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Guidebook

Excursion, September, 11th-12th 2019

Base of cretaceous sediments at Elbe valley

Castle of Stolpen; Medieval former palace is situated 27 km east of Dresden. 25 million years ago volcanic activities did form a basalt peak that is nowadays a geological natural monument and foundation for the castle.

ResiBil – Bilance vodních zdrojů ve východní části česko-saského pohraničí a hodnocení možnosti jejich dlouhodobého užívání

ResiBil - Wasserressourcenbilanzierung und –resilienzbewertung im Ostteil des deutsch-tschechischen Grenzraumes

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Freistaat SACHSEN
100 YEARS CZECH GEOLOGICAL SURVEY 1919/2019
VÚV TGM Výzkumný ústav vodohospodářský T. G. Masaryka veřejná výzkumná instituce

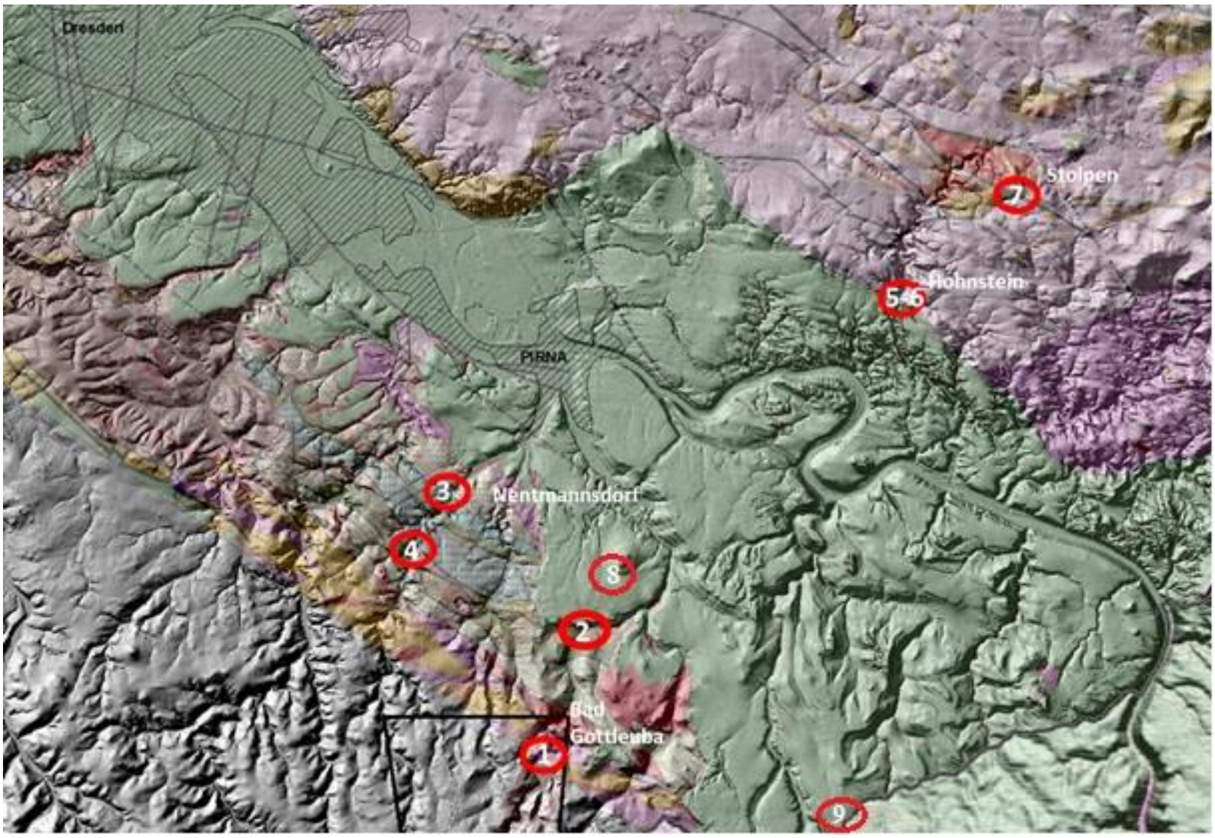

Figure 1: *Position of the excursion localities*

Excursion stops

1) Drinking water reservoir Gottleuba
2) Zehistaer Wände near Berggießhübel
3) Westlusatian fault, Seidewitz valley
4) Devonian slates, Seidewitz valley
5) + 6) Lusatian thrust, near Hohnstein
7) Stolpen Castle Hill
8) Seismologic observatory Berggießhübel (day 2)
9) ResiBil groundwater measuring point (day 2)

Stop 1

Drinking water reservoir Gottleuba

The drinking water reservoir is situated in the Eastern Ore Mountains near Bad Gottleuba. Measured from the deepest point of its foundation, the Gottleuba Dam is the highest dam in Saxony (65 m). It is a gravity dam and dams up the small river named Gottleuba. Construction started back in 1965 and ended in 1976. Since 1974 the reservoir is used to supply the region of Pirna with drinking water. In addition to its drinking water supply function, the reservoir is also used for flood protection and, to a smaller extent, for hydro energy production. The catchment area is nearly **half on Czech and half on German side**. As the reservoir is used only for drinking water supply, activities like swimming and water sports are strictly prohibited. Though, the surrounding forest attracts numerous nature lovers for hiking and relaxation. In addition to the reservoir, there are two further small sedimentation basins upstream the rivers Gottleuba and Oelsenbach (another small inflow).

Figure 2: *Drinking water reservoir Gottleuba, dam side with openings for flood relief*

Key figures

Construction period	1965 - 1976
Dammed rivers	Gottleuba / Oelsenbach
Catchment area	35,251 km²
Type of dam	Gravity dam
High above foundation	65 m
Crown length	327 m
Crown width	7 m
Construction volumina	270.000 m³
Raw water delivery	235 l/s
Water release downstream	≥ 40 l/s

