3. REE in Clinopyroxene:

The most incompatible behaviour exhibit the Clinopyroxenes which contain only Ti and no Al. The partition coefficients are generally below 0.03. Clinopyroxenes containing both Al and Ti are less incompatible. The light REE are strongly depleted. La/Sm reaches 0.15. For the heavy REE the partition coeficients lie in the range of 0.19. The least incompatible behaviour show the Ti–free but Al–bearing Clinopyroxenes. La/Sm reaches also 0.15. The partition coefficients for the heavy REE increase to 0.27. All 3 REE patterns run parallel: for this reason it can be stated that the presence of Al favours the incorporation of REE, wheras the presence of Ti hampers the REE distribution.

II. Al and Mg in Titanite:

In Titanites Al and Mg are incorporated only in minor amounts. The concentration of Al is always less 1 Wt%, that of Mg always less 0.5 Wt%. The partition coefficients reach max. values of DAl = 0.07 and DMg = 0.08. Nevertheless these elements influence the trace element incorporation.

l. Zr in Titanite:

Al–free Titanites show a partition coefficient for DZr = 1.54. This coefficient traces back to the direct substitution Ti ⇔ Zr. The presence of Al in Titanites raises the DZr =1.66. Two superposing mechanism can be distinguished: a) Ti ⇔ Zr and b) Mg + 2 Ti ⇔ Zr + 2 Al.

2. Nb and Ta in Titanite:

Titanites from the ternary system behave compatible for Nb and Ta (DNb = 1.24 and DTa = 6.0). Ta is by the factor 5 more compatible than Nb. The incorporation of Nb and Ta takes place by the coupled substitution 2 Ti ⇔ (Nb, Ta) + Al.

3. REE in Titanite:

Al–free, but Mg–bearing Titanites are depleted by the factor 2.5 in light and heavy REE with respect to the middle REE. The middle REE show max. partition coefficients of 0.4. Titanite bearing both, Al and Mg, exhibit the same shape of the REE pattern. The middle REE are also enriched by the factor 2.5. Nevertheless this REE group behaves compatible in these Titanites. The partition coefficients lie in the range of 1.35 – 1.83. This is an efect of the superposition of two different couples substitutions (Fig.1).

The REE content of the Al–free Titanites can be explained by a substitution mechanism in the form of 2 Ca + Ti ⇔ 2 REE + Mg. The Al–bearing Titanites which are compatible with respect to the middle REE incorporate these elements by an overlay of a second mechanism in the form of Ca + Ti ⇔ REE + Al. The later coupled substitution seems by far more effective for REE incorporation: Al content in Titanites controls the distribution behaviour of the REE.

STEADY STATE FLOW AND RHEOLOGY
OF DEFORMED ERZGEBIRGE GRANITOIDS

K. SCHULMANN[1], B. MLČOCH[2] & R. MELKA[1]

[1] Faculty of Natural Science, Charles University, Albertov 6, 12843 Praha 2, Czech Republic

[2] Czech Geol. Survey, Klárov 3, 11821 Praha 1, Czech Republic

Porphyric coarse grained pre–Variscan granite intrusion dated at 490–420 MY, K–Ar Hofmann et al. 1979 and cropping out in the central part of the Erzgebirge mountains was intensely reworked during Variscan westward ductile shearing (Mlčoch and Schulmann 1992). This reworking was heterogeneous producing 1) pervasive S–C granite as the most abundant rock type; 2) low–strain domains elongated in E–W direction, tens to hundreds meters in size and 3) zones of banded quartzofeldspatic mylonites.

The mylonitic flat–lying foliations bear east–west trending stretching lineation marked by elongation of quartz–feldspar aggregates and biotite clusters. Ubiquitous S–C relationships indicate west oriented shearing.

The textural transition from metagranite to banded mylonite during granite deformation is explained using a rheological model for bi– and polyphase material (Jordan 1988, Handy 1990). At the initial stages of granite deformation the strain rate and stress were concentrated into interconnected hard feldspar fraction while quartz was shielded from deformation. Tharp's load carying framework rheological model operated during this stage.

