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MESOSCALE INDICATORS FOR SYNKINEMATIC MIGMATISATION: EXAMPLES FROM THE RHODOPE MASSIF

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ABSTRACT
A large number of mesoscale structures testify about the synkinematic nature of the migmatisation in the central parts of the rhodope massif. Most of them are structures linked with the formation and the migration of the melts. Often in the domains of great structural complexity, relations between folds, shear zones and migmatites provide a good evidence for the penecontemporaneity of ductile deformation and migmatisation.

Structural patterns in the migmatitic complexes are often rather complex and traditionally have been regarded as indicators for polymetamorphic and polideformational nature. On the other hand, mesoscale structures in migmatites have a number of implications, such as (1) mechanical conditions of aplitoid-pegmatoid dyke emplacement; (2) synkinematic intrusive history.

In the central Rhodopes the migmatitic rocks crop out in the lowermost parts of the metamorphic complex – Prarhodopian supergroup and lower levels of Rhodopian supergroup (Kozhoukharov, 1983) or Arda tectonic unit (Ivanov, 1989, Burg et al., 1990). Detailed structural investigation in these areas have been conducted by Dimov and collaborators - along the Vacha river valley (Cherneva et al., 1995) and along the Chepelarska river valley (Dimov et al., 1996). This paper is mainly based on field work carried out in the central parts of the Arda unit. According to Ivanov (1999) and Ivanov et al. (2000) these high-grade rocks represent the core of the Central Rhodopian dome exhumed during the Tertiary. In recent years a wealth of new data (Arkadakskiy et al., 2000; Peytcheva et al., 2000; Ovtcharova et al., 2002) confirmed Tertiary age of migmatisation in the Arda unit (Arnaudov et al., 1990).

According to the scale of the melt migration two main types of migmatites could be distinguished – in situ melts and allohtonous. A great number of observations prove the allohtonous nature of some of the migmatites. (1) Sharp, intrusive contacts are a clear evidence for magmatic veining. (2) In a number of places magmatic breccias are clear indicator of magmatic behavior of granitoid material. High fluid pressures of the magma are required to explain such veining in the light of high confining pressures that prevailed during amphibolite facies shear event. In most places aplitic-pegmatitic magma is inferred to have been injected as an overpressured, anatectically derived fluid generated from greater depths.

For simplicity various migmatic rocks (aplitic, pegmatitic, granitic) are described as leucosome. The mesoscale indicators for synkinematic migmatisation could be devided in two main groups: (1) Mesoscale structures reflecting tectonic control on the formation and migration of the leucosomes; and (2) Mesoscale structures indicating overlapping in time of the processes of migmatisation and ductile deformation.

MESOSCALE STRUCTURES REFLECTING TECTONIC CONTROL ON THE FORMATION AND MIGRATION OF THE LEUCOSOMES

One of the strongest evidence of syntectonic migmatisation is the indication that the melt formation and migration is controlled by regional deformation and a great number of structures demonstrate this interaction. In these cases the position and the geometrical particularities of the leucosomes are dependent on: (1) foliation and lineation orientation; (2) the degree of noncoaxiality of the deformation; (3) sense of shear (in case of noncoaxial deformation). These structures are one of the unambiguous indicators for synkinematic migmatisation. Most often, they are formed by leucosomes generated in situ.

- Melt filled shear zones. Such structures are widespread in the Vacha river valley. They are linked with asymmetric folds described by Ivanov et al. (1985) as late migmatic folds.
- Melt filled boudin necks.
- Melt filled pressure shadows (strain shadows) around stiff objects – boudins, porphyroclasts, porphyroblasts, etc.
- Melt filled tension gashes. They are typical for the shear zones with higher strain rates.
- The development of a synmigmatic layering (Vanderhaeghe, 2001). This type of structure is underlined by regular alternations of continuous centimeter- to meter-thick granitic and mesosome layers. Several processes are supposed to lead to the formation of this structure: (1) metamorphic segregation; (2) intrusion of veins; and (3) transposition during deformation of the partially molten rock. The synmigmatic layering must be used carefully as indicator for synkinematic migmatisation, because similar banding could

be generated via intense ductile deformation and rotation of the older leucosomes.

