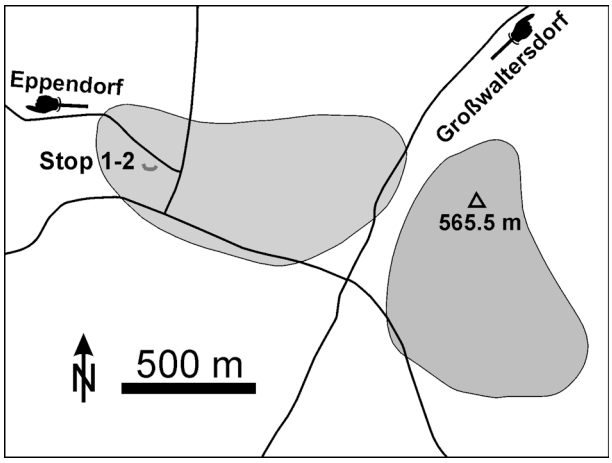
Stop 1-2 (Day 1). Eclogite, SE of Eppendorf

Coordinates: N50°46′36.3″ E13°14′49.2″

The route of the excursion continues to Pockau (go first to national route 174 via Lautaer Hauptstrasse, then 2 km to the north-west turning to the right; go on B101 for 9 km). Pass Pockau and reach the entrance to the village of Forchheim after going 5 km on B101. Directly on the left hand side there is the manor house of Forchheim. On the opposite side is a parking lot where the vehicle can be entered after the walking tour of stop 1-3. Continue to the exit of Forchheim and turn to the left heading for the village of Lippersdorf. After 3.5 km turn to the right following the main road through this village for 2.5 km. After a left and an immediate right turn proceed for 0.7 km. Then turn to the right. After 200 m park the vehicle in the vicinity of the exit of a road coming from the village of Eppendorf in the north-west.

In the abandoned quarry at stop 1-2 there is a good exposure of massive eclogite which shows the same geochemical signature as eclogite from stop 1-1 (see Table 2). The eclogite of stop 1-2 probably belongs to a large body (Fig. 5) or an assembly of several eclogite lenses. In spite of the two large eclogite bodies of Fig. 5 assumed to be below ground, additional outcrops of eclogite do not exist, although abundant large blocks of eclogite occur along the borders between fields and woods in the vicinity. These blocks and eclogite in the quarry may contain fresh omphacite, although locally this mineral may be completely altered to fine-grained symplectites of amphibole and plagioclase. Occasionally, amphibole porphyroblasts, as in eclogite at stop 1-1, can be found here as well. This amphibole and the rare enrichment of potassic white mica might be a reaction product by infiltrating H_2O during late eclogite facies conditions. Another interpretation of eclogitic layers rich in white mica is that they represent a pelitic protolith originally present as thin strata within the basic rocks.

