Geophysical Research Abstracts
Vol. 20, EGU2018-3547, 2018
EGU General Assembly 2018

The SE Extension of the Simplon Shear Zone, Central Alps: Narrowing Down the Options with Microstructural Mapping

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The Simplon Shear Zone (SSZ) is a major SW-dipping, normal-sense shear zone in the Central Alps, commonly cited as accommodating orogen-parallel extension in a releasing step between two dextral strike-slip faults (the Rhone Line in the NW, and various segments of the Periadriatic Fault system in the SE). While the connection between the NW end of the SSZ and the Rhone Line is relatively unambiguous, the SE extension remains contentious. This is due in part to the presence of the sediment-filled Ossola Valley at the SE end of the SSZ, from which two potential candidates for its continuation extend.

As a result, several models exist for how dextral transpression was accommodated after collision with the Adriatic Indentor: 1) motion was transferred from the SSZ onto the steeply dipping Isorno Shear Zone, which strikes NE into the Lepontine Dome; 2) motion was transferred onto the steeply dipping, WSW-ENE striking Centovalli Fault, and thereby onto the Tonale Fault (of the Periadriatic system); and 3) the SSZ has no SE extension – rather, displacement diminishes to the SE due to anticlockwise rotation of the hangingwall/indentor system, and the remaining dextral transpression was taken up by backfolding.

Based on a compilation of published structural data, thermochronology, and metamorphic- and petrological studies, we propose a fourth model, whereby distributed dextral transpression was initially transferred from the deep, high-T portions of the SSZ onto the amphibolite-grade Isorno Shear Zone, but later shifted onto the low-T, brittle Centovalli Fault. Thus, early motion (>26 Ma) was taken up by a broad zone of high-T dextral shearing (encompassing the Isorno, Tonale and Canavese Shear Zones) and diffuse SW-directed stretching (in the region of the SSZ), coeval with high-T backthrusting along the Tonale and Canavese Shear Zones. With cooling over time, deformation became increasingly localized and partitioned, and the Isorno Shear Zone became inactive. Dextral transpression under these later (∼25-19 Ma), intermediate-T conditions may have been accommodated by the formation of the greenschist-grade Masera Synform, and/or mylonitization along the future Centovalli Fault. However, any greenschist-grade mylonites along the Centovalli Fault were subsequently excised by late (∼5.5-2 Ma), brittle, normal motion. With further cooling, Masera backfolding became less important, and further dextral motion was taken up by the brittle Centovalli Fault (<14 Ma).

We test this hypothesis by mapping out microstructural zones across the SSZ, Isorno Shear Zone and Centovalli Fault, and associating each zone with macro-structures observable in the field, and deformation temperatures and -ages from the literature. Each zone is characterized by different quartz- and feldspar deformation mechanisms, and is representative of deformation at different temperatures. In largely quartzofeldspathic rocks, deformation microstructures can provide a higher-resolution indication of shearing temperature, within the amphibolite- to greenschist facies range, than mineral assemblages can. Taking into account the regional increase in metamorphic grade from NW to SE across the study area, we use the fine detail provided by microstructural mapping to investigate the viability of our model for the SE extension of the SSZ.