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Stop 2

Zehistaer Wände, Schmilka Formation; Lower Turonian and basal Middle Turonian

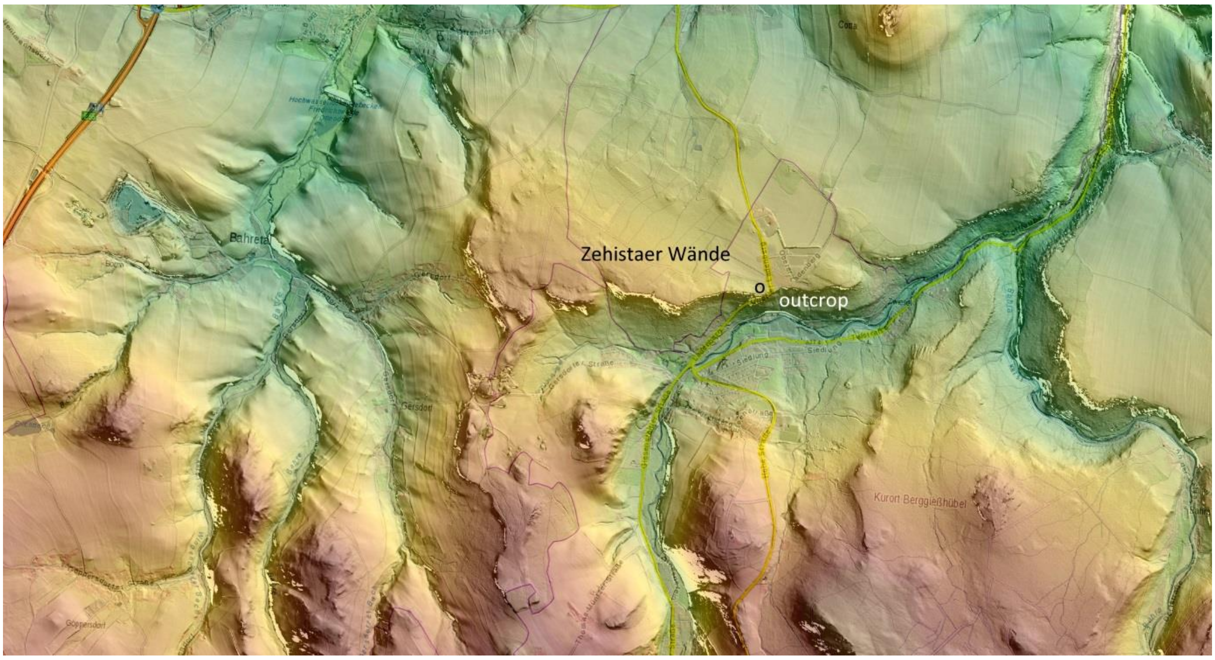

Figure 3: *Close to Berggießhübel, sandstones of the Schmilka-Formation (Lower Turonian) cover the weathered basement directly. This can be easily traced by the rock walls which form an elongated and strongly dissected plateau stretching from the area of the "Zehistaer Wände" to the south. Towards the east, thickness of Cenomanian deposits and the basal Briesnitz Formation units increase significantly. Numerous boreholes of the WISMUT SDAG proved a pre-Cretaceous morphology with a river valley system, which became successively filled with Cenomanian to Lower Turonian deposits.*

The rocks north of Berggießhübel consist of sandstones of the Schmilka-Formation. They form a couple of small rocks, showing the transition from bioturbated, fine-grained sandstones of the lower Schmilka Formation to approx. 2-3 m thick bed of coarse-grained quartz sandstones, which marks the top of the Schmilka Formation. The marlstones and bioturbated sandstones of the overlying Postelwitz Formation (middle to late Turonian) are preserved at the nearby basalt hill Cottaer Spitzberg, but were completely removed above the plateau of the hard top unit of the Schmilka Formation.

The fine-grained sandstones are best seen around the tableau of the Sorrowful Mother Maria (Mater Dolorosa; Our Lady of Sorrows) close to the road; the transition to the coarse-grained sandstones which overly the sandstones below with a sharp erosive surface follows above. In terms of facies interpretation we see the transition of the lower shore face which is dominated by occasional currents transporting fine sand and the homogenisation of different grain size distributions by bioturbation and the upper shore face, represented by numerous high energetic events (storms) washing out finer grain-sizes and wave action on the sea-floor. This points to the transition to the upper shore face which is dominated by currents and waves. Concerning hydraulic properties, permeability increases towards the top. The abruptly following Lower marls of the Postelwitz formation would mark a good aquitard, which is nevertheless missing in the surroundings of Berggießhübel.

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Figure 4: *Outcrop of the bioturbated sandstones of the Lower Turonian Schmilka Formation at the eastern margin of the "Zehistaer Wände". The coarse-grained sandstones follow on top.*

In this area, the strong morphology of the pre-Cretaceous basement and the fluctuating, but in general rising, Mid-Cretaceous sea-level caused stepwise flooding of the relief from Cenomanian to Lower Turonian. Fluvial deposits of the Niederschöna Formation were well- exposed in the Bahra-valley only (unfortunately, now covered by a stabilisation wall to protect the road above). These thin units belong to the Cenomanian "Pirna river" and two small creeks (Zwiesel creek and Bahra-Kirchberg creek), which discharged the area of the Markersbach granite to the west and to the north. These small river branches were the main uranium bearing units of the Königstein Uranium Mine. Thickness of fluvial deposits in the Pirna valley decreases from about 30 m to zero towards the margins of the catchment area. The above following units of the Oberhäslich and the Dölzschen formations show a stepwise onlap on the basement. Even the marly lower Turonian Briesnitz Formation is absent on the heights of the paleo-morphology. All units disappear in the subground of the Zehistaer Wände. Further to the east, at the "Felsenbrücken" near Bad Gottleuba, the Schmilka-Formation overlies directly weathered granites (Markersbach granite) of the eastern Erzgebirge (Elbtal-Schiefergebirge). On the Saxony side of the Bohemian-Saxonian Cretaceous Basin, this is the most significant island during the Cretaceous. It formed a watershed between the Pirna river and the Rosenthal-Sneznik river system.

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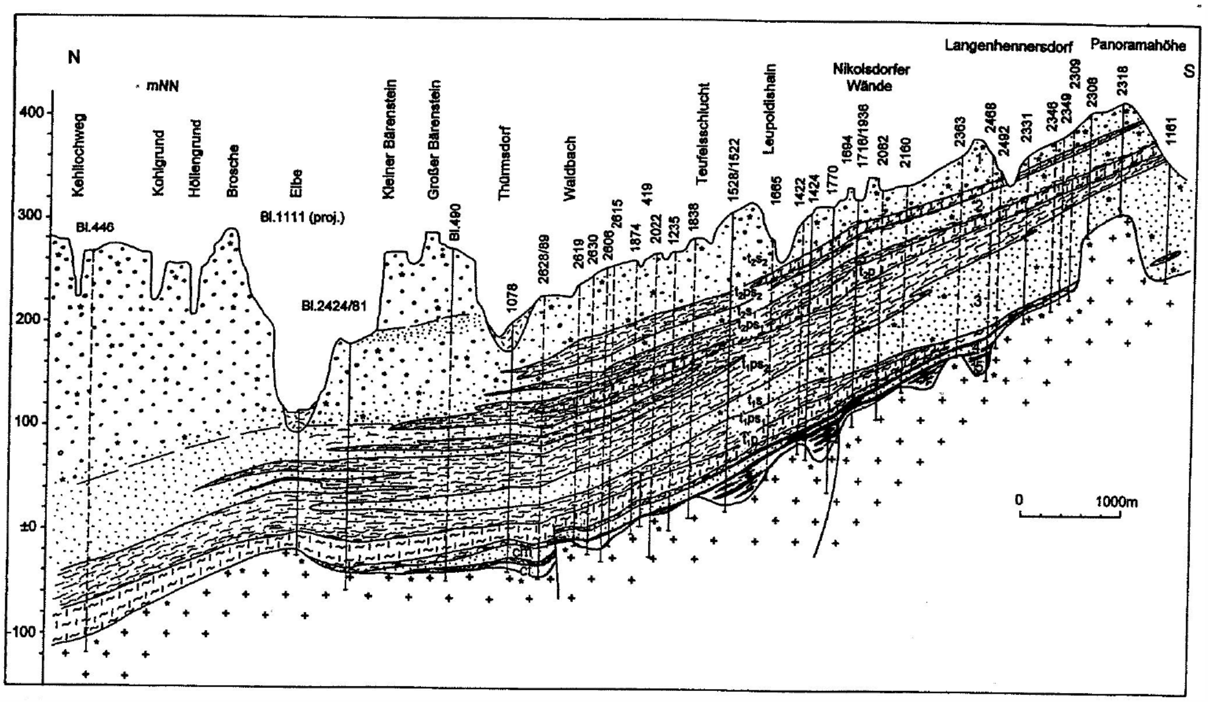