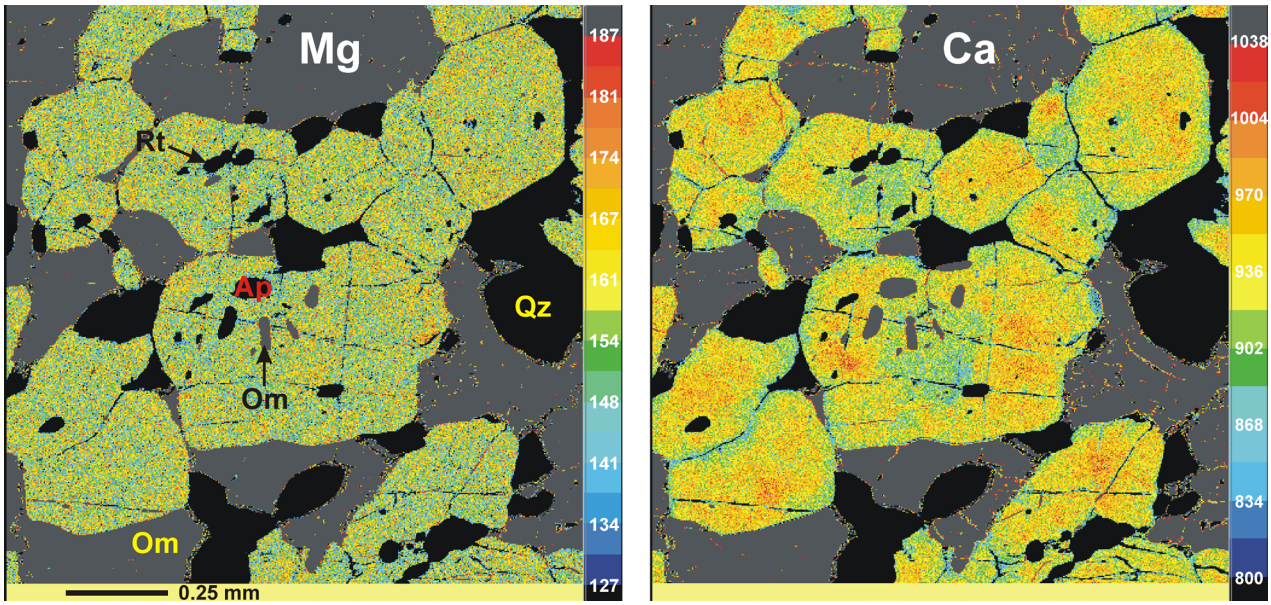
A fresh phengite-bearing eclogite (sample E174c) from the quarry of stop 1-2 was investigated in detail. Mineral compositions of moderately chemically zoned garnet (64 analyses: $X_{Prp} = 0.211–0.243$, $X_{Grs} = 0.300–0.359$, $X_{Sps} \leq 0.010$; see also Fig. 6) and omphacite (36 analyses: Na between 0.371 and 0.403 per formula unit = pfu) are given in Table 3. Phengite of the matrix and enclosed in omphacite (Fig. 7) shows Si contents between 3.30 and 3.35 pfu. Rims of matrix phengite can be lower in Si pfu (Table 3). Zr in rutile (19 analyses) of various textural positions is between 260 and 510 ppm (average 405 ppm). On the basis of a P-T pseudosection (Fig. 8A), which was calculated with the computer software package PERPLE_X (Connolly, 2005) for the bulk-rock composition of eclogite E174c (Table 2) reduced to the NCKFMASH-system with TiO_2, MnO, and O_2, and its contouring by various chemical and modal parameters (Figs. 8B–D, F) was used to derive the P-T conditions



■ **Fig. 5.** Location map for stop 1-2 south-east of the village of Eppendorf. The large eclogite bodies shown on the map were mapped by Hazard (1886).

Mineral	Garnet		Omphacite		Phengite	
	core	rim	core	rim	core	rim
Anal.-No.	1109/09	1109/91	1109/80	1109/12	1109/33	1109/72
SiO_2	38.32	38.04	54.87	54.39	50.45	48.25
TiO_2	0.12	0.10	0.08	0.23	1.55	1.12
Al_2O_3	21.66	21.63	10.19	10.80	26.98	30.60
Cr_2O_3	0.01	0.04	0.00	0.03	0.02	0.01
FeO	21.07	20.96	4.63	4.25	1.28	1.29
MnO	0.38	0.43	0.00	0.07	0.00	0.00
MgO	5.65	6.13	8.81	9.03	4.01	2.71
CaO	13.12	11.85	15.21	15.76	0.00	0.00
BaO					0.18	0.11
Na_2O			5.40	5.33	0.47	0.83
K_2O					9.57	9.00
Total	100.33	99.19	99.36	99.88	94.51	93.93
Si	5.811	5.830	1.976	1.949	6.705	6.437
AlIV			0.024	0.051	1.295	1.563
Ti	0.013	0.012	0.002	0.006	0.155	0.113
AlVI	3.871	3.907	0.409	0.405	2.932	3.247
Cr	0.001	0.005	0.000	0.001	0.002	0.001
Fe^{3+}	0.128	0.088	0.000	0.003		
Fe^{2+}	2.544	2.598	0.139	0.125	0.142	0.144
Mn	0.049	0.056	0.000	0.002	0.000	0.000
Mg	1.277	1.400	0.473	0.483	0.795	0.539
Ca+Ba	2.131	1.946	0.587	0.605	0.010	0.006
Na			0.389	0.371	0.120	0.216
K					1.623	1.531

