Geophysical Research Abstracts
Vol. 20, EGU2018-13671, 2018
EGU General Assembly 2018

Tectonic exhumation of isothermal planes: a crustal-scale reconstruction based on RSCM thermometry data from the Aar massif, central Alps

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We examine the relative timing of metamorphism and crustal thickening during continent collision in the European Alps by quantifying peak temperature on 28 samples situated along the strongly deformed and exhumed basement-cover contact of the Aar massif crustal dome, Switzerland. Temperature estimates based on Raman spectroscopy on carbonaceous material (RSCM) are presented on a new balanced cross-section, where we can link the exhumed pattern of peak temperature to the amount of Alpine deformation recorded at the basement-cover contact, acting as a continuous marker horizon. Peak temperatures reached during Early Miocene metamorphism increase non-linearly in orogen-perpendicular direction from <250°C to 500°C over 20 km distance and inferred isothermal planes correlate with the structural relief. Locally pronounced temperature steps coincide with major reverse faults, suggesting that most of the deformation occurred after the thermal peak, making the peak temperature envelope a tracer for post-metamorphic deformation and exhumation.

Using peak temperature as an indicator for paleo-depth we are able to reconstruct the geometry, the depth and the orientation of the under-thrusted European passive continental margin (top basement) at the time of peak temperature, i.e. near maximum burial and prior to inversion. Our data indicate top basement was 12° SSE dipping at peak temperature conditions. For the subsequent deformation we calculate relatively steep (>35°) displacement vectors, which is in accordance with field observations of intense thrusting and steep reverse faulting, bringing the basement-cover contact to its present day >30° NNW dipping position at the massif front. This study demonstrates that RSCM, when linked to a suitable marker horizon, can be a powerful tool for estimating vertical movements during continent collision.