TSK Jena 2018

17th Symposium of
Tectonics, Structural Geology and Crystalline Geology

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Pre-conference field trip 1: 19 March, 2018 Tectonic structures around Jena viewed from atop

Excursion leader: Kamil Ustaszewski

Itinerary:
Walk from downtown Jena (143 m) up to the Hausberg (392 m)

Stop 1: Saale river at Camsdorfer Brücke

Stop 2: Gypsum-bearing veins within Röt (Oberer Buntsandstein), Schillstraße
The outcrops displays numerous bedding-parallel, cm-thick extension veins with subvertically oriented fibres of anhydrite and gypsum, testifying to pore pressures exceeding overburden stresses.

Stop 3: Karst fissures in gypsum-bearing layers within Röt (Oberer Buntsandstein)
This stop shows several m-sized karst fissures within coarse-crystalline gypsum layers ("Gipsschlotten"), possibly enhanced by fluvial erosion. Notably, he site has been officially acknowledged by the municipality of Jena as a protected geotope.

Stop 4: Boundary between Buntsandstein and Muschelkalk with Gelbe Grenzbank ("Yellow boundary layer") at Ulmers Ruh'

Stop 5: Fuchsturm, Panorama around Jena

Stop 6: Sigmoidal vein structures ("Querplattung" or "Wellenstreifung") within marly limestones of the Lower Muschelkalk
This stop is located along the hiking trail along the crest of the Hausberg. Marly limestones in the Lower Muschelkalk of central and southern Germany frequently exhibit synsedimentary, mm- to cm-spaced fractures at high angles to the bedding. At times, these fractures have a sigmoidal shape in cross view. Such structures have been first described in Germany in the early 20th century (see Wagner [1967] for a review). They are termed "Querplattung" or "Sigmoidalklüftung" when viewed in cross section and

“Wellenstreifung” when looking onto bedding planes (Figs. 1 and 2). The most frequent English term in use is “Vein structures” (Cowan, 1982; Brothers et al., 1996; Ohsumi and Ogawa, 2008). Next to fossil settings in the limestone-dominated Lower to Middle Triassic of Germany (e.g., Föhlisch, 2002) and the Western Carpathians (Rychlinski & Jaglarz, 2017), vein structures were mostly described from (hemi)-pelagic argillaceous and siliceous sediments in numerous Neogene to recent accretionary trench-fill series of the circum-Pacific region (see Ohsumi and Ogawa, 2008 for a review).
Wagner (1967) interpreted such structures as principal stress indicators (Fig. 1). Brothers et al. (1996) performed analogue experiments with diatomite powder subjected to vibrations and could reproduce a range of vein structures very similar to those found in natural settings. They interpreted vein structures as a kind of “seismites” that form due to the passage of seismic p-waves through unconsolidated sediments (Fig. 2).
This interpretation was questioned by Ohsumi and Ogawa (2008) based on the notion that earthquake surface waves have too large wavelength (in the order of km) to produce mm- to cm-spaced fractures. They performed shear box experiments with dry clay powder subjected to oscillating vibrations. During each experiment, the dry powder separated into an upper layer behaving as if liquefied, and a lower, stiffer layer, which gradually developed systematically aligned vein structures with increasing shear along the interface separating liquefied and stiffer layer. Ohsumi and Ogawa (2008) hence concluded that rather than p-waves of earthquakes, high-frequency periodic shear waves can provide the external forces to create vein structures. Such high-frequency shear waves can be triggered by density flows (e.g., submarine landslides, debris flows, or faulting), without the need of invoking earthquake activity.