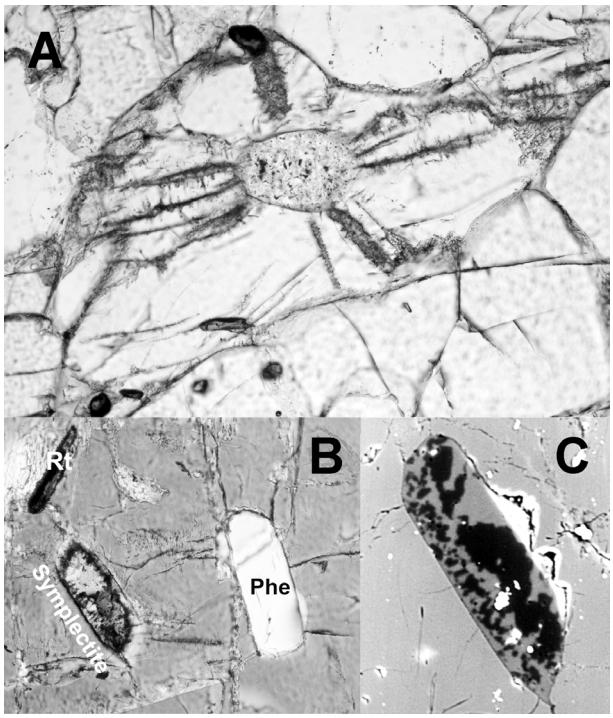
■ **Tab. 3.** Electron microprobe analyses (in wt.%) of minerals from eclogite E174c (stop 1-2) taken from Massonne and Bautsch (2004). Structural formulae were calculated as given in Table 1.



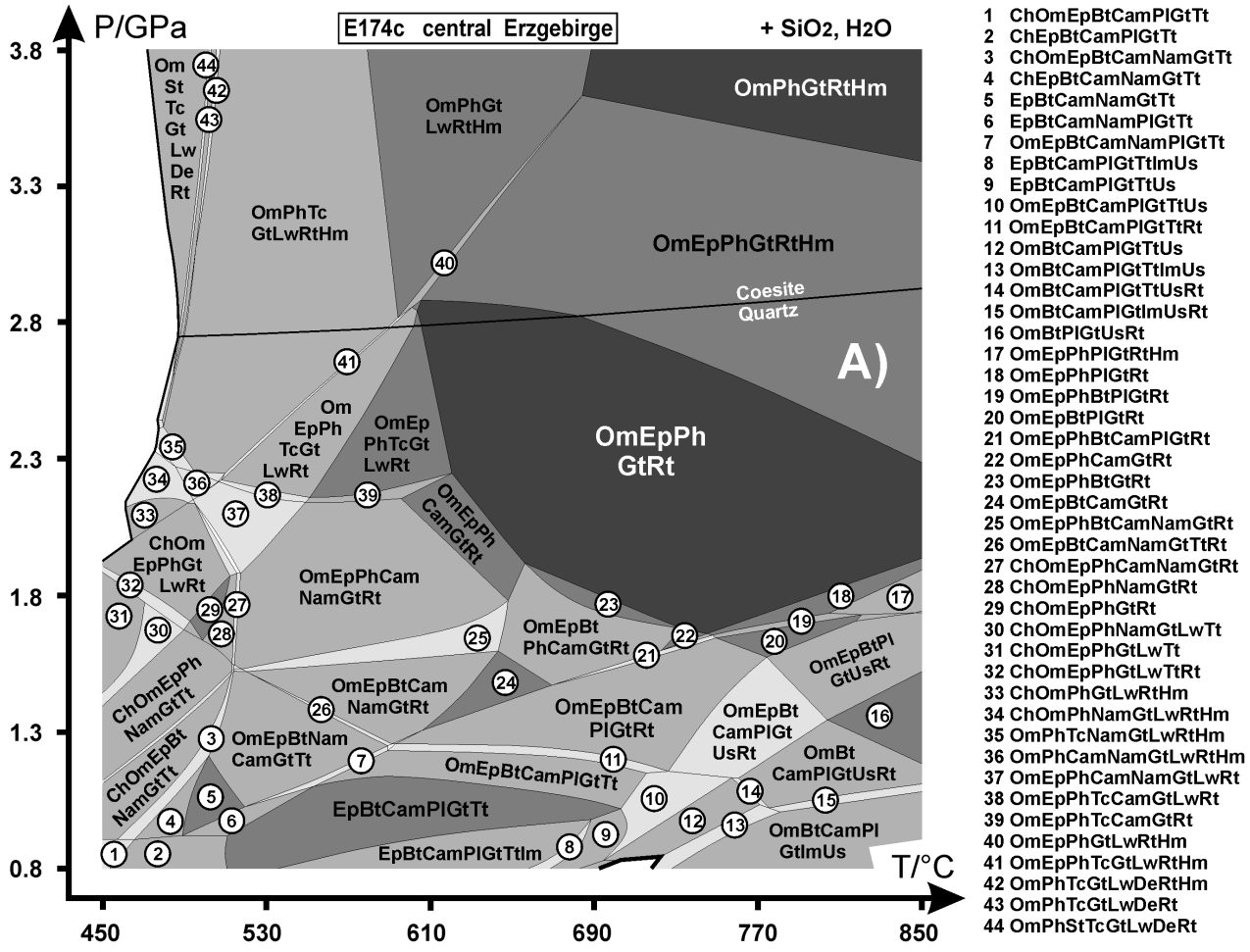
■ **Fig. 6.** Concentration maps of Mg and Ca in moderately zoned garnets of eclogite sample E174c (stop 1-2). Garnets contain inclusions of omphacite (Om), rutile (Rt), quartz (Qz), and apatite (Ap).