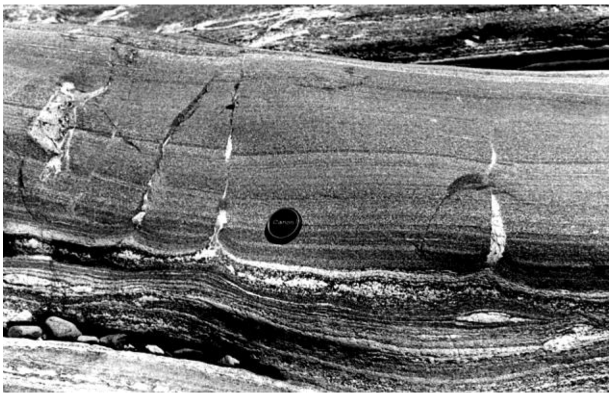

Figure 1. Example of foliation boudunage. The boudin necks are filled with generated in situ melt. The valley of Davidkovska Arda

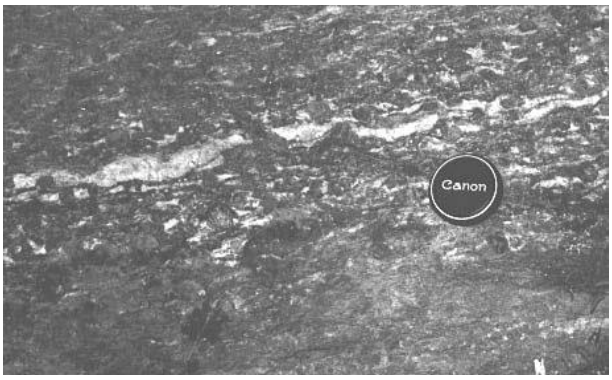

Figure 2. Localisation of leucosome in the sheltered domains around garnet porphyroblasts. East from the town of Chepelare.

MESOSCALE STRUCTURES INDICATING OVERLAPPING IN TIME OF THE PROCESSES OF MIGMATISATION AND DUCTILE DEFORMATION

The simplest types from this structure group are based on the type and orientation of penetrative planar and linear fabric in the leucosomes:

- Magmatic internal fabric in a cross-cutting leucosomes, parallel to the external foliation (Druguet & Hutton, 1998).
- Isoclinally folded magmatic foliation in the leucosomes with axes parallel to the regionally consistent trend of the folds in the host rocks.
- Other types of structures are based on relations between leucosomes and folds:
- Axial-surface leucosomes. This is a rather common association, often interpreted as result of melt emplacemet synchronous to the folding (Gosh, 1994). But as Vernon and Paterson (2001) showed, this type of structure must be used more carefully.
- The folds of the leucosomes are coaxial with those in the country rocks but more open. These examples could be regarded as a result of leucosome emplacement during the development of the folds.

Even the most complex structural patterns in migmatitic terains could give a lot of information about relations deformation-migmatisation. Mutual cross-cutting relationships between structures (shear zones, folds) and leucosomes indicate that deformation occurred in presence of a melt phase (Hollister & Crawford, 1986; Davidson et al., 1992; Davidson et al., 1994; Vanderhaeghe, 2001). The deciphering of such complex structures is only possible with integration of precise petrological and geochemical investigations (eg. Cherneva et al., 1995) as well as isotopic age determinations.

Figure 3. Leucosomes in the axial surfaces of mesoscale folds in a biotite gneiss. West from the town of Zlatograd.

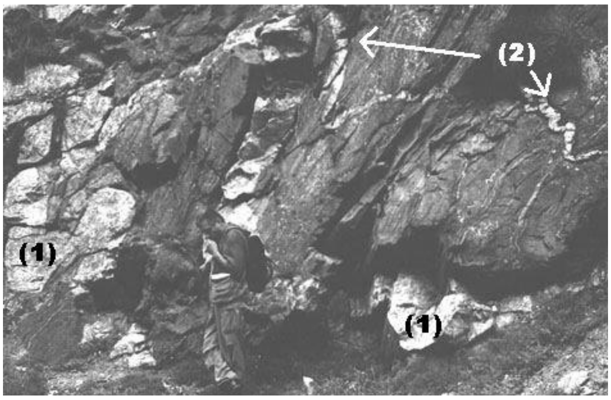

Figure 4. Weakly transgressive aplitic and pegmatitic veins emplaced synchronously to the folding. Later vein (2) is forming more open folds.

CONCLUSION

The structural analyses of the migmatites in a part of the Central Rhodopes indicate clearly the synkinematic nature of the migmatisation. Very often the structural patterns in the migmatites are rather complex and sometimes are interpreted as an indicator for polydeformational and polymetamorphic reworking of the crystalline basement (Zagorchev, 1976). But in fact they are a result of overlapped in time processes of ductile deformation and migration of melt. On the other hand, the existence of obviously postkinematic aplitic and pegmatitic veins (Костов, 1954; Dimov et al., 1996) is an indication that the magmatic activity, linked with migmatisation, outlasted ductile deformation.

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