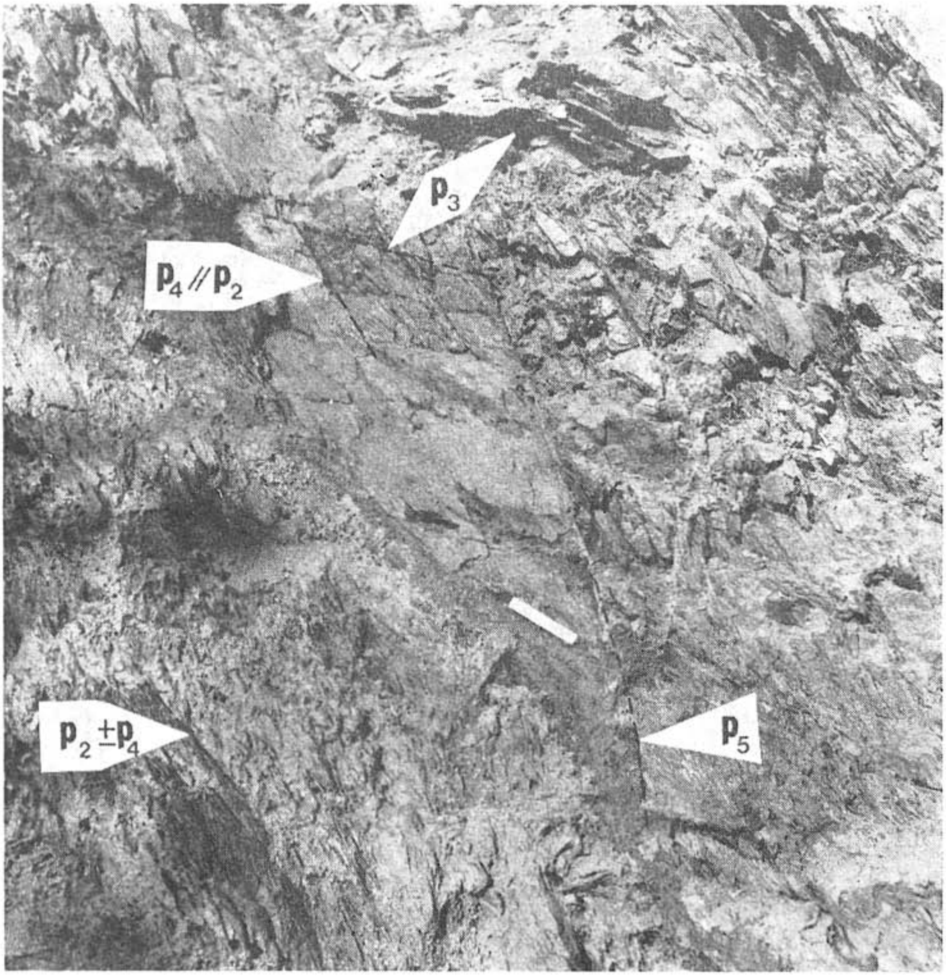


Fig. 3. Shear planes in the central part of the Čertovica fault zone 1,5 km SW of the Čertovica saddle. The 10 cm scale in the centre. Explanation in the text.

are subparallel with the ab-plane of these folds. The faults of the third system are in many places of both regions in the direction of their ac-plane.

Shear deformation had left conspicous traces in the whole metamorphite domain. Shear planes more or less penetrative beyond the fault zone originated in micaschists and gneisses. In the orientation diagram of the Ďumbier metamorphites a single distinct maximum appears. (fig. 4, diagram 1b). This maximum partly coincides with the maximum of primary schistosity. Conform overprinting may be recognized even mezoscopically. According to orientation it corresponds to the first fault system. In the Kraklová metamorphites the pattern is more complicated. In the submaxima cluster two smaller maxima

