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The fabric of the Culm conglomerates in the eastern parts of the Nízký Jeseník and Drahany Uplands, eastern margin of the Bohemian Massif, the Czech Republic

Josef Havíř

Institute of Physics of the Earth, Masaryk University Brno, Tvrdého 12, 602 00, Czech Republic, e-mail: havir@ipe.muni.cz

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Abstract The fabric of the Culm conglomerates was studied by geometrical strain analysis methods in the eastern parts of the Nízký Jeseník and the Drahany Uplands on the eastern margin of the Bohemian Massif. The shapes and orientations of pebbles were used as strain markers and the average final ellipsoids (Shimamoto & Ikeda, 1976) were calculated (final fabric ellipsoids representing both depositional and deformational influence on the sediments).

The geometric strain analysis shows a predominantly depositional or only partially deformational fabric. Only at some sites in the eastern part of the Nízký Jeseník Uplands a deformational fabric of the conglomerates occurs. But there is evidence of a very weak effect of ductile shortening in the Drahany Upland probably connected with rotation of the more rigid pebbles in the viscous graywacke matrix of the conglomerates. The orientations of the long axes of the final fabric ellipsoids are more or less uniform. The long axes are predominantly orientated N–S to NE–SW in the eastern parts of the Nízký Jeseník and the Drahany Uplands, which means nearly parallel to the major structures of the Variscan orogen in this region.

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INTRODUCTION

The Moravo-Silesian Devonian–Carboniferous units at the eastern boundary of the Bohemian Massif belong to the external domain of the Variscan orogen. Their geological characteristics display a Rhenohercynian type of evolution (for example Behr *et al.*, 1984; Ellenberger & Tamain, 1980; Hladil, 1995). During the Lower Carboniferous, Culm sediments (shales, graywackes, conglomerates) were deposited in the Moravo-Silesian region. There are two main outcrops of Culm sediments in the Moravo-Silesian region: the Nízký Jeseník and the Drahany Uplands (Fig. 1).

The Culm sediments represent flysch and early molasse, the age and deformation of which generally decrease eastwards or south-eastwards in the Moravo-Silesian units (Dvořák, 1973, 1993; Hrouda, 1979; Kumpera, 1972). In Dvořák's (1993) opinion, the Culm flysch sedimentation had already started during the Famennian, developing the Andělská Hora Formation (the western part of the Nízký Jeseník Uplands) and migrated eastwards during the Tournaisian up to the Namurian in the Nízký Jeseník Uplands. However, the age of the Andělská Hora Formation and the Horní Benešov Formation is not well evidenced. The supposed age does not agree with the U-Pb zircon date of 319 Ma – the Namurian (Přichystal, 1988) – for a tuff layer deposited near the boundary of the Horní Benešov Formation and the Moravice Formation at the Krásne Loučky–Kobylí quarry.

The Moravo-Silesian Culm sediments were folded during the Variscan orogeny, with the fold axes and strike of the cleavage planes predominantly NNE–SSW (Dvořák, 1973, 1993; Kumpera, 1983). There is some evidence for a nappe structure for the Moravo-Silesian Devonian–Carboniferous units (for example Čížek & Tomek,1991; Melichar & Buček, 1994), as already supposed by Cháb (1986).

The fabrics of the Culm conglomerates in the eastern parts of the Nízký Jeseník and Drahany Uplands were studied in order to distinguish the effects of tectonic strain on the primary depositional preferred orientations of the principal axes of pebbles. These conglomerates are probably the products of turbidity currents in the proximal parts of outwash cones (Dvořák, 1973, 1994) or delta fans (Nehyba & Mastalerz, 1995). This mechanism of deposition can be assumed to give a nearly random initial fabric of the conglomerates. The very low shape anisotropy of the fabric ellipsoids of the Račice conglomerate and Luleč conglomerate at some sites in the southern part of the Dra-