Figure 5: *Thinning of the Cretaceous succession towards the basin margin in the Cenomanian reflects the head of a river valley discharching from a smooth hilly mountain the west (Markersbach Granite). Morphology is proven by hundreds of boreholes cored during exploration of the Königstein Uranium deposit. (From Tonndorf 2000). Note that the "Labiatus Sandstein" progrades from the southwest (opposite direction to the Postelwitz Formation).*

Stop 3

Westlusatian Fault in the Seidewitz valley

The Elbtalschiefergebirge on the NW part of the Elbe zone is limited by two prominent faults of variscan age. The Mid Saxonian fault on the SW rim separates the gneisses of the Erzgebirge from the Old-Palaeozoic sediments of the Elbtalschiefergebirge. The Westlusatian Fault separates the Old-Palaeozoic sediments from the Proterozoic granodiorites and greywackes of the Lusatian massif in the NE.

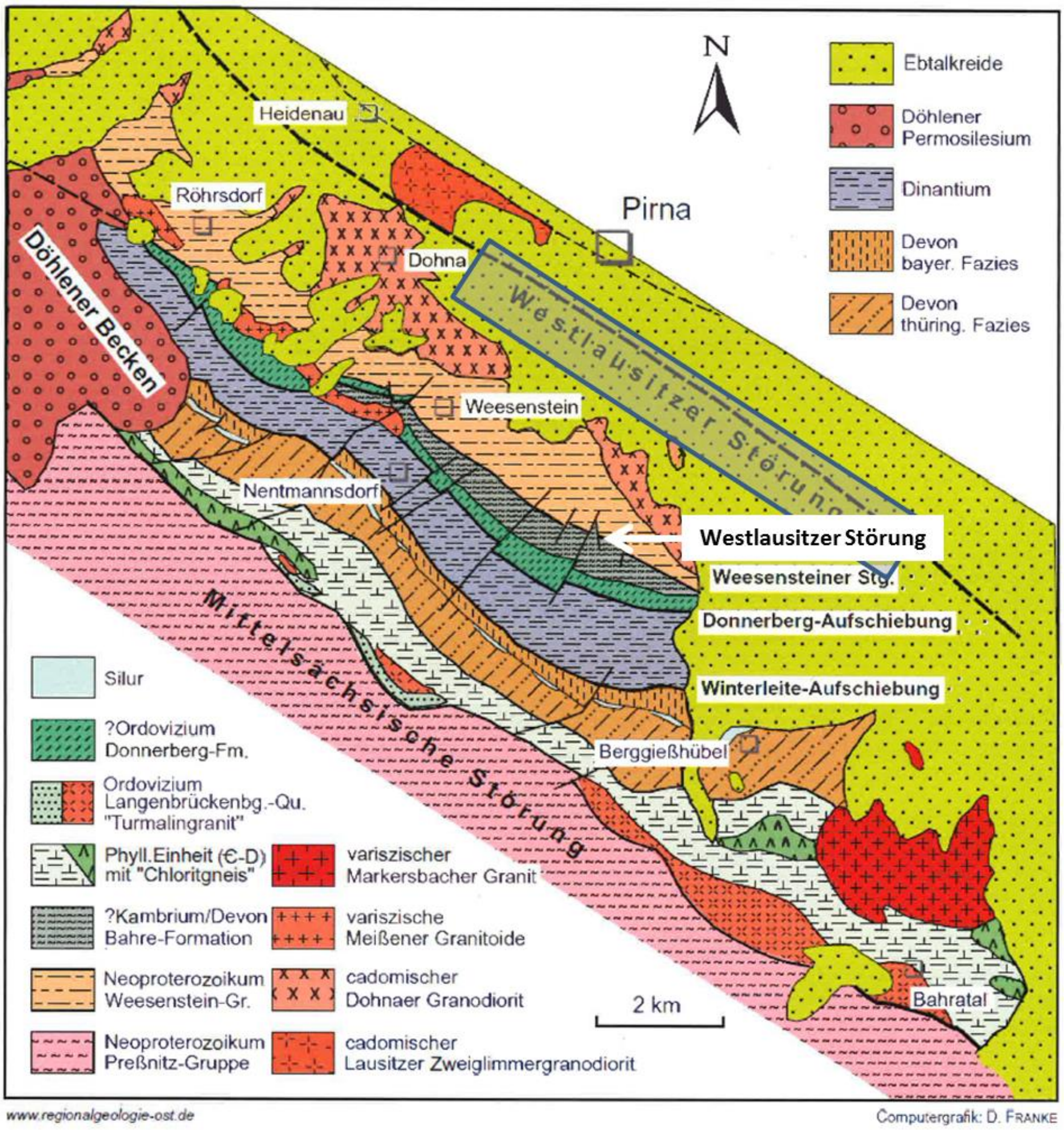

Figure 6: *Geological map of Elbtalschiefergebirge*

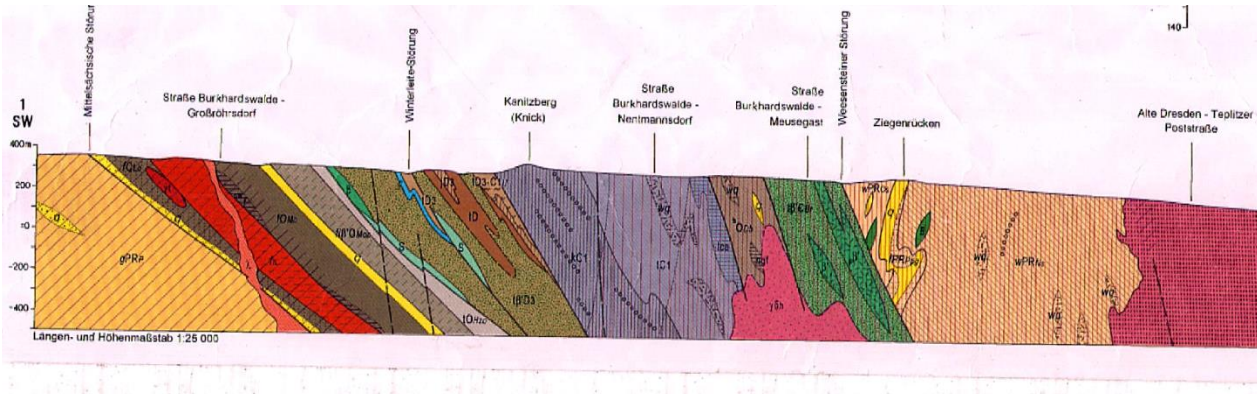

Figure 7: The geological map (FRANKE; above) and the geological cross section (ALEXOWSKY et al. 1996, below) of the Elbtalschiefergebirge shows the main faults and the position of the different Old-Palaeozoic units. Here, the Westlusatian fault (red frame) is still called Weesenstein fault.

