cally active, and it divides the sedimentary fill of the Horná Nitra Depression from the Pre-Tertiary rocks. This segment of the fault measures 4.71 km and it is in a NW-SE direction with an inclination towards the SW. The neotectonic activity is shown by the relationship with the Quaternary alluvial fans which are cut by this fault, by the considerable change of morphotectonic parameters (e.g. relief slope and segmentation, etc.), and the aerial photograph and satellite image interpretation.

The second category consists of faults which may possibly still have been active during the neotectonic period. In the studied area, these consist of the Nedožery, the Brezany, and the Hájske faults. These are faults whose activity during the Plio-Quaternary Period was not able to be unambiguously determined. The Nedožery fault is a N-S intra-depressional normal fault structure with a westward dipping and a visible length of 13.77 km. It separates the extent of the Pliocene Lelovce Formation on the east from the Quaternary alluvial fans on the west. This fault influences the Nitra river pattern, and it is identified in aerial and satellite images. The other methods of tectonic geomorphology do not reflect its activity during the Plio-Quaternary Period. The Brezany fault is also a N-S intra-depressional fault structure dipping towards the west. The dominant component of the movement on this fault plane is a normal slip, and the fault has a visible length of 10.86 km. This fault system divides the Lelovce Formation from the Biely Potok Formation (Oligocene), and it breaks the south-eastern segment of the Pravno fault. The relationships between the fault and the Quaternary sediments have not been definitely determined. Other methods of tectonic geomorphology do not reflect its activity during the Plio-Quaternary Period. The Necpaly fault is a NE-SW intra-depressional fault structure dipping towards the SE, with a visible length of 6.42 km. This fault structure breaks the volcanic sedimentary formations of the Upper Miocene (Sarmatian), and it cuts the south-eastern segment of the Pravno fault. This fault also limits the extent of the Lelovce Formation towards the Quaternary alluvial sediments, and it probably influences the size of the Holocene alluvial fans. The Hájske fault is a NE-SW normal intra-depressional fault dipping towards the NW with a length of 8.75 km. This fault limits the extent of the Lelovce Formation towards the south-east and it breaks the volcanic sedimentary formation of the Upper Miocene (Sarmatian), and it evidently cuts the south-eastern segment of the Pravno fault. The fault influences the Handlovka river and its Quaternary sediments, and it is clearly visible in aerial and satellite images. Other methods of tectonic geomorphology do not dipict its activity during the Plio-Quaternary Period.

The last category consists of neotectonically inactive faults in the Horná Nitra Depression. These are the Šútovce fault and the south-eastern segment of the Pravno fault, whose activity during the Plio-Quaternary Period, has been unambiguously eliminated. The Šútovce fault is a NW-SE polygenetical strike-slip structure with a subvertical dip. This fault is 9.51 km and it divides the Mesozoic and Paleogene sediments from the Tatric crystalline basement of the Malá Magura Mts. The last tectonic activity on the Šútovce fault was probably in the Middle Miocene age. Younger tectonic activity was not detected by any geological, tectonic or morphotectonic methods. The fault is not identified on the satellite images. The south-eastern segment of the Pravno fault separates the Tatric crystalline basement of the Žiar Mts. from the Mesozoic and Paleogene sediments. The fault length is 15.13 km with NW-SE striking and it dips towards the south-west. The dominant component of movement on the fault plane is a normal slip. The last tectonic activity on the fault probably occurred during the Upper Miocene age. Younger tectonic activity was not detected by any geological, tectonic or morphotectonic methods. Its NW end is covered by the Lelovce Formation, and the fault is clearly visible and identifiable on the satellite images.

The present-day stress in the Horná Nitra region Earth's crust was determined by paleostress analysis and tectonic geomorphological criteria. The principal maximum horizontal compressive stress SHmax was computed to be in a NNW-SSE direction, and the principal minimum horizontal compressive stress Shmin is perpendicular to this direction. This stress-field orientation may generate movement on the Malá Magura and the north-west segment of the Pravno faults. This data may be useful in compilation of a seismotectonic model of the area.

