# Geological Mapping of the Crystalline Complex in the SW Part of the Jeseníky Mts., Czech Republic

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The new geological mapping of the Czech Geological Survey to scale 1:25,000 was carried out in the period of 1998–1999 in a broad vicinity of the city of Šumperk, covering map sheets 14-423 Hanušovice (editor M. Opletal), 14-412 Šumperk (V. Pecina), 14-414 Zábřeh (J. Večeřa), 14-421 Velké Losiny (V. Žáček) a 14-423 Libina (J. Aichler). Mapping of the crystalline complex was supplemented by petrographical and geochemical studies, tectonic investigations, systematic measurements of magnetic susceptibility, by the study of petrophysical parameters (M. Chlupáčová) and magnetic anisotropy (F. Hrouda).

The mapping covered the geological structure of the Lugicum (E part of the Orlica-Snieznik Dome, the Staré Město Belt and the NE margin of the Zábřeh Crystalline Complex) and the Silesicum (the Keprník and Desná units). Both the Lugicum and Silesicum have undergone a complex polyphase tectonometamorphic history and, to a considerable extent, they differ in protholith characters as well as in the succession and P-T parameters of metamorphic events. Regional distribution of the units reflects chiefly the kinematics of the Variscan tectonics.

Results of the mapping support the idea that the contact between the Lugicum and Silesicum probably follows the Ramzová line (thrust) which is represented by ae westerly dipping sinistral strike-slip zone. This structure represents, in the surface level, a dividing line between two quite different lithospheric blocks. Relics of high-grade rocks (eclogites, granulites) and scraps of the upper mantle (serpentinised mantle ultrabasic rocks generally associated with the thrust planes) are common in the Lugicum. Mineral associations of the Silesicum were formed under low- to high-temperature and low- to medium-pressure conditions, and relics of high-pressure rocks are absent here.

The contact of the Keprník and Desná units runs also along the strike-slip fault system. These units differ in the character of deformation and in the intensity of retrograde processes. The polymetamorphic development and segmentation into a range of scales and nappes are their common feature.

The grade of the Variscan polyphase metamorphism generally increases towards NNW in the Desná Unit, passing from the chlorite zone through the biotite (locally with common chloritoid) and staurolite zones to the kyanite or sillimanite zone. An important role was played by the late tectonometamorphic Variscan processes, connected with the high activity of fluids at the increasing activity of oxygen, which took place under conditions of decreasing metamorphic intensity from the amphibolite to the greenschist facies. The high hydrothermal activity during deformations under the greenschist facies conditions is evidenced by the distinctive regional epidotization, chloritization, muscovitization and the irregular growth of magnetite-maghemite. These extensive but non-penetrative, low-temperature deformations partly overprinted the primary thrust structures.

The fold pattern of the Desná Unit ranges from millimetres to kilometres in scale with prevailing NE–SW-trending folds. The imbrication structure is well documented by the alternation of scales (boudins) of metagranites and volcano-sedimentary rocks of the Vrbno Group with complicated lithon pattern on the contacts. Very uniform NE–SW orientation of foliations and lineations (L3) is characteristic for both pre-Devonian and Devonian sequences.

Geological setting of the area under survey is considerably complicated by frequent NW- to WNW-striking faults diagonally dislocating geological bodies and, to a lesser degree, by NE–SW-striking normal faults. The most distinctive movements were interpreted along the Bušín Fault, which caused the significant bending of the Zábřeh Crystalline Complex and the Desná Unit as well as the cutting off of the block of the southern part of the Keprník Unit, its displacement to the SE by 10 km and its rotation to the NW–SE direction.

# Calciturbidite Record of Variscan Orogenic Polarity in Moravia - Relative Highstands and Lowstands as Indicators of Crustal Extension and Compression, Respectively

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Calciturbidite systems are highly sensitive to relative sea-level fluctuations (Reijmer et al. 1991) and syndepositional tectonic movements (Eberli 1991). Two factors are of essential importance: (i) timing of onset of calciturbidite deposition indicating extensional drowning of carbonate platform, especially when showing a distinct polarity in time and space, and (ii) compositional variations of calciturbidites that may reveal sea-level history of their source areas. As to the former case, quick replace-