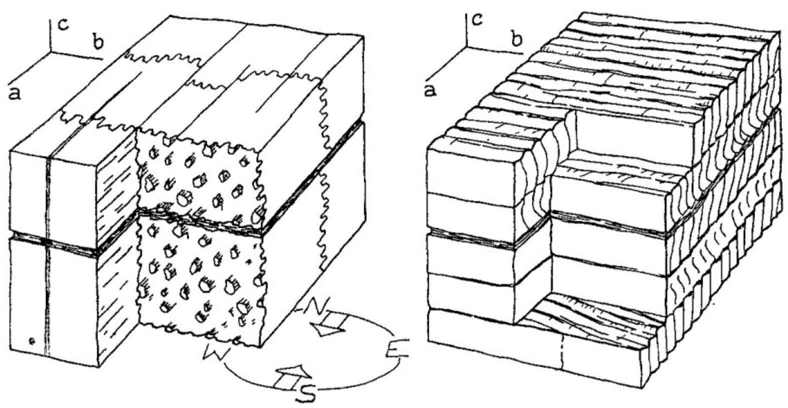

Abb. 1. Druckspannungsindizien mit Gefügekoordinaten:
a) Horizontalstylolithen in Weißjura-Kalkbänken. b) Querplattung im Unteren Muschelschelkalk (Wellenkalk).

Fig. 1: Interpretation of vein structures as principal stress indicators comparable to stylolite peaks (from Wagner, 1967).

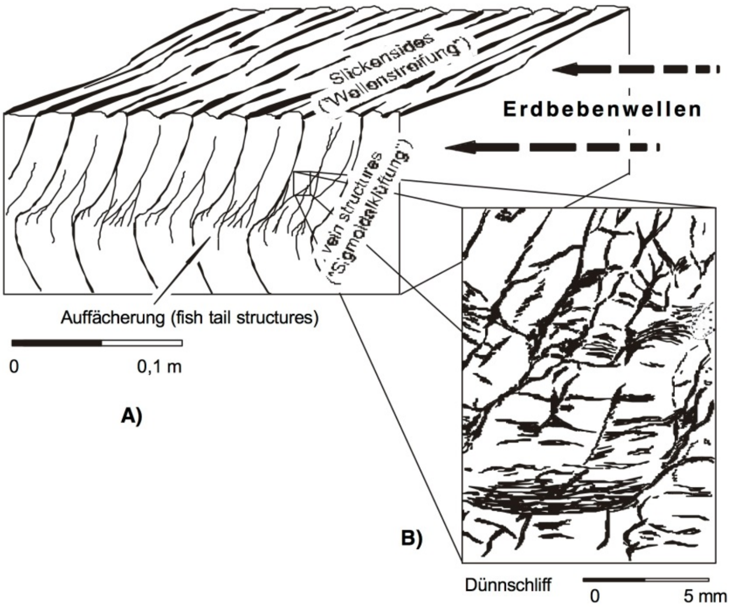

Fig. 2: Interpretation of vein structures as "seismites" due to the passage of seismic p-waves through unconsolidated sediment (from Föhlisch, 2002; based on Brothers et al., 1996).

