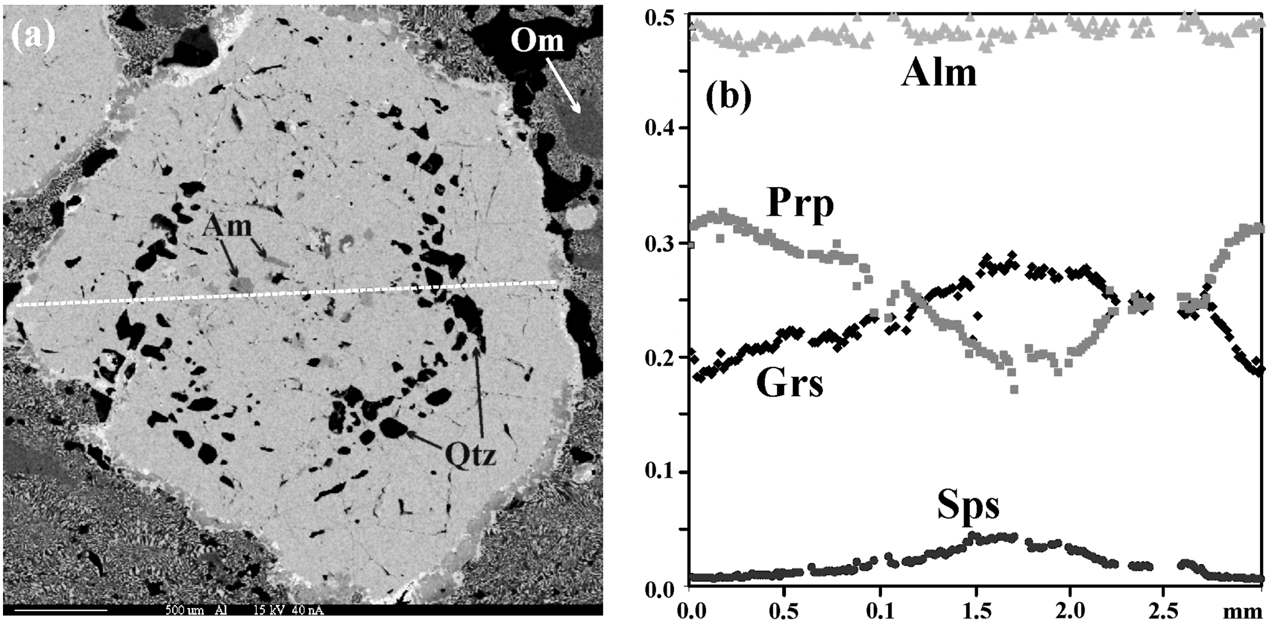
Stop 7-4 (Day 7). Eclogite, Borek

Coordinates: N49°47′34.3″ E15°34′41.3″

Eclogite at this stop is enclosed by serpentinite and located in the medium-grade Monotonous unit (Synek and Oliveriová, 1993). The eclogite and serpentinite occur in a ca. 400 × 250 lens-shaped body in an abandoned quarry, now used as a water reservoir, about 900 m west of the village of Borek. Two sets of fabrics, dipping steeply to the NW and SW, occur within the strongly serpentinised peridotite. Their origin and mutual relations are unclear due to strong serpentinization. The SW dipping fabric is parallel to the orientation of the eclogite layer, which occurs along the SW margin of the peridotite. The eclogite exhibits a foliation defined by the alignment of garnet grains and compositional layering and is concordant with the NW fabric in the peridotite.

Omphacite occurs as relics surrounded by symplectite in the matrix but may occur as inclusions in the rims of garnet. It has a jadeite content between 32–37 mol % and about 10–13 mol % aegirine content. Amphibole enclosed in garnet is taramite, in which the B site is occupied by 0.51 to 0.76 Na atoms per formula unit (a.f.u.) and the A site contains 0.6-0.8 Na+K a.f.u. (the ferric/ferrous ratio in amphibole was calculated by normalization to 13 cations and 46 charges). The $X_{Mg} = Mg/(Mg+Fe^{2+})$ ratio is about 0.5.

The pattern of compositional zoning and the presence of Na-Ca amphibole inclusions in garnet from eclogite suggest a prograde metamorphism from high-temperature blueschist



■ **Fig. 12.** (a) Al X-ray map of a garnet porphyroblast with inclusions of quartz (black) and Na-Ca amphibole (dark-grey) from the Borek eclogite. The matrix omphacite is replaced by amphibole+plagioclase symplectuite. (b) Rim-to-rim compositional profile for garnet prophyroblast in (a), illustrating variations in mol fractions of almandine, pyrope, grossular and spessartine.

