Tachov fault

Structure ID: TAZ
Fault Section IDs: TAZ1-TAZ6
Related terms: Tachov Fault (cze: tachovský zlom, hlubinný zlom českého křemenného valu, ger: Tachov Störung, Böhmische Pfahl)

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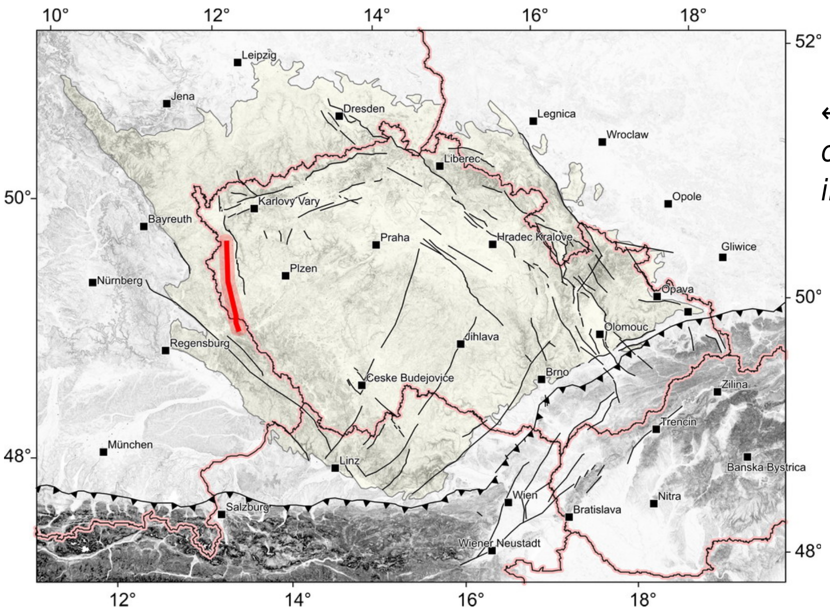

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General description

The Tachov Fault is considered to be the most significant component of the NNW–SSE trending West Bohemia Shear Zone, the deep-seated tectonic structure located along the Moldanubian (west) and Teplá-Barrandian (east) unit boundary of the Bohemian Massif for a length at least 100 km from the northeasternmost Bavaria (Germany) nearby Rimbach and Furth im Wald to Tachov area and western surroundings of Mariánské Lázně in southwestern Bohemia (Czechia); Mísař et al. 1983, Matte et al. 1990, Vrána, Štědrá et al. 1997, Pitra et al. 1999, Chlupáč et al. 2002, Zulauf et al. 2002. Some indicators point at possible continuation of the fault generally in the same strike to the Cheb and Aš areas and even southwesternmost Saxony (e.g. Babuška et al. 2007, Weinlich et al. 2006, Mrlina et al. 2009). In this my new evaluation, considering regional geomorphological features, I prefer this opinion. However, other authors rather propose in the northern regions direction of the fault either to north (eastern part of the Cheb Basin or western margin of the Tachov Basin (Trough); e.g. Václ (1979), Peterek et al. (2011); cf. Bankwitz et al. 2003, or even to the northwest along the Mže River valley up to Bavaria (cf. Špičáková et al. 2000, Weinlich et. al. 2003). These discrepancies include also a different terminology of the ruptures. While some researchers designate as the “Tachov Fault” mainly a wider zone along the specific phenomenon of the Bohemian Quartz Lode in the south, other use this term also for an oblique fault subparallel to the Mže River valley. In any case, since the main fault is associated with numerous other ruptures of similar trend, the entire structure is better to be referred as the "Tachov Fault Zone" (TAZ). Large parts of geological and geomorphological structures of the Český les Mts. (Oberphälzer Wald) in the west) and Cheb-Domažlice Graben in the east, the latter driven by the master Mariánské Lázně Fault, evolved consistently with the general trend of the Tachov Fault belt.