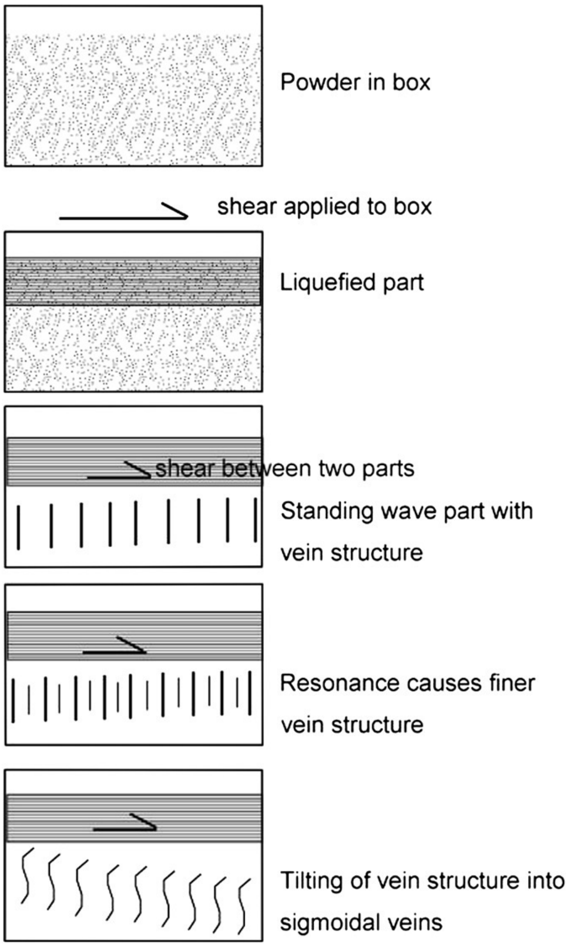

Fig. 3: Interpretation of vein structures as resulting from oscillating vibration induced by high-frequency shear waves. The schematic diagrams show the development of a vein structure in a shear box experiment with dry clay-sized powder. The darker top zone is the liquefied part, below which shearing occurs. Vein structures formed first as systematic fractures, then they were developed by resonance into several orders with closer spacing. Finally, veins developed in a Riedel shear zone causing the array to tilt to the right and the veins to become sigmoidal in shape.
From Ohsumi and Ogawa (2008).

Stop 7: Non-tectonic “Lasagne”-folds within gypsum-bearing marls of the Röt (Oberer Buntsandstein)

The outcrop is located along a roadcut right underneath the main building of the Institute of Geosciences. The strata exhibit cm- to dm-scale folds of variable wavelength and amplitude, apparently linked to the presence of fibrous gypsum-bearing veins. Possibly, the folds are related to the precipitation of veins, concomitant with phase transitions from anhydrite to gypsum that are linked to a volume increase, triggering contraction of the sediments (Fig. 4, left). They would hence be of rather non-tectonic origin and should be termed “Lasagne”-folds (in analogy to folds forming in Lasagne due to volume increase of pasta; Fig. 4, right).

Fig. 4: left: natural “Lasagne”-folds in strata of the Röt member associated with vein precipitation (Teufelslöcher, Jena). Right: Lasagne folds formed at laboratory conditions in Italian pasta. The folds formed due to volume increase of the pasta layers of a few percent during heating at 180°C for 50 min, while the bounding box, made of low-thermal expansion borosilicate glass, remained undeformed. Vertical scale approx. 5 cm.