KURZE et al. (1992) also called the fault in this region as "Weesenstein fault" caused of its position between the Weesenstein greywackes and the contact metamorphic units of the Donnerberg formation. Alexowsky et al. (1996) followed this opinion in the geological map 1:25 000 (sheet Pirna). Because of the regional importance of the fault in the hidden areas of the Elbe zone, the name "Westlusatian fault" is nowadays more common.

In the Seidewitz valley the Westlusatian fault crops out of a distance of about more than 100 m. Tectonic affected schist's, locally chert conglomerates ("Kieselschiefer-Hornstein-Konglomerat") and metabasites alternating in this zone probably as a succession of tectonic phacoides. A single main thrust zone is not visible.

Figure 8: *Overview of the SW part of the Westlusatian fault in the Seidewitz valley, near the quarry of Nentmannsdorf.*

Figure 9: Contact of metabasitic rocks and metasediments (left figure) and tectonic strongly affected shales in the Westlusatian fault zone (right figure).

Stop 4

Upper Devonian Chevron faults in the Elbtalschiefer valley

The Old-Palaeozoic rock sequences in the Elbtalschiefer valley are divided into two facies types – the Thuringian facies type (profile type I) and the Bavarian facies type (profile type II). The Thuringian facies is characterized by 300-500 m thick diabas-limestone series with different shales, basic tuffs and small metagabbro intrusions. For the Bavarian facies chert series are typical.

Figure 10: *Upper Devonian chert series of the Bavarian facies type in the Seidenbach valley. Well visible is the alternation of layered grey cherts with thin layers of slates.*

These series consist of an alternation of layered grey cherts with thin layers of slates, deposited in a deep marine environment. Often the layers are folded. The outcrop represents chevron faults in alternating lydite beds and shales. This type of folding tends to the isoclinal type of folding. The fold axis is dipping to the NE.

Figure 11: *Chevron folds in the upper Devonian chert series in the Seidenbach valley. Typical is the intensive isoclinal folding with NE-dipping of the beds.*

Stop 5 and 6

Lusatian Thrust near Hohnstein

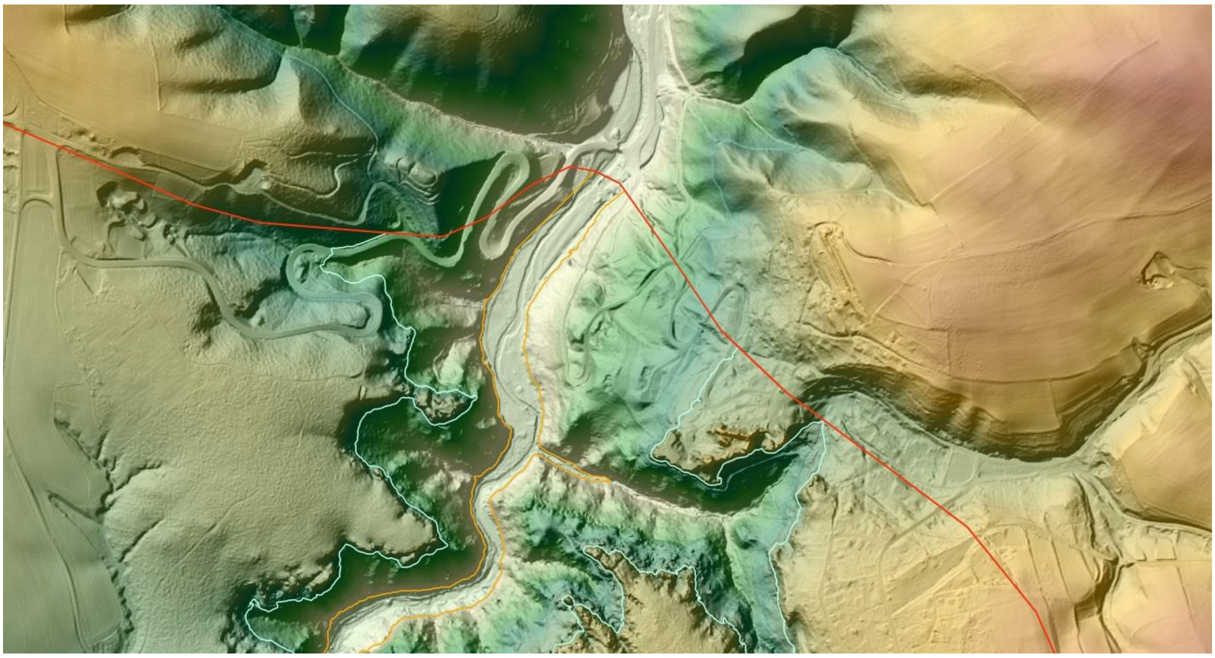

Figure 12: *Digital elevation model of the area around Hohnstein. The Wartenberg Road and the Mühlberg Road cross the Fault. Additionally, the base of Sandstone e (light blue) and sandstone d (orange) are marked. In the western part of the picture, the remains of the subground mine of the Cenomanian Zeschnig conglomerate is visible. Red: Trace of the Lausitz Thrust.*

The area around Hohnstein, especially the deeply incised Polenz valley, shows the best outcrops of the Lusatian Thrust in Saxony. The fault itself was superbly exposed during the construction of the Wartenberg road. The best outcrop was protected as a nature monument over nearly 100 years but is now strongly overgrown. Observations of the deformation effects are additionally possible at different places in the surroundings of the Polenz valley, the Schindergraben and at the castle rock in Hohnstein. The deformation zone extends about 500 m on both sides of the main fault plain, far-reaching deformation was even observed at the rock city of Rathen, where horizontal bedding planes show sometimes slickensides, related to a lateral transport of the hanging wall in SW direction.