Development of S–C fabric is marked by break–down of rigid feldspar skelet while weaker phase starts to be interconnected. Strain rate and stress are concentrated to quartz/mica weak layers shielding isolated pockets of rigid feldspar aggregates. Final stage of banded mylonite is marked by decreasing ratio of viscous contrast between both hard and weak phases. Power law creep mechanisms (dislocation creep) operate in both quartz and feldspar monomineral aggregates which are equally rheologically active.

This progressive microstructural development of deformed granite help to understand 1) a rheological behaviour of continental rocks in mid–crustal levels and 2) steady state flow microstructure of polyphase quartz/feldspar material under amphibolite facies conditions.

CHARACTERIZATION, 3–DIMENSIONAL ORIENTATION AND DECOMPRESSION OF THE ZEV MINERAL ZONES (NE–BAVARIA)

B. SCHULTE

Technische Hochschulle Darmstadt, Germany

In the main part of the ZEV (Zone of Erbendorf Vohenstrauß), three mineral zones of NNW–SSE extension were mapped (from W to E): a Staurolite zone with staurolite+garnet (+kyanite/sillimanite) + biotite + muscovite + quartz, a Garnet–Aluminiumsilicate zone with garnet + kyanite/sillimanite + biotite + muscovite + quartz and a Cordierite zone with cordierite + andalusite + biotite. The Cordierite zone extends along the late Variscan Leuchtenberg Granite, but is also found, in small "isles", far away off the granite.

In the KTB drill hole the first 7800 m represent the Garnet–Aluminiumsilicate zone with some migmatitic portions and a segment of Cordierite zone at 470 m. Below 7800 m in cuttings the assemblage staurolite + garnet + kyanite + sillimanite + biotite + muscovite + quartz and others with andalusite + biotite + quartz are recovered, the latter which eventually represents the Cordierite Zone.

Garnet of the Staurolite zone show bell–shaped Mn–profiles, but is nearly homogenized in the Garnet–Aluminiumsilicate zone except for a retrograde rim. In the latter mineral zone e decompressive reaction garnet + muscovite > biotite + sillimanite + quartz is observed. Wherever both aluminiumsilicates occur, sillimanite often seems to be the younger polymorph.

Calculated temperatures with garnet–rim / contact biotite pairs range from 568°C–616°C at pressures below 5–6 kbar as given by the stability of sillimanite. Cordierite zone is characterized by the reaction garnet + aluminiumsilicate + quartz > cordierite, indicative of a second decompression reaction.

TECTONOMETAMORPHIC EVOLUTION OF THE INTERNAL VARISCAN BELT – EXAMPLES FROM EASTERN/WESTERN ALPS, BOHEMIAN MASSIF, MASSIF CENTRAL AND SOUTHERN BRITTANY

B. SCHULZ[1], C. AUDREN[2], C. TRIBOULET[3]

[1] *Institut für Geologie und Mineralogie, Schloßgarten 5, D–91054 Erlangen, FRG*

[2] *Institut de Géologie, Géosciences Rennes, CNRS, Campus de Beaulieu, F–35042 Rennes Cédex, France*

[3] *Laboratoire de Pétrologie Minéralogique, CNRS, Place Jussieu 4, F–75252 Paris Cédex, France*

Pressure–temperature–time–deformation (P–T–t–d) paths from metamorphic rocks provide considerable insight to the tectonothermal history of single crystalline segments in an orogenic belt. Most precise information about the P–T–t–d–space evolution of a terrain can be obtained from single metapelite and metabasite samples by relating mineral zonations and successive mineral equilibria to linear and planar (L–S) structures of progressive deformation. When continuous reactions are considered in such rocks, each step of garnet or amphibole growth zonations represents a finite temporal and spatial domain of equilibration within the assemblages and allows to evaluate P and T or P–T changes for each deformational step by geothermobarometry based on cation exchange and amphibole