Europäische Union. Europäischer Fonds für regionale Entwicklung.
Evropská unie. Evropský fond pro regionální rozvoj.

SN CZ
Ahoj sousede. Hallo Nachbar.
Interreg V A / 2014 – 2020

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

ResiBil - Wasserressourcenbilanzierung und –resilienzbewertung im deutsch-tschechischen Grenzraum

Field guidebook

Geology of the Zittau Mountains

6th-7th of June 2017

LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE

Freistaat SACHSEN

ČESKÁ GEOLOGICKÁ SLUŽBA

VÚV TGM Výzkumný ústav vodohospodářský T. G. Masaryka veřejná výzkumná instituce

Saxon part

Dr. Thomas Voigt

Titel figure: Flat lying conglomeratic sandstones with intercalated conglomerate beds at the Nonnenfelsen (Middle-Turonian, Oybin Formation), Zittau Mountains

1. Introduction

The marine intracontinental Bohemian Cretaceous Basin in Central Europe (Fig. 1) has a northern prolongation in Germany (Saxony) which is characterized by high thickness and close position to a major fault, which was active during deposition of the Cretaceous sequence and let in consequence to thrusting of the ancient source area on the adjacent basin (Lausitz Thrust). Activity of this fault started in late Cenomanian (indicated by a source area in the northeast and enhanced thickness in a NW-SE-striking fore-deep (marginal trough) as was recognized by TRÖGER (1964). Like elsewhere in Central Europe, this NW-SE-directed fault is related to uplift of the source area and deposition of a thick sequence of Cenomanian to Santonian deposits, summarized as late Cretaceous basin inversion (e. g. KOCKEL 2003).

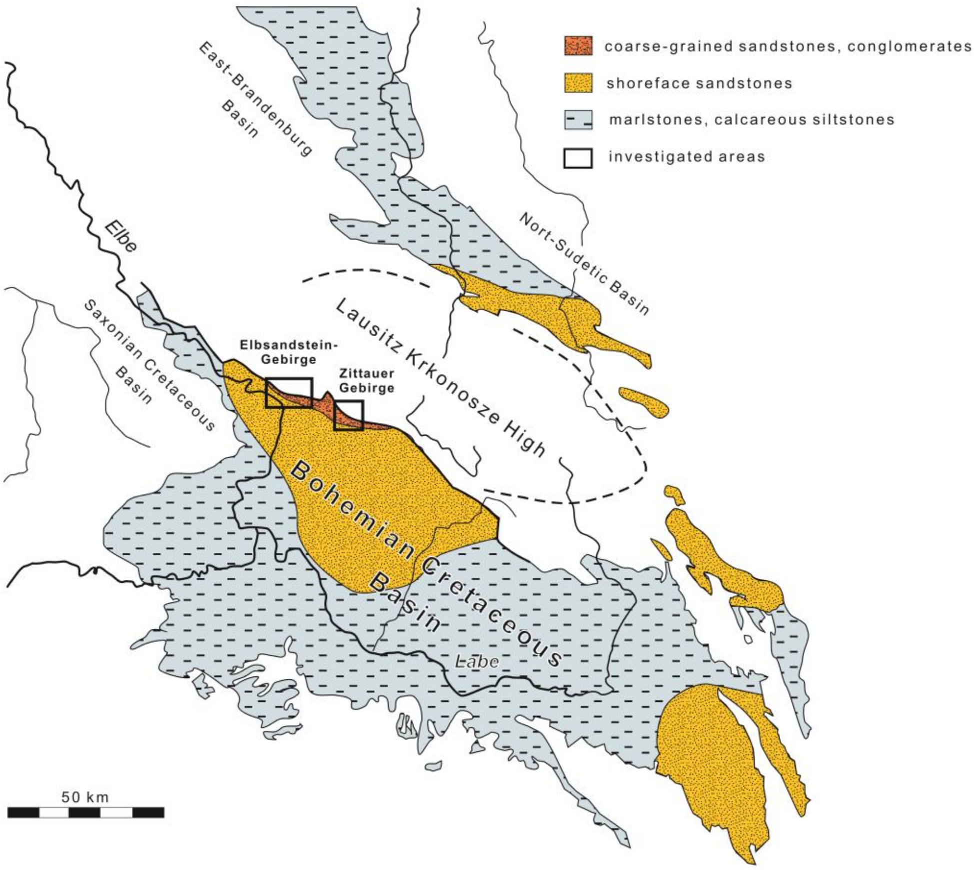

Fig. 1: Overview map of Lausitz-Krkonosze High and the surrounding basins during Turonian. Distribution of sandstones reflects clearly uplift of an isolated source area which was later thrusted onto the basin margins. All known deposits are of marine origin; thickness is highest close to the source area, pointing to the formation of marginal troughs. Both the Elbsandsteingebirge and the Zittau Mountains represent depositional systems close to the basin margin. (Figure redrawn from Voigt 2009).

The Saxonian part of the Bohemian Cretaceous basin is restricted to a 20 to 5 km wide remnant of the primary sediment occurrence. The Lausitz Thrust cuts oblique to the marine facies belts (fig. 1). Younger uplift of the Erzgebirge caused NE-directed tilting of the basement and widespread denudation at the eastern basin. Hemipelagic marls and limestones in the NW are well-dated (biostratigraphy based on inoceramids and ammonites) and comprise a succession from Lower Cenomanian to the Lower Coniacian (TRÖGER 2003). Marginal coastal sandstones comprise probably the same stratigraphic interval; but to the SE, these deposits are nearly completely represented by quartz sandstones of low fossil content. They form a spectacular landscape of canyons and vertical rock walls (Elbsandsteingebirge, "Sächsische Schweiz"). A second part of the marginal Bohemian Cretaceous Basin in Saxony is represented in the area of the Zittauer Gebirge (Zittau Mountains). Very proximal conglomeratic deposits in the Cenomanian and Turonian are followed by finer-grained sediments of Upper Turonian and Lower Coniacian age which are very different from the sections in the Elbsandsteingebirge and were therefore considered always separately (e. g. ANDERT 1929, TRÖGER 2008).

The stratigraphic position and correlation of these units between the regions of coastal deposits in Saxony (Sächsische Schweiz and Zittauer Gebirge) and the marginal parts of the Bohemian Cretaceous Basin are still in debate, because biostratigraphic data are sparse and lithostratigraphic correlations come to an end in the uniform and monotonous successions of coarse sandstones and conglomerates.

Investigations in the course of the EU-funded project GRACE (Groundwater Absence in Cretaceous Aquifers) gave already the opportunity to re-examine wells and surface outcrops. To interpret groundwater flow in the subsurface of the Bohemian Cretaceous basin, a correct geological model is essential. Therefore, stratigraphic correlation within the basin has to be revised and the extension of aquifers and aquitards together with their possible connections were investigated on the base of field observations and borehole data.

2. Lithostratigraphy of the Zittau mountains

In contrast to the southern Elbsandsteingebirge, which is characterized by a gently NE-dipping succession, the structural pattern of the Zittau mountains in eastern Saxony is much more complicated by Neogene volcanics (dykes, sills, intrusions, diatreme structures), and faults related to the north-eastern end of the Ohre-Graben (fig. 2). The succession is very monotonous in the lower part and poorly exposed in the upper units. No complete section exists, because preservation of youngest deposits (Coniacian) is related to the graben structure. Cenomanian deposits are not exposed at the surface on the German side. Early Turonian deposits are only accessible at the bottom of two deeply incised river valleys close to the Lausitz Thrust.

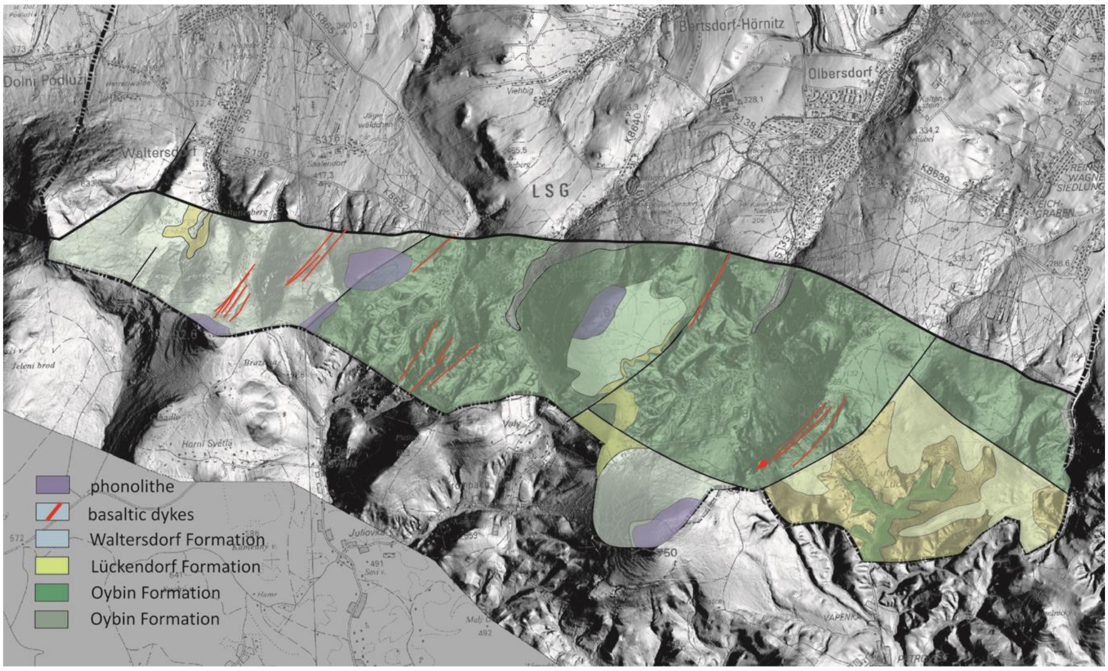

Fig. 2: Geological Map of the Cretaceous in the Zittau Mountains. In the eastern part, deposits from Upper Turonian to Lower Coniacian are exposed (Brezno Formation). The western part consits mainly of Middle Turonian deposits of the Oybin Formation and Lückendorf Formation (Jizera Formation, Teplice Formation).

