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NEWLY IDENTIFIED FAULTS INSIDE THE VOLCANIC COMPLEX OF THE ČESKÉ STŘEDOHOŘÍ MTS., OHŘE/EGER GRABEN, NORTH BOHEMIA

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ABSTRACT
Recent geological survey in the area of the České středohoří Mts. allowed to identify new fault structures inside the volcanic complex. Dip-slip faults were mostly detected, but strike-slip and combined movements were also observed, especially on faults parallel to graben margins. Fault plane geometries and the importance of strike-slip movements on the faults indicate the dominance of shear stress over the whole Ohře/Eger Graben structure rather than pure extension in the synvolcanic and postvolcanic periods. The newly identified structures are described in this paper, including their assumed kinematic function. An assessment of previously known tectonic structures in this area is also given.

KEYWORDS: Surface-detected faults, deep-seated faults, České středohoří Mts. volcanic complex, Ohře/Eger Rift, Cenozoic

INTRODUCTION

The volcanosedimentary complex of the České středohoří Mts. (CS) constitutes the largest mountain range lying within the graben of the Ohře Rift (Ulrych et al., 1998, 2002). Traditionally, it was believed to be nearly free of any major faulting (Hibsch, 1926). The official edition of geological maps 1:50 000 published by the Czech Geological Survey in the 1980s and early 1990s shows well defined faults in the Cretaceous sediments in the environs of the volcanic complex, i.e. the graben margins. However, the area between these main structures – the Krušné hory and the České středohoří Fault Zones – was still interpreted as unaffected by tectonic activity. Nearly the same situation is visible on the regional map of the CS (Cajz ed, 1996).

The recognition of faults inside the volcanics, especially in the superficial volcaniclastics of the complex, is more problematic during the fieldwork than that in sedimentary rocks. Volcaniclastic rocks show variable lithologies, which does not allow to use the same criteria for fault detection during mapping, as in the marine Cretaceous sediments. As revealed by recent studies, however, the central block of the graben is affected by tectonic activity manifested by faulting even in areas covered with volcanic rocks. Using the lithostratigraphic model of the CS complex (Cajz, 2000), some of the faults could be detected. Moreover, the use of lithostratigraphic criteria also allows the estimation of the dip-slip component on the faults and provides information about their relative age.

FAULTS LIMITING THE OHŘE GRABEN

For a better orientation in the terminology used below, see the Tables. The development of ideas on the graben limitation is shown in Fig. 1, and a detailed orientation in major structures is provided in Table 1.

A detailed survey of the region started more than hundred years ago and brought basic knowledge of its tectonic setting (Hibsch, 1930): an integral idea of a graben – or subsided block (*Senkungsfeld*) – with SW–NE-striking fault systems: the Krušné hory Fault (*Erzgebirgsbruch*) in the NW and the Ohře Fault (*Egerbruch*) in the SE. Likewise, the possible continuation of this structure in the direction to the Doupovské hory Mts. was published at that time (Hibsch, 1901).

The northwestern marginal structure of the graben, the ***Krušné hory/****Erzgebirge* ***Fault Zone*** (KHFZ) is clear in its course as it is accompanied by a fault escarpment. Nevertheless, its understanding is not unanimous. The structure was defined by Hibsch (1891), Beck and Hibsch (1895) and Michel (1914) as the *erzgebirgische Bruchzone* or *Erzgebirgsbruch-zone*. Kopecký (1978) and Váně (1985) believed that the KHFZ was continuous all along its course. Malkovský (1979) and Malkovský ed. (1985) conceded its discontinuity, and some geologists even disagree with its interpretation as the first-order

Table 1 Marginal fault zones of the NE part of the Ohře/Eger Graben, detected by geological survey and borehole data.

Fault zone	*Names of partial segments*	*Supposed relation to deep-seated structures*
Krušné hory Fault Zone KHFZ	Krušné hory Fault (Suess 1903, Hibsch 1891), Děčín Fault Field (Soukup 1963), Česká Kamenice Fault Field (Soukup 1963), Doubice Fault Field (Herčík et al. 1999)	Krušné hory Deep-seated Fault KHDsF
České středohoří Fault zone CSFZ	Ohře Fault Field (Hibsch 1930), Litochovice Fault (Vejlupek and Kaas 1986), Liběšice Fault (Klein ed. 1966), Úštěk Fault (Klein 1962), Liščí vrch Fault (Adamovič 1997) and Stráž Fault (Anton et al. 1973)	Litoměřice Deep-seated Fault LDsF

structure (Hurník and Havlena, 1984; A. Kopecký, 1989).