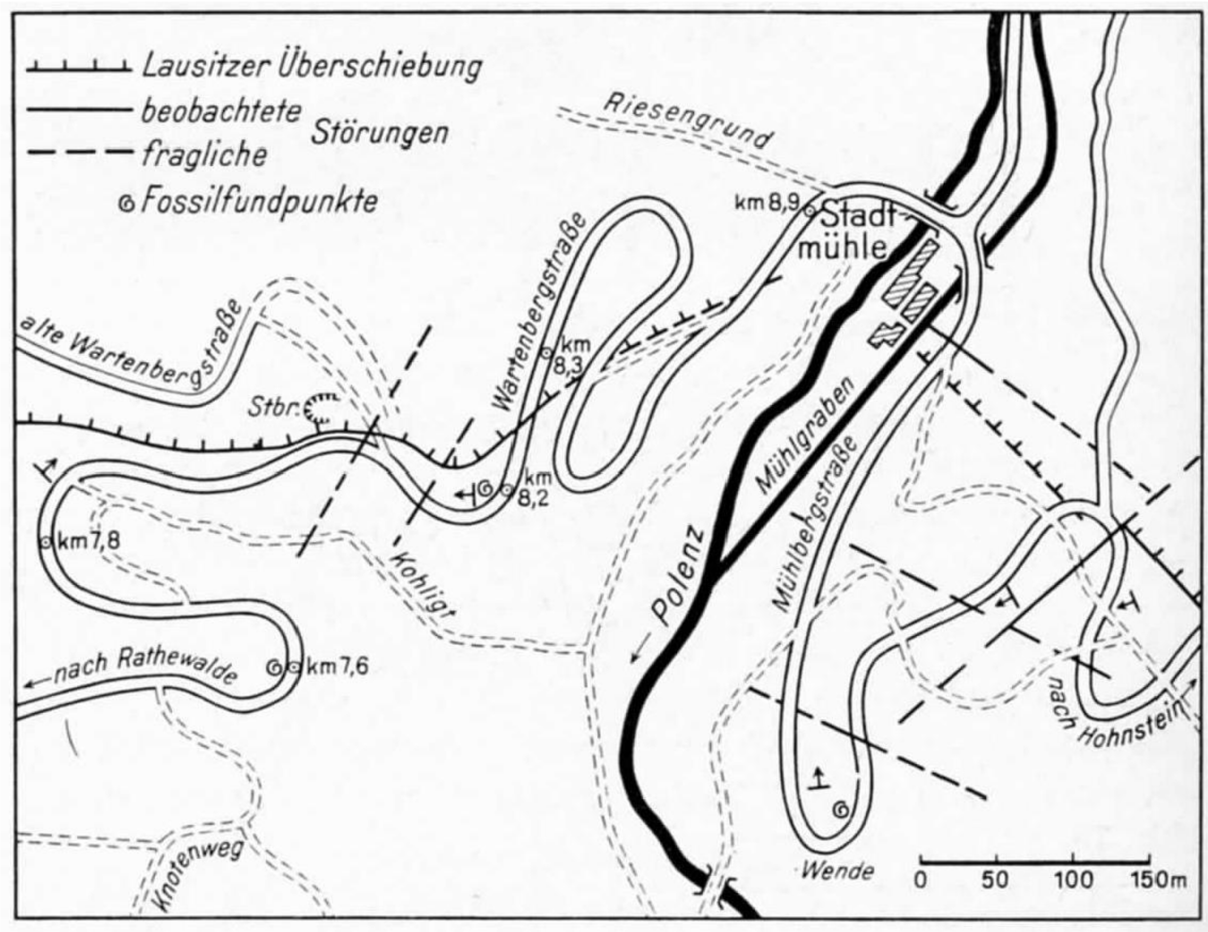

Figure 13: *Map of the Lusatian Thrust after the construction of the Wartenberg and Mühlberg roads. The roads cut the fault plane several times and are therefore a proof for the pure thrust geometry.*

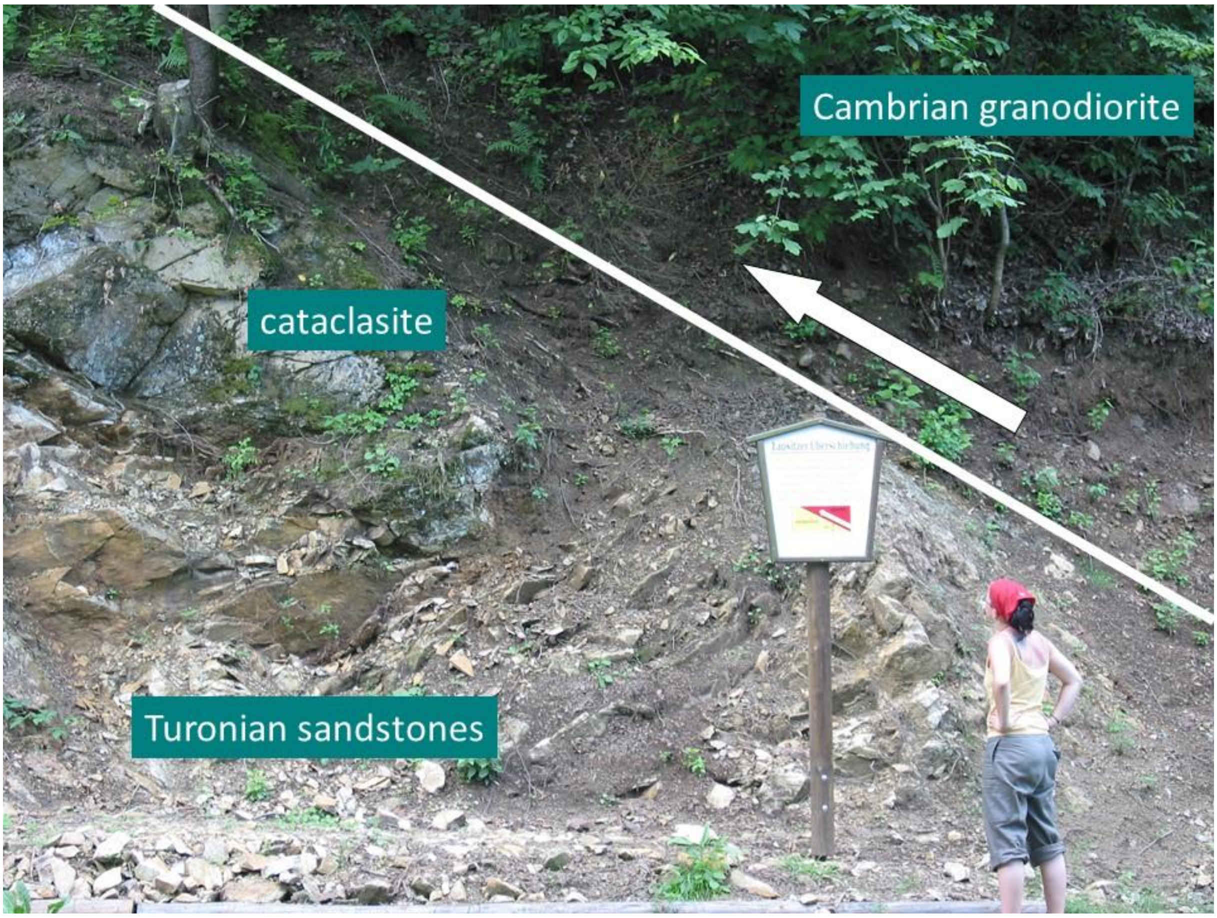

Figure 14: *The outcrop of the Lusatian Thrust at the Wartenberg road near Hohnstein (2004, after the last cleaning of the natural monument- please compare to the recent situation).*