Cretaceous sediments of the Zittau Mountains represent the most proximal area of the Bohemian Cretaceous basin which is expressed in a dominance of coarse-grained massive sandstones and intercalated conglomerate sheets of 0.5 to 2 m thickness over a major part of the section. Only one borehole was completely cored and well documented (Lückendorf 1/63; TRÖGER 1964), while some uranium-exploration wells were focused exclusively on the basal units (fig. 3). The succession starts with Cenomanian coarse-grained sandstones of the Oberhäslich Formation. The fluvial to estuarine deposits of the Niederschöna Formation are probably absent in the whole area. Boreholes provided a very homogeneous facies with two intercalated horizons of fine- to medium-grained sandstones representing probably equivalents the Upper Cenomanian Dölzschen (upper Peruc Korycany) Formation and the base of the Lower Turonian Briesnitz (Bila Hora) Formation. They have no clear border to the underlying and overlying sequence, so that the basal unit is considered as the Upper Cenomanian Oberhäslich Formation (VOIGT & TRÖGER 2000). The overlying succession forms steep rock walls at the surface and contains only rarely fossils. TRÖGER & VOIGT (2000) summarized these conglomeratic sandstones as Oybin Formation, corresponding to the Jizera Formation. According to the sparse fossil record, they comprise Early and Middle Turonian age (ANDERT 1929). Thickness exceeds 400 m (fig. 3). Depositional environment is clearly related to a high-energetic marine environment, because cobbles show sometimes borings of marine organisms and contain molds of shell debris. VOIGT (2012) interpreted the coarse (conglomeratic) layers as proximal storm beds and the poorly sorted sandstones as amalgamated tempestites of weaker storm events, homogenized by burrowing marine fauna.

The Oybin Formation unit is overlain by calcareous fine-grained sandstones with intercalated coarser, mostly poorly sorted sandstones. Bioturbation by decapod crustaceans is common. This unit is about 30 m thick and becomes finer to the top, resulting in sandy marlstones (fig. 6). According to the fossils this unit is of late Turonian age (ANDERT 1932, TRÖGER 2008). These carbonate-cemented sandstones and marlstones are summarized as Lückendorf Formation, corresponding either to the uppermost Jizera Formation or to the Teplice Formation. Although the upper marly parts of the formation were not exposed in the last 90 years, interpretation as a deeper shoreface environment is the most convincing version. The borehole Lückendorf 1/1963 is the type section, but only the lower part of this unit was cored.

The transition to the Lower Coniacian Waltersdorf Formation was previously unknown, but in the course of our investigations during GRACE project, the short documentation of the borehole Waltersdorf 1930 allowed the recognition of the Lückendorf Formation at the base of the Waltersdorf Formation (fig 6). In this borehole 23 m of marlstones above sandstones were described which follow above typical sandstones of the Lückendorf Formation. The uppermost part contains 8 m of a marlstone sandstone succession and 10 m of fine-grained sandstone. These sandstones are exposed in the same altitude in the adjacent Sonnenberg quarries and are considered as the Waltersdorf Formation.

The latter is composed of fine- to medium-grained sandstones, mostly bioturbated or sometimes cross-bedded, separated by sharp-bounded coarse units. These well-sorted gravelly, sheet-like beds have erosive bases, show sometimes oscillation ripples and are followed by clay to silty layers. Like the very similar facies of the Postelwitz Formation, the depositional system is interpreted to represent a deeper shore face environment with proximal storm beds (VOIGT 2012). Abundant fossils allow a good biostratigraphic control.

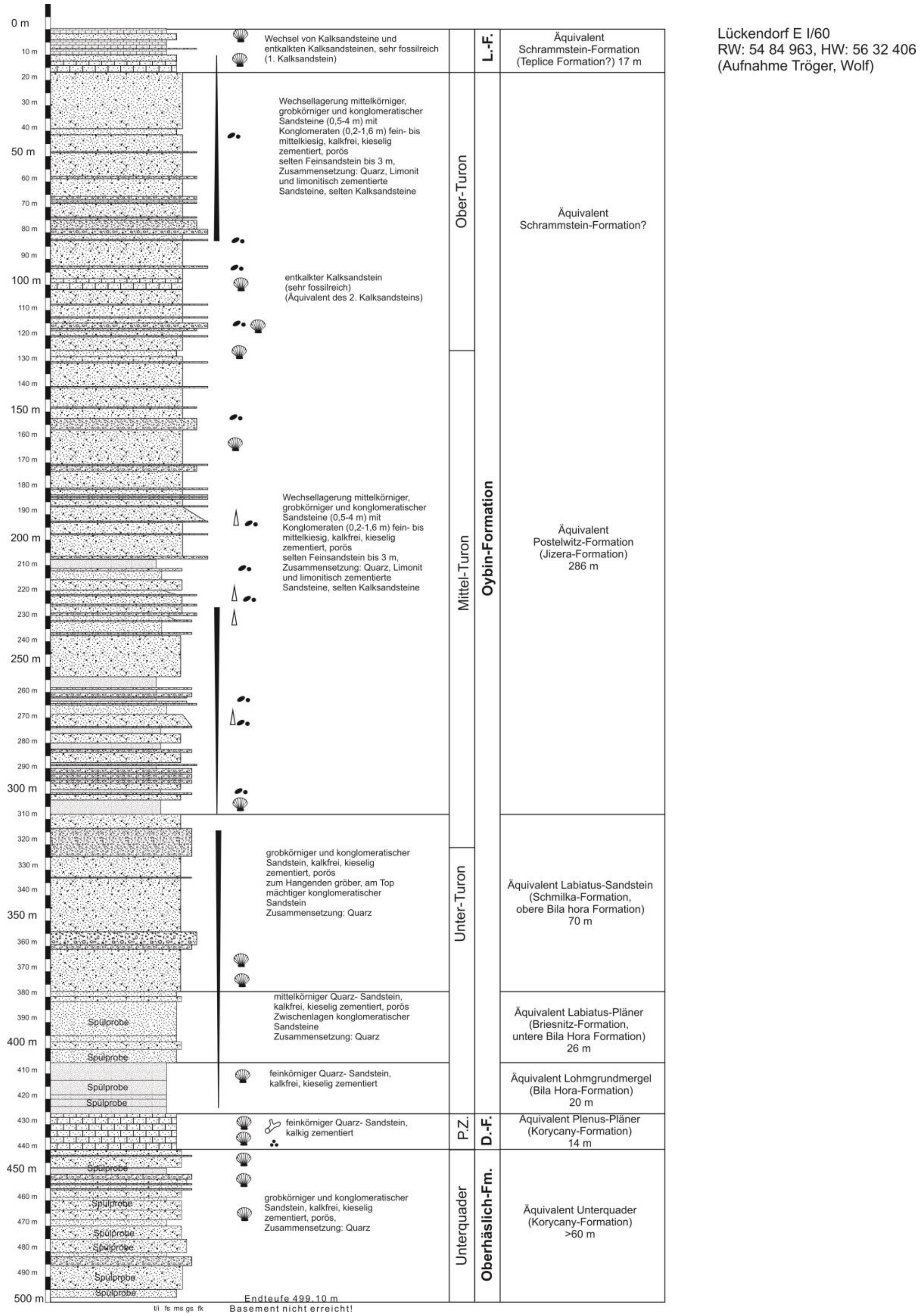

Fig. 3: Log of the Borehole Lückendorf 1/1960 after the detailed documentation of Tröger and Wolf (TRÖGER 1964).The complete borehole consists of sandstone of varying grainsize. Even the marly units of the Briesnitz Formation (Labiatus-Pläner; basal Bila Hora Formation) are replaced by sandstones.

Large abundant quarries and some rock walls at the slope of the Lausche Mountain allow the subdivision in three parts: the bioturbated, fossil-rich sandstones are defined as Sonnenberg member. A rich marine fauna dominated by bivalves and echinoids yields the inoceramids *Mytiloides scupini*, *Mytiloides carpathicus* and *Inoceramus lusatiae* in the lower part indicate a latest Turonian age (HEINZ 1929, TRÖGER 2008).

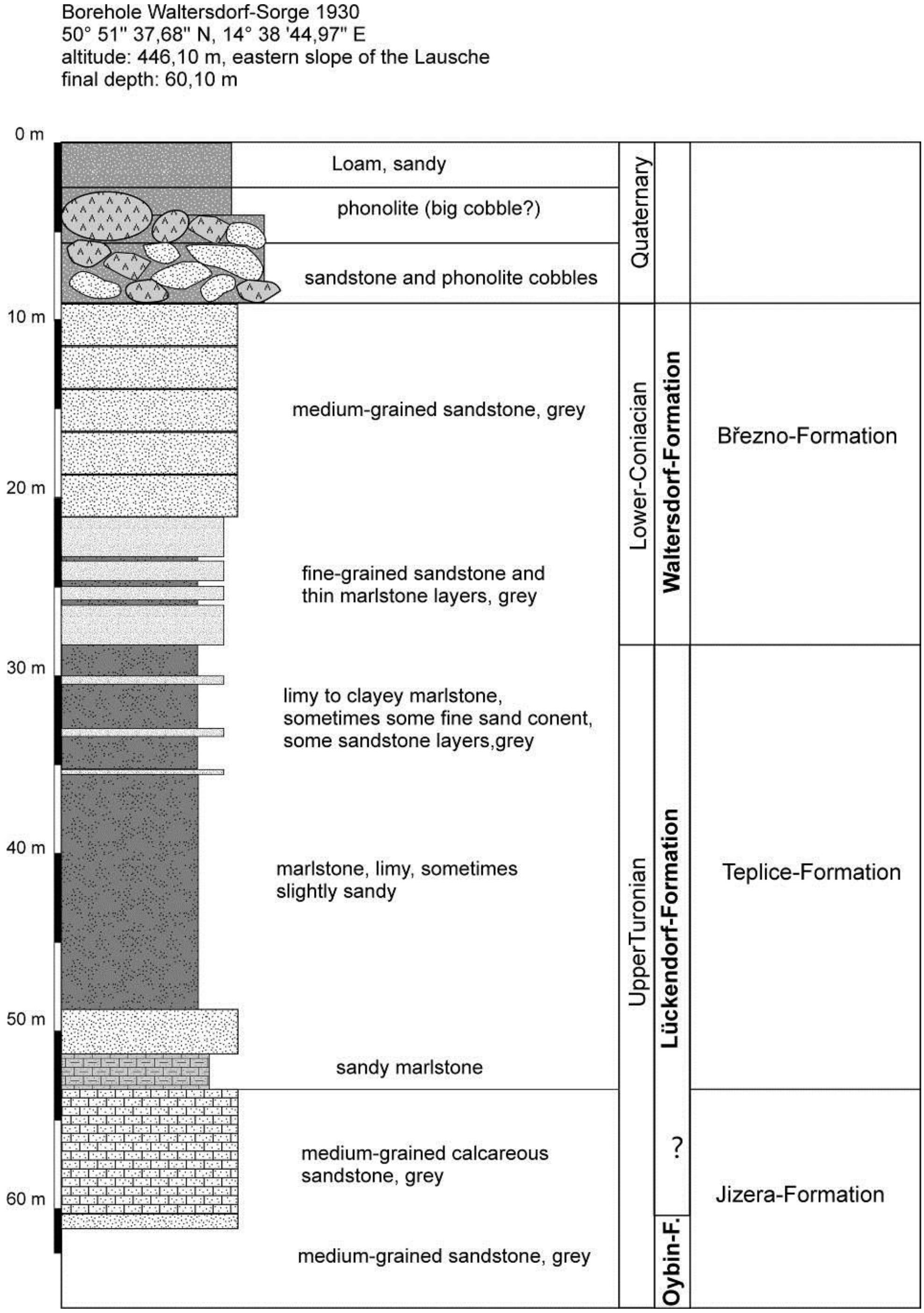

Fig. 4: Section of the Borehole Waltersdorf 1930, redrawn after the short description (core?). The borehole is situated close to the Lausitz Thrust at the foot of the Lausche and probably represents the transition from the Oybin Formation to the Lückendorf Formation