Fault structure and dip

The marked Tachov Fault Zone represents the axial part of more than 50 km wide NNW–SSE belt, where tectonic (mylonitized zones with phylonitized rocks, faults, various quartz-rich and granitic rock veins or ore deposits) and corresponding topographic phenomena (hillslopes or scarps, ridges or valleys) have evolved. However, some other elements of different trends presumably belong to the gross fault structure (see the chapter: Fault segmentation and cross structures). The Mariánské Lázně Fault Zone forms the eastern part of the wide tectonic belt. Two straight-lined, mutually parallel zones of the Bohemian Quartz Lode (in the east; suture-type boundary of the Tachov Fault s.s.) and the Nemanice-Rozvadov Fault (possibly own name of the structure in the west; lithologically non-distinct boundary, but accompanied by a number of correspondingly directed veins), limiting the highest elongated ridge in the southeastern part of the Český les Mts., are the main components of the TAZ. The linear features at the western margin of the Tachov Trough, opposite to the fault scarp along the Mariálnské Lázně Fault, are likely interconnected phenomena to the zone, as well as a number of linear features developed in the northern part of the Český les Mts., being subparallel to those within flexure section of the Mariálnské Lázně Fault at Mariánské Lázně. Based on schematic geological cross-sections within the TAZ resulting from a detailed geological mapping (Vejnar et al. 1975a, 1977a, 1977b, 1978a, 1986a, 1986b), local geological studies (e.g. Tomas 1971, Vejnar 1965a, 1972, 1973) or geophysical research (Hron 1961), elements of both main (eastern and western) tectonic structures are presumably normal 135–170° striking faults of 60–80°, sometimes up to 90° dip towards the ENE. However, local thrusts and short strike-slip movements were also recognized. The same, mainly normal dislocation style is developed through the entire Moldanubian unit in the southern part of the Český les Mts. Structural values of the associated NW–SE to NNW–SSE fault lines have not yet been referred to, but the available cross-section through most significant oblique line at Tachov shows geometrically similar steep lithological contacts dipping to the NE (Vejnar et al. 1967c). By contrast to the dominant NNW–SSE rectilinear trend occurring in the Český les Mts. area, at the southwesternmost Teplá-Barrandian Unit the part of the main fault is curvilinear and represented by a single tectonic element only, being influenced by a Late Paleozoic activity of the Bavarian Shear Zone (Pfahl line) in Germany, including the thicker Bavarian Quartz Lode developed in a similar time and crossing the near area in an oblique direction (e.g. Pitra et al. 1999). In the northern Český les Mts., ruptures of various directions have developed, but features of the main NNW–SSE trend are present as well even though frequently manifested only by linear occurrences of vein rocks. The trace of the main Tachov Fault (Bohemian Quartz Lode) locally roughly corresponds to a gravity gradient between the Moldanubian (lower values) and Teplá-Barrandian (higher values) geological units (e.g. Sedlák 1998). A clear indication of fault lines in regional magnetic (Šalanský 1995) or radiometric data (Manová, Matolín 1995) does not exist.

Cross structures and Segmentation

Besides clearly geologically defined southern section of the Tachov Fault, I considered at delimitation of its zone the spatial character of the wider marginal area between the Český les Mts. and the Domažlice Graben as two large geomorphological structures which used to be related to the fault, even though topographic properties do not strictly fit everywhere to faults known by geologists. An approximately uniform distance between the Tachov and Mariánské Lázně faults was taken as another premise, mainly in the northern part of the Český les Mts. The assumed multiple fault lines to the northwest in the Cheb Basin and further in the Elster Mts. do not yet allow to specify a trace of the main Tachov fault continuation reliably. The occurring ruptures along with the existing linear topographic trends enabled to divide the extracted linear elements (87 subsections in total) included in the Tachov Fault Zone (faults marked in 1:25000 and 1:50000 geological maps, clear linear geomorhological boundaries between different vertical levels as steep hillslopes or deep asymmetric valleys) into six discontinuous groups (sections) subparallel to individual parts of the Mariánské Lázně Fault Zone, each of which was represented by one general line – section trend. In case of common occurrence of geological and morphological features, a line trace of the former was preferred. Proved or assumed faults detected or indicated only during elaborating of some research reports have not been considered and illustrated (e.g. Ambrož et al. 1958, Vavřín et al. 1964–1965, Polanský 1975, Hlaváček et al. 1988, Hnízdo et al. 1992). The groups served for an ordination of fault subsections into their list, generally sequenced from the SSE to the NNW as follows (Fig. 2):

- TAZ 1 (length along the fault line 10 km, 2 subsections): A section with possibly only a single curvilinear trace of the fault changing to the north from the NW–SE to N–S up to NNE–SSW direction based on clear lithological differences between Moldanubian and Teplá-Barrandian rocks during geological mapping. No true linear features both in geology or geomorphology have developed along and non-uniform topographic indications occur there (both hillslope and subdued relief exist within). A southeastward continuation of the fault entirely towards the Moldanubian (outside the Teplá-Barrandian) unit is supposed, where it is disturbed by features of the Pfahl line (Pitra et al. 1999).