Vertical displacement magnitude on the KHFZ is estimated at 1000 m (Hibsch 1926). The largest displacement along the fault zone took place not earlier than after the deposition of the Most Formation, i.e., after the Lower Miocene (Adamovič and Coubal, 1999), and most probably in the Pliocene to Pleistocene times (A. Kopecký, 1989). The strike of the KHFZ varies along the northern periphery of the CS: faults striking NE–SW dominating the area west of Děčín combine with those striking E–W to ENE–WSW, thus giving the general ENE–WSW trend of the fault zone. East of Děčín, the largest vertical displacement (250 m relative subsidence of S blocks) can be seen on faults striking E–W, sometimes designated as the Děčín Fault Field (Soukup, 1963) and the Doubice Fault Field (Herčík et al., 1999). Farther to the east, the KHFZ is probably terminated by the Lusatian Fault.

The southeastern limitation of the graben, the ***České středohoří Fault Zone*** (CSFZ), is dominated by NE–SW faults dipping steeply NW. These are right-laterally displaced by faults striking E–W, especially in its NE reach (Adamovič, 1997). Minor displacements are also visible on faults striking NNE–SSW and NW–SE (Coubal and Klein, 1992, Adamovič, 1997). Vertical displacement on the CSFZ can be calculated at 400 to 700 m.

The term České středohoří Fault (*Mittelgebirgsbruch*) was coined by Müller (1924). Several ideas on its course were published in the past. The difference between them is most important west of the Labe River (Fig. 1). Hibsch (1930) situated the fault to the southernmost position, near the Ohře River to the Ohře Fault, Libochovice Fault and Roudnice Fault Field (*sensu* Herčík et al., 1999). Overestimating the significance of surface morphology for fault identification, Malkovský (1977) believed that the continuation of the southern graben limit lies in the Litoměřice Fault s.s. (LF), with a vertical displacement of only 20 m, moreover, of opposite sense. Compared to the previous idea of Hibsch (1930), the graben in this concept was narrower by some 10–15 km. Later Váně (1985, 1999) published the results of his investigations and pointed out the low importance of the LF. Vejlupek and Kaas (1986), on the other hand, noted the large vertical displacement on the Litochovice Fault (north of the LF), comparable to the graben limitation east of Labe River represented most notably by the Úštěk Fault and Stráž Fault. Incorporation of the Litochovice Fault into the CSFZ makes the graben yet narrower. Farther southwest, the vertical displacement is distributed in several faults of the Ohře Fault Field (see, e.g., Váně, 1985).

CONCEPT OF RIFT-RELATED DEEP-SEATED FAULTS

The southern margin of the CS was long known to coincide with the boundary between the crustal blocks (terranes) of the Saxothuringicum and the Bohemicum and to represent the northern limit of the Permo-Carboniferous basins (Ebert, 1932, Ohře Line of Máška, 1961, Úštěk Fault of Klein ed., 1966). Based on a synoptic map of geophysical indications, especially gravity measurements, this boundary was referred to as the Litoměřice Deep-seated Fault (LDsF) by Röhlich and Šťovíčková (1968). This Late Variscan collisional zone, however, only partly coincides with the SE limit of the later Ohře Graben in its course. The kinematic function of this boundary was revised by a new complex evaluation of available deep borehole and geophysical data (Mlčoch ed., 2001) and the study of crystalline rocks in the Bohemian Gate near Litoměřice (Mlčoch, 2003). The new data are not in favour of the LDsF concept of Kopecký (1974, 1978).

