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Fluids circulations during the formation of the Naxos Metamorphic Core Complex (Greece)

Olivier Vanderhaeghe (1,2), Marie-Christine Boiron (1), and Luc Siebenaller (2)

(1) Université de Toulouse; UPS GET, 14 avenue E. Belin, F-31400 Toulouse, France (olivier.vanderhaeghe@get.obs-mip.fr),
(2) GeoRessources, Université de Lorraine, CNRS , UMR 7359, BP 239 54506 Vandoeuvre-lès-Nancy, France

The island of Naxos, in the central part of the Cycladic Metamorphic Core Complex (Greece) represents a perfect example to address the evolution of fluid circulations during collapse of an orogenic belt. It displays a complex detachment system characterized by mylonites, cataclasites and high-angle normal faults which geometric relationships reflect rheological layering of the orogenic crust and its evolution during collapse.
The chemistry of fluid inclusions determined by microthermometry, RAMAN spectroscopy, LA-ICPMS, and crush-leach combined with C and H isotopic signatures point to three distinct types of fluids, namely (i) a H_2O-dominated fluid, (ii) a composite H_2O-CO_2 fluid, and (iii) a NaCl-rich fluid concentrated in metals. These different types of fluids are interpreted to reflect mixtures to various degrees among fluids generated by (i) condensation of clouds (meteoric aqueous fluid), (ii) dehydration and decarbonatation of metasedimentary rocks during metamorphism (metamorphic aqueous-carbonic fluid), and (iii) crystallization of granitic magmas (magmatic saline fluid with high metal contents).
The distribution of fluids with respect to microstructures evidences the close link between deformation and fluid circulations at the mineral scale from intracristalline deformation to fracturing. The orientation of fluid inclusion planes, veins and alteration zones allows to identify the scale and geometry of the reservoir into which fluids are circulating and their evolution during the formation of the Metamorphic Core Complex.
These data indicate that the orogenic crust is subdivided in two reservoirs separated by the ductile/fragile transition. Meteoric fluids circulate in the upper crust affected by brittle deformation whereas metamorphic and magmatic fluids circulate in relation to intracristalline ductile deformation affecting the lower crust. The geometry of these reservoirs evolves during the formation of the Naxos Metamorphic Core Complex as the orogenic crust is extended and cooled. In particular, the exhumation of metamorphic rocks and their transfer from the ductile to the fragile reservoir is marked by a transition from a lithostatic to an hydrostatic pressure associated with a drastic decrease of the geothermal gradient from 60-100°C/km to 35-60°C/km. This implies that fluid circulations during the formation of a Metamorphic Core Complex are intimately related to the rheologic layering of the orogenic crust and its evolution during collapse. Accordingly, the ductile/fragile transition, in addition to represent a fundamental rheologic boundary, also corresponds to a thermal and hydrologic crustal-scale transition zone.