Structure of the fault:

The fault dips with an angle of only 27° and represents a thrust. The spur of the thrust can be traced along the curve-rich Wartenberg Road from Hohnstein to Dresden. The thrust divides the early Cambrian granodiorite of the Lausitz Block from coarse-grained sandstones of the adjacent Cretaceous Basin. These sandstones contain abundant pebbles, mostly of calcareous fine-grained sandstones, limonitic ironstones and micritic limestones. Amazingly, no pebbles of the granodiorite can be found. This was interpreted by Voigt (2009) to be the expression of the removal of a Jurassic-lower Cretaceous basin which covered the granodiorite.

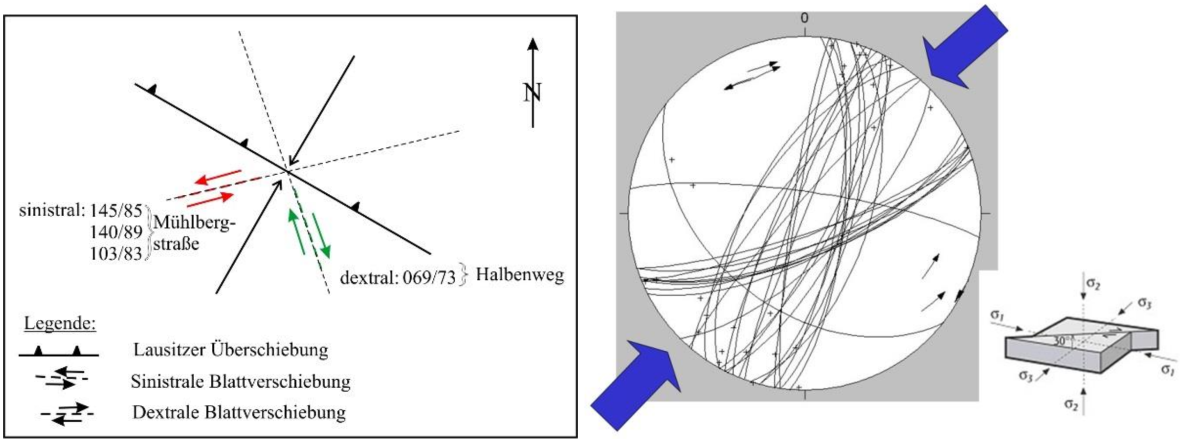

Figure 15: Tectonics at the Lusatian thrust near Hohnstein reveal the predominance of a simple thrust fault, resulting in thrust fault and an associated strike-slip system. The anticlines are not displayed, but their horizontal fold axis point also to a pure thrust without any strike-slip component.

According to the enormous throw of the Lusatian Thrust of at least 3-5 km (Apatite fission track data; Lange et al. 2008), the area which was affected by the thrust is of at least 1 km extent. Close to the fault, the granodiorite is jointed and strongly weathered, the fault plane itself is marked by cataclastic rocks; representing both the granodiorite with broken feldspars and quartz-grains, even showing deformation bands.

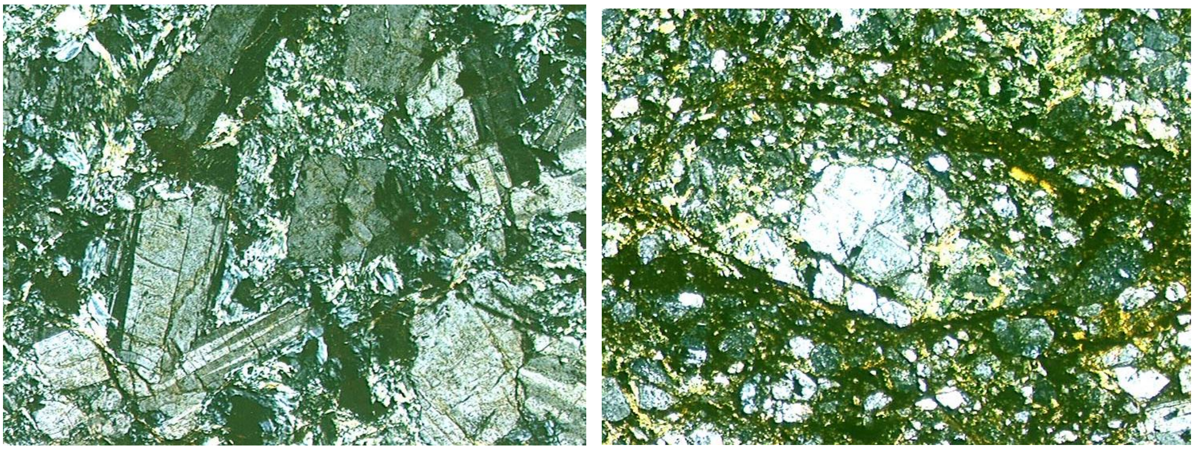

Figure 16: Thinsection of the Cambrian Granodiorite and the same rock affected by fracturing altered to a cataclasite characterized by fractured minerals and isolated clast.

The sandstones close to the fault are partly silicified and strongly jointed. Slickensides of seemingly varying directions are visible. In the footwall of the thrust shallow anticlines are developed in the sandstones, their axis are parallel to the fault. In contrast to Coubal et al. (2014) who observed a multi-history of the fault, tectonic investigations of students from the Jena University observed only thrusting and related deformations with no evidence of strike slip components or precursor normal faults. The measured slickensides and conjugated faults with strike-slip motion show a text-book-like pattern of a SW-directed thrust. This might be caused by the significant amount of deformation during thrusting which deleted all older structures.

But, according to the geological evidence, the fault had clearly an older history: between the sandstones and the Lausitz granodiorite, units are preserved, which are not visible elsewhere, even not in the subground of the Cretaceous basin: A large occurrence of Upper Jurassic limestones and marlstones with a rich faunal community was quarried in Hohnstein. The Jurassic units span the same time period like the Doubice Jurassic but are different in composition (limestones, marls and sandstones versus dolomites).