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Tectonics of Variscan Foreland Coalbearing Basin on Example of Karvina Subbasin – Upper Silesian Coal Basin

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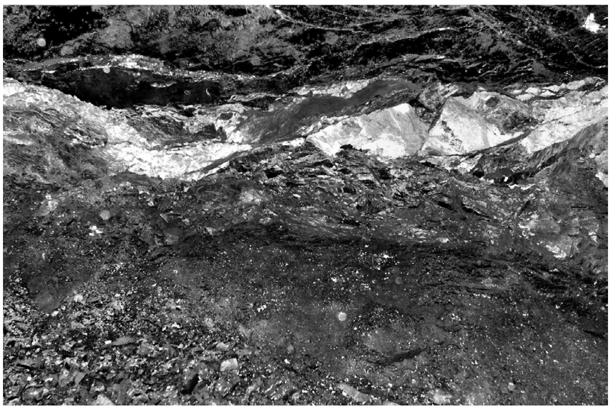
The Upper Silesian Coal Basin (USCB), the part of the Moravosilesian area, could be classify as the foreland basin located in the toe domain of the European Variscan accretion wedge (Grygar and Vavro 1995, Dopita et al. 1997, Grygar et al. 2000). The Karviná sub-basin represents the most eastward transverse structural depression (Grygar et al. 1989) of the USCB. The coal-bearing Karviná formation (continental molasse – Namurian B) is cropping out on buried Pre-Alpine basement relief and is covered by sedimentary filling of West Carpathian Tertiary Foredeep and Outer Carpathian nappes.

The Variscan orogenic belt of central Europe represents a complex of crustal blocks accreted to the Laurussian foreland during closure of oceanic domains between Laurussia and Gondwana. The general kinematics of accretion in Saxothuringian and Moldanubian/Lugian zone of the Variscan belt was towards the northwest up to NNE, however presence of Brunovistulian Pan-African (Cadomian) terrane (microcontinent) on the eastward flank in the Moravosilesian area resulted in more complex and anomalous kinematics and transpressional character of thrusting inside of Variscan sedimentary accretion wedge of Moravosilesian zone (Grygar and Vavro 1995).

Transpressional thickening of the inner Lugo-Moldanubian domain of Variscan orogeny (Grygar and Vavro 1995, Štipská et al. 2001) was contemporaneous with grow and sedimentary filling of synorogenic Moravosilesian flysh foredeep and subsequently more outer (eastward) coal-bearing foreland molasse basin located on the Brunovistulian foreland. Final crust thickening of internal Variscan orogeny domains during Upper Carboniferous orogeny stages resulted in consequent top-to-SE up to E-ward thrusting of sedimentary accretion wedge. Underplated Brunovistulian foreland with its pre-Carboniferous (mostly Devonian limestone facies) sedimentary cover carried out essential role in character, kinematics development and space distribution of regional deformations structures. Most significant role in Variscan accretion wedge thrusting played oblique tectonic ramps. They correspond to subequatorial transverse (in relation to longitudinal main fold-thrust structure trend) tectonic zones and by them limited structure elevations and depressions. The Karviná subbasin corresponds to this type of structure depression. This structure pattern is well evident in the case of Karviná Central Thrust Zone (Grygar et al. 1989). A final stage of nappe thrusting is related to widely extend dextral transpressional along WNW–ESE and NW–SE striking mostly brittle shears zones, which are very common in Karvina subbasin as in the whole USCB.

Progressive development of deformation inside accretion wedge was conditioned by layer parallel slip (Fig. 1) and detachment thrusting promoted by high bedding anisotropy of cyclic coal-bearing lithology. Similar role belongs to lithological inhomogeneities (Devonian carbonate versus flysh facies, sandstones layers versus coal seams and/or shales etc.). Slickensides on the bedding planes and intrafolial fault indicate WNW–ESE up-to NW–SE compression. Recently known easternmost limit of thrust front reaches today post-erosional eastern limit of the Karviná subbasin (easternmost coal field of Czech part of USCB – ČSM Mine – Grygar et al. 1989, 1998, Koníček and Ptáček 1999 etc.). Next progressive deformation stage was represented by tectonic ramping (Fig. 2) and fault-bend folds structures. Main fold-thrust system (e.g. Michalkovice Antikline, Orlová fold-thrust structure etc.) striking NNE-SSW. Dominant kinematics asymmetry (vergency) of folding and direction of thrusting is E to SE-ward. In the whole accretion wedge so as inside Upper Silesian Coal Basin entire thrusts system display also statistically conjugated (fan-like) structure pattern and kinematics. However back-thrusting is primarily limited only along the western domain of flysh foredeep and also partially on the western zone of Upper Silesian coal basin (Ostrava subbasin).