Jindřich (1971) introduced the idea of rift genesis using the term "Erzgebirge Rift" for a structure active from the Upper Paleozoic up to the Cenozoic in this area. Later, Kopecký (1974, 1978) described an asymmetrical rift graben active during the Cenozoic only, hosting the CS as one of two large

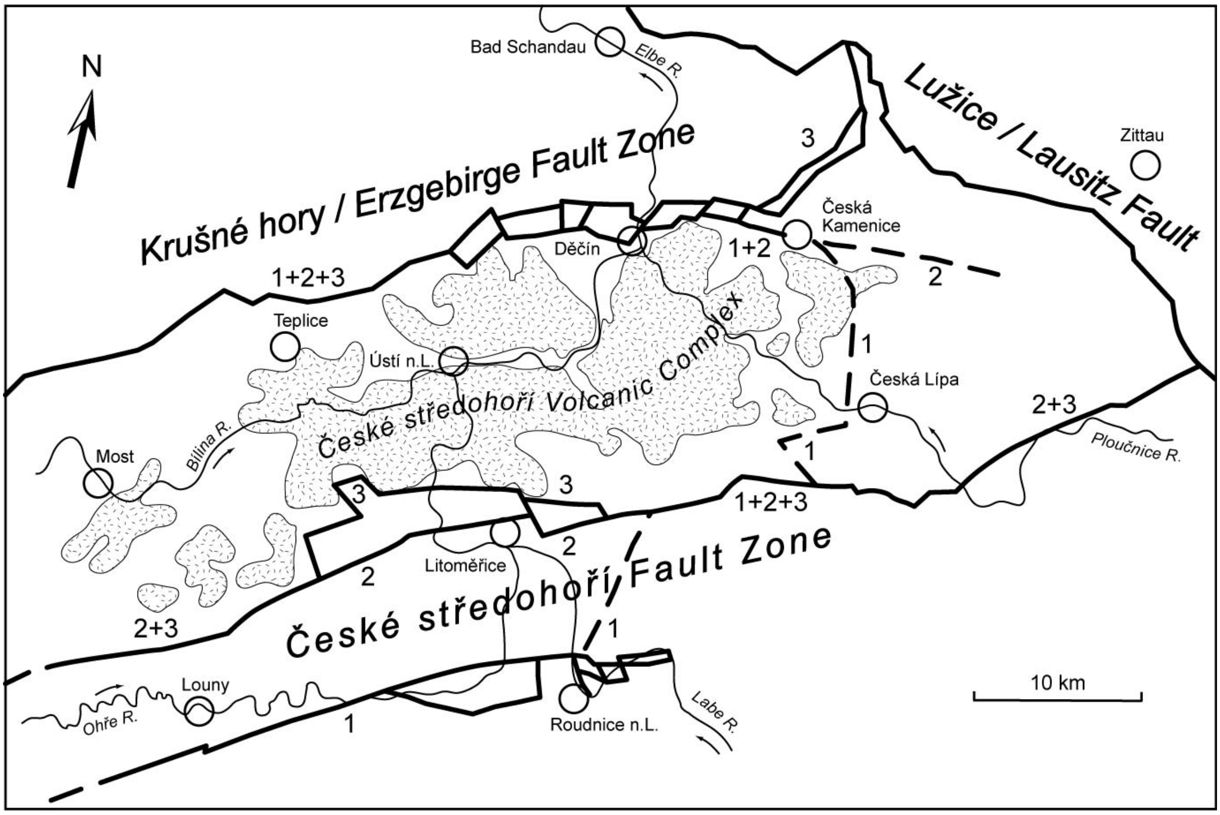

Fig. 1 Tectonic sketch showing the different interpretations of the Ohře/Eger Graben limits in its NE part: 1 – Hibsch (1930), 2 – Malkovský (1977), 3 – present idea.

volcanic complexes, and named it the Ohře/Eger Rift. His concept was based on data from geological survey from 1960s, petrological studies of volcanic rocks, evaluation of tens of deep boreholes and interpretation of gravity survey. The term LDsF was used by Kopecký (1974, 1978) for a hypothetical deep-seated structure limiting the Ohře Rift in the southeast. Additional terminological confusion was caused by Malkovský (1977, 1979) who coined the term LF for a particular segment of the CSFZ (see above). The LF was later frequently interchanged with the hypothetical structure of the LDsF.

The counterpart in the northwest of the LDsF was the Krušné hory Deep-seated Fault, with the KHFZ being its superficial manifestation (Kopecký 1974). The rift theory thus made use of clearly demonstrable superficial faults forming graben limits and attributed them a deep-seated character.