of the eclogite stage. In addition, the Ti-in-muscovite/phengite barometer (Massonne et al., 1993), calculated with the computer program PTGIBBS (Brandelik and Massonne, 2004), and the Zr-in-rutile thermometer (Tomkins et al., 2007) were applied to several potassic white mica compositions and the average Zr concentration in rutile, respectively. Corresponding average P-T curves (Si content of Si-rich potassic white mica, Ti content in potassic white mica, Na content of omphacite, Zr content of rutile, Mg content of garnet), including the calculated boundaries for biotite and amphibole (Fig. 8F), define a P-T datum of about 1.8 GPa and 715 °C (Fig. 8G) which is very close to the estimate of the conditions of the HP event for the surrounding gneisses of the GEU (Willner et al., 1997). The isopleth for the mean Ca content of garnet (Fig. 8G) even suggests lower pressures, but this isopleth can sensitively shift with the O_2 content, that can be related to the Fe^{2+}: Fe^{3+} ratio of the rock, selected for the calculation of the P-T pseudosection. According to this calculation, some epidote should be present in the rock, but as this is not the case, the O_2 might be lower than that selected resulting in a lower epidote content and, thus, in a higher grossular content at specific P-T conditions.

A peculiar feature in the eclogite at stop 1-2 are inclusions in omphacite, which consist mainly of intergrown K-feldspar and quartz, resembling a symplectite (Fig. 7). Often, these symplectites are surrounded by cracks in omphacite. This might be the reason why these inclusions were mistaken as pseudomorphs after coesite by Schmädicke et al. (1992), who also