- TAZ 2 (length along the main group of lines 34 km, 32 subsections): A uniform N 163° S linear trend of the main fault of clear topographic indications has evolved in this section, limiting from the ENE the highest elongated ridge of the Český les Mts. (Čerchov Upland) against the rugged surface at the southern Domažlice Graben (uplands and basins at 440–670 m). A short part of the main line bounds the Všeruby Hills (668) m. Locally, a distinct marginal scarps have evolved, while elsewhere a sharp topographic contact does not exist. The main fault strike is parallel to the trend of the southern Mariánské Lázně Fault. A number of shorter NW–SE to NNW–SSE faults and linear landforms within the Český les Mts. were added to this section, also being subparallel to some parts of the Mariánské Lázně Fault, as well other N 163° S directed elements in the Všeruby Hills to the east. In the TAZ 2 fault section, classic occurrences of the Bohemian Quartz Lode exist, frequently manifested as a prominent low ridges in relatively lower surface. To the NNW, the section is roughly terminated against the TAZ 3 one by the transverse Radbuza River valley within the Český les Mts. piedmont.

- TAZ 3 (total trend length 18 km, 11 subsections): A section of generally N 171° S oriented few faults and a number of possibly related topographic features. Clear, approximately linear low differences (scarps) between the Český les Mts. (summits at 700–900 m) and the Domažlice Graben floor (southern Tachov Trough at about 500 m) have been developed. N 13° S trend prevails in the mountain relief itself, N 19° S landform directions exist there as well. To the north, I terminated the section at southern rim of the large Mže River valley evolved along a crossing of multiple linear topographic systems; this limit is also supported by location of the longest transverse fault developed within in the Český les Mts of the NW–SE direction. The N 171° S trend is the same as at a number of sections of the Mariánské Lázně Fault at the opposite side of the Tachov Trough.

- TAZ 4 (total trend length 19 km, 4 subsections): A trace of this section was delimited solely based on linear topographic indications in roughly northern directional continuation of the TAZ 3 group. A more consistent N 171° S striking, up to 100 m high linear scarp evolved within the piedmont of the Český les Mts. (mountain summits at 700–950 m) at the margin of the Domažlice Graben (northern Tachov Trough; floor mean surface at about 500 m, rising to the north to about 550 m). In general, the geomorphological internal structure of the Český les Mts. is similar to that along the TAZ 3 section, however, other trends including transverse ones take there a larger part. The similar is valid for the near Mariánské Lázně Fault: towards the northeast, the N 171° S trend is supplemented with those occurring on the Český les Mts.
- NRF 1 (length along the main group of lines 52 km, 22 subsections): The main linear elements of this section, limiting the highest elongated ridge of the Český les Mts. (Čerchov Upland) from the WSW, are strictly parallel to the main lines of the Tachov Fault s.s. (TAZ 2 section) on the opposite ridge side. This second main section is longer and reaches further to the NNW towards a centre of the largest part of the mountains. Similarly, topography of the lower (WSW) section strand is quite variable. To the south, the line bounds a small basin along the Nemanický potok stream at Waldmünchen in Bavaria (floor at about 490 m). The pronounced, approximately linear common valley landform along the Nemanický potok and Radbuza contrary upstreams (floors at 500–600 m) bounds the Velký Zvon Upland (862 m) in the WSW. To the NNW, the larger Rozvadov Basin (floor at about 500 m) has evolved. Finally, the line is located between approximately 800 m- (west) and 700 m- (east) surfaces of the Český les Mts. nearly up to the Mže River valley. Within the two latter subareas, a number of curvilinear faults of a similar mean trend were found during the geological mapping, some of them also in Bavaria. Many of these ruptures were mylonitized.
- TAZ 5 (total trend length 28 km, 16 subsections): The most problematic section of the West Bohemia Shear Zone; it was added to the Tachov Fault Zone only preliminary. The section within the northern Český les Mts. is of no clear dominant topographic trend. However, there have developed a number of linear landforms parallel to the near part of the Mariánské Lázně Fault Zone, where it is flexured from the main NNW–SSE strike to the general NW–SW direction: N 138° S (limiting the Jestřábí vrch Upland 789 m), N 120° S (interconnection area between the Cheb Basin and the Domažlice Gragen); N 106° S (a large part of the northern Český les Mts.); the N 149° S, N 163° and N 171° S trends are less evolved. The landforms of N 13° S orientation, transverse to the former directions, occur as well. The TAZ 5 section forms a link between the clear Tachov Fault s.s. occurrence to the south and indications of similarly striking ruptures in the western Cheb Basin to the north. Against the TAZ 3 section, this section is separated by the complicated Mže River valley in the surroundings of Tachov. The representative trace of the TAZ 5 section was marked as a line interconnecting the two most distant fault „points“ within the corresponding part of the Český les Mts; its direction is subparallel to the general trend of the near Mariánské Lázně Fault.