In addition to the marginal faults, Kopecký (1974) also introduced another hypothetical fault: the ***Central Rift Fault*** (CRF) subparallel to the marginal structures, allegedly responsible for the main production of volcanics in the complexes of the České středohoří Mts. and the Doupovské hory Mts. It was first defined based on the existence of the Střezov Crystalline Ridge and the location of volcanic centres of both complexes, and drawn as a discontinuous zone consisting of three faults (Kopecký et al. 1970). Later, the location of volcanic centres inside the rift structure was explained by the same author (Kopecký 1987-1988) by intersections of the continuous CRF with transverse tectonic structures of the Jáchymov Deep-seated Fault and the Central Fault of Labe Tectono-volcanic Zone. This concept is shown in Table 2.

METHODOLOGY OF FAULT IDENTIFICATION

A new, detailed survey of the volcanic complex for edition of maps 1:25 000 started in the late 1980s. Later it continued within applied studies. The area as yet covered by a new survey is limited approximately by the towns of Libouchec – Děčín – Benešov nad Ploučnicí – Kravaře – Litoměřice – Třebenice – Řehlovice and Ústí nad Labem. New facts were also revealed by the study of brittle tectonics in the Děčín area (Adamovič 2000) and in the Litoměřice – Litochovice area. A similar study now concentrates on the volcanic centre of the CS near Roztoky (Cajz and Adamovič, 2002, Cajz, 2003). New results of these research activities call for a reassessment of the tectonic setting of the Ohře Graben interior.

Superficial volcanics are divided into three formations (*sensu* Cajz, 2000) but only lower two of them could be used for fault detection due to the high degree of erosion of the uppermost one. The older Ústí Fm. (UFm) represents a rift valley fill (Lower to

Table 2 Hypothetical deep-seated structures defining the Ohře/Eger Rift.

Name of the structure	*Abbreviation*	*Author*
Krušné hory/Erzgebirge Deep-seated Fault	KHDsF	Röhlich and Šťovíčková 1968, (*NW-marginal rift fault sensu Kopecký 1974, 1978*)
Litoměřice Deep-seated Fault	LDsF	Röhlich and Šťovíčková 1968, (*SE-marginal and main rift fault sensu Kopecký 1974,1978*)
Central Rift Fault	CRF	Kopecký 1978

Middle Oligocene) and the Děčín Fm. (DFm) is a relic of a large composite volcano formed afterwards (Middle to Upper Oligocene). These formations differ in the geochemistry of their lavas and the environment of their deposition, which both influenced the style of their effusion, as well as the character of concomitant volcaniclastics.

Faults with dip-slip component in the superficial volcanic products were mostly detected by altitude differences in the bases of lithostratigraphic units. In several cases, strike-slip component could be clearly identified. The authors are aware that a dip-slip fault cutting an inclined normal fault may simulate features of an apparent strike-slip fault. Strike-slip movements on faults indicated in Fig. 2 are, however, documented by: 1) displacements by many hundreds of metres of steeply dipping to vertical faults and dykes, 2) lack of measurable vertical displacement on strike-slip faults, obviously with the exception of their parts between the segments of dip-slip faults they offset, and 3) evidence from slickensides. Orientations of fault planes could be occasionally measured owing to construction activities. Pieces of indirect evidence like morphology, water regime, etc. were also taken into account.

The identified faults can be subdivided into "synvolcanic" ones deforming only the UFm rocks, and "postvolcanic" ones deforming rocks of both the UFm and DFm. Faults not deforming volcanic products are called "prevolcanic" in this paper. Their activity is documented by variations of stratigraphic units directly underlying the continuous base of the volcanic complex. Reactivation of movement on some faults was documented, with the dip-slip component in prevolcanic period being often opposite to that in syn- or postvolcanic times.

This paper concentrates on the description of the newly identified faults, especially their courses. Detailed kinematics of the faults will be interpreted from cross-cutting relations and measurements of kinematic indicators (Riedel shears, slickenlines, feather structures, arrest lines etc.). Results of this ongoing study will be covered by a special paper.