References

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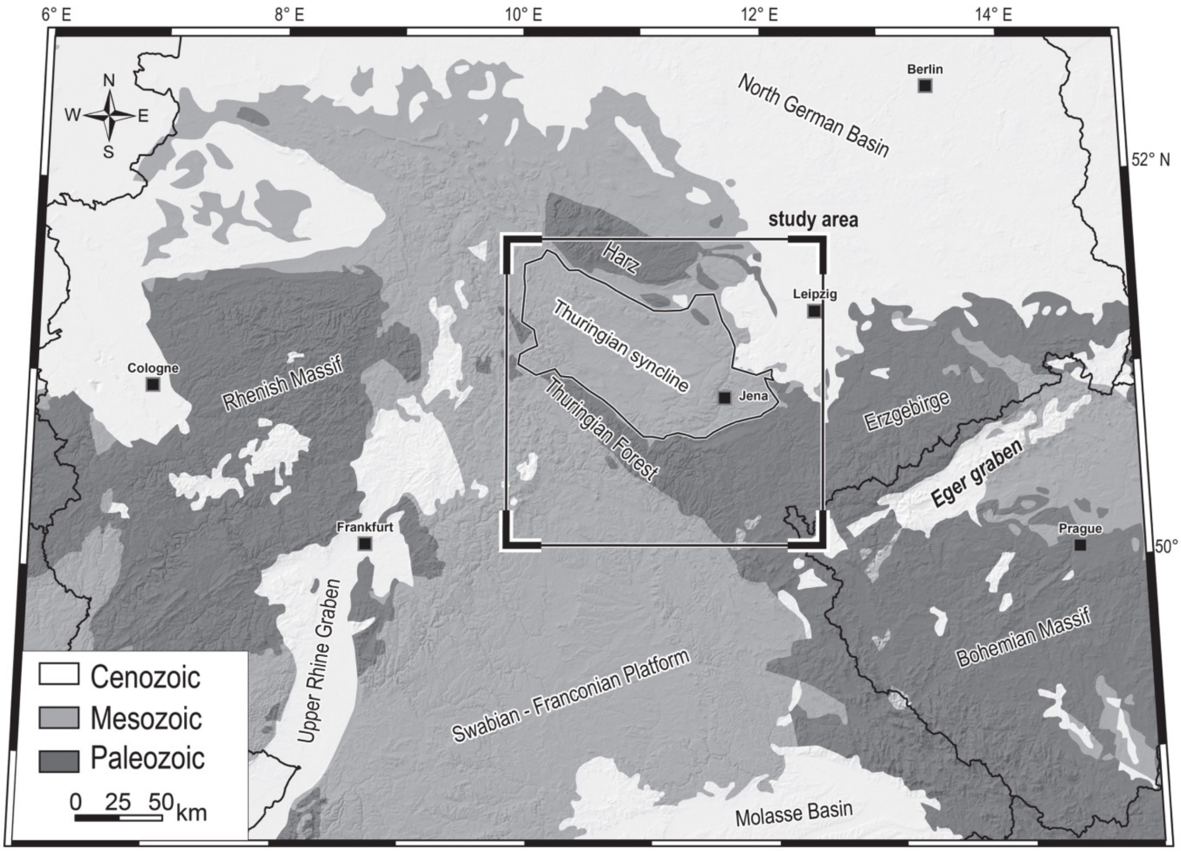

Fig. 5: Geological overview of central Germany (from Thieme et al., in revision)

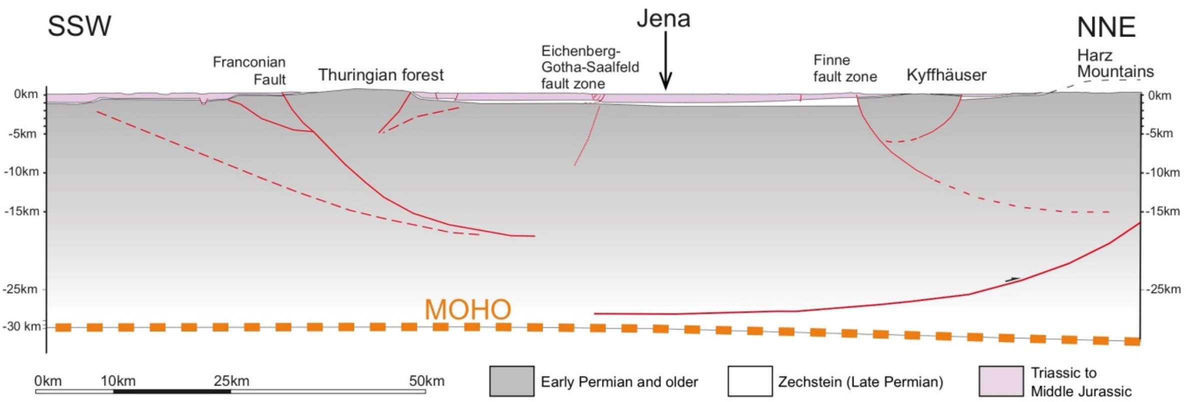

Fig. 6: Crustal-scale cross section across the Thuringian syncline (modified from Thieme et al., in revision).

