



Automated image analysis of microstructures from the detachment mylonites of the Serifos Metamorphic Core Complex (Greece)

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The Attic-Cycladic belt is part of the Alpine orogene in the eastern Mediterranean. It is located SE of the Greek mainland and trends parallel to the Hellenic volcanic arc. Since the Miocene the whole area of the southern Aegean region is characterized by a NS orientated extensional regime which is the result of back-arc extension and/or collapse of the inner part of the thickened Alpine crust. After a period of crustal thickening achieved in a cold thermal environment attested by high-pressure, low-temperature metamorphic complexes, internal thrusts were reactivated by extensional structures such as large-scale detachments, below which high-temperature metamorphic core complexes (MCC) were exhumed (Jolivet & Faccenna 2000)

Some of the islands in the eastern Cyclades (Naxos, Paros, Ios) have been suggested to represent MCC indicating an asymmetric extension partly to the N and to the S (e.g. Lister et al. 1984).

The island of Serifos is situated about 100km SSE of Athens in the Aegean Sea (Salemink 1985) and belongs to the Attic-Cycladic massif. The geology of Serifos is largely characterized by a shallow hornblende-biotite granodiorite pluton that intruded into a, under blueschist conditions previously deformed, sequence mainly consisting of ortho- and paragneisses, calc-silicate marbles, amphibolites and schists. The pluton takes the form of a dome-shaped body occupying the central and southern parts of the island (Salemink 1985). Published geochronological data (Altherr et al 1982) of Hornblende from the granodiorite yield a K-Ar age of 9.5 ± 0.3 Ma while biotite shows Rb-Sr ages ranging from 7.92 ± 0.08 to 8.42 ± 0.08 Ma.

Whereas the northern contact of the pluton is intrusive, in the SE, towards structurally higher levels, this core becomes foliated with increasing intensity and, under greenschist facies conditions, transformed into S dipping low temperature mylonitic to ultramylonitic rocks with abundant SSW-directed kinematic indicators (scc' fabrics, sigma and delta clasts, flanking structures and mica fish). This zone forms the main greenschist facies to brittle/ductile detachment of the Serifos MCC. The lineation in these rocks has a remarkably consistent NNE-SSW direction whereas the foliation varies and follows the dome shaped structure caused by the exhumation and unloading of the MCC.

On peninsulas in the S and SE part of Serifos (E of Livadi) statically recrystallized mylonitic marbles and amphibolite grade metabasic and metapelitic rocks with typical Ca-Fe-Mg skarns, a rock association which is typical for the northern intrusive margin of the pluton, occur in a hanging wall position of the main detachment zone. These characteristic lithologies also occur as mega boudins (several tens of meters long) in the main detachment zone. We therefore conclude that the detachment displaced and shear the northern margin of the pluton in the order of several kilometres.

Quantitative kinematic indicators and micro structures with monoclinic symmetry have been investigated in order to characterize the flow within the main detachment zone. It is well known that in mylonitic zones, an increase in intensity of deformation is expressed by a decrease in grain size, accompanied by recrystallisation (Berthé et al. 1979) as it can be observed in the ultramylonitic granodiorites of the SE detachment zone. There the undeformed core gets, with increasing intensity, foliated towards the S and turns into a ultramylonite with quartz-, feldspar- and biotite-porphyroblasts in a very fine grained matrix.

Rigid objects in rocks undergoing penetrative ductile non-coaxial flow will tend to rotate with respect to the kinematic frame of the bulk flow, and disturb the developing foliation pattern in a small adjacent domain. Gosh & Ramberg (1976) have shown that, even in non-coaxial flows, rigid objects of specific axial ratio will follow asymptotic movement patterns and can become stationary at high strain (Passchier 1987). This work focuses on the investigation of the rotational behaviour of porphyroblasts in aspect to their shape. With the image analysis program Scion Image (www.scioncorp.com) thin sections of the ultramylonitic Hbl-Bt granodiorite of the southern detachment were analyzed and quartz, feldspar and biotite were separately plotted in aspect to their orientation (θ) and the normalized length-width ratio (B^*) of their ideal strain ellipsoid.

Governing equations of the movement of rigid objects in homogeneous flow are least complex for axially symmetric ellipsoidal objects. The axial ratio of such objects can

be expressed by a component B^* of the Bretherton shape (Bretherton 1962).

At low B^* values, objects rotate permanently and generate δ -type and complex tails. At high B^* values, to the right of the 'cut-off point', objects have their long axis at a stable sink position and generate σ -type tails only. η increases with decreasing B^* (Passchier 1987).

As Jeffery 1922 estimated, for simple shear, all rigid inclusions rotate in the same sense. But during combined pure and simple shear elongate rigid inclusions can stabilize with long axes parallel to the shear plane, and there is a range of orientations for which rigid inclusions rotate in an opposite sense as the sense of shear (Ghosh & Ramberg, 1976).

The presented data show that the deformation of the southern detachment zone of the Serifos metamorphic core complex was very close to simple shear though the p/t-conditions are emphasizing a low temperature/low pressure deformation. In contrast to usual theories this shear zone shows a transtensional character probably triggered from the last emplacement of the Hbl-Bt-granodiorite intrusion and decreasing extension in the far field. Quartz c-axis patterns taken from samples of this detachment support this thesis.

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