■ **Fig. 1.** Brittle-ductile boudins and layer parallel mylonitisation in the tectonic zone of Central Thrust (roof of Seam No. 30 – Saddle Member – Namurian B, Coalface No. 300205, ČSM Mine).



■ **Fig. 2.** Duplex and small ramps tectonics in the roof of Seam No. 30 (Saddle Member – Namurian B, Coalface No. 300205, ČSM Mine) represents easternmost thrust tectonics (Central Thrust Zone) of the Variscan accretion wedge in the Karviná subbasin (USCB).

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Tectonic Features within the Cap Rock of the Mogilno Salt Structure, Central Poland

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Cap rocks mantelling upper parts of salt structures are attributed to rock salt dissolution occurring at the salt structure contact with overlying formations in response to circulation of unsaturated brine/ground water within the salt surroundings. They are commonly thought as uniform films protecting salt structures from outer factors. However, seismic and geological studies (e.g. Krzywiec *et al.* 2000, Wilkosz 2005) as well as salt mine catastrophic inundation (e.g. inundation of Wapno Salt Mine, Poland in 1977) have shown that cap rocks have complex structures, they are fractured and faulted, thus, they do not isolate salt series from the surrounding rocks that perfectly. The studies carried out over the Mogilno Salt Structure, central Poland, has proved that tectonic processes exert significant impact not only on a cap rock stability but also on its internal structure.

The Mogilno Salt Structure is one of 11 salt structures in Poland piercing through the Mesozoic cover up to the shallow subsurface (up to about 60 m below the surface). The structure has developed between the Triassic and present, therefore it remains in contact with various Mesozoic and Cenozoic formations. Its cap rock locally borders with Pleistocene deposits, indicating, thus, relatively recent episode of structure's uprise. The cap rock has differentiated thickness (77–190 m), morphology of the surface (±100 m of relative height difference) and lithology. The latter was revealed by boreholes which evidenced three dominant rock constituents of the cap rock: gypsum, anhydrite and clays, forming altogether varying lithofacies. Additionally allochtonous sediments (gravels, sands, muds and lignite) occur within the cap rock.

This study aimed to analyse tectonic meso-scale structures occurring in the cap rock material in three drill cores. Alas the cores were not spatially oriented, thus only qualitative analysis was possible. The set of tectonic structures documented in the analysed rocks can be divided into two groups according to relative time of their development: (i) inherited tectonic structures and (ii) structures developed in the cap rock *sensu stricto*. The first group includes features developed in salt series during salt flow and they are observed in competent rocks (anhydrite/gypsum) incorporated as blocks into the cap rock. These are stylolites, slickolithes, joints/shear fractures and veins. All structures have varying orientation relative to the core axes dependent on overall block orientation and the stylolites, slickolithes, and veins depict variable geometry and petrographical characteristics throughout the cap rock. Phase changes between anhydrite and gypsum are also evidenced in their structure. The second group includes structures preserved in the gypsum-anhydrite-clay rocks originated due to salt series dissolution and these are represented by joints, shear fractures, shear zones and veins. Due to small area of observations the distinguishing between joints and shear fractures is arbitrary: joint system is attributed to rare fractures cutting the lamination almost vertically and the shear fracture system to those making almost constant angle of 30–50° throughout the cap rock. Joints are dominantly preserved in sulphate rocks and the shear fractures (as well as shear zones) are observed both in sulphate rocks and clays. Some shear fractures has transformed into microfaults as evidenced by slickensides and gypsum coatings with clear fibre lineation and older-vein offset. The latter features are also observed in shear zones which are demonstrated by 10 cm-wide zones of closely spaced fractures that make an angle of about 30° with the shear zone boundary. Generally the angular relationships between all types of fractures and the primary bedding in the cap rock indicate that the fractures developed due to vertical interaction of the salt structure occurring beneath the cap rock and the load overlying it. Timing of their origin can not be deciphered at present.

Progressive growth of gypsum crystals within the fractures (some crystals exceed 10 cm in length) has resulted in formation of continuous veins of varying thickness and locally to substitution of primary clay layers by gypsum ones. This observation indicates that tectonic factors both lead to disintegration of primary structure of the cap rock and to transformation of its lithological composition.

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