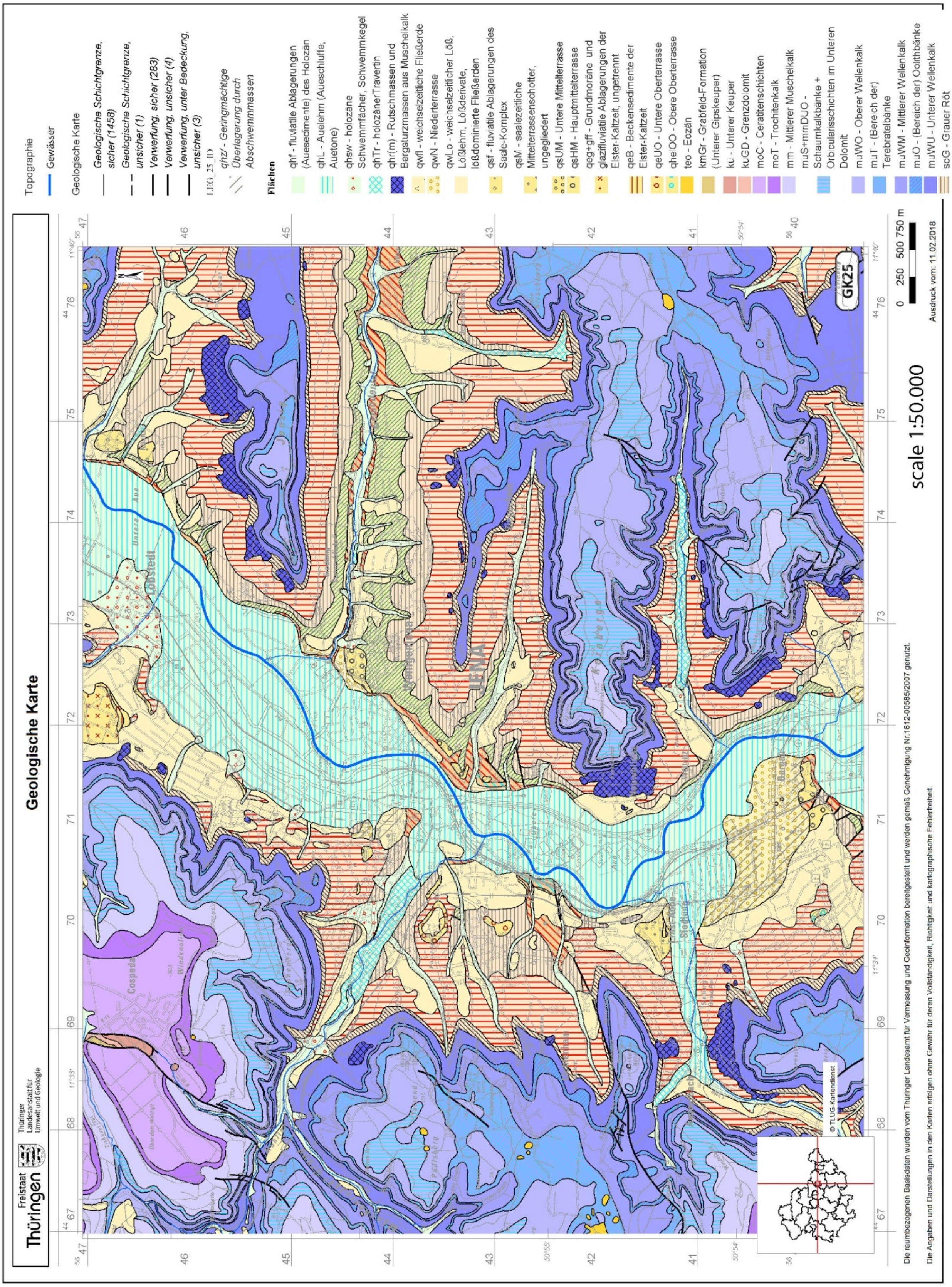

Fig. 7: Geological map 1:50.000 around Jena (TLUG, dl-de/by-2-0).