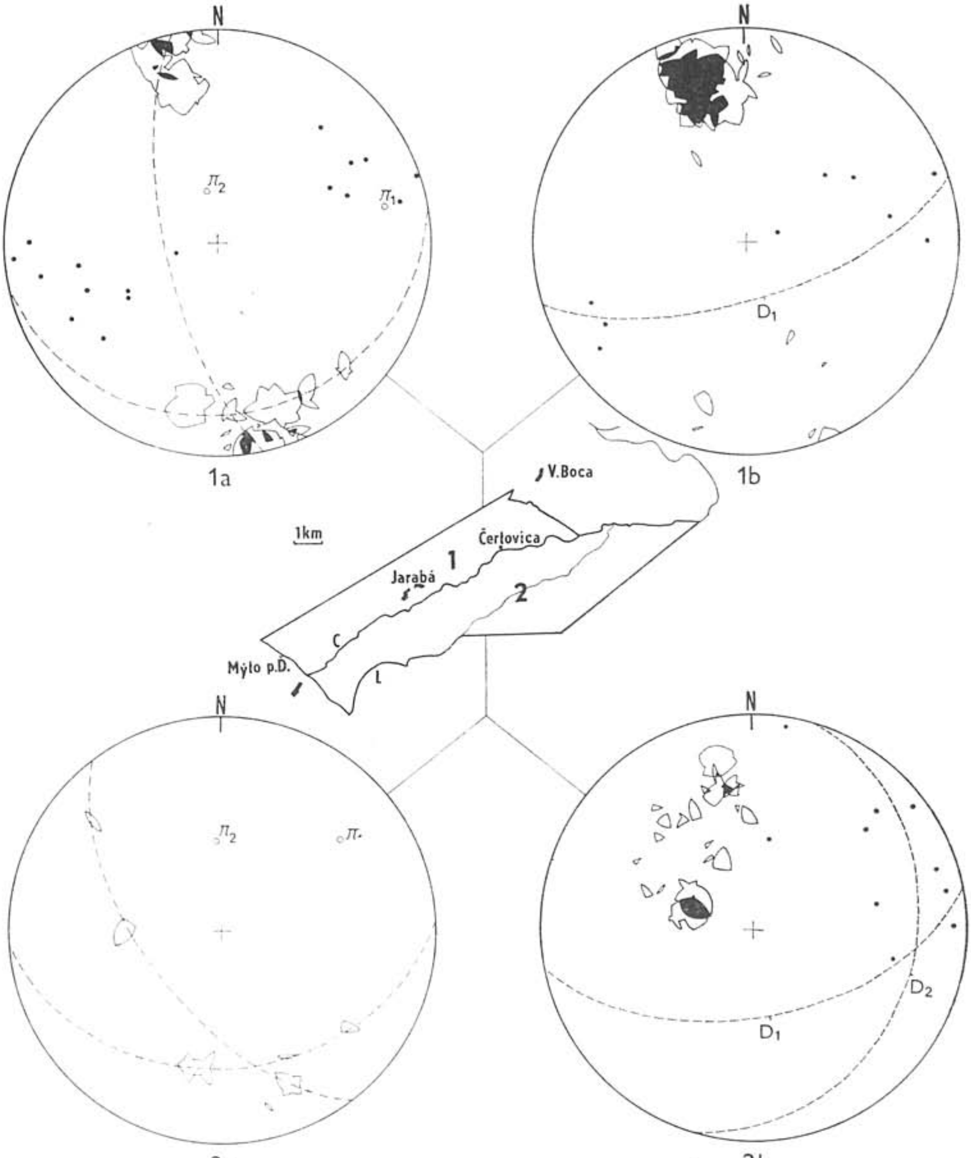


Fig. 4. Orientation diagrams of foliations and lineations in the contact area of the Ďumbier (domian 1) and the Kraklová (domain 2) metamorphites. 1a — 72 poles of primary schistosity (interval 3—6 %) and 17 pre-Alpine minor fold axes (dots), 1b — 84 poles of secondary shearing schistosity (interval 3—6 %) and 8 Alpine minor fold axes, 2a — 38 poles of primary schistosity (interval 3—6 %) and 12 Alpine minor fold axes.

appear, one of which lies in the place of the Ďumbier metamorphites maxima, the other (near to the diagram centre) is specific. It belongs to gently dipping shear planes occurring in separate as well as in conjugate sets in the Kraklová metamorphites only. From a separate analysis in three subdomains it resulted, that the two-maxima pattern is not due to inhomogeneity of the macrodomain. The planes corresponding to both maxima and the parallel fault zones are observable in outcrops. They belong to the first and second system of macroscopically differentiated faults.

Sets of shear planes parallel with the third fault system were not found. Origin of this fault system was not accompanied by penetrative postcrystalline deformation. In domains with penetrative shear planes minor Alpine folds appear locally. One part of them are drag folds syngenetic with faulting, the majority is, however, older. In some cases the shear planes form the ab-plane cleavage. The axes of these folds are parallel with the first or second fault system.

Unlike the metamorphic rocks dependence of faults on primary fabric is not recognizable in granitoids. No definite relation was found between fault zone orientation and primary foliation of modal inhomogeneity. The fabric of joints had originated in a similar stress plan as the faults. The majority of the joints is of NNE strike and steep dip (fig. 12 in K. Siegl, 1976). They are normal to the northern section of the Čertovica fault.

Stress orientation in fault zones and in the contact area

In places where two conjugate shear plane sets occur, approximate stress orientation in the fault zone may be estimated from the Hartmann's law (W. H. Bucher, 1920; E. M. Anderson, 1942). According to this, direction of maximum compressive stress bisects the acute angle included by the conjugate shear planes and medium stress is in direction of their secant. Stress orientation estimated in this way is valid for the period of the conjugated shear planes formation. The change in stress orientation due to later rotation of planes and that not indicated by conjugated planes cannot beestimated. The found stress positions showed, that fault zones with identic orientation must not necessarily belong to the same fault types. In such zones the conjugated planes belong once to the normal fault in another place to the overthrust. Furthermore a change of stress orientation in the same fault zone noticeable even in a section of several ten meters was confirmed. The most frequent case is demonstrated also by the Čertovica and Lenivá faults. The SW sections of both faults (NE and E from Mýto p. Ďumbierom) are normal and reverse faults, while the central and NE sections are overthrusts of variable dip. In most cases, however, we dispose in order of stress direction estimation only with the strike and dip change of one shear plane set. Maximum stress directions vary not only in vertical but also in inclined planes (most often in a 30° to SE dipping plane). Minimum stress is mostly nearly vertical, so that in the later case doublings and bendings occur (e. g. central part of the Lenivá fault).

