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A crustal-scale shear zone transecting the late-Hercynian crust in the Sila Massif (Calabria, Italy): implication for the syntectonic emplacement of granitoids

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An important shear zone, 4 km wide and 60 km long, transects the late-Hercynian continental crust exposed in the Sila Massif. The shear zone can be clearly seen where mid-crustal rocks are exposed, in the neighborhood of the migmatitic paragneisses/Paleozoic granitoids contact.

In the Sila massif, the late Hercynian continental crust is basically composed of three main parts, from bottom to top: (a) high-grade metamorphic rocks, mainly migmatitic paragneisses occupying the Hercynian middle-lower crust; (b) nearly tabular late-Hercynian granitoids and minor quartz-dioritic to gabbroic bodies, located at mid-crustal levels and (c) low grade metamorphic rocks affected by sharp contact metamorphic effects in the neighbourhood of the granitoids, belonging to the upper crust.

The emplacement depths of granitoids range from 8 to 18 km and their age, deduced by the 40Ar/39Ar method on hornblende and muscovite and by the U-Pb method on zircon and monazite, ranges from 304 to 290 Ma. The contact between granitoids and high-grade metamorphic rocks is transitional and characterized by a migmatitic border zone.

Geochemical features of the intermediate granitoids indicate that they are derived from a wide range of hybrid magmas in which the mantle component was dominant. This implies that a magmatic accrectionary process occurred at mid-crustal levels during the late-Hercynian evolution of the Calabrian crust, cropping out in the Sila Massif. Furthermore, the lack of clearly medium-grade metamorphic rocks suggests that the magmatic accretionary process was coeval with tectonic omission.

In order to promote the understanding of the granitoids emplacement, we carried out a structural and petrological study at the granitoids/migmatitic paragneiss boundary, i.e., within the lowermost part of the Hercynian mid-crust. Close to the boundary the granitoids are mainly represented by foliated granodiorites and tonalites. Two-mica granites and pegmatites occur also as late magmatic dykes or small bodies intruding migmatitic paragneisses, foliated granodiorites and foliated tonalites.

Migmatitic paragneisses, foliated granodiorites and tonalites show concordant lineation and foliation orientations. The foliation dips about 60˚ towards the NE and the stretching and magmatic lineations plunge 40-45˚ towards N70. The development of anisotropic magmatic structures is pointed out by the alignment of euhedral feldspars in granodiorites and by spectacular magmatic folds, outlined by coarse euhedral feldspars.

Operation of solid-state deformation in foliated granodiorites and tonalites is indicated by several microstructures developed under decreasing temperature conditions. Deformation at high temperatures (above ca. 700˚ C) is documented by chessboard patterns in quartz. Deformation under lower amphibolite to uppermost greenschist facies conditions is suggested by fine-grained feldspar recrystallization and polygonization.

These features strongly suggest that shear deformation was active during crystallization of granitoids and continued under subsolidus conditions.

Several types of kinematic indicators were observed in the wall rocks, foliated granodiorites and tonalites. All of them indicate a top-to-the-W sense of shear, similar to the shear sense of magmatic flow indicated by the tiling of euhedral feldspar megacrysts in granodiorites.

The shear deformation is bracketed between the magma emplacement (304 to 293 Ma) and the age of the undeformed pegmatites (265 Ma) crosscutting the main foliation.

In order to define the tectonic environment in which the magma emplacement occurred, the 40˚ crustal tilting deriving by the Tertiary evolution was restored and led to an almost horizontal shear. This result is geometrically consistent with a crustal delamination at mid-crustal levels, in the framework of the precursory events of the Thetyian rifting process.