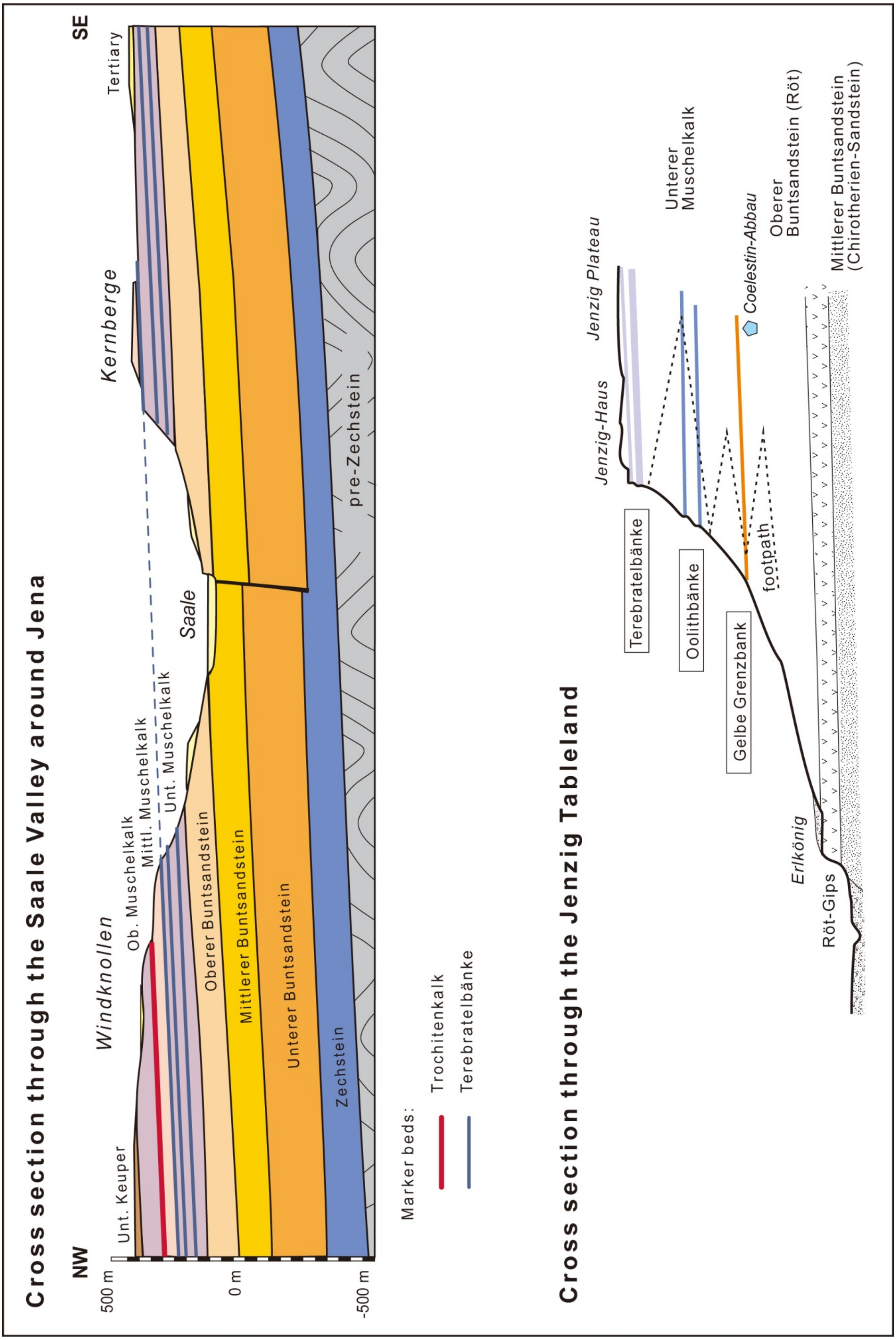

Fig. 8: Cross section across the Saale valley at Jena and sketch of the Jenzig Plateau (modified after sketches by T. Voigt, Jena).