DESCRIPTIONS OF INDIVIDUAL FAULTS

PREVIOUSLY KNOWN FAULTS

As mentioned above, the area of CS inside the graben structure lacks adequate "tectonic image" compared with the marginal limitations of the KHFZ and CSFZ. Some faults inside the structure were detected before, mostly on the basis of abrupt lithological change in sedimentary rocks. Only several of the faults were previously mapped in the volcanic products. The first record of faulting in the graben area was drawn in the synoptic map of Hibsch (1926), compiled from detailed geological maps by this author (1:25 000), and briefly also in the Geological Guide (Hibsch, 1930). The detailed maps, as well as the regional map, are more or less free of any faults, nevertheless, most of these previously known structures were later confirmed and only several structures were reinterpreted. This reinterpretation is based mostly on the recognition of frequent mass movement activity in this region: some superimposed rock packages with repeated stratigraphy formerly considered tectonic slices in fact represent slided blocks. The initiation of the mass movements esp. in the Ploučnice River valley may result from the existence of the Ploučnice Fault or some smaller structure parallel to it.

Continued survey in the 1960s specified especially the marginal tectonic structures, but the detection of faults in the area between was not too successful. The new complete edition of geological maps (1:50 000) was based on this survey and reflects tectonic knowledge at that time. Some other investigations were focused on the flow of thermal waters and preservation of their sources (Čadek et al. 1968) but no faults inside the volcanic complex were discussed. The latest study complexly covering the tectonics of the Bohemian Cretaceous Basin was the one of Herčík et al. (1999). It also attempted to incorporate faulting in the CS volcanic complex: the Žitenice Fault and the Malečov-Okřešice Fault were marked as observed ones, the others were considered uncertain. Previously known faults, such as the Hradec Fault (Klein ed., 1966) and the Zubrnice Fault (Pivec et al., 1984) were not discussed.