Cremnoceramus rotundatus and *Cremnoceramus waltersdorfensis* in the upper sections of the quarries are typical of Early Coniacian (WALASZCZYK 1996). They are followed by massive medium- to coarse-grained sandstones (Lausche member) without fossils. These sandstones are moderately sorted and cross-bedded. Thickness is about 50 m. They are well exposed at the northern slope of the Lausche (Luž). Terraces with wet lands between the 5-10 m thick massive sandstone beds might point to thinner intercalations of finer sandstones or marlstones. The Hochwald member is probably on top of these deposits, but the lack of outcrops makes correlation difficult. In particular, the northern slope of the Hochwald Mountain (Hvozd) lacks any exposure and a fault probably runs between the Upper Turonian of Lückendorf and the much younger deposits on the southern slope of the Hochwald. Sandstones, exposed in a few quarries on the Czech southern side of the mountain are again characterized by bioturbated sandstones with coarse intercalations.

According to findings of *Cremnoceramus crassus* it represents the highest Lower Coniacian and is therefore younger than the sections at the Lausche. Nevertheless, the contact of the Hochwald sandstone to the older units is unknown, because the slopes of the Hochwald Mountain are covered by volcanic debris of a major phonolithe body on top of the mountain. MÜLLER (1932) mapped additionally a several meters thick claystone unit on top of the Hochwald Mountain (Hvozd), but the section is now completely covered by phonolithe debris. According to TRÖGER (2008), findings of *Cremnoceramus erectus* in these marlstones are typical of late Early Coniacian.

It has to be emphasized that a new mapping of the whole area would be essential for both better understanding of stratigraphy and tectonics in this area.

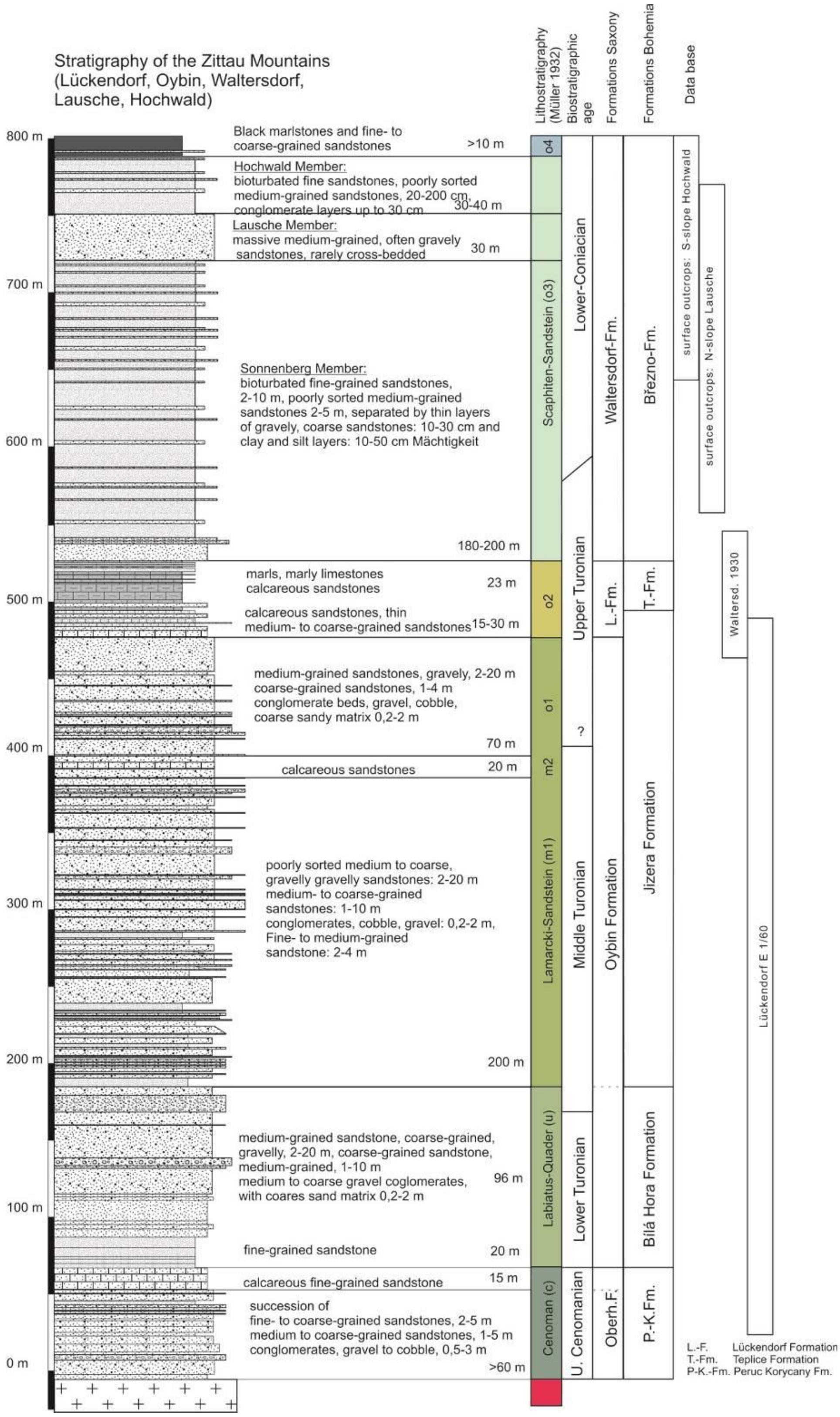

Fig. 5: Lithology of the Cretaceous in the Zittau Mountains, based on the combination of some well-documented boreholes and several sections allows the correlation with the standard section of the better known Czech side (sheet Dolni Podluži).

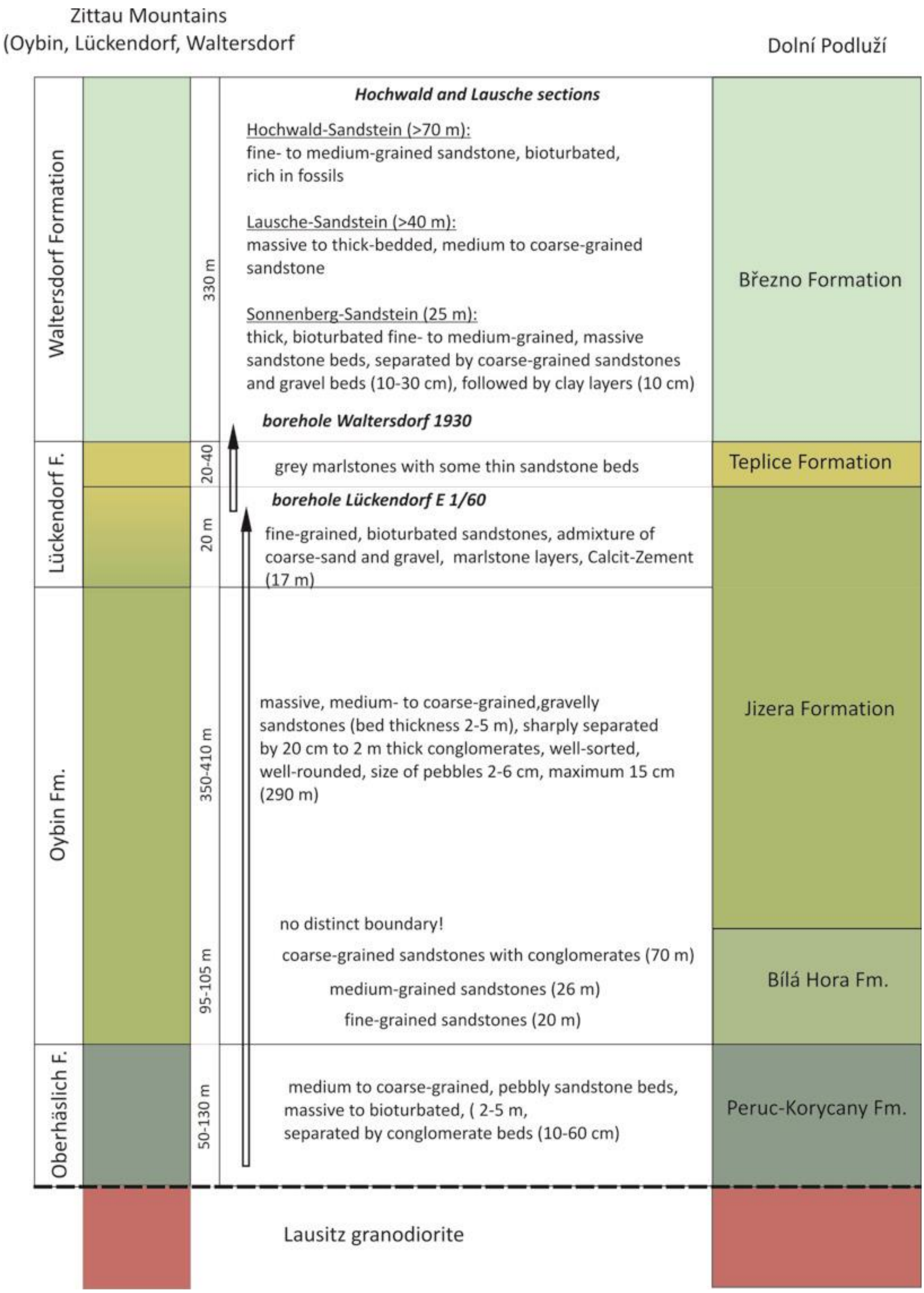

Fig. 6: Combined simplified section of the Cretaceous in the Zittau Mountains. The compilation of several sections allows the correlation with the standard section of the better known Czech side of the Lausche (Dolní Podluži).

3. Tectonics and volcanics

The major fault, controlling distribution of rocks in this region, is the Lausitz Thrust which runs roughly in E-W direction (fig. 2). It marks the boundary of the basement to the Cretaceous basin and should incline normally with an angle between 25-30°. Nevertheless, much of the inverted normal faults in the Central European basin preserved their initial inclination of the extensional phase and are much steeper (e. g. KLEY 2013).

