Geophysical Research Abstracts
Vol. 19, EGU2017-5138-2, 2017
EGU General Assembly 2017

Estimating strength differences within the Monte Rosa nappe using a combination of field observations and 2D modelling

Joshua Vaughan Hammon (1), Cindy Luisier (2), Stefan Schmalholz (3), and Lukas Baumgartner (4)

(1) Institute of Earth Sciences, University of Lausanne, Lausanne, Switzerland (Joshua.vaughan-hammon@unil.ch), (2) Institute of Earth Sciences, University of Lausanne, Lausanne, Switzerland (Cindy.Luisier@unil.ch), (3) Institute of Earth Sciences, University of Lausanne, Lausanne, Switzerland (Stefan.Schmalholz@unil.ch), (4) Institute of Earth Sciences, University of Lausanne, Lausanne, Switzerland (Lukas.Baumgartner@unil.ch)

The Monte Rosa nappe is a major high-pressure (HP) tectonic unit within the Western Alps. However, the tectono-metamorphic evolution during subduction and subsequent exhumation still remains ambiguous. One reason for this ambiguity is that the published estimates of peak metamorphic pressure and temperature vary significantly between 1.2 - 2.7 GPa and 490 - 650 ˚C, respectively.
Several mechanisms have been proposed to explain the exhumation of this HP nappe: i) synconvergent return flow within a subduction channel, ii) lithospheric extension associated with slab rollback, and iii) buoyancy driven Stokes flow during subduction or associated with slab detachment. This study will consider exhumation of the Monte Rosa nappe by buoyancy driven processes.
Field observation of the Monte Rosa basement complex show remarkable differences in deformation intensity between: relatively undeformed granite with undistributed igneous textures, variably deformed HP 'whiteschist' lenses, and highly deformed metapelites. These differences in deformation intensity provide a unique setting to quantify strength differences within an exhuming tectonic body.
Assuming that the Monte Rosa peak and retrogressive pressure relates directly to lithostatic pressure, it is possible to estimate an exhumation velocity using age estimates for the respective pressures. This estimate provides an exhumation velocity of approximately 1 to 2 cm/yr. Using this velocity to solve Stokes' law for a rising sphere enables a first-order viscosity estimate for the lithology surrounding the Monte Rosa nappe, which is in the order of 10^{20} Pas. Implementing this viscosity within a simple 2D Stokes numerical model for buoyant rise of a circle, mimicking the granitic Monte Rosa unit, can produce viscosity estimates for the Monte Rosa unit by requiring that the unit does not deform significantly during its rise. Both linear and non-linear flow laws are applied together with reasonable model conditions. The viscosity estimates resulting from the 2D modelling are compared with viscosity estimates from laboratory-derived flow laws for granite, quartz and feldspar.
This study aims to evaluate strength (effective viscosity) variations within the Monte Rosa nappe by combining structural field observations with 2D numerical modelling and experimentally derived flow laws. Furthermore, we aim to quantify tectonic stress and potential deviations from lithostatic pressure that these strength variations may cause. The future aim of this research is to evaluate whether different observed metamorphic conditions within the Monte Rosa nappe could be linked to different deformation intensities and, hence stress variations within the nappe.