TO Brownbag Seminar
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Mark Brandon

The Evolution of the Retro-Side of the Alpine Wedge, Switzerland, as Resolved by Structural Thermochronology

Abstract

We use thermochronology to measure Cenozoic tilting in the retro-side of the Alpine orogenic wedge in southern Switzerland and northern Italy. Argand (1916) was first to recognize that the structure of the southern part of the Alps was dominated by a large back fold, with a vergence to the south, which opposite that for the more frontal part of the Alps to the north. Modern concepts of wedge tectonics would ascribe this deformation to "back shearing" within the retroside of a doubly vergent wedge. Densely distributed cooling ages can be used to define isochrones, which are surfaces of equal cooling age. Stratigraphic markers within the frontal part of the Alps indicate that thermochronologic isochrones should have quite complex structure within the frontal part of mountain belts, where accretion and thrust imbrication dominate. The situation is simpler in the rear of the Alps, where the overall structure is more coherent and less dismembered by faults. When cooling ages are sparse, we tend to view each age as an estimate of the time and depth of exhumation. A denser vertical transect might be allow an interpretation using the correlation of age with elevation, but this approach requires that thermochronologic isochrones are horizontal. We consider here a more generalized used of thermochronology, as a kind of stratigraphic marker for structural geologic analysis.

Our analysis is based on 83 fission-track zircon (FTZ) ages in the Ticino part of the Alps, which range from 256 to 9 Ma. The FTZ system has a nominal closure temperature of ~240 C and, in the Alps, a closure depth of ~8 km, which is deep enough to ensure that the FTZ isochrones are initiated as planar horizontal surfaces, much like bedding. But unlike bedding, the FTZ isochrones in the retroside of the Alps were formed as an "upside down" stratigraphy, with zero ages at the closure isotherm and getting older with increasing height from that surface.

We introduce a set of empirical least-squares models for analysis of these data. This approach shows that the FTZ data are well represented by a series of gently dipping isochrones, with average dip of ~12 degrees to the south. The southward dip of the isochrones is consistent with top-south shearing in the retro-side of the Alp wedge. Our analysis also shows a well defined "break-in-slope" at 18 Ma within these tilted isochrones, recording an increase in the vertical velocity of rock through the closure isotherm. We have developed a generic kinematic model for formation of thermochronologic isochrones within the retroside of an orogenic wedge. This model indicates that the trailing limit of the Alpine wedge has remained fixed during its evolution. We extend that model to account for thermal and thermochronologic evolution of the FTZ cooling ages. That work shows that the "break-in-slope" recorded at 15 Ma was caused by the onset of fast erosion at ~30 Ma, which roughly coincides with the subaerial emergence of the Alps. The lag simply reflects the response of the closure isotherm to a change in erosion rate. The Alps highlight the ability of thermochronology to "paint" in a kind of stratigraphy onto rock

sequences that otherwise lack stratigraphic markers. We need to greatly increase the spatial density of our dating if we are going to take advantage of this opportunity.