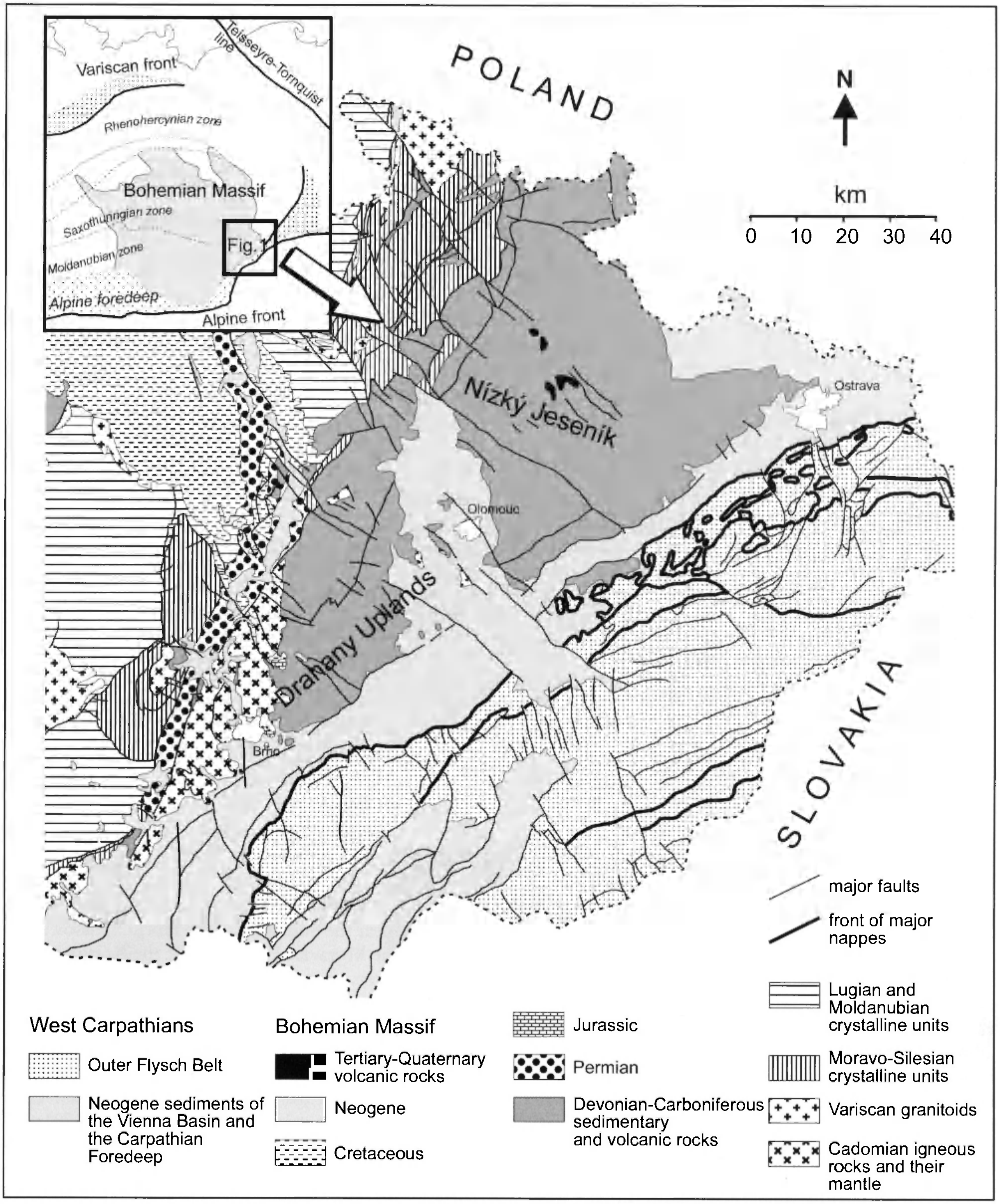

Fig. 1. Schematic geological map of the eastern part of the Bohemian Massif and position of the Nízký Jeseník and Drahany Upland areas.

hany Upland region corresponds with this presumption. But the sediments were also influenced by currents in the basin. Kumpera (1971) considered the transport of clastic material into the Culm basin from the W or SW in the southern part of the Drahany Upland area and its later north-north-westwards traction along the basin axis to the Nízký Jeseník region. Dvořák and Maštera (1974) suppose similar traction of material in the Culm basin, however, they show some reasons to presume the existence of two basins separated by the Upper Moravian Basin Block area and the transport of material by rivers from the west into these basins. The currents in the Culm basin could have produced weak preferred orientation of the long axes of pebbles in the Culm conglomerates. A pre-existing orientation has to be taken into account for a weak ductile deformation in the eastern parts of the Nizký Jesenik and Drahany Upland regions.

Some authors investigated the fabric of the Lower Carboniferous rocks of the Moravo-Silesian region by studying the anisotropy of magnetic susceptibility and by geometric strain analysis (for instance Havíř, 1996a; Hrouda, 1979; Kos, 1987; Melichar & Buček, 1994; Rajlich, 1990). An anisotropy of magnetic susceptibility of the Culm rocks in the Nízký Jesenık area was studied by Hrouda (1979). Kos (1987) obtained similar results from the graywackes and shales of the Drahany Uplands. Strong deformation of the Culm rocks is clearly visible from the results of geometrical strain analyses in the western part of the Nízký Jesenik area and in the Culm rocks in the southern continuation of the Boskovice furrow near Hostěradice (Havíř, 1996a; Melichar & Buček, 1994; Rajlich, 1990). The soft pebbles of graywacke, limestone and silt in the conglomerates of those regions are strongly stretched and their passive behaviour could be assumed to have occurred during ductile deformation. The more rigid pebbles of crystalline rock and quartz were significantly less stretched. They probably only rotated in the viscous matrix. New results of geometrical strain analysis from the eastern parts of the Nízký Jesenık region and the Drahany Uplands, where there seems to be only weak ductile deformation, are discussed in this article.

THE CHARACTERISTICS OF THE FINAL FABRIC OF THE CULM CONGLOMERATES

The studied fabrics of conglomerates, understood as orientations and shapes of pebbles, were described using "final fabric ellipsoids". This ellipsoid corresponds with the "averaged final ellipsoid" defined by Shimamoto and Ikeda (1976): $\bar{c}^{f}_{ij}x_i x_j = 1$ (see Shimamoto & Ikeda 1976; equation 37). Its components $\bar{c}^{f}_{ij}$ are arithmetic means of corresponding components of the final-shape matrix describing separate pebbles (Fig. 2). The "averaged final ellipsoid" is identical with the strain ellipsoid only in the case of the initial fabric having negligible influence. But the initial preferred orientation of pebbles has to be taken into account in the eastern parts of the Nízký Jeseník and the Drahany Uplands because only weak ductile deformation is assumed in these areas. Then the final fabric ellipsoids