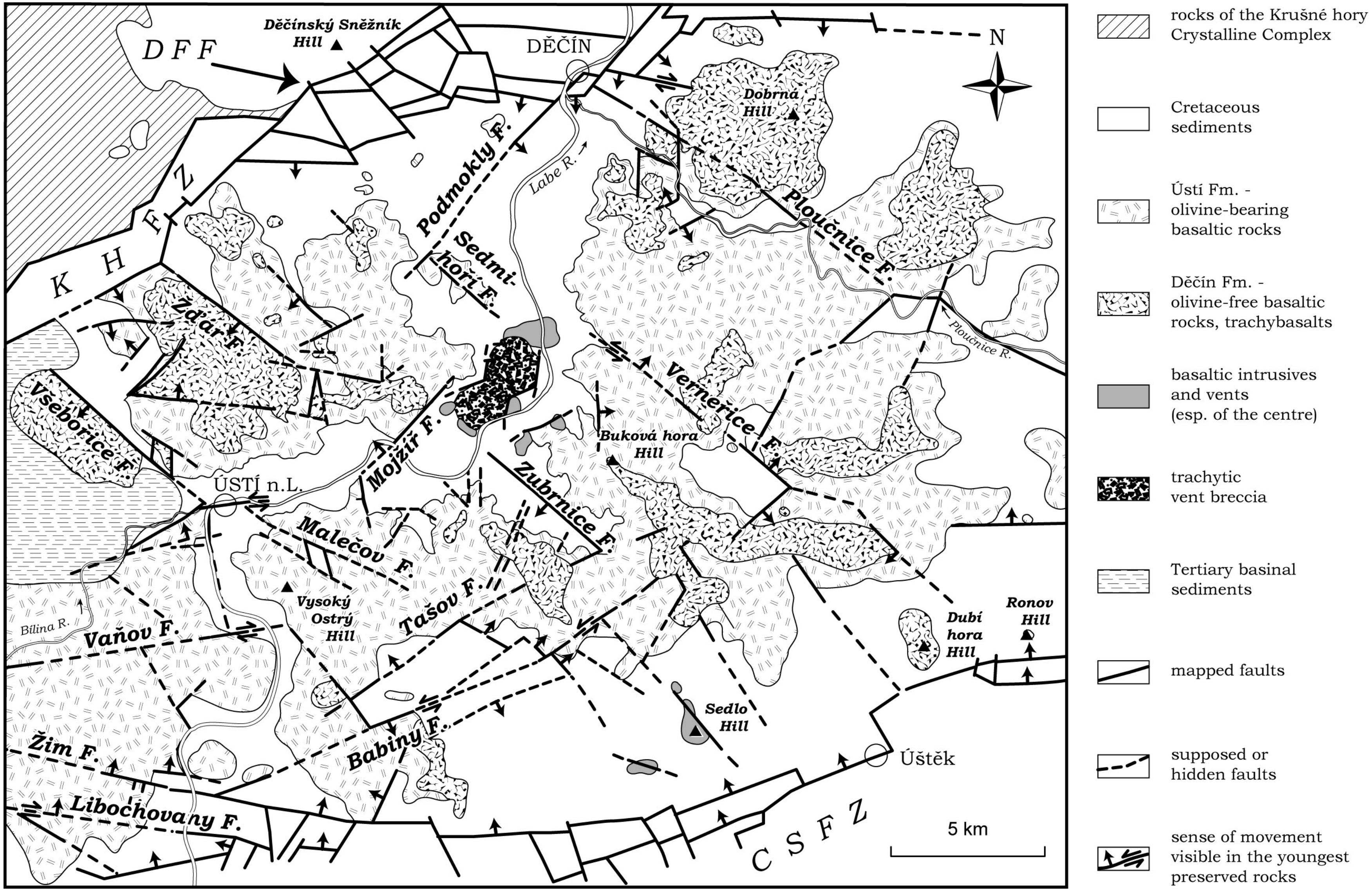

Fig. 2 Newly identified or reinterpreted faults inside the graben structure. CSFZ – České středohoří Fault Zone, DFF – Děčín Fault Field, KHFZ – Krušné hory Fault Zone

Table 3 Faults identified in the studied area (the Střezov Fault outside the studied area)

Faults / Fault zones	***Author of the primary definition or redefinition***	***Relation to deep-seated structure***
	LONGITUDINAL FAULTS	
Střezov Fault	Václ and Malkovský (1962)	supposed CRF
Tašov Fault	this paper	none
Babiny Fault	this paper	none
Vaňov Fault	this paper	none
Žim Fault	this paper	none
Libochovany Fault	this paper	none
Mojžíř Fault	this paper	none
Podmokly Fault	this paper	none
	TRANSVERSE FAULTS	
Hradec Fault	Klein et al. (1966)	none
Sedlo Fault	this paper	none
Zubrnice Fault	Pivec et al. (1984), this paper	none
Ploučnice Fault	Pivec et.al. (1984), this paper	West Lusatian Fault (?)
Střekov Fault	Pivec et.al. (1984), this paper	none
Verneřice Fault	this paper	Mid-Saxonian Thrust Fault (?)
Sedmihoří Fault	this paper	none
Žďár Fault	this paper	none
Všebořice Fault	this paper	none
Malečov Fault	Herčík et al. (1999), this paper	none

Table 3 reviews the most important mapped fault structures. The faults with highlighted names in the text below are drawn in Fig. 2.

Previously known Hradec and Zubrnice faults probably represent a single important tectonic structure within the graben limits, transverse to its elongation. The Hradec Fault runs from the W environs of Úštěk towards Lovečkovice and shows a relative subsidence of the NE block by max. 100 m (Klein ed., 1966). The ***Zubrnice Fault*** was active in prevolcanic and synvolcanic times but its activity in postvolcanic period cannot be excluded either. Its course is marked also by elongated intrusions of basaltic lamprophyres: the thickest dyke of "camptonite" in the CS following this fault in the length of >700 metres, and the dyke-shaped body of brecciated "mondhaldeite" developed in the continuation of this fault across the Labe River. This fault seems to be transected by a younger transverse fault, left-laterally displacing the thick "camptonite" dyke at first tens of metres. The Zubrnice Fault could be important for the development of the CS Volcanic Centre, as the "mondhaldeite" body on this fault limits the crater vent filled with trachytic breccia in the SW. Moreover, it strikes parallel to numerous smaller dykes of lamprophyres and semilamprophyres. It ends on the newly recognized longitudinal Tašov Fault and cannot be followed up to the CSFZ, as supposed before (Pivec et al., 1984).