Scarp morphology

Topographic features along faults of the Tachov Fault Zone are very variable, from clear vertical differences on their strands (developed subparallel scarps or valleys) related to up to many hundred metres wide mylonitized zones to inexpressive or even absent surface changes. Locally, differently resistant rocks of the Moldanubian vs. Teplá-Barrandian units on both fault sides, followed by uneven denudation, have played a role. Some faults of the Bohemian Quartz Lode themselves are accompanied by resistant fill, due to selective erosion locally manifested in the surface as narrow protruding elongated ridges up to several metres high. By contrast, the surrounding mylonites have been are resistant less and at the present-day correspond to lower topography. The most prominent regional phenomena are the high summits and slopes of the Český les Mts., rising up to 250–500 m above the Domažlice Graben floor in the east (e.g. Lochmann 1968), more in the southern part of the TAZ within the Čerchov Upland than in the north at the Tachov Trough, and more than 200 m above the Rozvadov Basin in the west. However, while the general hillslope trends are quite linear, the marginal scarps (usually 50–200 m high) are usually not continuous (short steep sections frequent alternating with wider valleys) and, in detail, rather curvilinear. Subparallel valleys asymmetric in height of the Radbuza River, the Nemanický potok stream and the Teplá Bystřice River occur in the south. On the contrary, flat surfaces within fault trace exist in Bavaria outside the Český les Mts. or at Bělá nad Radbuzou nearby the mountains.

Seismicity

To be revisited after completion of earthquake catalogue. Fix Me!

Pre-Miocene evolution

The important structural contact in the TAZ mainly formed in the Carboniferous (Late Paleozoic) during the Variscan orogeny, presumably by dextral strike-slip tectonics also reaching the Saxothuringian unit in the NNW and central parts of the Moldanubian unit in the SSE. The fault was conjugated with other, not strictly coeval transverse or oblique shear ruptures tearing its trace (Pitra et al. 1999). Those mainly included the ENE–WSW Saxothuringian / Teplá-Barrandian unit boundary and the NW–SE to WNW–ESE Pfahl line within the Moldanubicum (also Malkovský 1980, Mísař et al. 1983, Matte et al. 1990, Hirschmann 1996, Špičáková et al. 2000 or Babuska et al. 2007). A number of intrusive bodies of basic or acid composition were emplaced along the developed structural contacts between metamorphosed crystalline blocks (e.g. Mariánské Lázně Complex, Bor Massif, Babylon Massif, Sedmihoří Stock or Neukirchen-Kdyně Complex), partly related to the near Mariánské Lázně Fault as another significant tectonic zone of Paleozoic origin, formed roughly subparallel to the Tachov Fault to the ENE in about 10–15 km distance (Malkovský 1980, Mísař et al. 1983, Babuška et al. 2007; cf. Hirschmann 1996). Deformations of the intrusive bodies point at younger post-Variscan movements, while there were also referred to some findings like numerous small serpentinite bodies localized lengthwise indicating a possible older (Late Proterozoic Cadomian) structural predisposition of the main Tachov Fault.