A second exotic unit is represented by late Cenomanian conglomerates (Dölzschen Formation?) west of Hohnstein (Zeschnig conglomerate; Hockstein-Schänke). These conglomerates reach at least 20 m thickness and are composed of Jurassic limestones, sandstones and ironstones within a sandy matrix. Pebbles diameters are typically between 10 and 20 cm, they are well-rounded, bored by marine bivalves and associated with a marine fauna. Their formation is related to the erosion of Jurassic deposits. The conglomerates are followed by a few meters of glauconitic fine-grained sandstones of the Plenus zone. The unit occurs as an isolated block between the granodiorite and Upper Turonian sandstones and is bounded by the Lusatian Thrust and a second parallel thrust. These conglomerates were used for the production of caustic lime and were extracted in an underground mine close to the former restaurant “Hocksteinschänke” and in the open cast mine north of Hohnstein, where they covered the Jurassic limestones. No accessible exposures of these deposits remained.

Outcrop 1: Granodiorite in the Polenz-valley

The small outcrop at the parking site exposes the undisturbed early Cambrian Lausitz granodiorite. According to thin-sections it is composed of plagioclase, biotite, amphibole, quartz and microcline. The strong jointing is probably already an indication of the fault activity.

Mapping in the surroundings prove the existence of doleritic and rhyolithic dykes of unknown age within the Cadomian granodiorite massive. They are between 1 and 4 m thick.

Outcrop 2: Sandstones in the Polenz valley

The Polenz valley shows a distinct change in valley shape in the transition from the granodiorite to the sandstones from a v-shaped fluvial valley to a Canyon. About 200 m from the fault, middle Turonian sandstones with some conglomerate layers are exposed. They are part of the Postelwitz formation (sandstone c). In comparison to other areas, composition of sandstones point to a very proximal, high energetic deposition. The section of the nearby well Maimühle (100 m) showed a succession of sandstones and conglomerates in the level of the lower Postelwitz formation. Some small thrusts and slickensides are exposed.

Outcrop 3: Thrust at the Wartenberg Road

The Wartenberg road shows still the outcrop of the Lusatian Thrust, especially the sandstones with conglomerate layers are well-exposed. The bedding planes are very difficult to identify, because the whole succession is faulted and jointed in a very strong manner. The fault trace is marked by a few meters thick cataclasite which is strongly weathered due to enhanced fluid flow. Thin sections show a strong fracturing of quartz and feldspar and strong alteration of biotite and amphibole to clay minerals.

Stop 7

The Basalt of Stolpen

The basalt of the Stolpen Castle Hill is of special interest for two reasons. On one hand it is the geological base of the castle of Stolpen, built up in the 13th century. The castle was extended in the following centuries. As the main component for the castle construction the rock basalt was taken, which was obtained from a quarry on the food of the hill. The most prominent resident of the castle was the Countess Cosel, a concubine of the Saxon king „August the Strong". She had to live here for 49 years from 1716 – 1765.

Figure 17*: The Stolpen Castle Hill with the basalt quarry in the foreground in the year 1775 (etching by Adrian Zingg 1734–1816). Source: Staatliche Schlösser, Burgen und Gärten Sachsen gGmbH, Burg Stolpen. Foto: Frank Höhler*

Figure 18: *Recent view of the basalt quarry on the Stolpen Castle Hill.*

On the other hand the basalt of Stolpen is the type locality of the rock "basalt". The research history can be traced back to the year 1546. Georgius Agricola originally called the rock of the Stolpen Castle Hill basalt. However, further investigations showed that the rock at Stolpen Castle Hill is not basalt, it is rather best described as basanite in the context of present rock nomenclature (BÜCHNER et al. 2017).

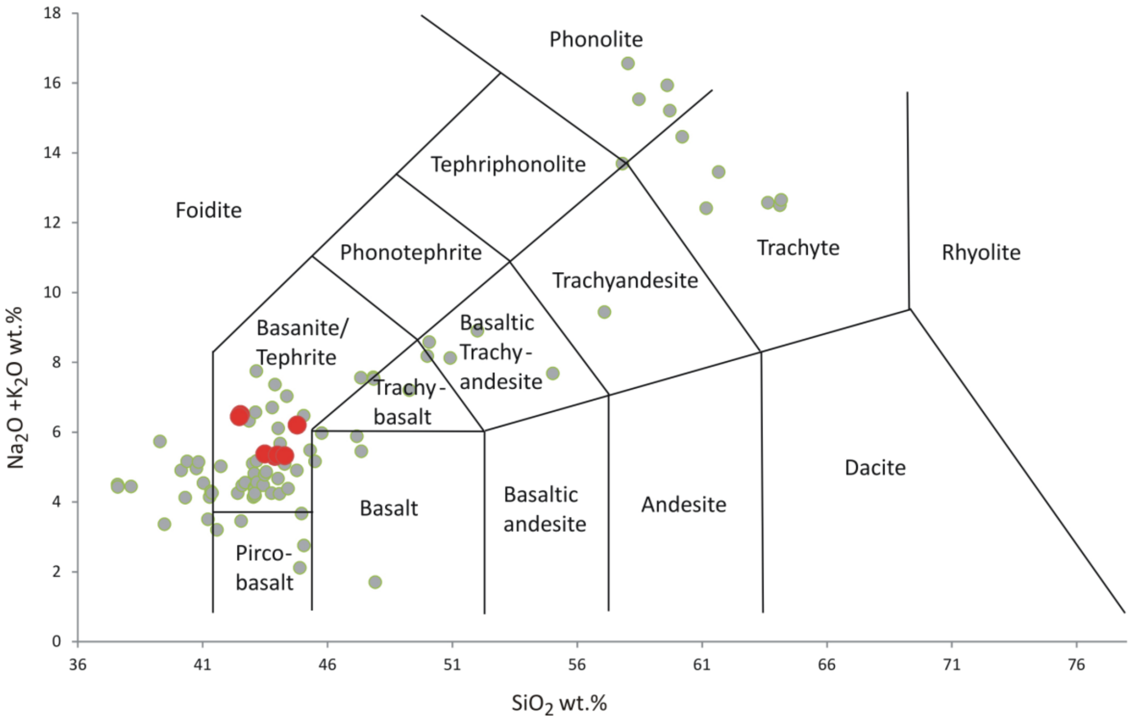

Figure 19: *TAS diagram with the lava of the Stolpen Castle Hill (red points) and the Lusatian basaltic field (gray points) (BÜCHNER et al. 2017).*

The basalt of the Stolpen Castle Hill belongs to the tertiary volcanic cycle, which also formed the volcanites of the Ceske strede hori Mountains. However, it is situated clearly outside the eruptive centre of the Eger Rift. The age is specified between 30 my (BÜCHNER et al. 2017) till 27 my (Stanek, personal information).