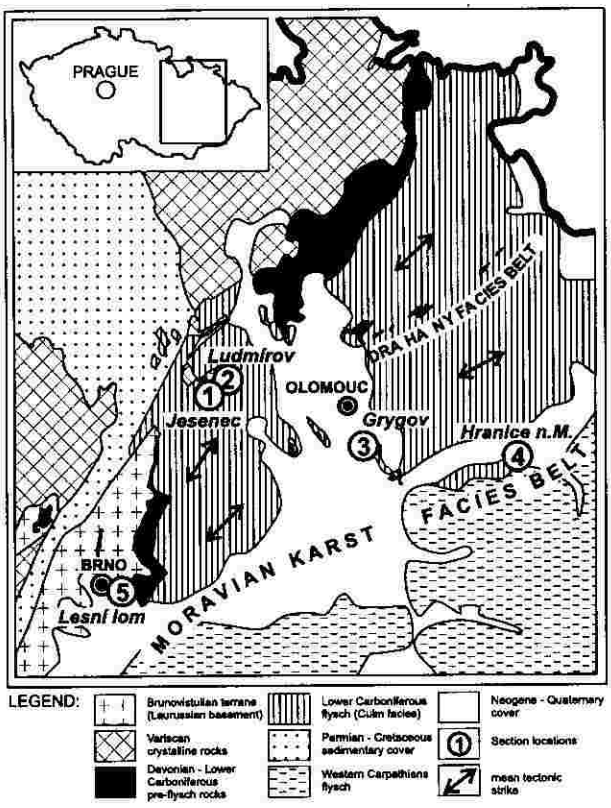


**Fig. 1.** Simplified geological map of Moravia with position of calciturbidite sections studied.

ment of carbonate platform deposits by calciturbidites indicates a rapid growth of accommodation space, i.e., a relative highstand condition. In such case, eustatic sea-level rise scenario is unrealistic as it would result in evolution of drowned platform with flat topography, capped by pelagic deposits. Instead, tectonic subsidence (block tilting) can provide better explanation as it allows for evolution of at least some topographic gradient necessary for calciturbidite sedimentation. On the contrary, as to the latter case, compositional features such as reworking and mixing of extinct fossil taxa and presence of terrigenous grains (detrital quartz, lithoclasts etc.) indicate deep erosion of calciturbidite source areas due to relative lowstands presumably induced by tectonic uplift.

Both processes are common in the Devonian to Early Carboniferous sedimentary successions of Moravia (Fig. 1), and do, indeed, show a distinct polarity approximately in the direction perpendicular to the mean strike (NE-SW). Earliest calciturbidites occurred in Ludmírov facies belt (Ludmírov "Development") in the Givetian Po. varcus conodont Zone (approximately 378 to 380 Ma), later becoming widespread as they propagated successively towards SE (Fig. 2) to the Hranice area (Moravian Karst facies belt) in mid-Frasnian Pa. hassi Zone (approx. 370 to 372 Ma), Bedřichovice near Brno in middle to late Frasnian, and finally to Lesní lom near Brno in Upper Famennian Pa. marginifera Zone (approx. 364 to 356 Ma). Facies characteristics and compositional changes indicative of relative sea-level highstand differ from locality to locality, reflecting different local conditions. However, for the pre-Late Frasnian part of the sedimentary successions, the skeletal compositions of basal calciturbidite beds, with predominance of crinoids as rather deeper-water dwellers during Devonian times (Armstrong and Mamet 1977) and pelagic dacryoconarid tentaculites and virtually no purely shallow-water derived grains, indicate rather deep-water, hemipelagic source areas instead of carbonate platform top ones. This phenomenon is typical of relative sea-level lowstands within the concept of highstand shedding of carbonate platforms (Schlager et al. 1994). Though contradictory it may be seen, such coeval occurrence of relative lowstand and highstand deposits seems to be viable if placed within the model of tectonic half-graben sedimentation. Conformable with the model, hangingwall blocks subside to start accommodating gravity-flow deposits whereas footwall blocks rise to become exposed. On the other hand, Late Frasnian and Upper Famennian onset of proximal calciturbidite deposition in Bedřichovice and Lesní lom (Kalvoda et al. 1996), respectively, with majority of shallow-water derived grains, indicates platform drowning with uninterrupted flooding of the footwall block source area. In such a way the Moravian carbonate platform was gradually destroyed as a consequence of extensional tectonic regime governing the Middle to Late Devonian evolution of the Moravian-Silesian sedimentary basin. In this respect, such carbonate platform destruction may be compared with the destruction of Southern Alpine Triassic carbonate platforms during the Early Jurassic phase of Neotethys extension (Eberli 1987, Winterer and Bosellini 1981).

However, the extensional regime and subsequent tectonic quiescence did not persist for a long time in Moravia. A major compositional and facies change occurred in the Middle Tournaisian Lower Si. crenulata Zone (approx. 355 to 358 Ma) in the Drahany facies belt (Drahany "Development") near Jesenec. Gravity-flow carbonate breccias with high percentage of non-skeletal grains (peloids and ooids), terrigenous quartz grains, reworked Frasnian and Famennian conodonts and carbonate and

