KTB Hauptbohrung - what's beneath the seismic reflector SE1 ?

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Several seismic reflectors were met in the drilled sections of the KTB Vorbohrung and KTB Hauptbohrung (WIEDERHOLD 1992, HIRSCHMANN 1992). Especially, the identification of the prominent reflector SE1 as a broad bundle of faults and cataclastic zones from 6850 m (or 6700 m, respectively) to more than 7200 m is in good agree with the predicted depth range and may be taken as a remarkable success of the seismic investigation. At the surface, this 55° NE dipping reflector is connected with the Altenparkstein Fault Zone. The latter represents the most important fault zone of the Franconian Lineament. It separates the Oberpfalz crystalline complexes in the NE from the Permocarboniferous, Triassic and Upper Cretaceous platforms sediments in the SW. The total vertical displacement of this fault system is in the order of at least 2-3 km. Considerable movements are of Late Cretaceous or even younger age. Down to the present depth of more than 7200 m, the Hauptbohrung drilled into a steeply inclined and large-scale folded succession of ZEV paragneisses and metabasites. The base of this complex has not been reached so far.

The great depth range of the ZEV is an unexpected result and involves serious implications concerning the crustal architecture and development as well as the prediction of the geological profile beneath the reflector SE1 (Altenparkstein Fault Zone). Though results of seismic investigation provide structural information their interpretation depends greatly on structural models.

Structural model

At present, structural models give different explanations of the position of the deep-reaching ZEV and the character of its emplacement: (a) The ZEV is derived from a transpression zone at the western margin of the Bohemicum (Zone Teplá-Domažlice = ZTT) and represents a klippe at the front of a foreland dipping duplex. The latter comprises early Variscan MP(HP) units and Variscan LP units. The intra-crustal nappe complex is widely overthrust on the Saxothuringian crust. The basal shearzone includes equivalents of the Erbendorf Greenschist Zone (EGZ) and, possibly, of low-grade Palaeozoic rocks (WEBER 1992, WEBER et al. 1993). (b) ZEV and ZTT are deeply downfolded (allochthonous ?) units at the flanks of the NNW-SSE striking "Oberpfalz Transcurrent Fault Block" (TFB). The seismic structures of the Erbendorf Body may either be part of the Variscan orogenic structure or represent post-Variscan discordant structures (BEHR 1992). (c) The ZEV is derived from the Bohemicum which, according to Late Caledonian orogenic processes, was subducted underneath the Moldanubian crust and subsequently exhumated by upthrusting in the zone of the present-day western margin of the Bohemian Massif. The Erbendorf Body is, possibly, part of the subducted Bohemicum (STETTNER 1990, 1993). A similar model was proposed by HIRSCHMANN (1989).