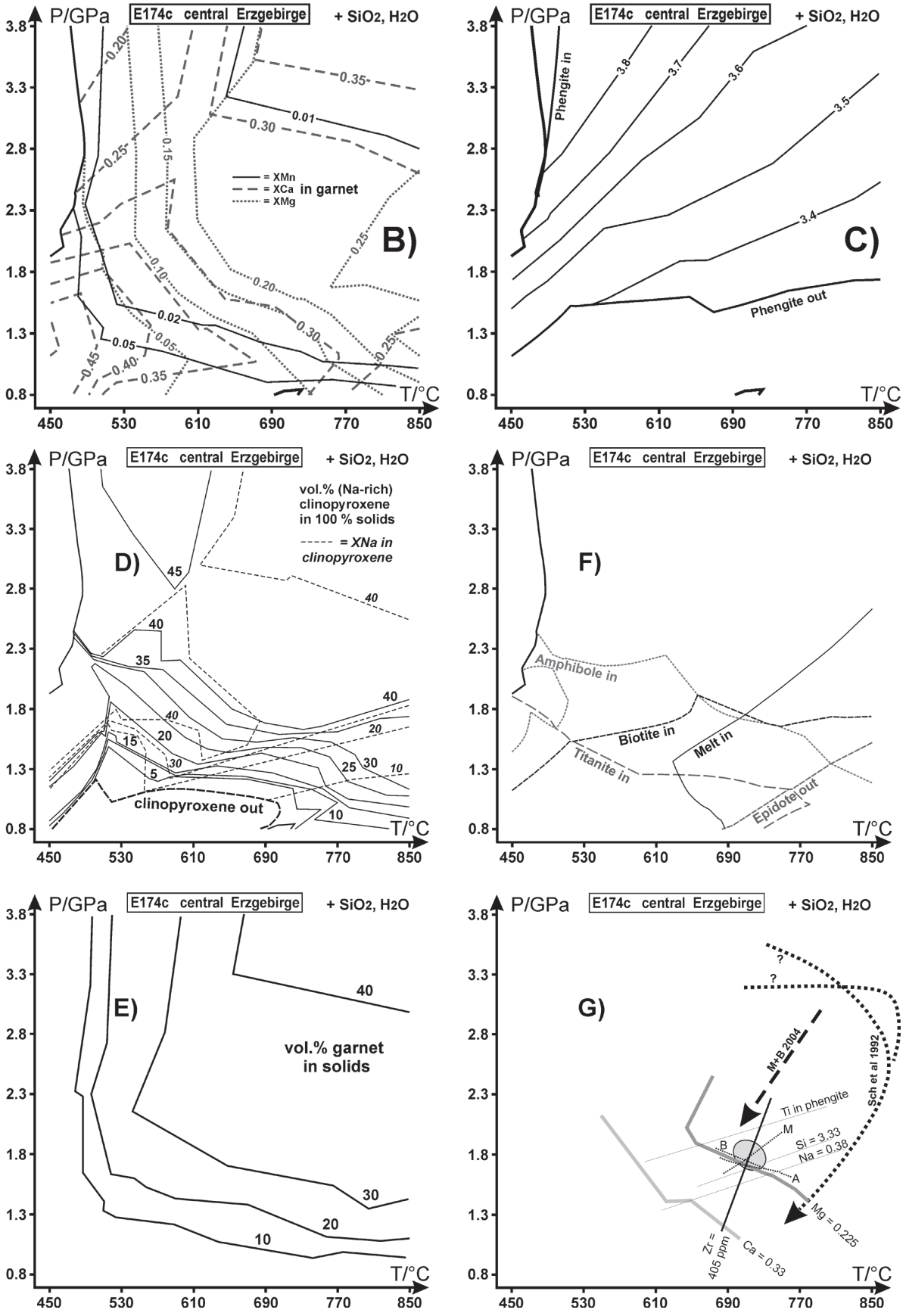


■ **Fig. 7.** Photomicrographs of minerals in eclogite E174c (stop 1-2) taken from Massonne and O'Brien (2003). A) Large inclusion of a symplectite, mainly composed of K-feldspar and quartz, in omphacite under plain polarized light. The inclusion is typically surrounded by cracks. Image width is 0.7 mm. B) A symplectite, somewhat smaller than that of A), rutile (Rt) and phengite (Phe) enclosed in omphacite (crossed nicols). Image width is 0.4 mm. C) Back-scattered electron image of the symplectite in B). Dark: quartz, light grey: K-feldspar and omphacite.