Tilting of Cretaceous units close to this thrust points either to the formation of a frontal syncline or to additional faults striking parallel to the Lausitz Thrust. As no flattening of dip angles were mapped until now, the cross-sections in fig. 7 show faults. To solve this question, detailed mapping is necessary.

A second, younger fault system is represented by the Ohre rift, and accompanying basaltic dyke systems. The main fault separates a young western unit (Lausche, Luž and Sonnenberg) with Cretaceous sediments of Upper Turonian to Lower Coniacian age from a western unit (Johnsdorf, Oybin, Lückendorf), composed of Lower to Upper Turonian units in the surface outcrop. The amount of down-throw of the eastern unit is estimated to be in the order of 400 m; the fault is interpreted to be a normal fault with a dip angle of about 60°.

The high thicknesses of monotonous, conglomeratic sandstone units make the recognition of minor faults difficult. Nevertheless, rapid changes in dip angles and lack of correlation on opposite sides of the valleys indicate faulting in NE-SW direction, parallel to the orientation of basaltic dykes. These dykes of several metres thickness cut through the succession but they are rarely exposed. Instead, hydrothermal water and subsequent weathering caused the transformation into clay minerals. The Felsengasse between Lückendorf and Oybin and the millstone quarries near Jonsdorf are the most prominent features of those basaltic dykes. The only evidence of their existence is the impregnation of the sandstones with mobilized quartz and iron oxides, columnar jointing of sandstones and some relictic, completely altered basalts.

Phonolites occur as intrusions, the Lausche represents a complex volcanic structure, which was investigated very recently by WENGER ET AL. (2017).

In the course of the GRACE project, several cross-sections were constructed on the base of old maps, punctual field observations and boreholes. They reflect the recent state of knowledge, but will probably revised after new field work.

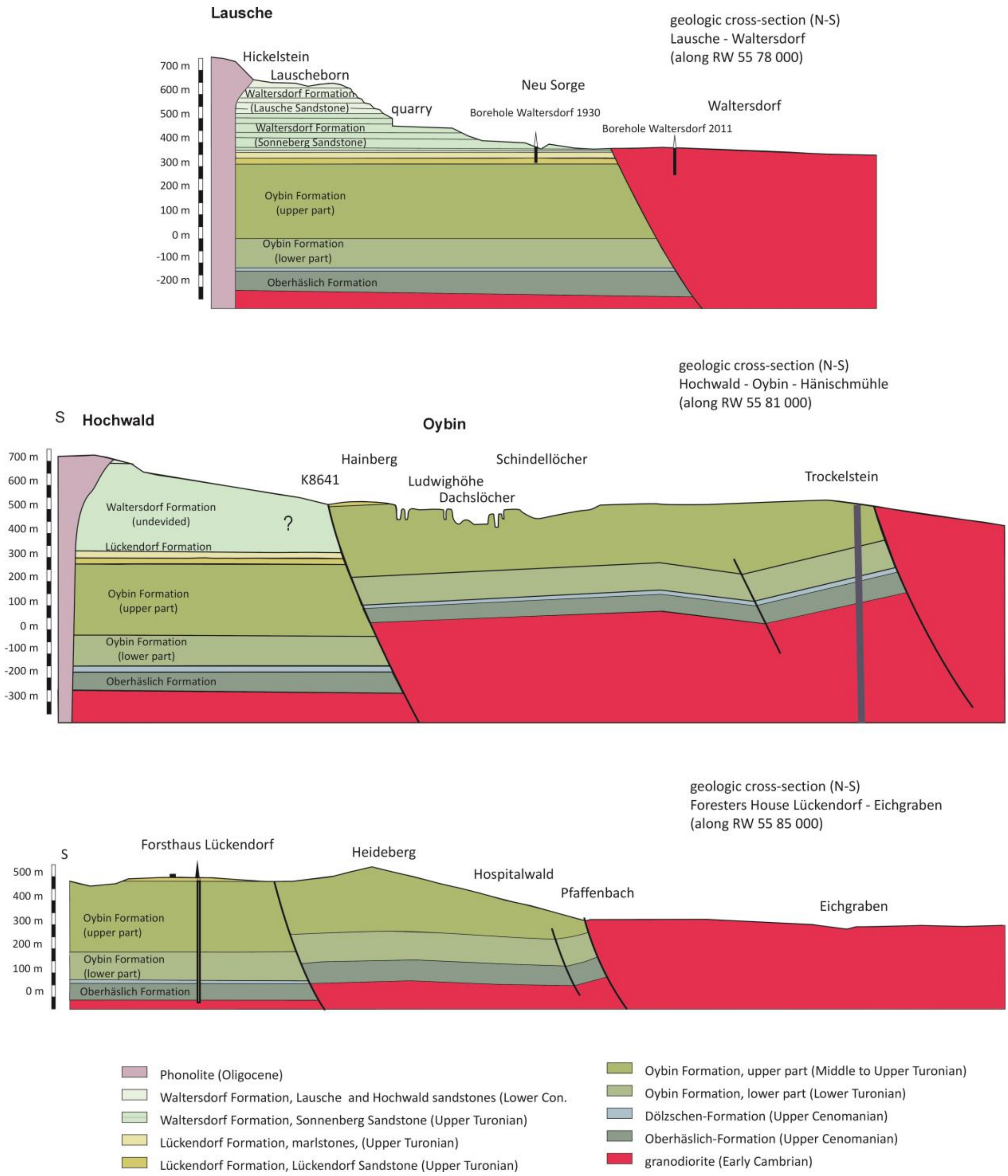

Fig. 7: NS-directed cross-sections across the Lausitz Thrust and the Zittau Mountains show the thick stratigraphic succession of the Cretaceous. Thickness at the Hochwald and the Lausche Hill might exceed 1000 m.

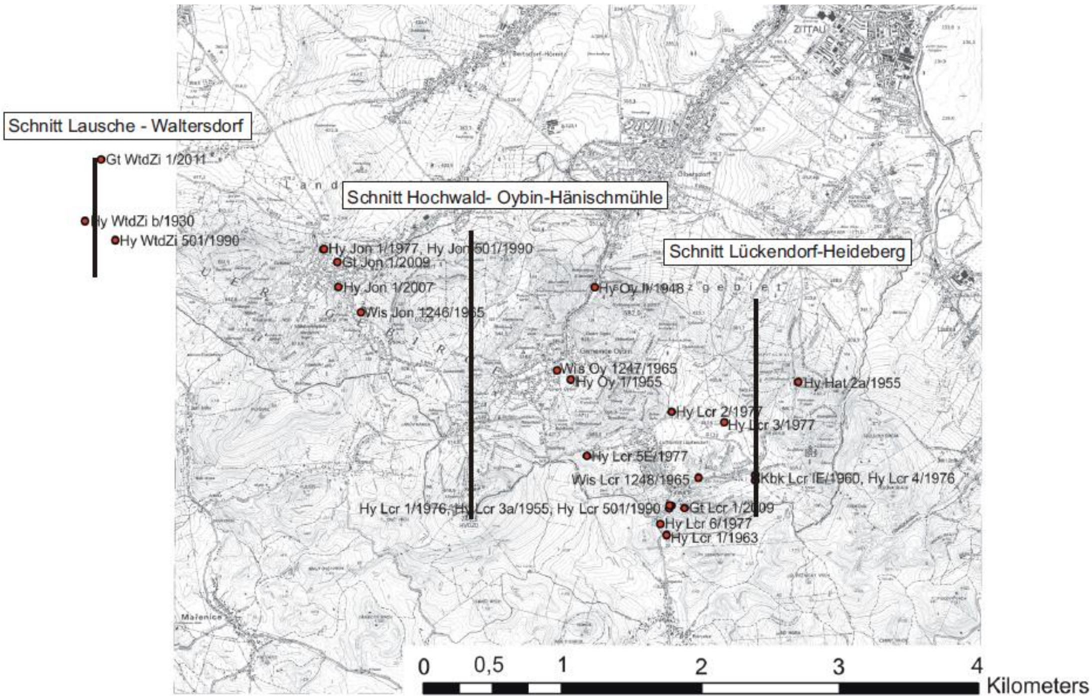

Fig. 8: Position of boreholes and cross-sections used for Fig. 7.

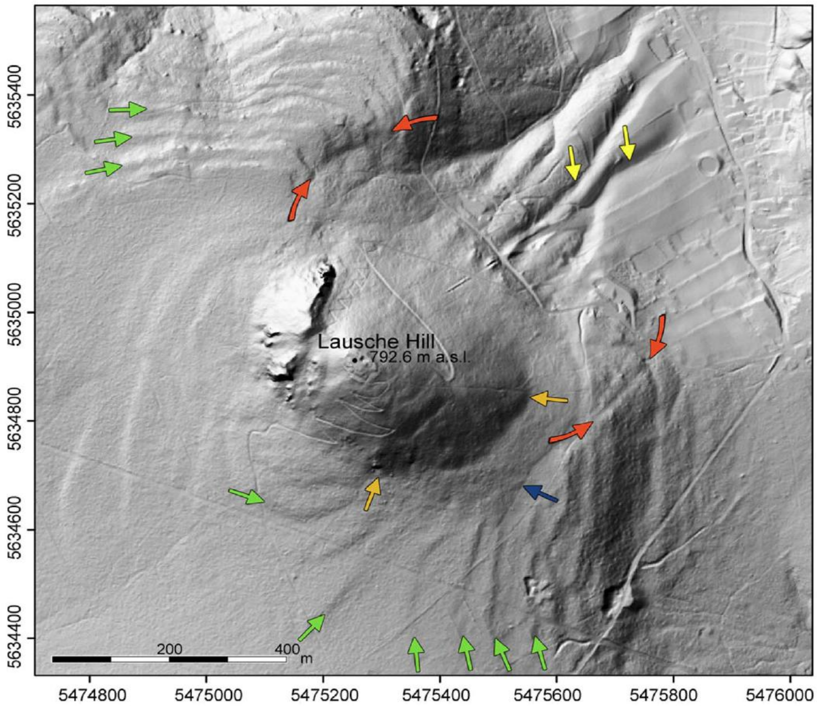

Fig. 9: Digital elevation model of the Lausche Hill area (shaded relief, data from Staatsbetrieb Geobasisinformation und Vermessung Sachsen). Morphological features marked by coloured arrows indicate limits of geological units. Green: horizontal cuestas of Upper Cretaceous sandstone (Waltersdorf Formation, Lausche sandstone); Orange: sudden limits of sandstone cuestas mark the crater edge of a maardiatreme volcano; Yellow: deep erosional grooves cut through unconsolidated material filling the maar-diatreme; Blue: sharp margin of the lava flow; Beige: notable change in slope angle along the base of the phonolite dome due to differing internal structure and erodibility of rocks. Coordinates according to DHDN/3-degree Gauß-Krüger zone 5. Figure from WENGER ET AL. (2017).