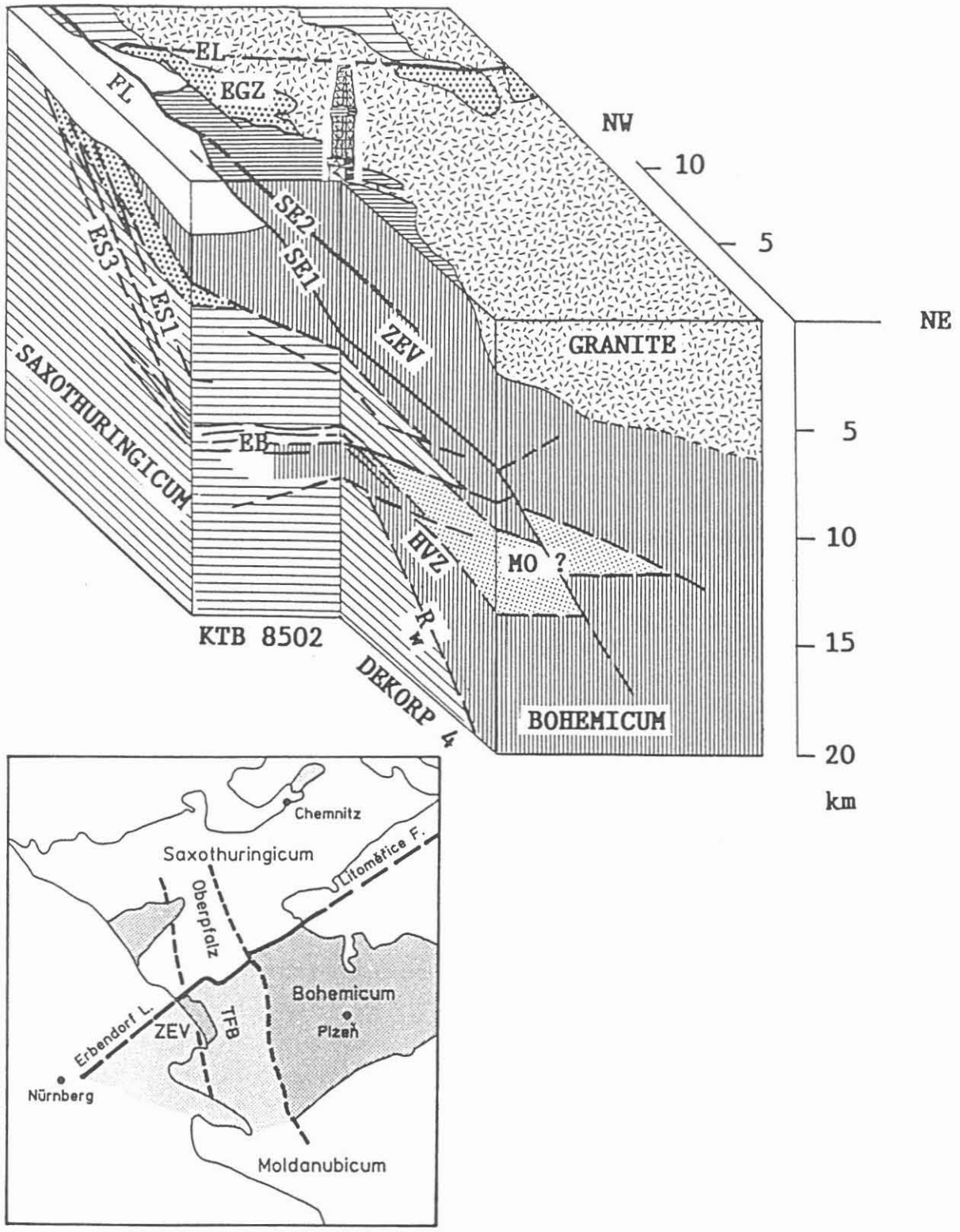

Figure 1: Schematic 3-D model of the KTB drill site. The ZEV is derived from the buried Bohemicum. EGZ = Erbendorf Greenschist Zone and Wetzldorf Unit; MO = Moldanubicum; white = Permocarboniferous and Mesozoic; EB = Erbendorf Body; HVZ = high velocity zone; FL = Franconian Lineament; EL = Erbendorf Line; SE1, SE2, ES1, ES3 = 3-D reflectors; RW = wide angle reflector.

According to radiometric data, the uplift of the ZEV complex to the upper crust occurred shortly after the Early Devonian MP metamorphism. Apparently, the emplacement of the ZEV was connected with alternating NE- and SW-directed movements. It seems to be impossible to distinguish between deformations before or during nappe transport and deformations after such a transport. The development of ductile to semiductile deformations ended with the steepening and large-scale folding of the rock sequence probably prior to the Carboniferous. It may be concluded that the position of the ZEV between the Moldanubian and Saxothuringian crustal units did not result from nappe transport during the Variscan collision but from earlier orogenic processes during the Devonian. Apparently, the latter were bound to the western margin of the Bohemian Massif thus indicating the pre-Variscan or early Variscan origin of the "Oberpfalz Transcurrent Fault Block" (TFB).

Primarily, the terrane of the Bohemicum extended from the Czech territory farther to the W and separated the Moldanubicum from the Saxothuringicum. Parts of the Bohemicum were buried due to subduction beneath the Moldanubicum or thrusting of Moldanubian units over the Bohemicum. The buried Bohemicum is widely distributed in the lower crust of the W-Bohemian and NE-Bavarian region. Probably, the ZEV is rooted in this submerged Bohemicum (Fig.1). A strong SE-dipping wide-angle reflector (RW) in the lower crust (GEBRANDE 1992, GEBRANDE et al. 1993) may be interpreted as the primary pre-Variscan terrane boundary of the Bohemicum. The seismic structures of the Erbendorf Body (EB) and especially the High Velocity Zone (HVZ) may correspond to the roof of the buried terrane. The SE-dipping 3-D reflectors ES1-3 represent, possibly, the continuation of the wide-angle reflector to the upper crust and the connection with the Erbendorf Line at the surface. In the authors opinion, the Erbendorf Line does not represent the suture between the Moldanubicum and the Saxothuringicum but developed from the primary terrane boundary between the Bohemicum and the Saxothuringicum in continuation of the Litoměřice Fault Zone in N-Bohemia. It was reworked and dismembered during the emplacement of the ZEV in the Devonian and during the Variscan compressional tectonics.

Geological profile beneath the SE1

The general character of the Altenparkstein Fault Zone (SE1) is that of a reverse fault system. Beneath it, the Hauptbohrung will probably meet again folded ZEV rocks. According to the outlined structural models, it cannot be excluded that the ZEV complexes reach to a depth of more than 10 km. On the other hand, some seismic results indicate, possibly, a structural subdivision of the interval between the SE1 reflector and the Erbendorf Body (EB). In the 2-D section KTB 8502, the reflectivity pattern shows slight differences between the upper part of this interval and its lower part. The boundary between both parts is a zone of E-dipping reflections. In the Hauptbohrung, this boundary may be expected in a depth between 7.5 and 8 km. Possibly, this structure can be correlated with a flat reflector from wide-angle data at a depth of appoximately 8 km (GEBRANDE et al. 1993). Similarly, a structural discontinuity "somewhere between 3 and 11 km" may be indicated by a change of the direction of fast and slow shear waves (LÜSCHEN & WERNER 1992).

These observations may be interpreted as follows: The upper structural unit corresponds to the ZEV (NW-SE structures). It rests, at least locally, on Saxothuringian complexes which are characterized by NE-SW structures. The nature and the exact spatial position of the structural boundary are unknown but it may be one of the overthrusts or reverse faults which developed during the successive stages of exhumation and emplacement of the ZEV.

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