Fault activity in late Cenozoic

Tertiary

The West Bohemian Shear Zone and the Mariánské Lázně Fault Zone were reactivated several times during later phases of tectonic activity, including the young period in the Pliocene to earliest Quaternary when morphologically pronounced, about 100 km long and 10–15 km wide Cheb-Domažlice Graben filled with fluvio-lacustrine deposits (e.g. Tomas, Vejnar 1965, Gabrielová, Konzalová 1970, Nosek 1978, Bouška et al. 1995), formed in between both the zones. The reactivation was partly independent on the late Variscan structures; some accompanying faults outside the lithological boundaries developed. Sinistral movements along both faults during the graben evolution are preferred (e.g. Havíř 2000, Špičáková et al. 2000, Švancara et al. 2000, Fischer, Horálek 2003, 2009, Horálek, Fischer 2008, Peterk et al. 2011), even though some contrary results have been also presented (e.g. Schenk et al. 2009a, 2009b). Thus, a reverse kinematics in different stress field is assumed compared with presumed original movements during the Late Paleozoic. However, the activity in the later Quaternary appears to persist only along the northern part of the deformation belt in the wider surroundings of the Cheb Basin (young volcanism, higher seismicity, mineral springs, gas emissions; Bankwitz et al. 2003, Mrlina et al. 2009, Mrlina 2016 and many others), since younger movements in a transverse direction, related to a reactivation of the ENE–WSW Cenozoic Eger Rift (e.g. Peterek et al. 2011) and possibly also differently oriented features changed a crustal mobility in the south, uplifted both the northern Český les Mts. and the northern Slavkovský les Mts. and detached the Domažlice Graben as a supressed negative structure (Peterek et al. 2011). While sedimentation in the Cheb Basin has continued also in the later Quaternary, the Pliocene-earliest Quaternary fill of the Domažlice Graben has been unevenly uplifted and largely removed by a variable erosion activity within drainage areas of several transverse streams; small sedimentary relics at 390–560 m a.s.l. vertical span have been preserved only, mostly within eastern part of the graben due to asymmetry of the depressed structure. Two more extensive topographic basins at Tachov and Horšovský Týn evolved within the original graben area. Adjacent, up to 600 m higher areas along both main faults, primarily that of the Český les Mts. to the WSW (1040 m vs. 380 m a.s.l.), have been subjected to related neotectonic activity and strong erosion during the young geological period as well. As a consequence, a number of systems of subparallel linear topographic features have developed in the region from which only a part may be attributed to the Domažlice Graben activity, while other are results of only differential erosion along older, but recently inactive linear elements. The Tachov Fault Zone itself is at the present time manifested not only by a relatively narrow main fault belt coming from its Paleozoic evolution, but presumably also by a wider complex zone of ruptures and landforms roughly subparallel to gross or detail features of the master Mariánské Lázně Fault Zone, largely originated in neotectonic period. To decide which lines or their trends may be related to the TAZ activity, including that in neotectonic time, and which ones are more likely linked to different structures of various age, a new general geomorphological assessment of regional linear landform patterns appeared to be a convenient tool. Real data on surface topography (Czech area: DMR 4G product from airborne scanning; ČÚZK, German area: SRTM product from satellite scanning; ©NASA–USGS) were applied within the analysis. A comparison with recently evaluated important linear trends across the entire Bohemian Massif, penetrative or zonal, served as a basis for the lineament extraction process in the wider Domažlice Graben region. Besides geologically mapped sections, I primarily considered there a similar evolution style of both – Mariánské Lázně Fault and Tachov Fault – regional zones during selection of relevant system directions and related linear surface features.

Quaternary

- ***Continuity and character of overlying strata***

- A little is known about Quaternary evolution of the TAZ; existing successions of loess, colluvial or fluvial deposits are not extensive enough to provide sufficient indices. One possible exception may be represented by a number of 10–32 m thick near-surface sequences drilled by borehole survey along the Bohemian Quartz Lode between Hostouň and Trhanov at the foot of the Český les Mts. against the Horšovský Týn Basin, considered to be of Quaternary age (Kašová 1962, Bylová et al. 1967, Vejnar et al. 1970a, 1970b, Linhart 1971, Hnízdo et al. 1992, Přibyl 1997, Stočes 1989). Mostly colluvial and alluvial origin of various clastic deposits (alternating clay, sand or even gravel washes) may be involved (cf. Tomas, Vejnar 1965). In the former regional geological map (Vejnar, Zoubek et al. 1962), a large part of these occurrences were merged together and designated as a sedimentary Neogene occurrence, possibly related to the Pliocene-earliest Quaternary sites along the Mariálnské Lázně Fault. However, the greater thickness of Quaternary is not referred to along the entire 20 km length of this TAZ belt; solid crystalline frequently reaches there nearly the surface. Thus, some boreholes may be described incorrectly when mostly in-situ weathered material would be taken as significantly transported one.