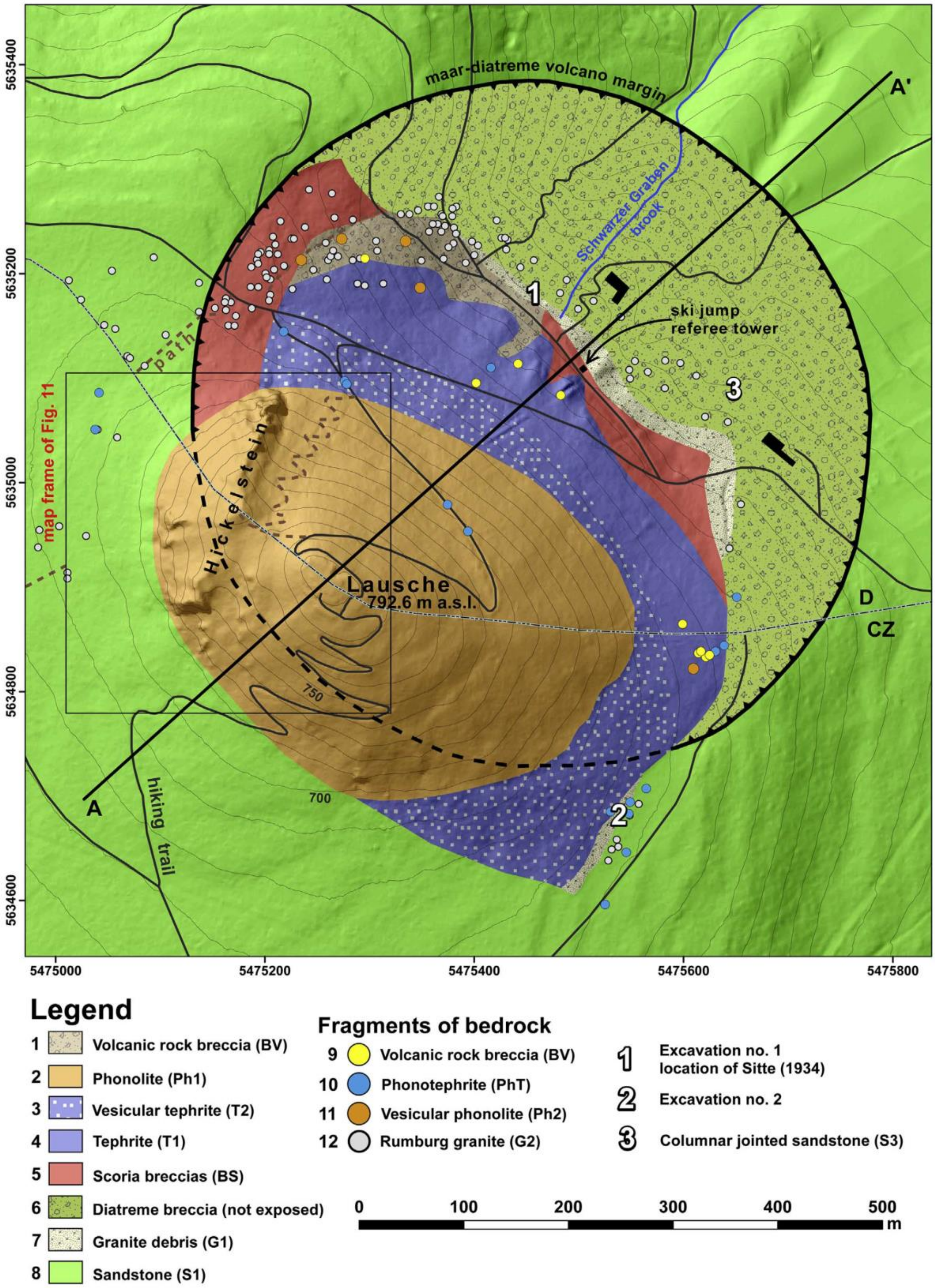

Fig. 10: Geological map of the Oligocene Lausche Volcano. Geological ages of the rocks: 8 is Lower Coniacian; 7 and 12 are Middle Paleocene–Lower Eocene (62–50 Ma); 6 is Lower Oligocene (slightly older than 30.75 ± 0.56 Ma); 3–5 are 30.75 ± 0.56 Ma; 1, 2, 9 and 11 are 29.05 ± 0.12 Ma; 10 is Lower Oligocene (slightly younger than 29.05 ± 0.12 Ma). See Fig. for cross-section A – A′ Coordinates according to DHDN/3-degree Gauß-Krüger zone 5. Figure from WENGER ET AL. (2017).

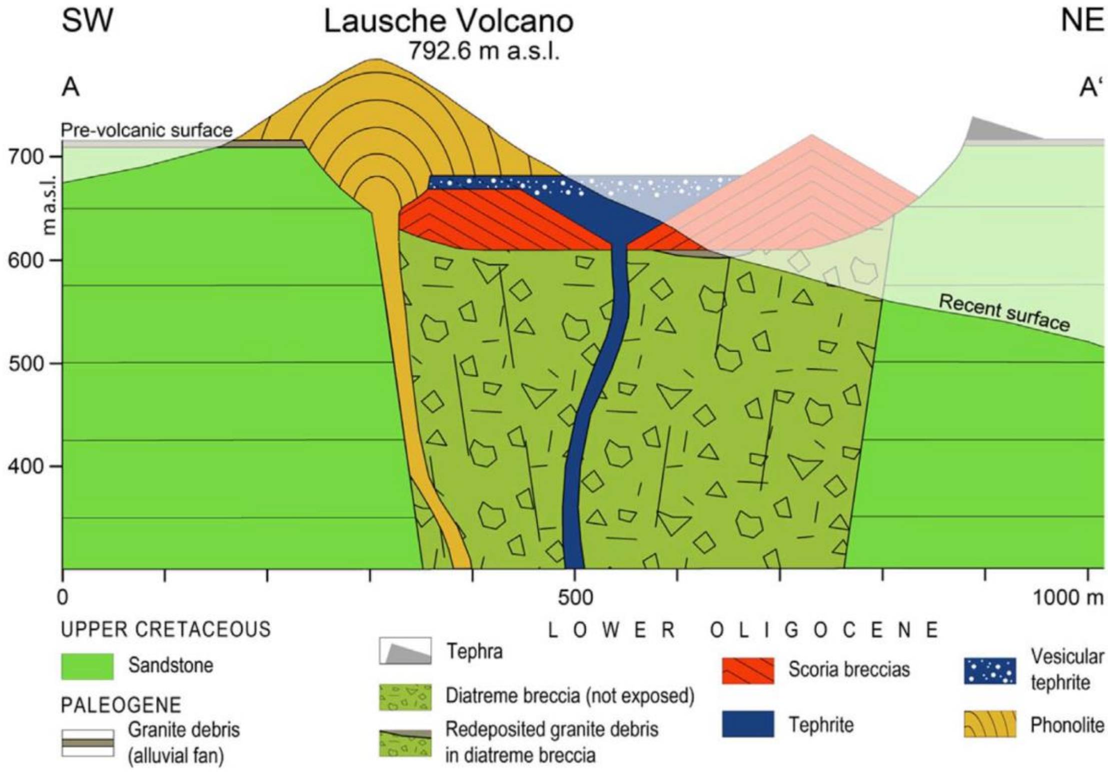

Fig. 11: Reconstructed geological cross-section of the Oligocene Lausche Volcano. A relic of the pre-volcanic surface is marked by granite debris which is preserved by the covering phonolite dome. Weak colouring illustrates erosion since the time of volcanism. See Fig. 10 for position of cross-section A – A′. Figure from WENGER ET AL. (2017).

Excursion stops in Saxony

1. Teufelsmühle: Lausitz Thrust, Cambrian granodiorite, Lower Turonian sandstones (Oybin Formation)

2. Gratzer Höhle: Oybin Formation, Middle Turonian, coarse conglomerates, conglomeratic sandstones

3. Castle Oybin: Oybin Formation, conglomeratic sandstones

4. Felsengasse, Kelchstein: Jizera Formation, influence of hydrothermal water on sandstones

5. Foresters House Lückendorf: Lückendorf Formation: calcareous sandstones with late Turonian fossils, correlating to the Teplice Formation

6. Jonsdorf, Mühlsteinbrüche: weathered dykes, columnar jointing of sandstones (Jizera Formation)

7. Waltersdorf, Sonnenberg: Waltersdorf Formation, fossilrich fine to medium grained sandstones with inoceramids of late Turonian age

8. Lausche, Steinbruchweg: diatreme, phonolite intrusion, Waltersdorf Formation: sandstones of the Sonnenberg member, Lausche sandstone