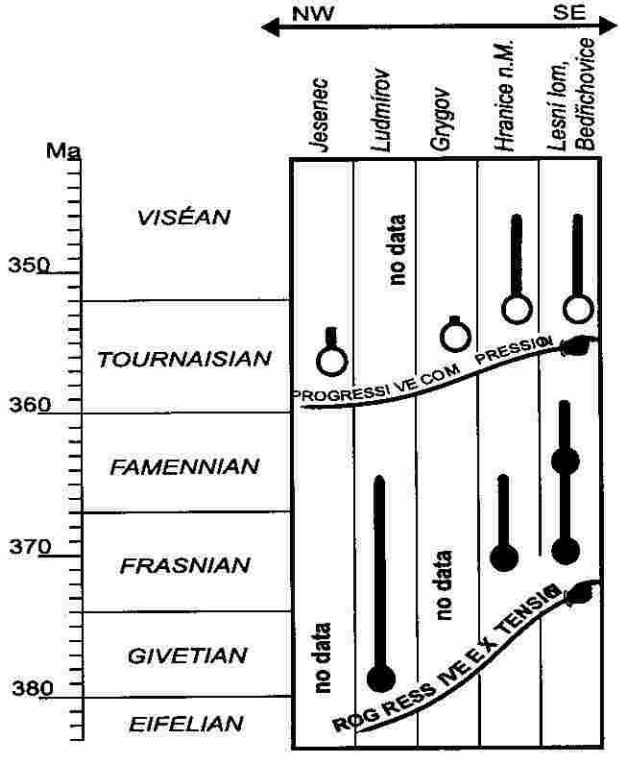


**Fig. 2.** Time correlation of calciturbidite events in Moravia: full circles = onset of calciturbidite deposition and relative sea-level highstand on hangingwall blocks; empty circles = onset of lithoclast breccia deposition and relative sea-level lowstand.

non-carbonate lithoclasts such as phosphorites and Frasnian corals, indicate erosion of the source area and a sudden influx of terrigenous material due to tectonic uplift and subsequent relative sea-level lowstand. The breccias started to expand towards SE to emerge successively near Grygov (Moravian Karst facies belt) at the Si. isosticha-Upper Si. crenulata / Gn. typicus boundary (approx. 354 to 356 Ma), and finally in the Hranice n. M. area and in broader vicinity of Lesní lom near Brno in the Late Tournaisian (352 to 353 Ma). In all the localities above, this conspicuous carbonate facies commonly precedes the onset of siliciclastic flysch sedimentation of Culm facies, indicating a sudden switch-over from extension to compression. Considering the rate of propagation of this indicator of tectonic compression in direction perpendicular to the tectonic strike, allowing for the absolute ages of its emergence in particular localities, we can roughly estimate the original distance between the localities. The rate of propagation of tectonic compression was assumed approximately equal to the rate of subduction (derived from recent subduction rates taken from 10 locations world-wide, varying from 2 to 12 cm/yr., with arithmetic mean of 7.1 cm/yr.). The average estimate of the pre-Middle Tournaisian distance between the innermost and outermost accommodation sites for the breccias (Jesenec and Hranice or Lesní lom, respectively) is 230 km, with maximum and minimum of 720 km and 0 km, respectively, taking the present-day distance perpendicular to the tectonic strike (50 km) into account. This is not in direct contradiction with the palinspastic reconstruction of the Moravian-Silesian basin presented by Hladil (1994).

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# Phase Petrological Study of the Bohemicum/Moldanubicum Boundary Zone (an Example from its Westernmost Part at the Czech/German State Border)


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Mineral assemblages from both metapelitic and metabasic rocks of the Bohemian and Moldanubian Units were studied.

Metapelites from the Neukirchen–Kdyně massif (Bohemicum) and from the area of Železná Ruda (Markt Eisenstein, Moldanubicum) comprise remnants of prograde, medium-pressure metamorphic evolution. Garnet–staurolite–kyanite–sillimanite succession is typical of these rock types. The age of this MP is taken as about 380 Ma (Kreuzer et al. 1989).

Low-pressure metamorphic assemblages have a dominant position in Moldanubicum to the S of the Central Bohemian Shear Zone (CBSZ) in the form of either crd–fsp migmatites in the major parts of Moldanubicum, or of nearly periplutonic to contactly metamorphozed mica schists in the Královský Hvozd Unit (KHU) (Moldanubicum), with and–crd non-migmatized rocks. Age of this event is considered to be about 320 Ma (Kreuzer et al. 1989).

An important crustal domain was distinguished in the close neighbourhood of the CBSZ, positioned to the S of CBSZ. Grt–chl schists and granitic mylonites conserve a PT-path position of 420–450 °C / 8–10 kb (Babůrek 1995). Neither the rare chloritoid-bearing mica-schists with Ca-saturation and plagioclase of the two different compositions ($An_{01}$–$An_{31-23}$) reached peak temperature conditions of 500 °C. Thus, this exotic crustal domain with MP–HP/LT metamorphic record and areal size of approximately 3 by 2 km, rimmed by tectonic faults or by the Central Bohemian pluton, either conserves the former metamorphic history of the Moldanubicum (and/or Bohemicum?), already overprinted in other parts of these units, or represents an absolutely different block of the crust. Very high $X_{Mg}$ of chloritoid (0.22) included in garnets of the Ostrý (Osser) mica-schists in the KHU south of this transitional domain, and the similar structural features of the KHU and this domain, argue for the first mentioned possibility as $X_{Mg}$ of chloritoids of intermediate pressure conditions should not exceed the value of 0.15 (Spear 1993).

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