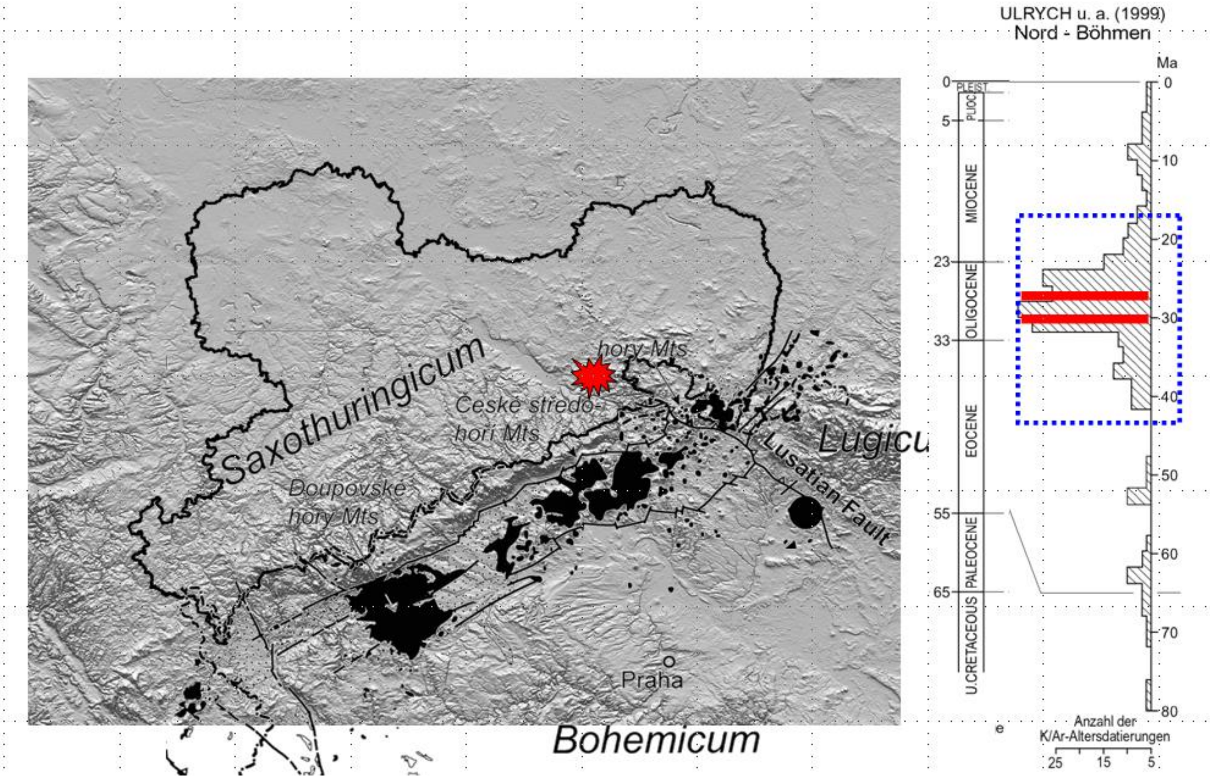

Figure 20: *Position of the Stolpen volcanites in relation to the volcanites of the Ceske strede hori Mts- Ages of the volcanites of the Ceske strede hori Mts. by* ULRYCH *et al. 1999. Ages of Stolpen volcanites by* BÜCHNER *et al. 2017 and Stanek (personal information).*

Stop 8

Seismologisches Observatorium Berggießhübel

In September 1957 the observatory Berggießhübel was officially put into operation as "Erdgezeitenstation" after the completion of the station building. 1969 the observatory was attached to the "Zentralinstitut für Physik der Erde" (ZIPE; Central Institute of Physics of the Earth) of the Academy of Sciences and Humanities in Potsdam. After the strong earthquakes in Northern Italy (1976) and Romania (1977) a Seismic information system was built. Therefore the Observatory functioned as base station for seismological monitoring and seismic engineering investigations.

After the affiliation of ZIPE to the „Geoforschungszentrum" (GFZ; German Research Centre for Geoscience) Postdam, the observatory was equipped with modern recording and communication technology. Since then it is considered as one of the base stations of the German Regional Seismic Network (GRSN). At the same time it was integrated into the Global Digital Seismograph Network (GDSN), which is globally used for control programmes as evidence for underground nuclear explosions and for seismological investigations..

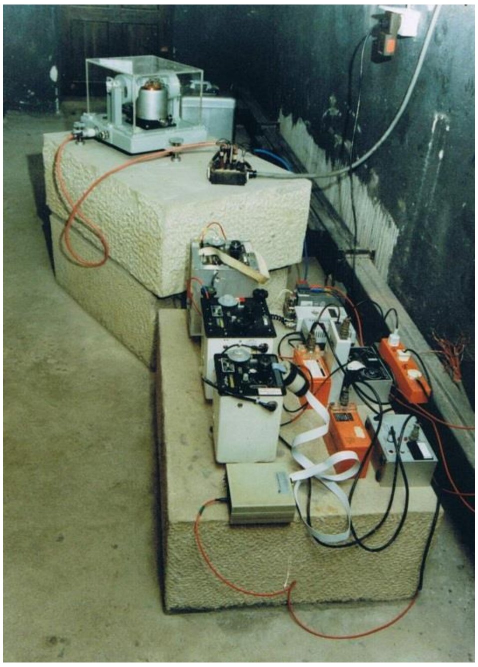

Figure 21: Seismic observation equipment

In 1994 the observatory was returned to the Institute of Geophysics at TU Bergakademie Freiberg.

In 1995 a local station network was installed from the State Office for the Environment and Geology (LfUG) in the context of founding of a Seismology association and the observatory took on the scientific support of the online station network, which is mostly used for seismic engineering investigations.

Stop 9

ResiBil groundwater measuring point

Within the ResiBil project, two new monitoring boreholes had been drilled in the area of Děčínský Sněžník. Boreholes provide new data, which are used to improve description of hydrogeological conditions of the area. The data was gained by geophysical measurements and hydrodynamic testing. Automatic pressure probes are continuously logging groundwater levels in the boreholes.

Borehole Re001 is located 1,7 km North of the settlement Zadní Ves, just few meters of the national border, by the road to Rosenthal. It was drilled in August 2017 to a depth of 100 m. The geological profile of the borehole is generally sandstone. Clayey sandstone was detected in the upper part to depth 11,7 m and in the lower part below 71,3 m, where content of clay minerals begins to increase with depth (Turonian aquifer basement). The terrain surface is at 502 m a.s.l. and groundwater level is at depth 65 m below surface (435 m a.s.l.). Well logging detected considerable lateral groundwater flow through the borehole at depth around 73 m. Small part of the water flows downwards through the borehole to depth 85 m, where water sinks into a crack in the borehole wall behind perforated PVC casing. According to results of an 8 day hydrodynamic test (pumping test and groundwater rise test) the transmissivity of the monitored Turonian aquifer is between 1,65E-3 m^2/s (pumping section) and 3,14E-3 m^2/s (recovery section). With aquifer thickness of about 23 m, this means hydraulic conductivity around 1E-4 m/s.

Borehole Re002 is located about 4 km north of the municipality Maxičky. In comparison to Re001, the geological profile is similar but depth of sandstone layer is about 58 m lower. The terrain surface is at 366 m a.s.l. and groundwater level is at depth 92 m below surface (280 m a.s.l.).

Figure 22: *ResiBil groundwater measuring point*

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