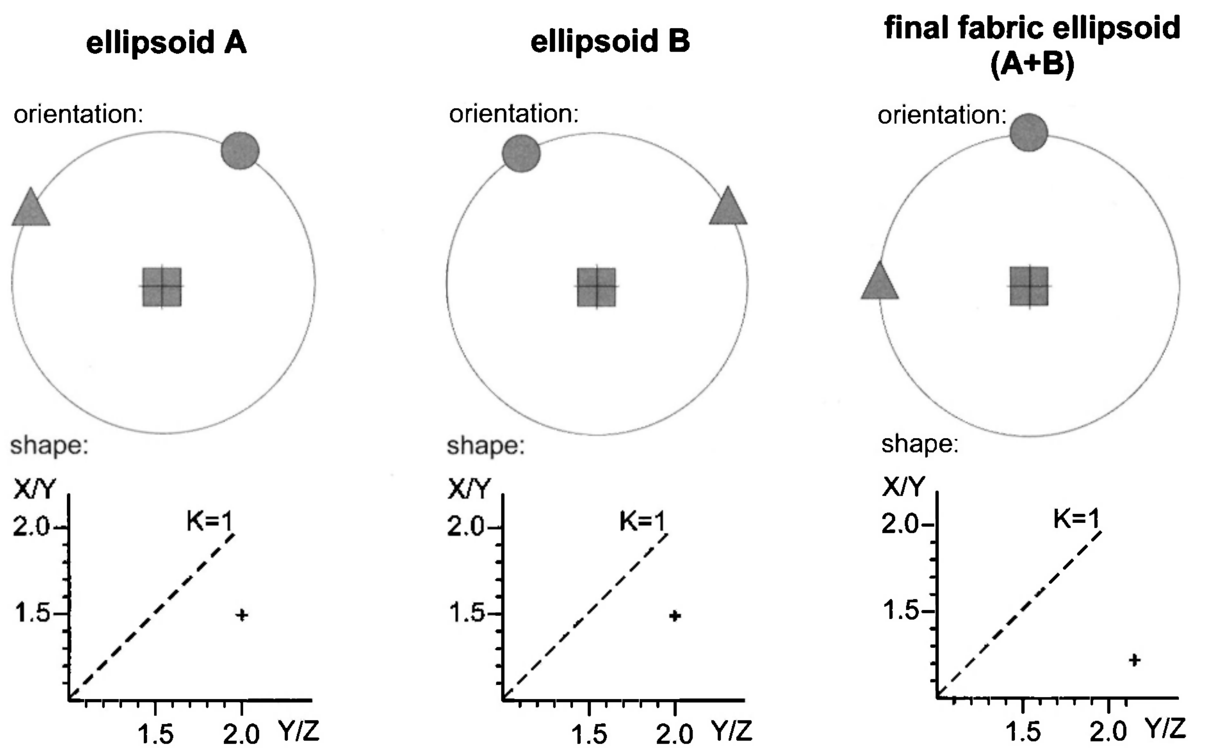

Fig. 2. An example of the averaging process of two ellipsoids. Axial ratio X/Y is 1.5 and axial ratio Y/Z is 2 for both ellipsoids (A and B). The long axis of ellipsoid A is orientated at 30°, the long axis of ellipsoid B is orientated at 330°. If **A** and **B** are matrices of the ellipsoids A and B, the matrix **C** of the averaged final fabric ellipsoid is calculated as: **C** = 0.5(**A** + **B**) . The orientation of the averaged ellipsoid is determined by eigenvectors of the matrix **C**, the lengths of the principal axes are determined by eigenvalues. Thus, axial ratio X/Y of the averaged final fabric ellipsoid is 1.215, axial ratio Y/Z of this ellipsoid is 2.155. The long axis of the averaged ellipsoid is orientated at 0°. Key to the principal axis orientations: long axis - circle; intermediate axis - triangle; short axis - square (Lambert projection, lower hemisphere).

represent both depositional and deformational components and cannot be equated with the strain ellipsoids.

The orientation and shape of pebbles from the Culm conglomerates and computed final fabric ellipsoids were used as the ellipsoidal strain markers. The shape of the final fabric ellipsoids and the relationships between the orientations of their principal axes and of other structures (bedding, cleavage, etc.) were used as key criteria to determine the character of fabrics (depositional, partially deformational or deformational). Orientation matrixes (their eigenvalues and eigenvectors) of the long and short axes of pebbles were also computed at each site where three-dimensional data was measured. The Woodcock ratios (Woodcock, 1977) and the Vollmer indexes (Vollmer, 1989) were used to characterize the distribution (cluster or girdle distribution) of long and short axes.

At some sites three-dimensional measurements of the orientation and shape of pebbles were not possible. Two-dimensional matrices based on separate sections of pebbles were averaged on three planes and the three-dimensional results were computed by combining the two-dimensional results. The chosen planes (fractures) for the two-dimensional analyses were roughly perpendicular to each other. Calculation of the principal axis orientation matrices for pebbles and the statistical tests of sample distribution requiring three-dimensional data were only applied at the sites where three-dimensional data was measured.

Simple methods of strain analysis assume passive behaviour of strain markers – ie: homogeneous deformation of objects which strain like their matrix (see Lisle, 1985). Pebbles of more rigid crystalline rocks predominate in the studied Culm conglomerates, which have a graywacke matrix. Passive behaviour is not possible because there is a significant viscosity contrast between the pebbles and the matrix. Passive behaviour can only be considered in the case of soft pebbles measured at some sites in the Drahany Uplands. Rigid pebbles probably did not change shape, they rather only rotate in the viscous matrix during weak ductile deformation. Such a rotation of rigid pebbles is also visible in the more deformed Culm sediments, for instance in the southern continuation of the Boskovice furrow near Hostěradice (Havíř, 1996a). In this case the problem of strain ellipsoid calculation is very complicated. A good knowledge of the mechanism of ductile deformation is necessary. That is why only the shape and orientation of the final fabric ellipsoids of the Culm conglomerates are discussed in this article, and not the strain ellipsoids which cannot be calculated exactly enough from the available data.

The shape and orientation of the final fabric ellipsoids are also compared with the results of magnetic anisotropy studies (which also represent both depositional and deformational influence on the Culm sediments) carried out in the investigated regions by Hrouda (1979) and by Kos (1987). This comparison is important for the determination of character of fabric and for obtaining information about strain.

THE CULM CONGLOMERATES OF THE EASTERN PART OF THE NÍZKÝ JESENÍK UPLANDS

The eastern part of the Nízký Jeseník Uplands (east of the Šternberk-Horní Benešov Belt) is formed by the Moravice and Hradec-Kyjovice Formations. The age of the flysch sediments decreases from the Moravice Formation – Upper Viséan, Goα–Goβ – eastwards to the Hradec-Kyjovice Formation – Upper Viséan, Goγ–Namurian A (Dvořák, 1994). The Culm sediments form cycles with clearly visible graded bedding. Graywackes pass continuously upwards into silts or shales, while layers of conglomerates in the lower part of the cycles are less extensive. The studied conglomerates mainly contain pebbles derived from rigid crystalline rocks closely dispersed in a graywacke matrix. The percentage of soft sedimentary rock pebbles is low. Pebbles of the order of centimetres in diameter were measured in the conglomerates.

Flexural slip folds and cleavages developed in rocks in the eastern part of the Nízký Jeseník Uplands during the Variscan orogeny. The orientations of the fold axes and the strikes of the cleavage planes are predominantly NNE-SSW, while southwards the orientations turn NE-SW (Kumpera, 1983). The vergency of the fold axial planes in the eastern part of the Nízký Jeseník area differs from that in the western part. West of the Šternberk-Horní Benešov Belt the fold axial planes are of western vergency, while varying attitudes of axial planes are characteristic of the area east of the Šternberk-Horní Benešov Belt up to the eastern boundary of the Moravice Formation. East of this boundary, fold structures are of eastern vergency (Dvořák, 1993, 1994).