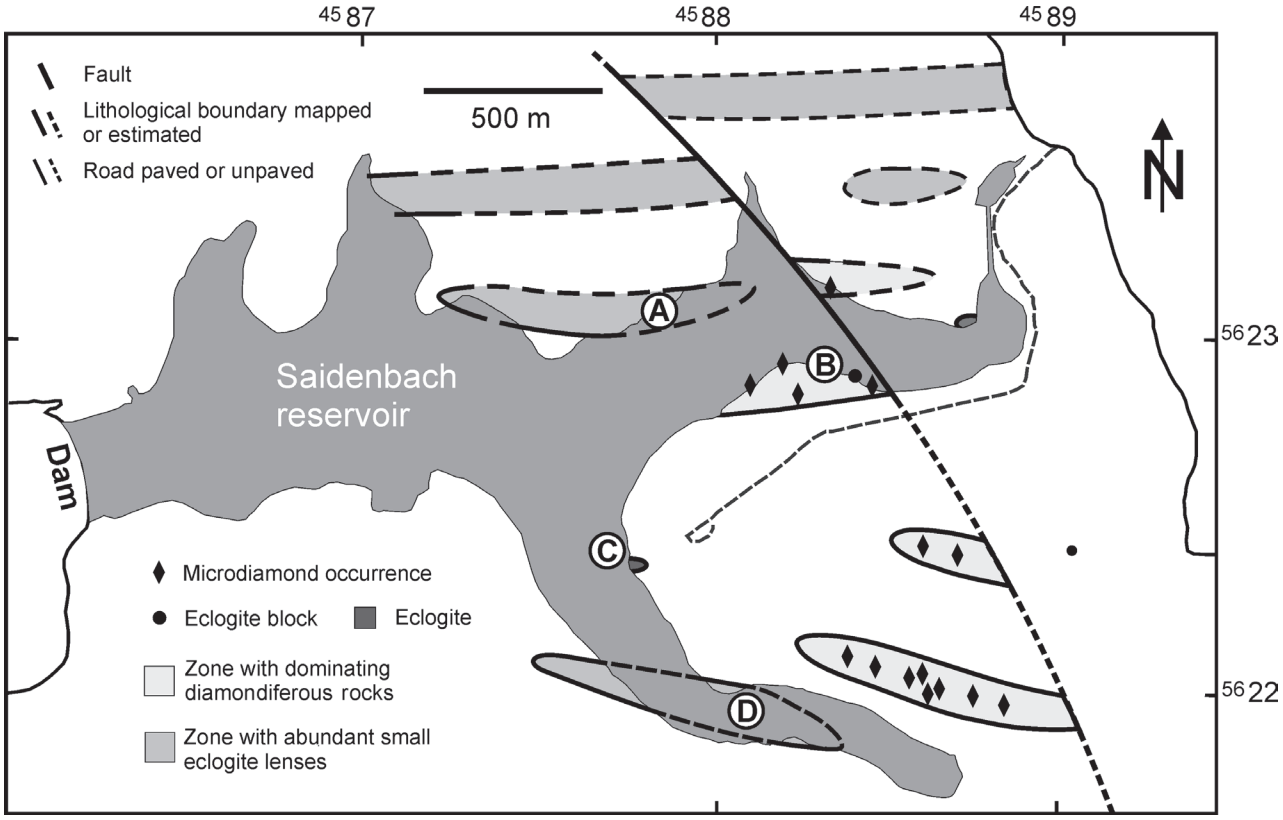


■ **Fig. 8.** (A) P-T pseudosection calculated for the simplified composition of eclogite E174c (SiO_2: 47.82 wt.%, TiO_2: 1.86 wt.%, Al_2O_3: 14.30 wt.%, FeO: 10.92 wt.%, O_2: 0.10 wt.%, MnO: 0.19 wt.%, MgO: 6.12 wt.%, CaO: 11.73 wt.%, Na_2O: 2.24 wt.%, K_2O: 0.22 wt.%, H_2O: 4.5 wt.%) with the computer software package PERPLE_X (Connolly, 2005). This calculation was undertaken as reported by Massonne and Toulkeridis (2010). However, (1) the solid-solution model IlGkPy for ilmenite was additionally selected from the corresponding data-file newest_format_solut.dat and (2) TiBio(HP) was applied instead of Bio(HP). Furthermore, a model for the magnetite (1)-ulvöspinel (2) solid-solution, Usp(M), was newly introduced with Margules parameters W_{112} = 6600 Joule/mol and W_{122} = 14300 Joule/mol. Abbreviations: Bt = biotite, Cam = Ca-amphibole, Ch = chlorite, De = deerite, Ep = epidote, Gt = garnet, Hm = hematite, Im = ilmenite, Lw = lawsonite, Mt = magnetite, Nam = Na-amphibole, Om = Na-bearing clinopyroxene, Ph = phengite, Pl = plagioclase, Rt = rutile, St = stilpnomelane, Tc = Talc, Tt = titanite, Us = magnetite-ulvöspinel. The P-T pseudosection was contoured by isopleths for (B) molar fractions of Ca, Mg, and Mn in garnet, (C) Si contents pfu in potassic white mica, (D) modal and Na content of clinopyroxene, and (E) modal content of garnet. (F) displays curves limiting the P-T occurrence of specific minerals. The P-T position of the solidus curve "Melt in" was calculated additionally using the haplogranitic melt model "melt(HP)"(see, e.g., White et al., 2001) also stored in Connolly's file newest_format_solut.dat (see Massonne and Toulkeridis, 2010). This curve demonstrates that the low-pressure, high-temperature portion of the P-T pseudosection shows metastable phase relations with regard to silicate melt. (G) exhibits specific curves (A, B, M = amphibole, biotite, and melt in) shown or related to those in (A)-(F) and average ones referring to the Zr and Ti contents in rutile and phengite (see text), respectively, which are relevant to the derivation of a P-T datum (grey ellipsis) for the studied eclogite E174c. In addition, P-T paths for eclogites from the central Erzgebirge are displayed (Sch et al. 1992 = Schmädicke et al., 1992; M + B 2004 = Massonne and Bautsch, 2004).

