The Variscan tectonics of the Moldaunubian gneisses, Oberpfälzer Wald: A compressional history

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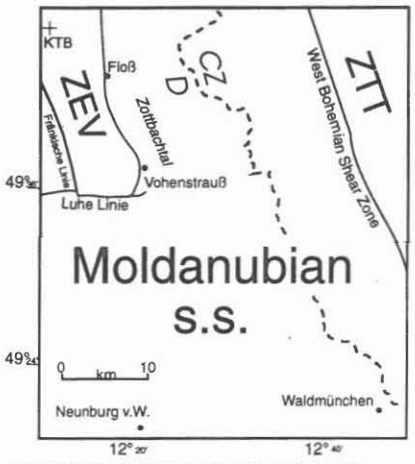
Aims of this work

We have investigated the Moldanubian gneisses of the Oberpfälzer Wald in order to ascertain the structural history, with respect to the present petrological and geochronological findings, and to constrain models for the tectonic development of the Moldanubian units and the Bohemian Massif. These are the results of this investigation and a synthesis of the deformation history obtained.



The studied area, showing the surrounding geological units.

The deformation history of the Moldanubian of the Oberpfälzer Wald

D1/2

The earliest fabrics which can be seen are folds and foliations preserved in calc-silicate and quartzitic lithologies. This deformation event is termed $D_{1/2}$ since at least two fabrics S_1 and S_2 have been found. Internal fabrics found in pre-S_3 garnets are also correlated to $S_{1/2}$. Little can be said about the true orientation of these textures since most are found in boudinaged material which has undergone rotation during D_3. Thus $F_{1/2}$ fold axes lie invariably in the plane of S_3 foliation and near-parallel to the L_3 stretching lineation, even if the D_3 fabrics vary themselves. It is possible to remove the strain of the D_3 deformation, if known, and hence find the pre-D_3 orientation of the fold axes. Although this is only achieved with a large margin of error, it can be seen that $F_{1/2}$ fold axes probably plunged shallowly NNE (fig. i).

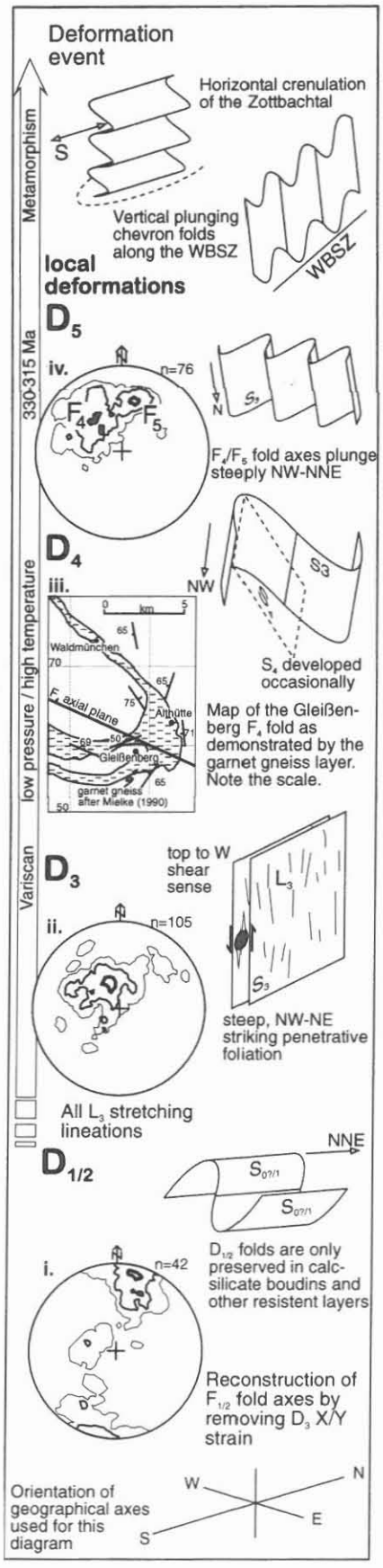
D3

This deformation is characterised by a regional, penetrative foliation, S_3, which defined by all the minerals present in the gneisses. A L_3 stretching lineation is also well developed. From petrological studies it has been shown that D_3 is coeval with the onset of the low pressure/ high temperature metamorphism of the Moldanubian, dated by various authors at around 315-330 Ma.

The S_3 foliation is always steep to near-vertical, striking NW-SE to NE-SW. The L_3 lineation also plunges steeply towards the north-west or north (fig. ii). The shear direction was east side up (top to the west) although very few shear indicators are present. This is probably due the high temperatures during deformation, i.e. 770°C at 4 kbar (TANNER *et al* 1992) and not a small amount of simple shear.

