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The mechanical evolution of the European continental crust through the Alpine orogenic cycle: insights from the Rotondo granite (Gotthard massif, Central Swiss Alps)

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The deformation sequence recorded in granitoid units of the External Crystalline Massifs (Aar-Gotthard, Mont Blanc) is commonly characterized by a brittle-ductile-brittle evolution. The same evolution is here described for the Rotondo granite (Gotthard Massif) and used to constrain the mechanics, rheology and timing of this brittle-ductile-brittle deformation sequence. Here we present meso- and microstructural, mechanical and petrochronological analyses of the deformation features of the Rotondo granite.

We distinguish four different deformation stages in the Rotondo granite based on structures, cross-cutting relationships, PT conditions and *in-situ* dating. The earliest structural features are brittle cataclasites and hydraulic breccias that appear to have formed under variable differential stresses and elevated fluid pressures. They host garnets that grew over the sheared texture and record peak metamorphic conditions of 600 ºC and 0.9 GPa. Ductile mylonitic shear zones overprint and exploit these early brittle structures at retrograde conditions (550 ºC and 0.7 GPa, ~18 Ma *in-situ* Rb-Sr in white mica), at differential stress <40 MPa and elevated fluid pressures during Alpine exhumation exemplified by the development of syn-kinematic, subhorizontal quartz veins. Strike-slip tectonics was dominant afterwards, as exemplified by the occurrence of brittle-ductile shear zones developed sequentially through decreasing fluid pressure and increasing differential stress conditions. The pre-existent mylonitic shear zones were initially partially reactivated during strike-slip shearing (400 ºC and 0.5 GPa, ~14 Ma *in-situ* Rb-Sr in white mica) and subsequently overprinted by conjugate brittle faults. The latest deformation stage involves zeolite- gouge-bearing faults that exploit pre-existent structural discontinuities, aided by low friction coefficients of the fault gouges. All three youngest deformation stages are interpreted to be Alpine in age and are observed to exploit/reactivate the earliest (presumably Variscan or prograde) breccias and cataclasites.

The structural sequence of the Rotondo granite exemplifies the effects of pre- and syn-orogenic structural inheritance and variable metamorphic fluid conditions on the mechanical evolution, rheology and strain distribution of crystalline (granitoid) basement units of the European continental crust through the Alpine orogenic cycle.