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Cockade breccia: a geological marker of ancient seismic faulting

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Few fault zone rocks are known to be associated undoubtedly to seismic faulting. Here we investigated the mechanism of formation of cockade breccias found in Miocene in age extensional faults from the Col de Teghime area (Alpine Corsica, France). Cockade breccia are relatively common fault rocks consisting of clast cores from the wall rocks bounded by concentric mineral rims from vein precipitation. Structural geology surveys and microstructural and mineralogical/geochemical investigations of the fault veins from the Col de Teghime area indicated that: (i) the core clasts of the cockades are composed of quartz fragments larger >300 μm in size which are suspended in the fault veins and disposed in inverse grading; (ii) the concentric rims are zoned and made of saddle dolomite, Mg-calcite, goethite and anatase; (iii) the cockade-bearing fault veins are associated with minor fault veins made of fine quartz fragments (< 300 μm in size) cemented by the same minerals of the rims.
We propose that cockade-bearing faults formed at shallow crustal depths (< 2 km) and recorded all the phases of the seismic cycle: (1) co-seismic fragmentation of the wall rocks in presence of CO_2- and Fe-rich fluids; (2) co-seismic fluidization of the rock fragments resulting in elutriation of the fine particles, which might be deposited in distal veins, and formation of a residual porous and well-sorted clast assemblage which will make the cores of the cockades. Inverse grading resulted by co-seismic shaking (Brazil-Nut Effect) and shearing; (3) post-seismic to interseismic cementation by deposition of carbonate-rich rims due to slow (years to centuries) mineral pressure growth, resulting in the progressing lift of the clasts in the slipping zones.
Given the scarcity in the current literature of fault zone rock assemblages associated to seismic faulting, the results of this study may allow us a better comprehension of earthquake-related processes at shallow crustal depths and find application in seismic hazard studies.