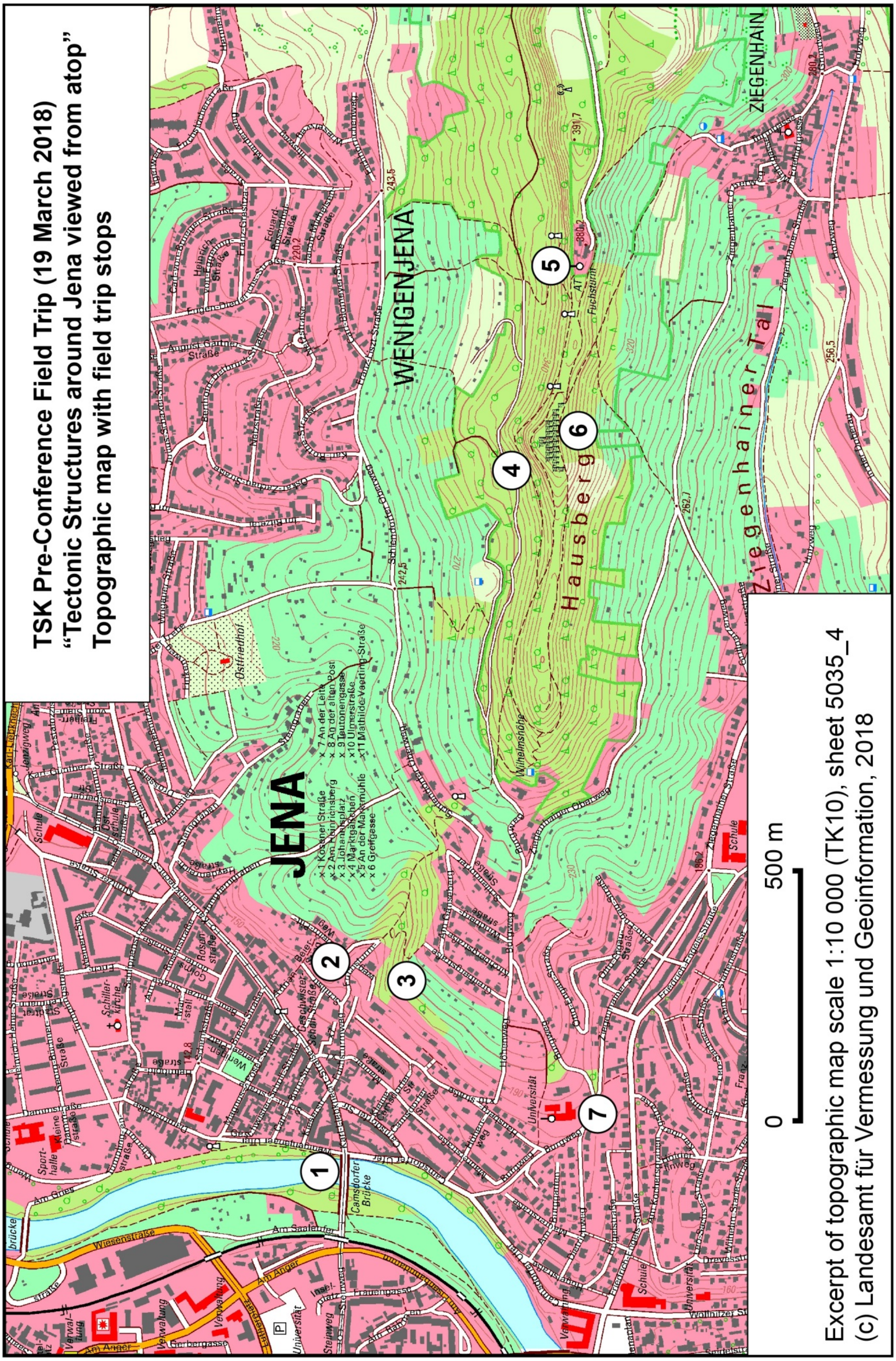

Fig. 9: Topo map of the excursion route with stops (TLVerm, dl-de/by-2-0).