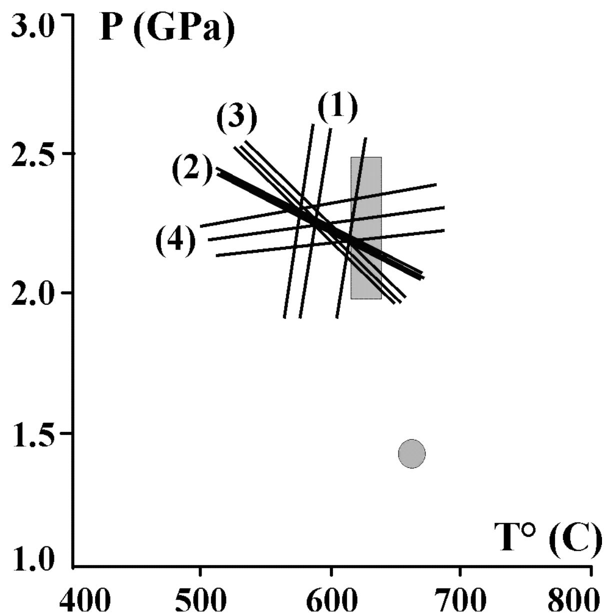
The serpentinized peridotite consists of harzburgite with minor lherzolite and dunite (Fiala and Jelínek, 1992). In addition to olivine (Fo90) it contains orthopyroxene (En90), minor diopsidic clinopyroxene and accessory spinel. The eclogite forms a 60–70 m thick lens-like body in the serpentinite. Eclogite has the composition of tholeitic basalt and consists of garnet, omphacite, and quartz, with Na-Ca amphibole inclusions in garnet. The eclogite has been partly retrogressed, resulting in the replacement of omphacite by amphibole-plagioclase symplectite and the development of thin coronas of plagioclase and amphibole around garnet.

Garnet contains abundant inclusions of quartz and Na-Ca amphibole (Fig. 12a). It shows prograde zoning with high Mn and Ca in the core ($Grs_{28}Prp_{20}Alm_{48}Sps_4$) and high Mg at the rim ($Grs_{19}Prp_{32}Alm_{48}Sps_1$), while Fe is almost constant (Fig. 12b).

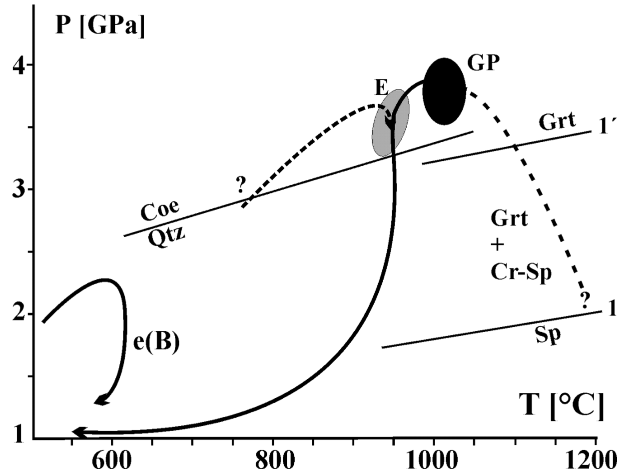
facies to eclogite facies conditions. Temperatures of 632 ±23, 616 ±34 and 690 ±46 °C, calculated at 2.2 GPa, were obtained using the garnet-pyroxene thermometers of Ravna (2000), Ai (1994) and Ganguly et al. (1996), respectively. Using the compositions of amphibole inclusionsnband adjacent garnet and omphacite, a pressure of 2.3 GPa at 590 °C is calculated, based on end-member reactions and the PTGIBS program (Brandelik and Massonne, 2004) (Fig. 13).

Summary

The lithological and metamorphic characteristics of HP/UHP rocks from the Kutná Hora complex and the adjacent Monotonous unit suggest subduction of crustal and mantle fragments from different geotectonic positions. Some garnet peridotites with layers of garnet pyroxenites and lenses of eclogites seem to represent fragments of lithospheric mantle that were incorporated in the subduction zone, where they crossed the spinel stability field to the garnet stability field and reached a maximum pressure of 4.0 GPa/1000 °C (Fig. 14). Different rock compositions and garnet zoning in eclogite within garnet peridotite indicate that some eclogites could have been tectonically emplaced into peridotite during different stages subduction and exhumation. Calculated PT conditions (~3.5 GPa, 950 °C) and the preservation of prograde-zoned garnet in kyanite-bearing eclogites within granulite suggest their subduction to the coesite stability field, followed by rapid exhumation and cooling, as indicated by the coexistence of retrograde high-grossular garnet with amphibole and plagioclase (point A in Fig. 11). In contrast, the present mineral assemblages in granulite indicate maximum pressures of 2.2–2.3 GPa at 900 °C. However, the association of granulite with eclogite and the preservation of zoning and inclusion patterns in garnet (Faryad et al., 2010) suggest that some granulites could have reached deeper levels in the subduction zone than that indicated by their calculated P-T conditions. During subsequent, buoyancy-enhanced *exhumation,* granulite could have entrained denser *mantle* rocks during their return flow up the subduction channel. The presence of the Borek MT eclogite in the Monotonous unit suggests that this may have been part of an accretionary wedge into which the HP/UHP Kutná Hora Complex was tectonically emplaced.



■ **Fig. 13.** Results of PT calculations for the Borek eclogite using PTGIBS software (Brandelik and Massonne, 2004) for reactions 1-4 and garnet-clinopyroxene thermometry (box) from calibrations of Ravna (2000) and Ai (1994). Reactions 1-4:
(1) prp + hed = di + alm
(2) parg + q = prp + gr + di + jd + H_2O
(3) parg + alm + q = prp + gr + jd + hed + H_2O
(4) parg + hed + q = gr + di + jd + alm + H_2O
Circle shows the minimum P-T conditions, estimated for the Borek eclogite by Medaris et al (1995)



■ **Fig. 14.** PT conditions and proposed metamorphic evolution of garnet peridotites (GP) and eclogites (E) from the Kutná Hora Complex (Bohemian massif) (Faryad, 2009, simplified). e(B) is the possible PT path for eclogite in spinel peridotite at Borek. Lines 1 and 1' indicate spinel-garnet transition curves from Klemme and O'Neill (2000) and calculated for the compositions of spinel and garnet in the analyzed rocks.

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