The anisotropy of magnetic susceptibility of the Culm rocks in the Nízký Jeseník Uplands was investigated by Hrouda (Hrouda, 1979; Hrouda & Přichystal, 1996). His results show that the fabric of the sediments is predominantly depositional in the Hradec-Kyjovice Formation and in the most northern part of the Moravice Formation (the Osoblaha sub-block) and partially deformational in the main part of the Moravice Formation. A significant flattening of the oblate anisotropy of magnetic susceptibility ellipsoids was found. This is important because it indicates significant vertical shortening of the Culm sediments.

Geometrical strain analysis of the conglomerates of the Moravice Formation and the Hradec-Kyjovice Formation was carried out at eight sites in the Nízký Jeseník area (Fig. 3). Three sites were situated in the western part of the Moravice Formation – at the base of this formation (the Bělá conglomerates, south of Domašov n. Bystřicí), and other sites are in layers of psephites in the eastern part of the Moravice Formation and in the western part of the Hradec-Kyjovice Formation. At four sites (12, 15, 26, 39) measuring of pebbles in three dimensions was extremely difficult, so two-dimensional analyses on three planes were

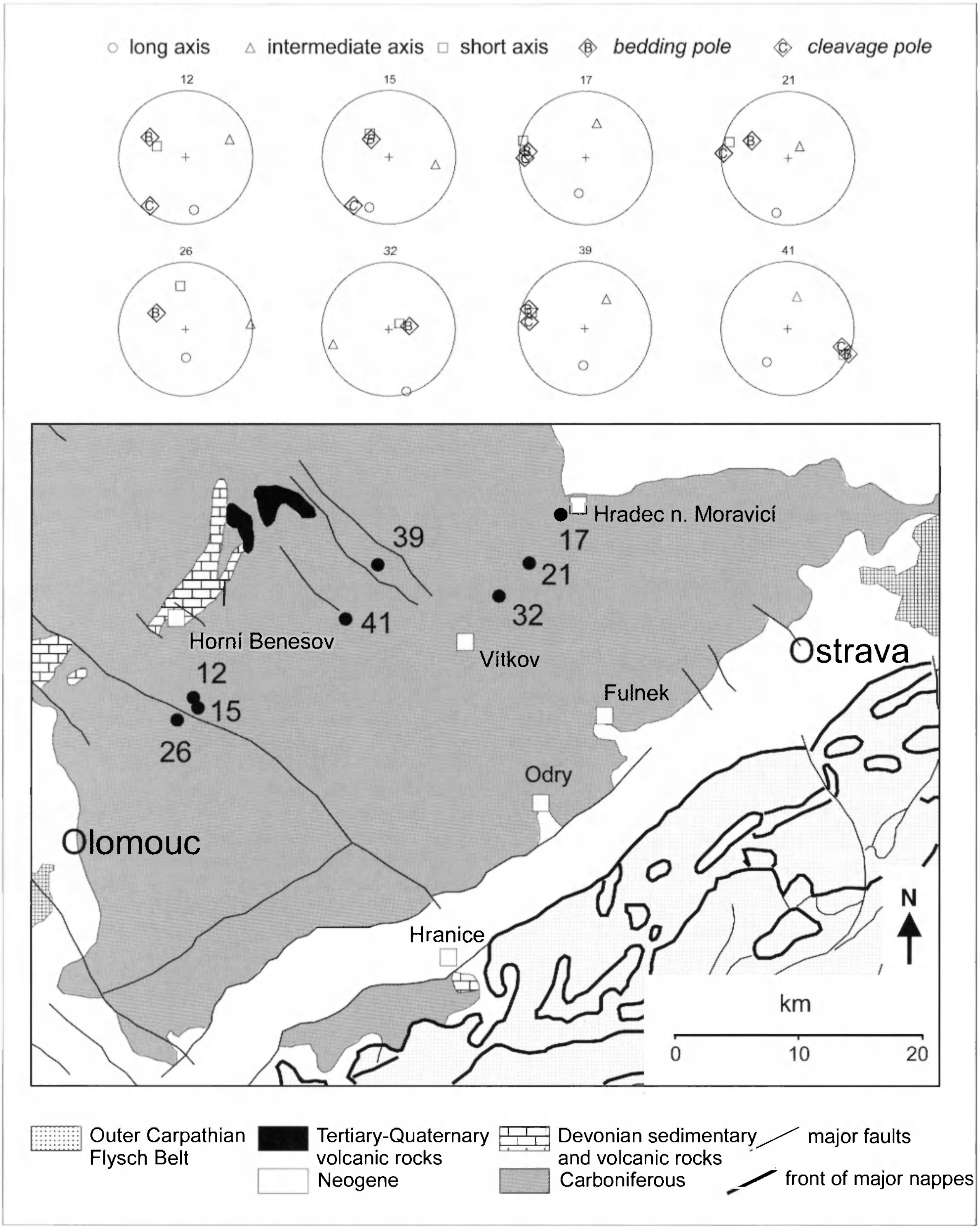

Fig. 3. Sites of geometrical strain analyses in the eastern part of the Nízký Jeseník area and the orientations of the main axes of the final fabric ellipsoids – the number of each site is over each diagram (Lambert projection, lower hemisphere).

carried out and the three-dimensional final fabric ellipsoid was computed by combining the two-dimensional results.

