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Tectonically controlled fluid flow and water assisted melting in the middle crust: Tertiary migmatites in the Southern Steep Belt of the Central Alps

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This study investigates the Tertiary migmatite belt of the Central Alps (southern Switzerland/northern Italy). Alpine migmatites are almost entirely confined to the Southern Steep Belt (SSB), a regional-scale, transpressional shear-zone at the southern margin of the Central Alps. Two processes contributed to the origin of this migmatite belt: (1) water-triggered melting of granitoid rocks, commonly leading to 10-30 vol% total leucosome; (2) muscovite dehydration melting in pelitic rocks, yielding small leucosome-fractions. Overall, fluid-present melting is the dominant process, and dehydration melting is of minor importance. Pressure-temperature conditions of partial melting estimated for amphibole-bearing leucosomes are 0.6-0.8 GPa and 700 ś 50°C, indicating mid-crustal partial melting. Structural observations and estimated leucosome volumes show substantial variations in melt-fractions. In partially melted granitoids, these correlate with the amount of infiltrated aqueous fluid. In order to estimate the fluid required, we used experimental data on melt fractions and thermodynamic mineral equilibrium models. In the example of the SSB, 1-3 wt% (˜4-6 vol%) water entered this crustal section. However, such water-assisted melting poses a problem: either fluid was produced above the water-saturated solidus and used directly to produce melts; alternatively, if fluid was produced below the solidus, fluid pathways would have to be directed so as to infiltrate granitoids at PT-conditions suitable for melting. This requires lateral migration of fluids, down the gradient in fluid pressure (which need not be vertical). Thus the observed water-assisted melting requires consideration of the potential fluid production sites and fluid flow patterns in the middle crust. The most realistic fluid source are metasediments, which underwent prograde metamorphic dehydration at subsolidus conditions. In the Insubric Alps, partial melting

occurred in a transpressional shear zone related to indenter tectonics of the Southern Alps into the Central Alps. This involved a steep, northward dipping tectonic boundary separating a deforming, hotter hanging-wall from a more rigid, colder footwall. For such a setting, hydrological models have to be discussed, which consider fluid flow in response to pressure gradients, as well as temperature gradients and differences in permeability. Assuming metamorphic dehydration reactions in metapelites in the colder Southern Alps, fluids produced may flow "up-temperature" gradient and thus lead to water-assisted melting in the hot SSB. Indenter tectonics additionally favour such fluid flow patterns because the permeability in deforming rocks of the SSB is higher then in undeformed rocks of the Southern Alps.