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Relation between structural control and fluid characteristics, considering rocks migrating through the brittle/ductile transition during the development of a Metamorphic Core Complex (MCC), Naxos Island,Greece

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Recent work on MCC indicates that surface-derived fluids penetrate the continental crust down to the brittle/ductile transition represented by detachment zones. Can trapping conditions of fluids having circulated during the development of a MCC be correlated to the different deformation stages, affecting rocks during their migration through the brittle/ductile transition? To address this question, we performed a detailed study on quartz-calcite veins sampled as a function of their position with respect to the detachment.

The island of Naxos displays a structural section from a non-metamorphic upper unit affected by brittle deformation juxtaposed to ductilely deformed high-grade metamorphic rocks along a detachment zone characterized by pervasive cataclasis and retrogression. The circulation of fluids is attested by transposed and discordant crosscutting veins which abundance increases towards the detachment. Fluid inclusion analyses (microthermometric and RAMAN spectroscopy) reveals an increasing complexity going deeper in the structural section.

A particular halite-calcite-sulphur bearing fluid was only recorded at the deepest structural level and constitutes a group of primary inclusions which are randomly distributed within quartz grains. These fluids yield trapping temperatures of 420 to $>$500˚C and pressures of 1.0 to 2.0 kbar and are related to the latest ductile fabrics before rocks passed to the brittle deformation zone. This transition is reflected by the presence of well defined fluid inclusion planes (FIPs) crosscutting these quartz grains.

Within the quartz-calcite veins from the detachment zone mainly secondary inclusions found in well defined FIPs, have been studied. This group is mostly constituted of low salinity, low density H_2O-CO_2 fluids trapped under P-T conditions ranging from 210 to 340˚C and 0.4 to 1.5 kbar. Microtectonics and FIP studies show that FIPs have similar orientations to outcrop-scale faults in respect to their respective relative chronologies and thus these structures reflect fracturing at different scales.

A global trend of salinity decrease as a function of decreasing homogenisation temperatures is observed while rocks from below the detachment zone migrate through the brittle/ductile transition during exhumation. Thus combining microtectonics, FIP studies and determination of the corresponding fluid characteristics seems to be an accurate methodology to decipher relative chronologies, the respective sources of fluids and the correlation to the different deformation stages. The earliest fluids record the transition from ductile to brittle deformation and the latest ones record only brittle deformation and are mostly surface derived fluids.