The orientations of the short axes of the final fabric ellipsoids are similar to the bedding pole orientations at most sites. In the case of the Bělá conglomerates (sites 12, 15 and 26) there is a conspicuous low shape anisotropy of the final fabric ellipsoids and large differences between the orientations of the short axes of ellipsoids and the pole of

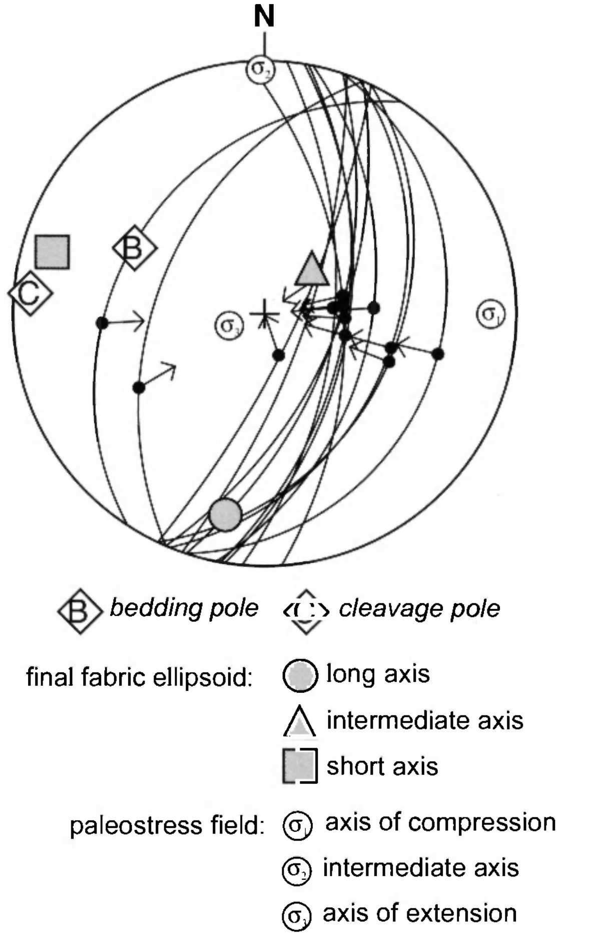

Fig. 4. Reversed faults (the fault planes are represented by great circles, arrows show the orientations of striation and sense of movements) at site 21 in the eastern part of the Nízký Jeseník area. The orientation of the Variscan stress field was calculated by reversed fault analysis and the orientations of the main axes of the final fabric ellipsoid were obtained by geometrical analysis of the Culm conglomerate (Lambert projection, lower hemisphere).

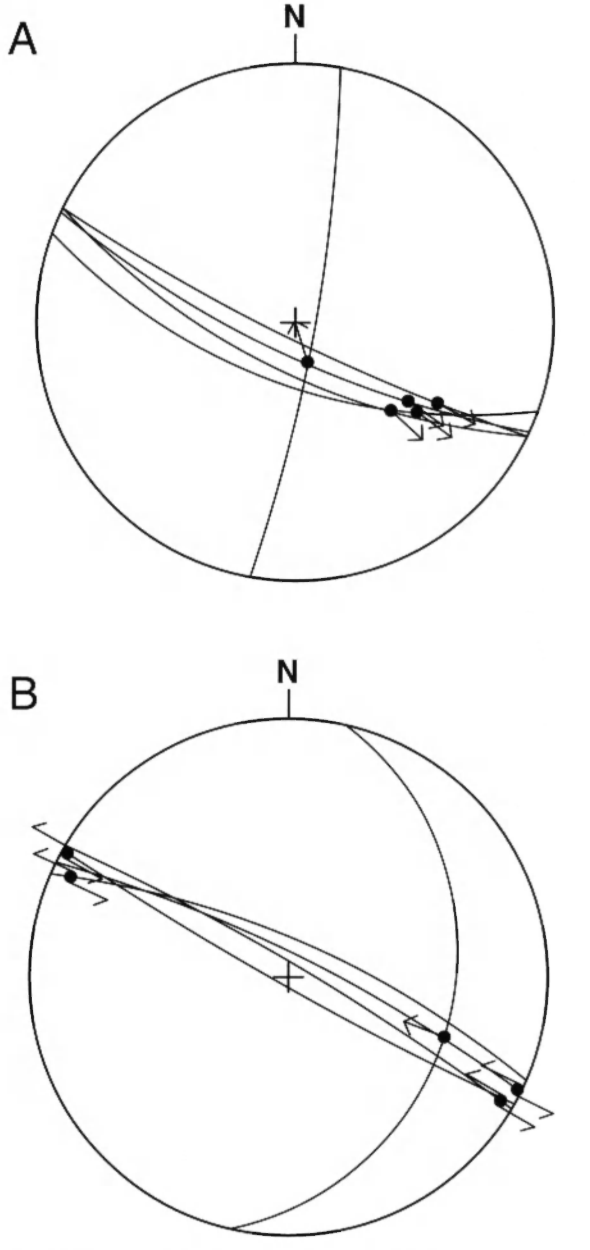

Fig. 5. A) Measured fault geometry at site 17 in the eastern part of the Nízký Jeseník area. B) Presumed fault geometry before the Variscan folding. The strike-slip faults were passively rotated and their geometry was changed into strongly-dipping normal faults. The fault planes are represented by great circles, arrows show the orientations of striation and sense of movement (Lambert projection, lower hemisphere).

cleavage, which indicate a depositional fabric for the Bělá conglomerates.

The final fabric ellipsoids of the conglomerates at other sites have higher shape anisotropy and differ from the fabric of the Bělá conglomerates. There are two kinds of conglomerate fabric in the eastern part of the Moravice Formation and in the western part of the Hradec–Kyjovice Formation. The first kind of these inner fabrics (at sites 17, 32 and 41) is represented by oblate final fabric ellipsoids. The orientations of the short axes of the ellipsoids are similar to the orientations of both the bedding poles and the cleavage poles at the sheared fold limbs. There is a close orientation of the bedding and cleavage planes. The short axes of pebbles have developed cluster distribution at these three sites, while the long axes have rather girdle distribution. The high shape anisotropy of oblate final fabric ellipsoids fits the results obtained by the magnetic method (Hrouda, 1979). This oblate shape indicates significant vertical compression of sediments, which can be explained by the existence of hypothetical thick superposed layers (probably nappes). The close orientations of the bedding poles and the short axes of the final fabric ellipsoids prove that sediments were vertically compressed prior to folding. Other than vertical shortening there is no evidence for any other ductile deformation influence. Thus, the first kind of fabric is probably depositional or only partially deformational.

The second kind of fabric of conglomerates in the eastern part of the Moravice Formation and in the western part of the Hradec–Kyjovice Formation (at sites 21 and 39) is represented by prolate final fabric ellipsoids with higher shape anisotropy. The long axes of pebbles have developed cluster distribution and the short axes have developed girdle distribution with cluster at site 21. The short axes of the final fabric ellipsoids are more similar to the cleavage pole than bedding pole. This fact shows a ductile deformation influence, so the second kind of fabric is rather deformational in origin.