studied the eclogites SE of Eppendorf. On the basis of this assumption, these authors estimated metamorphic pressures as high as 3.6 GPa (Fig. 8G). In addition, a temperature peak of 850–900 °C, reached at pressures between 2.5 to 3.2 GPa, was proposed by Schmädicke et al. (1992). The symplectites enclosed in omphacite were carefully studied by Massonne et al.



■ **Fig 8.** – see previous page.



■ **Fig. 9.** Locations of stops 1-3 A to D along the shore of the Saidenbach reservoir. The simplified geological map was taken from Massonne (2001).

(2000), who concluded that they are breakdown products of K-cymrite. On the basis of this assumption and geothermobarometry with garnet, omphacite, and phengite components as applied to eclogite E25d from stop 1-1, Massonne and Bautsch (2004) proposed a P-T path, which started at UHP conditions of somewhat more than 3.0 GPa and ended close to 2.0 GPa and 700 °C (Fig. 8G).

The P-T conditions derived here and by Willner et al. (1997) for the GEU are compatible with a continent-continent collisional scenario in which one continental plate was thrust under the other. This process led to thickened continental crust, which was eclogitized at and close to its base. The eclogites of stop 1-2 provide evidence for this event. During the burial of rocks located in the lower crust of the lower plate, heating may occur from temperatures of 600–650 °C (0.8 GPa) to around 700 °C, and Ca-amphibole in basic rocks (calculated modal content of E174c at 620 °C and 0.8 GPa in vol.% : 8.9 % epidote, 54.7 % amphibole, 1.9 % biotite, 2.4 % garnet, 25.6 % plagioclase, 3.0 % quartz, 2.8 % titanite, 0.8 % ilmenite) breaks down to form anhydrous phases and H_2O or melt (see "melt in" curve of Fig. 8E). In the latter case and before reaching the peak pressure conditions (1.8 GPa, 715 °C), the solidus curve is crossed again (Fig. 8G). Thus, the symplectite inclusions in omphacite of eclogite E174c could be the result of enclosed melt, the albite component of which was consumed by the overgrowing omphacite. Consequently, mainly K-feldspar and quartz remained in these inclusions.

Stop 1–3 (Day 1). HP and UHP Rocks at the Saidenbach Reservoir

Go the same way back to Forchheim. However, before reaching Forchheim stop at the small bridge crossing Saidenbach brook. From here one has good access to the Saidenbach reservoir by walking on forest roads. To visit the coesite-bearing eclogites at the northern shore of the reservoir (see Fig. 9), take the trail on the north-western side of the brook. Walk for somewhat less than 2 km to reach stop A of the tour along the shore of the reservoir provided that (1) the water level is at least a few metres below maximum and (2) a permit was granted by the responsible person for the reservoir (office directly north of the dam). Chances for (1) are best in the late summer and early autumn. In case the water level is at or close to maximum, alternative stops in the adjacent forests can be considered, especially to see the diamondiferous quartzofeldspathic rocks, which are called saidenbachite (Massonne, 2003) according to the type locality.