The ***Ploučnice Fault*** (Pivec et al., 1984) strikes WNW-ESE and follows the course of the Ploučnice River between Děčín and Hradčany (SE of Česká Lípa). It is rather a fault zone about 500 m broad, with numerous cases of fault bifurcation. Deformations of Cretaceous sediments show that the strike-slip component clearly prevails over dip-slip component. In Děčín, faults pertaining to the Ploučnice Fault structure right-laterally displace the faults of the KHFZ with the total magnitude of 1.6 km (Adamovič, 2000). Post-Cretaceous left-lateral strike-slip movement of max. 450 m was documented on the other end of the fault near Hradčany south of Mimoň. This discrepancy indicates multi-phase history of strike-slip movements.

In the graben area, the Ploučnice Fault was active during prevolcanic and synvolcanic periods. No movement could be proved in postvolcanic times. This structure functioned as the NE limit of the graben fill during the development of the UFm, which indicates relative subsidence of the SW block during the UFm deposition. The UFm lavas were mostly deposited in aquatic environment and show hyaloclastic features in the SW, but those reaching beyond the Ploučnice Fault to the NE are mostly developed in terrestrial facies. In the NE, the volume of volcaniclastics is significantly reduced, too. The Ploučnice Fault may represent epitectonic continuation of the West Lusatian Fault *sensu* Ebert (1932). Its role during graben filling was undoubtedly very important.

The Střekov Fault (Pivec et al., 1984) is a structure running from Ústí nad Labem to the SSE with a relative syn- or postvolcanic subsidence of the WSW block by more than one hundred metres in its northernmost part, continues further S with a much smaller displacement magnitude, possibly as far as to the Vaňov Fault. Its interconnection with the Žitenice Fault (*sensu* Herčík et al., 1999) in Cretaceous sediments is not probable, as well as the continual change of its course to the SW (*sensu* Pivec et al., 1984).

NEWLY DETECTED FAULTS

a) structures transverse to the graben course

The newly detected Verneřice Fault (Verneřice – Rychnov – Babětín) limits the area of the CS Volcanic Centre from the NE. It strikes NW–SE and shows a synvolcanic relative subsidence of the NE block by 20–30 m accompanied by right-lateral strike-slip movement. Deformations of lamprophyre dykes 28–26 Ma in age along a NW–SE-striking transtensional zone related to this fault are visible in the Těchlovice quarries (Cajz and Adamovič, 2003) and correspond to E–W extension. The Verneřice Fault represents an epitectonic continuation of the Mid-Saxonian Thrust Fault sensu Ebert (1932).

Some faults on the left bank of the Labe River have the same strike as the Zubrnice or Verneřice faults. The ***Žďár Fault*** north of Ústí nad Labem shows postvolcanic relative subsidence of the SW block by >50 m. It may represent a continuation of the Zubrnice Fault, but shows a larger dip-slip displacement. The ***Všebořice Fault*** in the city of Ústí n.L. is also postvolcanic in its activity, with relative subsidence of the SW block by >100 m. Its continuation to the SE, across the Labe River, may be represented by a structure previously called the "Malečov-Okřešice Fault" (Herčík et al., 1999). However, no evidence for the interconnection of the ***Malečov Fault*** with the Okřešice Fault S of Česká Lípa was found inside the volcanics. More probably, the Malečov structure terminates at the newly recognized Tašov Fault. If the Všebořice and the Malečov faults pose an originally continuous structure, it must have been left-laterally displaced at a distance of ca. 200 m on an E–W-striking fault in the Labe River course: the one responsible for the deformation of the once integral phonolite body of the Mariánská hora/Kamenný vrch hills (Ulrych et al., 2000). The Všebořice and Malečov faults are accompanied by small rhombic blocks, which were relatively sunken and uplifted, respectively.

The existence of pairs of faults of the same strike on opposite sides of the Labe River valley (Všebořice/Malečov faults, Žďár/Zubrnice faults and Sedmihoří/Verneřice faults) slightly shifted relative to each other may be caused by their left-lateral displacement on a set of E–W faults. This remains a hypothesis, however, as the only such fault positively identified in the field is the above mentioned one in Ústí nad Labem and possible other faults may be hidden beneath the Quaternary fluvial sediments. The same style of shearing was reported from the phonolite body of Vrátenská hora Hill SE of Česká Lípa by Coubal and Klein (1992).