At some sites the results of geometrical strain analysis were correlated with the results of the stress analysis which was also carried out in the eastern part of the Nízký Jeseník Uplands (Havíř, 1996b). The orientations of the main stress field axes were computed by the analysis of micro-fault planes with striations. The orientation of maximal compression of the Variscan paleostress field corresponds to the orientations of the cleavage pole and the short axis of the final fabric ellipsoid (probably deformational in origin) at site 21 (see Fig. 4). This could indicate relationships between the E–W compression inferred from the stress analysis (brittle deformation of the Hradec graywacke) and the ductile deformation of the conglomerate. On the other hand, the passive rotation of fault planes and lines of striation during Variscan folding was observed, for example at site 17 (see Fig. 5), where a rather depositional fabric of conglomerate was found. The paleostress field computed from this fault geometry has to be older than the folding and there is probably no relationship at site 17 between this stress field and strain connected with folding.

The long axes of the final fabric ellipsoids are orientated almost NNE–SSW or N–S at all sites. This long axis orientation is similar to the results of Hrouda's (1979) investigations of the magnetic susceptibility anisotropy. The long axis orientations found are similar to the predominant orientations of the fold axes and the strike of the cleavage planes in the eastern part of the Nízký Jeseník Uplands (NNE–SSW). These long axis orientations are also similar to the orientations of the sedimentary lineations and paleo-current markers developed in the Moravo-Silesian Culm basin (Kumpera, 1983). The deformational character of the prolate final fabric ellipsoids at sites 21 and 39 indicates the close relationship of the long axis orientations to the orientation of tectonic structures. At other sites the depositional origin of these orientations could be assumed although the influence of weak ductile deformation cannot be excluded.

THE CULM CONGLOMERATES OF THE EASTERN PART OF THE DRAHANY UPLANDS

The Myslejovice Formation forms the eastern part of the Drahany Uplands. In the most southeastern part of the Drahany Uplands, the Račice conglomerate and the Luleč conglomerate are the main members of the Myslejovice Formation. Northwards, the amount of fine-grained sediments, graywackes and shales increases. Sedimentation of the Myslejovice Formation took place during the Late Visean (Goα–Goγ), i.e. at the same time as the middle and upper parts of the Moravice Formation and the lower part of the Hradec–Kyjovice Formation in the eastern part of the Nízký Jeseník Uplands (Dvořák, 1963, 1993; Dvořák & Maštera, 1974).

The coarse grained Račice conglomerate and Luleč conglomerate forming the thick layers contain pebbles of various sizes. Pebbles of the order of centimetres in diameter were measured for analyses but pebbles of the order of decimetres are also contained in these conglomerates. The pebbles are closely dispersed in a graywacke matrix, and they are mostly derived from rigid metamorphic rocks. Only at some sites, the conglomerates include a higher percentage of soft sedimentary rock pebbles. Pebble supported fabric was observed rarely.

In the northern part of the Drahany Uplands, the fold axes and strikes of the cleavage planes are predominantly orientated NNE–SSW (Dvořák, 1973). But in the Upper Moravian Basin Block area, near the strike-slip zone creating the northern block boundary, this orientation turns to NE–SW. In the southeastern part of the Drahany Uplands no cleavage developed, except for some fracture cleavage planes in shale layers in the central part of this area. The strikes of these planes (from SE–NW to S–N) is different from the predominantly NE–SW strikes of the well developed cleavage in the northern part of the Myslejovice Formation (Dvořák, 1973). Tectonic deformation intensity in general descends from the western to the eastern part of the Drahany Uplands and from the central Drahany block towards the peripheral blocks (Dvořák, 1973). That is why the influence of only weak ductile deformation can be supposed in the south-eastern part of the Drahany Uplands where the Račice conglomerate and the Luleč conglomerate lie.

Kos (1987) studied the anisotropy of magnetic susceptibility in the Culm sediments of the Drahany Uplands. From his analyses it follows that the fabric of sediments in the eastern part (the Myslejovice Formation) is depositional or only partially deformational, while to the west (the Rozstání Formation) the magnetic fabric is more influenced by a ductile deformation.

The fabric of the Culm conglomerates in the eastern part of the Drahany Uplands was investigated at ten sites (Fig. 6). Nine sites were situated in the Račice and Luleč Conglomerates in the south-eastern part of the Drahany Uplands. One site (site 123) was situated in the layer of conglomerate in the northern part of the Myslejovice Formation. At site 123 two-dimensional analyses on three planes were carried out and the ellipsoid was computed by combining the two-dimensional results. Unfortunately, only the orientation of the long axis was obtained at this site because the errors in the determinations of the other principal axes were extremely high.

The final fabric ellipsoids obtained from the Račice conglomerate and the Luleč conglomerate are mostly oblate with very low shape anisotropy. Their shape is predominantly comparable with the shape of the final fabric