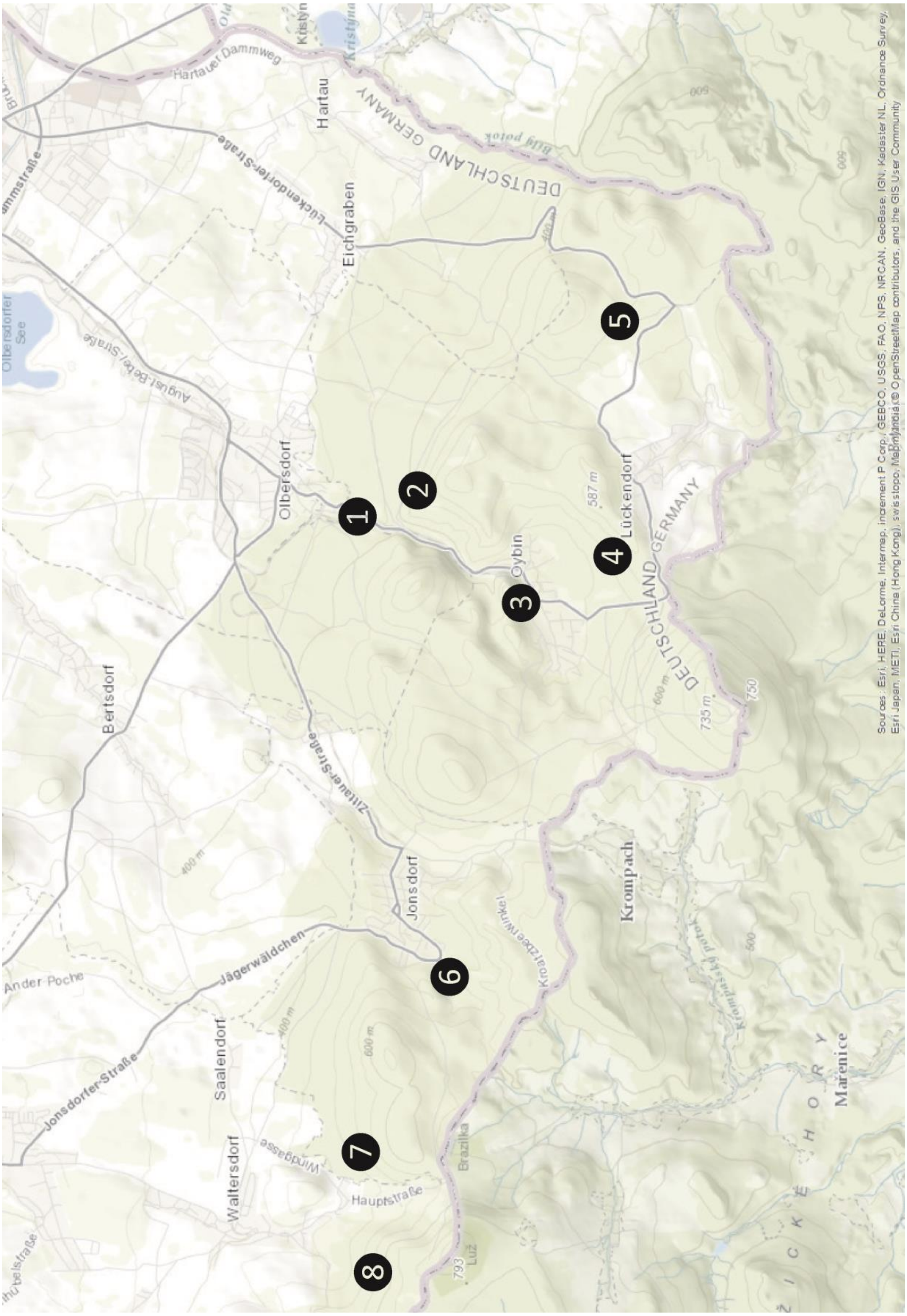

Fig. 12: Excursion stops in Saxony

Saxony - Stop 1

Location: Teufelsmühle - Lausitz Thrust

Stratigraphy: Cambrian granodiorite, Lower Turonian sandstones (Oybin Formation)

Things to observe: fresh granodiorite in close relation to strongly jointed and silicified sandstones of the Oybin (Jizera) Formation, age probably Lower Turonian

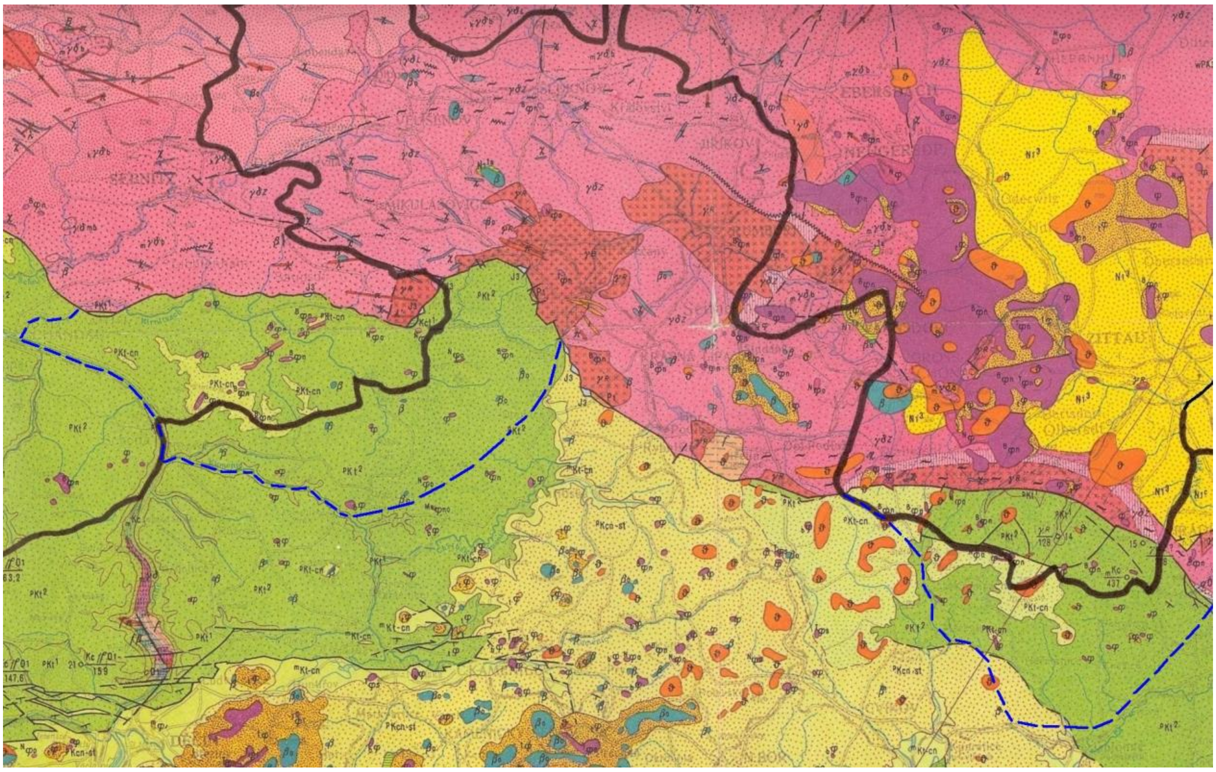

Fig. 13: Map of the excursion area and the changing direction of the Lausitz Thrust. In contrast to other regions of the basin, the Cretaceous sandstones are higher than the thrusted Lausitz granodiorite.

Saxony - Stop 2

Location: Gratzer Höhle (sandstone rock near Teufelsmühle)

Stratigraphy: Oybin Formation, Middle Turonian

Things to observe: coarse conglomerates, conglomeratic sandstones, conglomerates consists of sandstones, ironstones and limonitic sandstones; no granodiorite!, tectonic thrust-related features

Interpretation: The absence of granodiorite pebbles is of striking evidence for inversion of a sedimentary basin which was on top of the later Lausitz-Krkonosze High.

Fig. 14: Several generations of displaced joints

Fig. 15: Conglomerate bed of quartz pebbles

Fig. 16: Reworked sandstones and ironstones

Saxony - Stop 3

Location: Castle Oybin

Stratigraphy: Oybin Formation, Middle Turonian

Things to observe: conglomeratic sandstones, conglomerate beds mainly composed of quartz; marine sandstones of an high energetic environment, probably wave agitated, conglomeratic sandstones are the result of bioturbation

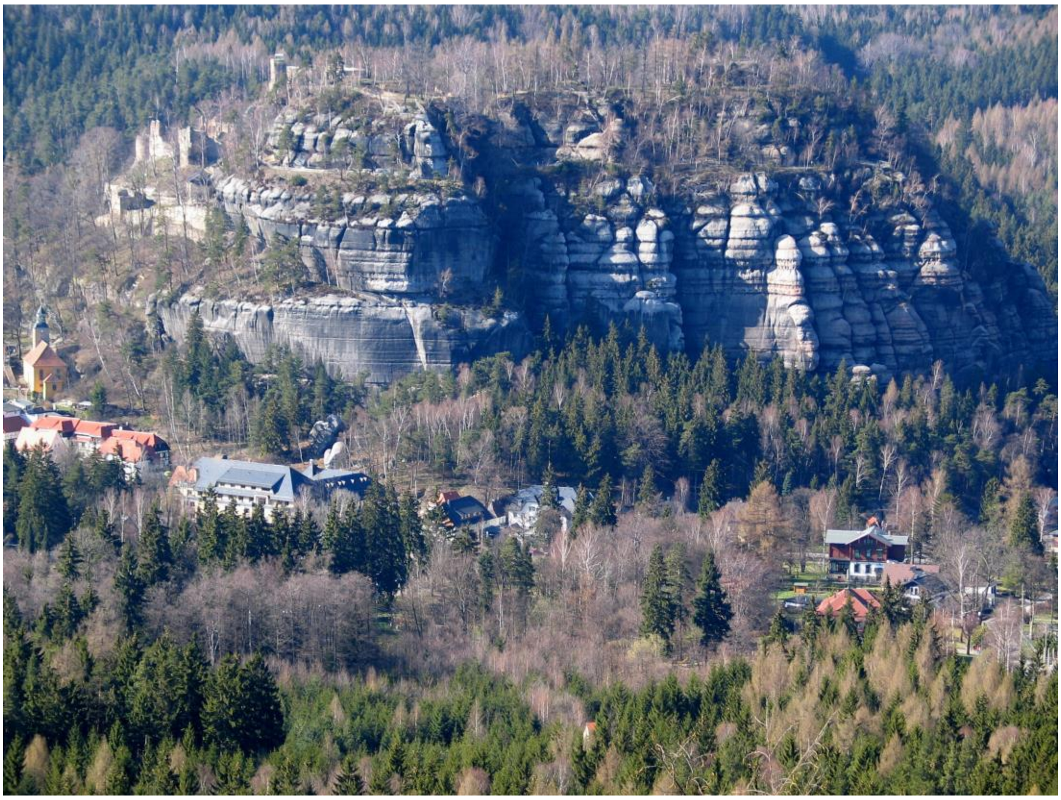

Fig. 17: Flat lying deposits of the Oybin Formation, corresponding to the Jizera Formation. Layering is marked by conglomerate beds which have lower weathering resistivity than the conglomeratic sandstones.

Saxony - Stop 4

Location: Felsengasse, Kelchstein between Oybin and Lückendorf

Stratigraphy: Jizera Formation

Things to observe: sandstones with only few pebbles, red coloured, jointed, impregnation of iron oxides, trace of a weathered basaltic dyke

Interpretation: Intrusion of a thick basaltic dyke caused late diagenetic alteration, also the red colour is a secondary feature

Fig. 18: Kelchstein, the most impressive rock in the Felsengasse, consists of red colored sandstones of the Oybin Formation. Some surfaces show impregnations of iron oxides.

Saxony - Stop 5

Location: Foresters House Lückendorf

Stratigraphy: Lückendorf Formation (Teplice Formation)

Things to observe: calcareous sandstones with late Turonian fossils, correlating to the Teplice Formation?