Partial anatexis began in the Moldanubian with the onset of D_3. The most common form of anatexis are long (upto 1-2m), planar, thin (<2cm) S_3 parallel leucosomes (Zeilengneis). A detailed investigation of such a structure (TANNER & BEHRMANN, 1993) has shown that the leucosome formed by a melting process in a closed system, which filled a foliation-parallel shear fracture. Such textures were stable with upto 30% volume melt in the gneiss. Thereafter a complex pattern of foliation-oblique leucosomes formed, cumulating in networks and ponding of melt. The process of anatexis continued until the end of the deformation.

Most of the strain information demonstrates the effects of part of D_3 and the later events. Most deformation was through near-plane strain (k=1). Furthermore, if the stretch is calculated in the vertical axis, it can be shown that there was little extension or compression in this direction, i.e. although the most important deformation of the Moldanubian, D_3 caused little thinning or thickening of the crust.



D4

The S_3 foliation is folded into large map-scale tight synforms and antiforms (½ wavelength >5km, see fig. ii). The axial planes are steep, slightly west inclined and strike NW-SE, the fold axes plunge 60° NW (fig. iv). These structures can be recognised throughout the region. Some anatexis is connected with F_4 folds, where the leucosomes form parallel to the axial plane. In pelitic lithologies a S_4 foliation formed.

D5

D_5 folds, far less intense and smaller than the previous folding, interfere with the F_4 folds and thus the fold axes plunge steeply NNW or steeply NNE (fig. iv), depending on which limb of F_4 they occur. The fold axial plane is near vertical and strikes N-S.

Local deformations

A number of deformations ensue D_3 but can only be locally found. In the Zottbachtal of the NE Oberpfälzer Wald, there is a zone of retrograde gneisses known as the „Diaphtorite" zone (FORSTER 1965). This zone has a characteristic crenulation, the fold axes plunge horizontally N-S and the fold axial planes are horizontal.

Along the West Bohemian Shear Zone (WBSZ), which is the contact between the Moldanubian *s.s.* and the ZTT (Zone Teplá-Taus), the S_3 foliation is folded into vertical-plunging chevron folds. It is probable that these folds are due to lateral movement along the WBSZ.

Small discrete shear zones (displacement <10cm) are also present at some localities throughout the Moldanubian which are at least younger than D_3 and older than the granite intrusion. These strike approx. N-S and dip sub-horizontally, but the sense of shear is in both directions.

Granite intrusion was post-deformation as can be clearly shown at many localities throughout the studied area.

Conclusions

The deformation can be divided into three major events, pre-D_3 (timing unknown), D_3, and post-D_3 non-penetrative deformation (mainly folding events), whereby the latter two occurred during the LP/HT metamorphism of the Moldanubian.

This structural history can be used to constrain and reject some of the models put forward for the cause of the LP/HT metamorphism. The fact that D_3 stretching fabrics (both lineation and foliation) are steep to near-vertical, although there is no change in metamorphic grade over the whole area, rules out the possibility of an extensional „metamorphic core complex" model, or model involving north-south strike-slip. On the contrary, a more compressional regime is indicated, but without involving a large thickening of the crust, as shown by the kinematic and strain data.

The flatness of the metamorphic isogrades in the Moldanubian also excludes the possibility that the Moldanubian has been tilted „en bloc" in a way as to steepen D_3 fabrics.

The late Carboniferous LP/HT metamorphism may be due to a short-lived large scale thermal event.

It is important to note the differences between the deformational history of the Moldanubian (of the Oberpfalz) and those of the surrounding units of the Moldanubian, i.e. the ZEV (Zone von Erbendorf-Vohenstrauß), ZTM (Zone von Tirschenreuth-Mähring) and the ZTT (Zone von Teplá-Taus).

References

FORSTER, A. (1965): Geol. Karte von Bayern, 1:25000, Bl. 6340 & 6341.

MIELKE, H. (1990): Geol. Karte von Bayern, 1:25000, Bl. 6542 & 6642.

TANNER, D.C., SCHUSTER, J., BEHRMANN, J.H. & O'BRIEN, P.J. (1993): New clues to the Moldanubian puzzle: structural and petrological observations from the Waldmünchen area, eastern Bavaria. *KTB-Report* **93-2**, Contrib 6th KTB Coll. Geoscientific Results. 97-102.

TANNER, D.C. & BEHRMANN, J.H. (1993): Analysis of progressive deformation and material transfer in a syntectonic migmatite. *Terra Abstracts* **1** (Terra Nova **9**), p.311.