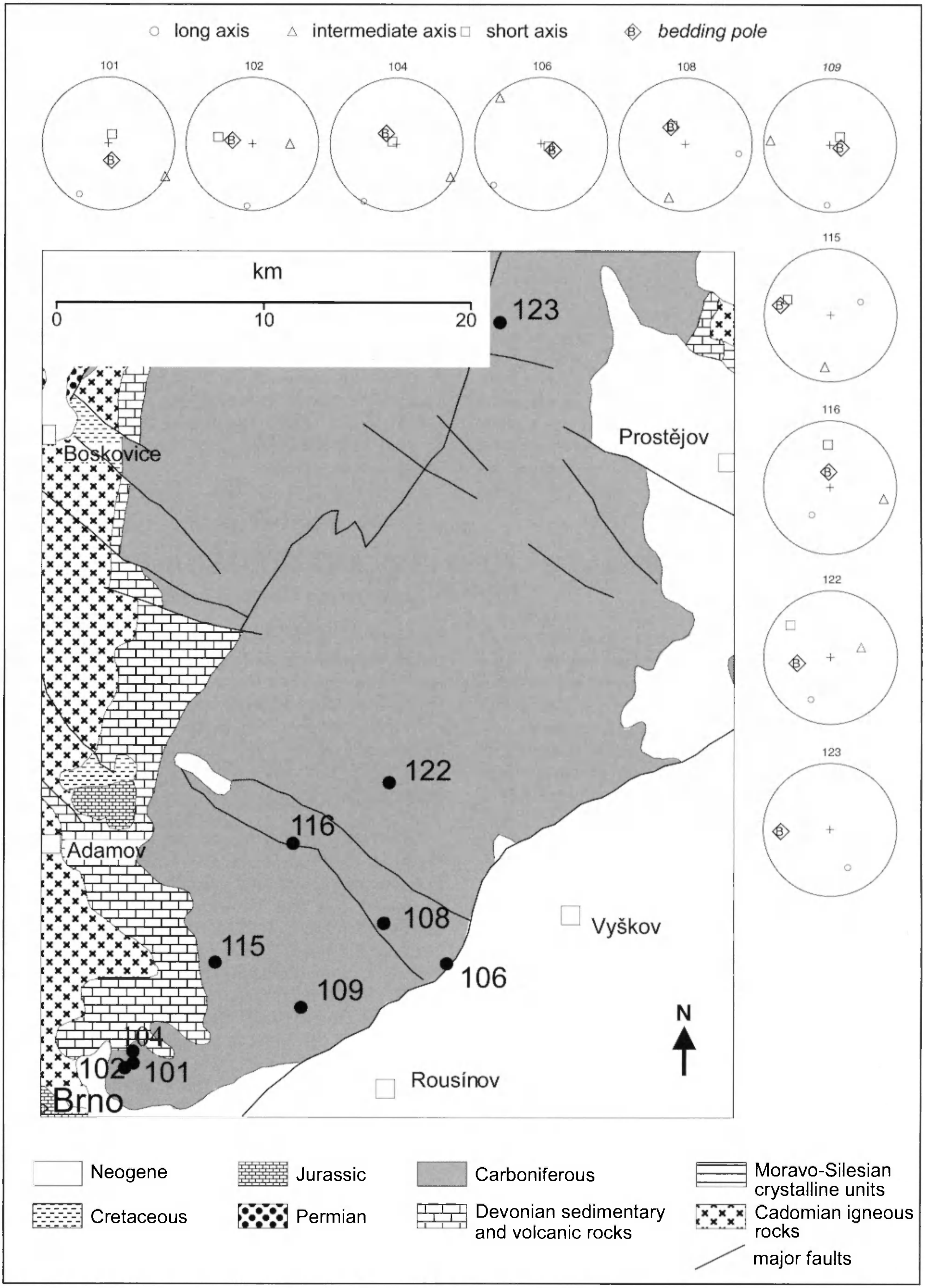

Fig. 6. Sites of geometrical strain analyses in the eastern part of the Drahany Uplands and the orientations of the main axes of the final inner fabric ellipsoids – the number of each site is over each diagram (Lambert projection, lower hemisphere).

ellipsoids of the Bělá conglomerate (the base of the Moravice Formation in the Nízký Jeseník Uplands). The orientations of the short axes are similar to the bedding pole orientations at most sites, while only at sites 116 and 122 in the northern part of the Račice and Luleč conglomerates' outcrops do the orientations of the short axes differ from the bedding pole significantly. The short axes of pebbles mostly developed rather cluster distribution. The long axes mostly developed rather girdle distribution. Both the short and long axes often have only weak preferred orientation. These facts could indicate a depositional origin for the inner fabric of the Račice and Luleč conglomerates at most sites.

In spite of the depositional character of this fabric, there is some evidence of a weak ductile deformation influence. At five sites it was possible to measure a sufficient amount of data for the final fabric ellipsoid calculation, separately for soft sedimentary rock pebbles and for more rigid igneous and metamorphic rock pebbles. Viscosity contrasts between the pebbles and the graywacke matrix were quite different for these two kinds of pebble sets. The comparison of the final fabric ellipsoids calculated from the pebbles of soft sedimentary rocks and from the pebbles of more rigid rocks shows statistically significant differences in the long and intermediate axes orientations (Havíř, 1997), which could be explained by different rates of rotation of the principal pebble axes during weak ductile deformation of the conglomerate. Other evidence of some weak ductile deformation is the presence of marks made by impressions of more rigid pebbles on other pebbles at some sites in the Račice conglomerate. Štelcl (1960) described similar marks in the Luleč Conglomerates. Thus, the fabric of the Račice conglomerate and the Luleč conglomerate could be denominated as partially deformed at least at some sites.

Maximum shortening of the Račice conglomerate and the Luleč conglomerate probably took place parallel to the bedding planes because the orientations of the short axes of the final fabric ellipsoids do not show any rotation. The rate of rotation of the long and intermediate axes of the final fabric ellipsoids was probably also low during this shortening and the influence of the initial sedimentary fabric on the final fabric of the conglomerates dominates. That is why the directions of the long axes of the final fabric ellipsoids (predominantly from SSW–NNE to SW–NE) cannot be simply regarded as the direction perpendicular to the maximum shortening direction. The orientations of the long axes are mostly the results of both depositional and deformational influence on the sediments. The considered predominant easterly direction of transport of the clastic material into southern part of basin (Dvořák, 1973; Kumpera, 1983) could be the reason for the east-west orientation of the long axes of the final fabric ellipsoids at sites 108 and 115 in the Drahany Uplands. But the ratio of lengths of the long and intermediate axes is close to the value of the standard deviation at these sites.

No relationship between the cleavage planes and the orientations of the principal axes of the anisotropy of magnetic susceptibility ellipsoids was found based on the study carried out by Kos (1987) in rocks of the northern part of the Myslejovice Formation. The relationship between the orientation of the cleavage planes in the Myslejovice Formation, the orientations of the final fabric ellipsoids and the direction of maximum ductile shortening of the Račice conglomerate and the Luleč conglomerate is not clear so far.