In spite of variations the orientation of maximum and minimum stresses in fault zones of metamorphic rocks is evidently preferred. Stress distribution in the macrodomain may be modelled according to it. In the orientation diagram (fig. 5) two maximum stress maxima and one minimum stress maximum are noticeable. The plunge of maximum stresses is in most cases less than 45° and they acted in E and S direction. Four fifths of the cases are reverse faults and overthrusts and the rest are normal faults. From the diagram it follows that orientation change of maximum stress was not allied to the change of minimum stress whose single maximum plunges 60° to NE. Minimum stress is not vertical and this entitles the assumption that the overthrusts did not originate in the

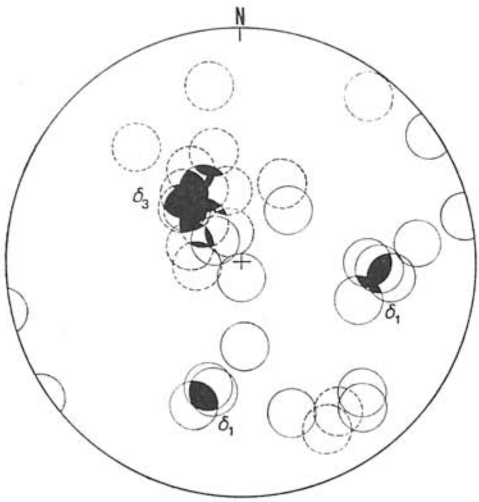


Fig. 5. Orientation diagram of maximum (δ_1) and minimum (δ_3) stresses in 17 fault zones metamorphites of the contact area. Wulff's net projection.

shallow level. The penetrative character of shear planes beyond the fault zones accounts for it. In the case of younger rotation of conjugate shear planes this assumption is incorrect. The elevation of the northern Ďumbier crystalline block might induce slight rotation of whole macrodomain. Such a rotation would affect the stress orientation, and modify the course and inner structure of the fault zones. The original dip of the thrusts would be smaller and in eastern region even horizontal. Certain features of differential uplift may be recognized in the fabric of the Čertovica fault zone (shear planes p_5), as well as in stress distribution in one part of the faults in the Ďumbier crystalline (vertical maximum stress). Its impact on the stress distribution pattern is, however, not known.

Conclusion

Three fault systems had been mapped in the contact area of the Ďumbier and Kraklová crystalline complexes in the central Low Tatra Mts. They differ by fault zone orientation and by intensity of dislocation metamorphism. The faults of the first and second system are mostly reverse faults and overthrusts of NE strike and SE dip. Faults of the third system are normal and wrench faults of NW and N strike. Some of the faults are conditioned by suitable lithology and by contrasting rheology. The fault fabric in metamorphic rocks is imbricated and in granitoids blocky.

The geometric properties of the largest first and second system faults vary in dependence on the structural level. In SW sections in the lower altitude the vertical component of separation predominates. In NE sections in the higher altitude the horizontal component of separation predominantes. The thrusting of the Kraklová on the Ďumbier crystalline set in only in the NE part of the contact area. It realized on the second system faults in the upper Alpine structural level. Dimensions of separation components and slip directions are not known, owing to the absence of reliable key horizons and movement traces. The complicated fabric of the fault zones with superposed shear planes indicates reperated faulting in places. Some normal faults might have generated in reverse fault and overthrust zones in course of the uplift.

The relation of faults to the fold structure in metamorphites may be established only in domains without destructive panetrative shear planes. In the Ďumbier crystalline faults of the first system, in the Kraklová crystalline a part of the second system faults are parallel to the southern limbs of older Alpine macrofolds. The third fault system runs close to the ac-plane of these folds. Beyond the fault zones penetrative shear planes accompanied formation of the first fault system in Ďumbier metamorphites and the first and second fault system in the Kraklová metamorphites. The third fault system was not accompanied by penetrative shear planes.

Kinematics of the first and second fault systems have been studied from the orientation of main compressive stresses in the fault zones with conjugate shear planes. Maximum stresses in the fault zones acted in two direction plunging 30° to E and S. The change of maximum stress direction was not accompanied by change of minimum stress direction. The plunge of maximum stress direction was greater in the SW part of the contact area. The directions of main compressive stresses and their variation confirm the structural field data and furnish the compound mechanism of faulting within the scope of time and structural level.

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