Interpretation: deeper shore face, normal marine, storm influence, bioturbation dominant

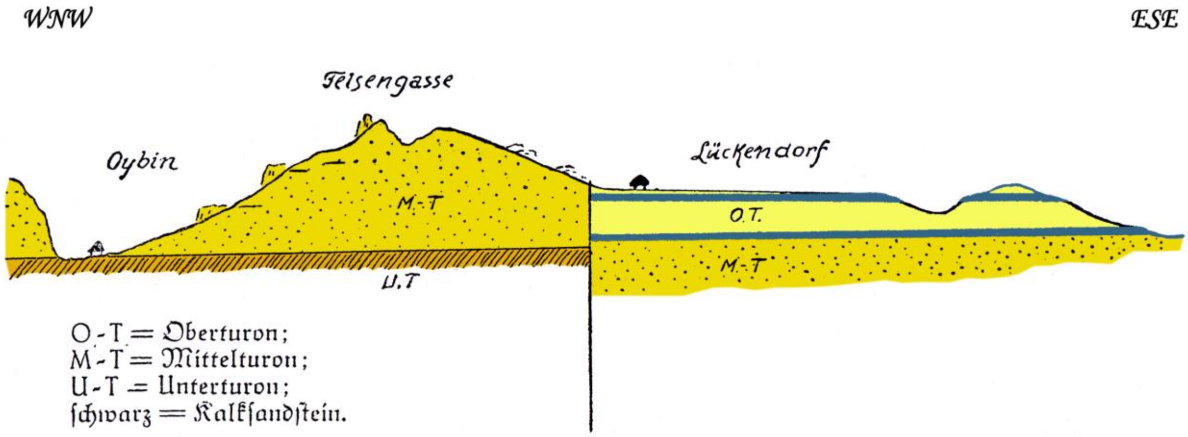

Fig. 19: EW-cross-section of the Oybin area towards Lückendorf shows the vertical displacement of the eastern units (about 80 m according the borehole data).

Saxony - Stop 6

Location: Jonsdorf, Mühlsteinbrüche

Stratigraphy: Jizera Formation

Things to observe: massive, partly silicified sandstones weathered dykes, columnar jointing of sandstones, canyon was formed by weathering of a thick basaltic dyke

Fig. 20: gorge near Jonsdorf

Fig. 21: Columnar jointing of sandstones proves the former existence of a basalt dyke.

Saxony - Stop 7

Location: Waltersdorf, Sonnenberg

Stratigraphy: Waltersdorf Formation (Brezno Formation)

Things to observe: fossil-rich, fine- to medium grained sandstones with inoceramids of late Turonian age, claystone layers

Interpretation: storm-dominated environment of the deeper shoreface

Fig. 22: Abandoned sandstone quarry at the slope of the Sonnenberg (Waltersdorf Formation)

Fig. 23: Late Turonian inoceramid from the Sonnenberg sandstone

Saxony - Stop 8

Location: Lausche, Steinbruchweg

Stratigraphy: Waltersdorf Formation (Brezno Formation): Sonnenberg member, Lausche sandstone

Things to observe: fossilrich, fine- to medium grained sandstones with inoceramids of late Turonian age, claystone layers, overlain by 8 horizons of thickly bedded, coarse-grained sandstones; diatreme, phonolite intrusion

Interpretation: storm-dominated environment of the deeper shoreface, progardation and transition to upper shoreface sandstones

Fig. 24: Abandoned sandstone quarry at the slope of the Lausche (Sonnenberg sandstone)

Fig. 25: Massive sandstones (Lausche sandstone) of the higher Waltersdorf Formation.

References

ANDERT, H. (1929): Die Kreideablagerungen zwischen Elbe und Jeschken II. Die nordböhmische Kreide zwischen Elbsandsteingebirge und Jeschken und das Zittauer Sandsteingebirge. – Abh. Preuß. Geol. Landesanst., 117: 1-227, Berlin.

HEINZ, R. (1929): Zur stratigraphischen Stellung der Sonnenbergschichten bei Waltersdorf in Sachsen (westsüdwestlich von Zittau). Beiträge zur Kenntnis der oberkretazischen Inoceramen IX. – 23. Jber. Nieders. geol. Ver.: 22-53, Hannover.

KOCKEL, F. (2003): Inversion structures in Central Europe - expressions and reasons, an open discussion. – Netherlands J. Geosciences: Geologie en Mijnbouw, 82(4): 367–382, Utrecht.

LAMPRECHT, F. (1927): Schichtenfolge und Oberflächenformen im Winterberggebiete des Elbsandsteingebirges. – Mitt. Ver. Erdkunde Dresden, N.F., Jg. 1927: 1–48.

MALKOVSKY, P. (1987): The Mesozoic and Tertiary basins of the Bohemian Massif and their evolution. – Tectonophysics, 137: 31-42.

MÜLLER, R. (1932): Die geologische Sektion Deutsch-Gabel des Kartenblattes Rumburg-Warnsdorf. – Sbor. Geol. úst. CSR, sv. VIII, roc. 1928-1929, Praha.

PRESCHER, H. (1981): Probleme der Korrelation des Cenomans und Turons in der Sächsischen und Böhmischen Kreide. – Z. geol. Wiss. 9: 367-373.

TRÖGER, K.-A. (1964): Die Ausbildung der Kreide (Cenoman bis Coniac) in der Umrandung des Lausitzer Massivs. – Geologie, 6/7: 717–730, Berlin.

TRÖGER, K.-A. (2008): Kreide – Oberkreide. – In: PÄLCHEN, W. & WALTER, H. (2008) eds.: Geologie von Sachsen. 311-358. Stuttgart.

TRÖGER, K.-A. & VOIGT, T. (2000): Sachsen. – In: Stratigraphische Kommission Deutschlands (Hrsg.): Stratigraphie von Deutschland III. Die Kreide der Bundesrepublik Deutschland. 123-132, Frankfurt.

VOIGT, T. (2009): Die Lausitz-Riesengebirgs-Antiklinalzone als kreidezeitliche Inversionsstruktur: Geologische Hinweise aus den umgebenden Kreidebecken. – Z. Geol. Wiss., 37: 15–39.

VOIGT, T. (2011): Sturmdominierte Sedimentation in der Postelwitz-Formation (Turon) der Sächsischen Kreide. – Freiberger Forsch.-H., C 540 (Karl-Armin-Tröger-Festschrift): 3–25.

ULIČNÝ, D. (2001): Depositional systems and sequence stratigraphy of coarse-grained deltas in a shallow-marine, strike-slip setting: the Bohemian Cretaceous Basin. – Sedimentology, 48: 599–628.

VALEČKA, J. (1984): Storm surge versus turbidite origin of the Coniacian to Santonian sediments in the eastern part of the Bohemian Cretaceous Basin. – Geologische Rundschau, 73(2): 651-682.

WALAZSZYK, I. (1996): Inoceramids from Kreibitz-Zittauer area (Saxony and northern Bohemia): revision of ANDERT´s (1911) descriptions. – Paläont. Z., 70 (3/4): 367-392, Stuttgart.

Czech part

Česká geologická služba

4. Lužice Fault

The most prominent tectonic structure along the NE border of the Bohemian Cretaceous Basin is Lužice (Lausitz) fault (LF). The tectonosedimentary evolution of the basin can be divided into three stages: early to middle Cenomanian, latest Cenomanian to late Turonian and Coniacian to early Santonian (ULIČNÝ ET AL. 2003). During second stage the Lužice (Lausitz) -Jizera sub-basin was evolved. The activity along this tectonic line started in Late Cretaceous and continues to Cenozoic. The dominant movement and deformation are documented in the Late Cretaceous to Paleocene (ADAMOVIČ & COUBAL 1999). The oldest deformational structures have character of folds and flexures. The vertical movements in the middle part of the LF (Saxony in the Zittau-Oybin area and Czech part near Hrádek n. N and Jítrava) coincide with the period of the volcanic activity of the Ohře (Eger) Graben. The uplift of the Cretaceous sediments in this area is the result of the tectonic activity of Pliocene or younger age along of the FL and NE-SW and E-W-striking faults (KRENTZ & STANEK 2015).

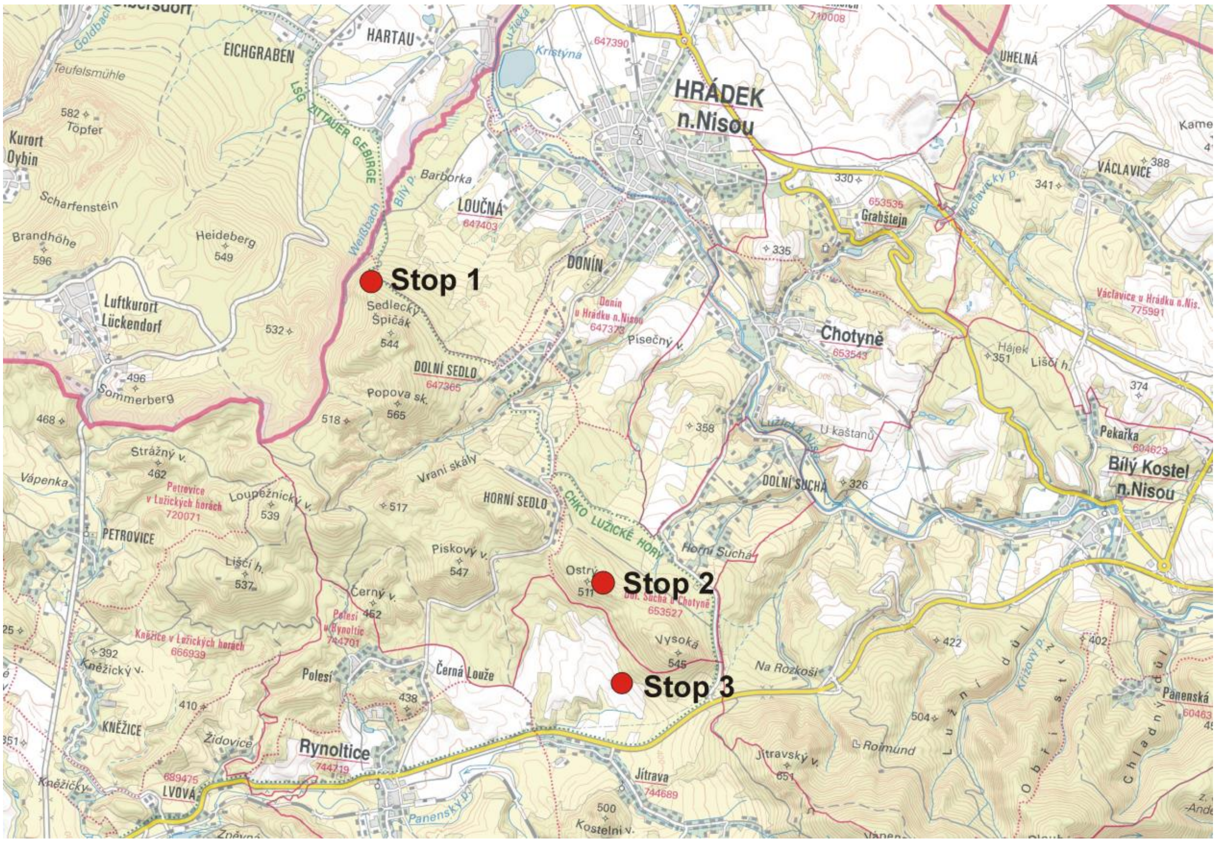

Fig. 26: Position of the excursion localities in the Czech part of the study area

The Czech stop 1 and 2 document these vertical tectonic movements along LF (Fig.27).