DISCUSSION AND CONCLUSIONS

The shapes of the final fabric ellipsoids of the conglomerates in the Nízký Jeseník area and in the Drahany Uplands are significantly different. The results of the geometrical strain analysis are in agreement with the results of the studies of the anisotropy of magnetic susceptibility in the eastern part of the Nízký Jeseník (Hrouda, 1979) and Drahany Uplands (Kos, 1987). In general the ellipsoids show higher shape anisotropy in the Nízký Jeseník area than in the Drahany Uplands (Fig. 7). The relatively more prolate shape of ellipsoids obtained at some sites in the eastern part of the Nízký Jeseník Uplands is not known from the Myslejovice Formation in the Drahany Upland area. Oblate ellipsoids from the Nízký Jeseník area are also more flattened. Comparison of the final fabric ellipsoids calculated from soft sedimentary rock pebbles and from more rigid rock pebbles shows a weak ductile deformation influence on the Račice conglomerate and the Luleč conglomerate in the Drahany Uplands. Similar weak deformation (other than older vertical shortening) could be also supposed in the case of the oblate final fabric ellipsoids of the conglomerates in the eastern part of the Nízký Jeseník Uplands. Maximum shortening probably took place nearly parallel to the bedding plane.

In both the Nízký Jeseník and the Drahany Upland areas, the final fabric ellipsoids show lower shape anisotropy than final fabric ellipsoids found in the western parts of the Moravo-Silesian Culm units, for instance in the conglomerates near Hostěradice (Fig. 6), where sediments were significantly affected by ductile deformation (Havíř, 1996a). The area near Hostěradice is situated in the southern continuation of the Boskovice furrow created on the NNE–SSW major tectonic zone which played a significant part during the Variscan collision. The strongly deformed Devonian–Carboniferous rocks analysed by Rajlich (1990) in the western part of the Nízký Jeseník area also occur near this zone. Rajlich (1990) considered this "Moravo-Silesian shear zone" to be a strike-slip shear zone, but an oblique thrusting of the Lugian and Moldanubian blocks of the Bohemian Massif on the Moravo-Silesian block supposed already by Suess (1912) and newly discussed by Melichar (1995) could explain this situation as a combination of simple shear along the tectonic boundary and compression perpendicular to this zone. The movements along this zone strongly affected the deformed sediments in the

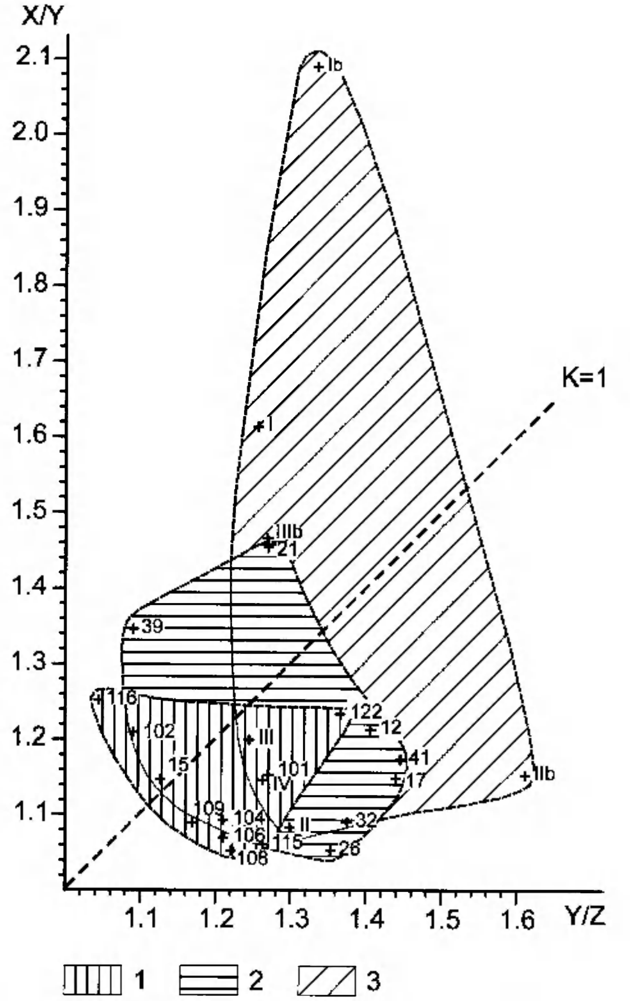

Fig. 7. K-graph of the final fabric ellipsoids obtained from the Culm conglomerates: *1* – the Drahany Uplands; 2 – the Nízký Jeseník area; *3* – the area near the Hosteradice (see text for more information).

western parts of the Moravo-Silesian Culm units. In the Culm conglomerates in the eastern part of the Nízký Jeseník and Drahany Uplands no influence of this deformation was found.

The results of the geometrical strain analysis agree with the results of the anisotropy of magnetic susceptibility studies done in the eastern part of the Nízký Jeseník (Hrouda, 1979) and Drahany Uplands (Kos, 1987). The geometric strain analysis shows a predominantly depositional or only partially deformational fabric. But there is evidence of a very weak effect of ductile shortening in the Drahany Upland. The more rigid pebbles probably moderately changed their orientations in the viscous graywacke matrix of the conglomerates. Similar shortening could also have influenced Culm conglomerates in the eastern part of the Nízký Jeseník area. In addition, at some sites in the eastern part of the Nízký Jeseník Uplands deformational fabric of the conglomerates occurs.

The final fabric ellipsoids of the conglomerates generally show more anisotropy in the Nízký Jesemk area than in the Drahany Uplands. Both the short and long axes of pebbles often have only weak preferred orientation in the Drahany Uplands. The preferred orientation of the principal axes of pebbles is significantly better developed in the Nízký Jeseník area. Shortening must have been extremely weak in the southern part of the Drahany Uplands. Some effect of this ductile shortening on the fabric of the conglomerates seems to be indisputable at least at some sites.

The orientations of the long axes of the final fabric ellipsoids are more or less uniform, except at two sites in the Drahany Uplands (sites 108 and 115). The long axes are orientated predominantly N-S to NE-SW in the eastern parts of the Nízký Jeseník and the Drahany Uplands. This orientation is nearly parallel to the major structures of the Variscan orogen in this region. It is also the predominant orientation of the fold axes and strike of the cleavage planes. However, the orientation of currents was also predominantly NNE-SSW (Kumpera, 1983). That is why both tectonic and depositional origins of the orientations of the long axes of the final fabric ellipsoids are possible.

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