Some other graben-transverse structures were found having lower importance (see Fig. 2). One of them intersects the multiphase trachybasaltic vent of the Sedlo Hill, the second highest peak of the CS volcanic range – thus it can be called the Sedlo Fault, parallel to the Hradec Fault farther NE (Klein ed., 1966).

b) structures subparallel to the graben course

Completely new structures subparallel to the course of marginal fault systems of the graben were detected inside the CS volcanic complex. The Tašov and Babiny faults constitute a complicated fault zone parallel to the CSFZ inside the products of the volcanic complex. The NE–SW-striking ***Tašov Fault*** (Zubrnice – Proboštov – Tašov – Čeřeniště) shows a relative subsidence of the NW block by >170 m in the synvolcanic period. The subparallel ***Babiny Fault*** transecting Trabice, Varhošť and Panna hills shows a left-lateral displacement by ~100 m in synvolcanic and possibly postvolcanic times and a minor dip-slip displacement. Near its SW end, kinematic indicators on subvertical joints parallel to the Babiny Fault in the phonolite body at Rýdeč show a purely tensional character. These two faults also terminate less prominent transverse faults (see Fig. 2).

The NE–SW-striking ***Podmokly Fault*** can be traced from Javory in the SW to Podmokly in the NE with a relative subsidence of the SE block by >60 m. Farther NE, it enters the Děčín Fault Field as the NW-dipping *Hauptverwerfung* of Hibsch (1915). The vertical displacement magnitude increases to ca. 200m.

The ***Mojžíř Fault*** limits the extent of volcanics on the left bank of the Labe River west of the trachytic vent breccia. The fault forms a boundary between Cretaceous sediments and a special type of volcanics – deep-paleodepression synvolcanic fill (Cajz, 1993) and is characterized by possible subsidence of the NW block by ca. 60–70 m.

The ENE–WSW-striking ***Vaňov Fault*** was discovered as one of the main factors responsible for large active mass movements at Vaňov, where striae indicate right-lateral strike-slip movement. Its course further WSW across the volcanics can be traced by mass movements on a steep slope in the area of Řehlovice – Stadice.

The Žim and Libochovany faults further south strike E–W to ENE–WSW, representing splay faults to the master Litochovice Fault (a segment of the CSFZ). The ***Žim Fault*** can be traced on both banks of the Labe River by the altitude difference in Cretaceous sediments on either side of the fault: subsidence of the N block by 50 to 160 m. Post-volcanic right-lateral strike-slip movement in the zone of the Žim Fault is indicated by the deformation of a small sunken block of Cretaceous rocks in the Debus Hill quarry. The ***Libochovany Fault*** also shows a relative subsidence of the N block by ca. 50–200 m, depending on the tectonic position of smaller blocks on its sides (crystalline rocks vs. Coniacian marlstones of the Březno Fm. are juxtaposed SE of Řepnice near Libochovany). Movements in the post-volcanic period are evidenced by large exposures of striated fault planes in the Kubačka Hill quarry reported by Watznauer (1941): right-lateral strike-slip and reverse movements combine on a S-dipping fault plane.

CONCLUSIONS

New fault structures were discovered inside the volcanics of the CS complex by a detailed field survey. The outcrops mostly allowed to determine the vertical displacement but the strike-slip component was safely detected in several cases. The faults are vertical or very steeply inclined, dips of fault planes will be further studied using geophysical methods. The first results from the evaluation of small-scale brittle structures show frequent stress reversals even on major fault planes within the marginal fault zones, with the magnitudes of horizontal displacement often exceeding those of vertical displacement. Fault plane geometries and the importance of strike-slip movements on the faults indicate the dominance of shear stress over the graben structure rather than pure extension in the synvolcanic and postvolcanic periods. The newly identified faults in the volcanic fill of the graben indicate segmentation of the graben area into rhombic blocks of different sizes and elongations.

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Allow the authors to dedicate this paper to the memory of their recently passed friend, their teacher in field geological survey, their colleague from the Institute of Geology Acad. Sci. and an excellent geologist – RNDr. Miroslav Fajst, CSc.

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