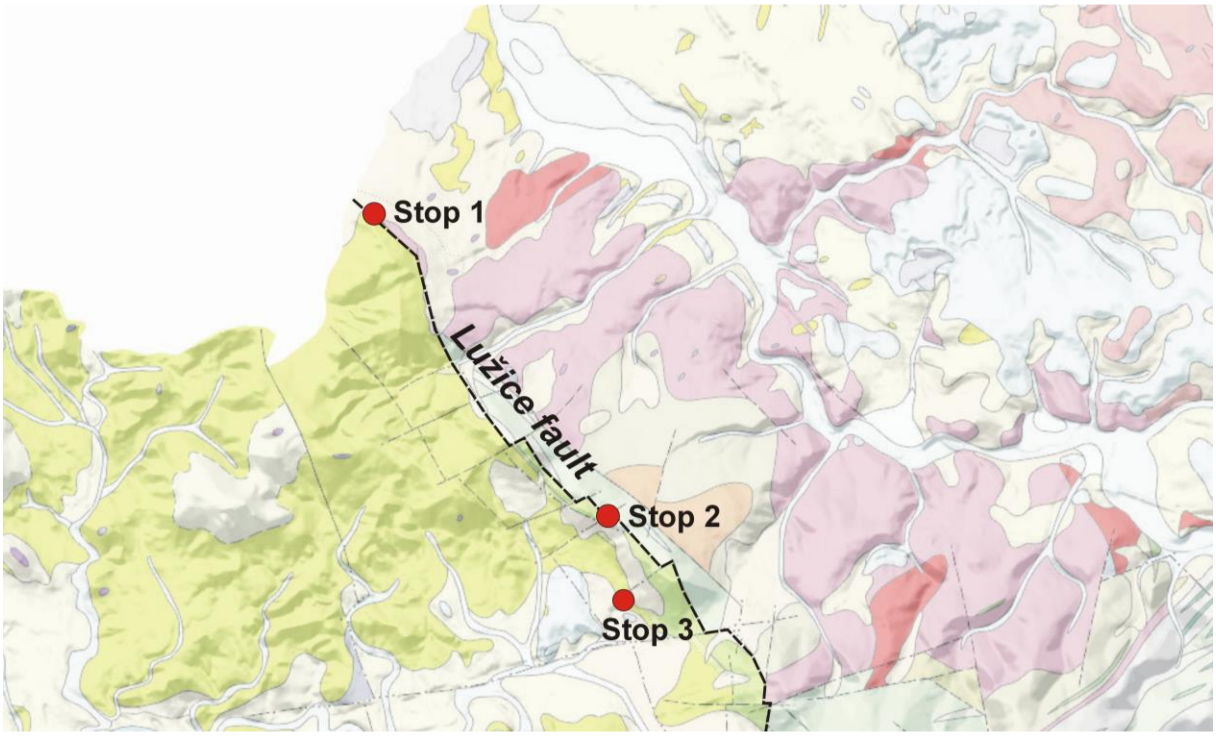

Fig. 27: Position of the excursion localities in the geological map 1 : 50 000

Czech Republic – Stop 1

Location: Kohoutí vrch (former Lipový vrch)

Stratigraphy: Middle to Upper Turonian Jizera Formation

The Kohoutí vrch hill, formerly Lipový vrch hill, runs northeastward from the triangulation point Sedlecký Špičák (544 m a. s. l.), situated SSE of Hrádek nad Nisou near the border with the Free State of Saxony. The whole hill consists of Cretaceous quartz sandstones (Quadersandsteine) and conglomerates of the Jizera Formation of mid to late Turonian age. In the vicinity of the Lusatian Fault they have been silicified. The almost vertical layers of those sediments are well-exposed at impressive sandstone walls on the hill ridge and exhibit slickensides (fault polish) that are due to tectonic movements along the Lusatian Fault. This outstanding tectonic line runs parallel to the ridge and separates the Cretaceous sediments from the northeastern up-thrown block represented by granodiorite of the Lusatian Pluton (the medium-grained Zawidów type). Crystalline rocks occur on the northeast slope only in the plough scatter, regular outcrops are found only along the newly upgraded forest road above the Bílý potok (Weissbachtal) valley.

The resistant sandstones were extracted as building stone in several large quarries, merging together and surrounding the top of the Kohoutí vrch hill from three sides. The extraction stopped probably in the 1st half of the 20th century, today, the quarries have been abandoned and overgrown by woods. Near an old path on the northern slope of the Kohoutí vrch hill, there stood a pub, Volkertbaude, called after its owner. It was a stone-built mountain cottage with a large sun roof providing a majestic scenic view of the land along the Neisse River.

Fig. 28 and 29: Locality Kohoutí vrch

Cretaceous sandstone (left) on the top of hill and outcrop of the granodiorite on the northeast slope (right).

Czech Republic – Stop 2

Location: Ostrý vrch hill (Kozí hřbety/Ziegenrücken)

Stratigraphy: Middle to Upper Turonian Jizera Formation

Southeast of Horní Sedlo, an about 2 km long range is situated, having on its top an important geological boundary, called Lusatian Fault. The times after Cretaceous sedimentation were marked by an uplift of the northeastern block in relation to the southwestern, downthrown one. The opposite motion of the two blocks on the Lusatian Fault caused the originally horizontal beds of the Jizera Formation (Middle to Upper Turonian) near the Fault having been bent into an obliquely dipping almost vertical position. This led subsequently to intense erosion on the up-thrown northeastern block so that at present, phyllites, green-schists and meta-dolerites of the Ještěd Crystalline complex (Krkonoše-Jizera Unit) occur on the surface.

They are of late Devonian to early Carboniferous age and represent the Cretaceous basement. A nameless hilly area occurs southeast of the Ostrý vrch hill built by sandstone walls with steeply dipping beds. One of the walls displays the so called slickenside with fault polish.

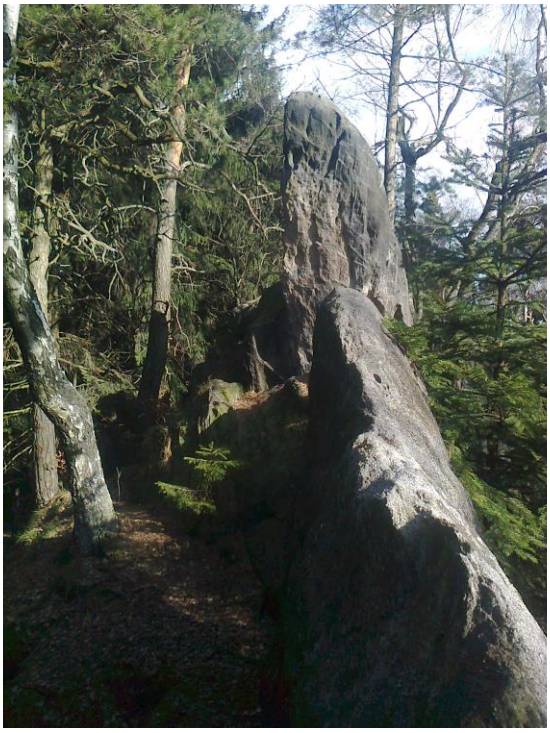

Fig. 30 and 31: Locality Ostrý vrch hill: Cretaceous sandstone in the vertical position along the Lusatian fault (left) on the contact with outcrop of the phyllites and green schists (right) of the Ještěd Crystalline complex.

Underneath the hill top there is a group of old quarries, where sandstone was extracted for construction purposes. The stonemasons cut not only rectangular blocks out of it, or door lining and stairs but also sculptures, ornamental portals, stone vases and other decorations. The quarrying boomed at the turn of the 18th and 19th centuries, as the stone material was hauled to Liberec to build large houses for its wealthy citizens. The quarrying continued until 1835, but gradually it ceased to be a paying business and the quarries were abandoned. Besides sandstones, also coarse-grained conglomerates with bigger pebbles occur, displaying numerous molds of Mesozoic pelecypod shells in many places.

Czech Republic – Stop 3

Location: Bílé kameny (White stones)

Stratigraphy: Middle to Upper Turonian Jizera Formation

The Bílé kameny site forms an isolated, morphologically outstanding rock group ca. 1 km north of Jítrava, at the foot of the Vysoká hill. They strike one´s eyes by their white color and rounded forms, reminding of formidable backs of resting elephants, sometimes being called Sloní skály (Elephant´s rocks). Since they are an exhibit of unusual weathering pattern of Cretaceous sandstones they were given protected status in 1955.

They are made up of quartz sandstones (Quadersandsteine). The uniform petrographic composition and grain size have given rise to their displaying rounded, mushroom-shape or regular ball-shape forms, in particular in the apical parts of the rock outcrops. They are medium-grained to coarse-grained and diagonal bedding developed at some horizons. They belong to the Jizera Formation and are of mid Turonian to late Turonian age.

Fig. 32: Locality Bílé kameny (White stones or Elephant´s rocks).

AFTER MACKOVČIN ET AL. (2002): "originally horizontal beds were uplifted and tilted on the Lusatian Fault". Upper part of the sandstone sequence is marked by high proportion of the kaolinite cement in the intergranular space and poorly developed bedding. These lithologic properties gave rise to the unusual weathering pattern described above. At the top of one of the rocks a well-developed oval-shaped rock pan occurs with a draining flute. Another point of interest is several small pseudo-karst caves and cavities generated by selective weathering and erosion of coarser-grained layers in the sandstones. At present, the Bilé kameny rock group is divided by three broad, almost vertical fractures into a number of independent rock blocks, forming a small rock city. Oval-shaped cavities and caves, the longest being ca. 6 m long, developed on the rock walls or at their footwall due to the selective weathering of less resistant sandstone layers. One of the rock walls contains a small, more than 4 m long rock tunnel.

References

ADAMOVIČ, J.– COUBAL, M., (1999): Intrusive geometries and Cenozoic stress history of the northern part of the Bohemian Massif. *GeoLines 9*, 5–14.

KRENTZ, O. – STANEK, K. (2015): Die Lausitzer Űberschiebung zwischen Meissen und Jeschen – neue Aspekte. – Berichte der Naturforschenden Gesellschaft der Oberlausitz, Band 23, pp. 123-137, Gőrlitz.

ULIČNÝ, D. – ČECH, S. – GRYGAR, R. (2003): Tectonics and depositional systems of a shallow-marine, intra-continental strike-slip basin: exposures of the Český Ráj region, Bohemian Cretaceous Basin. *GoeLines 16*, 133–148.