Related local evidence

(See layer **Local evidence** *on a map. The sites are listed in south-to-north order.)*

Considering the above mentioned facts, **no indisputable local evidence of younger Quaternary fault activity could yet be defined**. At the present time, the Tachov Fault Zone within the southern and central Český les Mts. appears to be inactive. Numerous mineral springs at the northern margin of the mountains against the Cheb Basin (Faflík 1996) may be, perhaps, related rather to the activity of the Mariánské Lázně Fault or the southern continuation of the Počátky-Plesná Zone (a belt of the most abundant seismic events in the eastern part of the basin) instead (cf. Bankwitz et al. 2003, Mrlina et al. 2009). However, some findings in the future, reliably supporting a slight activity of some elements of this fault system, can be possibly made when considering several discrepancies related to Cenozoic deposits in the wider area.

Main data sources for fault map

Geological maps and explaining texts:

- scale 1:25000:
  - sheet 11-143 Cheb (Fiala et al. 1992a)
  - sheet 11-321 Lipová (Fiala et al. 1992b)
  - sheet 11-322 Lázně Kynžvart (Fiala at al. 1993a)
  - sheet 11-323 Mohelská pláň (Fiala et al. 1993b)
  - sheet 11-324 Tři Sekery (Fiala et al. 1993c)
  - sheet 21-121, 21-122 Rozvadov (Vejnar et al. 1986a)
  - sheet 21-124 Železná (Vejnar et al. 1981)
  - sheet 21-211 Stráž (Vejnar et al. 1986b)
  - sheet 21-213 Bělá nad Radbuzou (Vejnar et al. 1977a)
  - sheets 21-142, 21-231 Poběžovice (Vejnar et al. 1978a)
  - sheet 21-232 Horšovský Týn (Vejnar et al. 1978b)

    - sheets 21-233 Klenčí pod Čerchovem, 21-411 Bystřice (Vejnar et al. 1975a)
    - sheet 21-234 Domažlice (Vejnar et al. 1977b)
    - sheet 21-412 Všeruby (Vejnar et al. 1975b)
    - sheet M-33-61-D-a Františkova Lázně (Šantrůček et al. 1969a)
    - sheet M-33-61-D-d Cheb (Šantrůček et al. 1969b)
    - sheet M-33-73-B-b Oldřichov (Tomas et al. 1969)
    - sheet M-33-73-D-b Pavlův Studenec (Vejnar et al. 1966a)
    - sheet M-33-74-A-a Tři Sekery (Vejnar et al. 1969a)
    - sheet M-33-74-A-b Mariánské Lázně (Vejnar, Tonika et al. 1968)
    - sheet M-33-74-A-c Broumov (Vejnar et al. 1969b)
    - sheet M-33-74-A-d Planá (Vejnar et al. 1968)
    - sheet M-33-74-C-a Halže (Vejnar et al. 1967b)
    - sheet M-33-74-C-b Tachov (Vejnar et al. 1967c)
    - sheet M-33-74-C-c Hošťka (Vejnar et al. 1967d)
    - sheet M-33-74-C-d Staré Sedliště (Vejnar et al. 1967e)
    - sheet M-33-86-A-a Diana (Vejnar et al. 1965b)
    - sheet M-33-86-A-b Bělá nad Radbuzou (Vejnar et al. 1965c)
    - sheet M-33-86-A-c Pleš (Vejnar et al. 1965d)
    - sheet M-33-86-A-d Mutěnín (Vejnar et al. 1965e)
    - sheet M-33-86-B-c Poběžovice (Vejnar et al. 1963)
    - sheet M-33-86-C-b Nemanice (Vejnar et al. 1966b)
    - sheet M-33-86-C-d Květná Skalná (Vejnar et al. 1966c)
    - sheet M-33-86-D-a Klenčí pod Čerchovem (Vejnar et al. 1970)
    - sheet M-33-86-D-c Pec (Vejnar et al. 1970)
- scale 1:50000:
    - sheet M-33-73-D Knížecí Huť (Vejnar et al. 1967a)
    - sheet 11-34 Tachov (Müller et al. 1994)
    - sheet 11-13 Hazlov, 11-14 Cheb (Müller et al. 1996)
    - sheet 21-23 Domažlice (Barnet et al. 1994)
    - sheets 21-21 Bělá nad Radbuzou, 21-12 Rozvadov (Müller 1993)
- scale 1:200000:
    - sheet Mariánské Lázně a Švarcava (Vejnar, Zoubek et al. 1962)
- scale 1:500000 for Bavarian area:
    - geological map of the Czech Republic (along with the adjacent areas; Cháb et al. 2007)

Geophysics:

- regional gravimetry (Sedlák 1998)

Other notes

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