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Coupled inverse and forward modelling to assess the range of acceptable thermal histories, a case study from SE Brazil

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We performed a new thermochronological study (fission track analysis and (U-Th)/He dating on apatite) in SE Brazil and integrate those data with inverse and forward modelling via QTQt software (Gallagher, 2012) to obtain thermal histories.
The inversion results were used to characterize the general thermal histories and the associated uncertainties. For most of the samples we had a first phase of cooling during Late Cretaceous or Early Tertiary with subsequent reheating followed by Neogene cooling.
The inverse modelling does not provide a unique solution and the associated uncertainties can be quite significant. Moreover the Tertiary parts of thermal histories were usually near the accepted resolution of the thermochronometric methods (∼50-40°C). Therefore we performed deterministic forward modelling within the range of uncertainties to assess which solution is the most consistent with the data and independent geological information. These results are always conditional on the assumed kinetics for fission track annealing and diffusion of He, so we do not test the validity of that aspect. However, we can look at the range of predictions for the different forward models tested.
This apporach implies that the reheating is required only for the samples around onshore Tertiary basins. For other samples we cannot conclude but geological information are against this hypothesis. However the Neogene cooling is required for all the samples.The combination of forward and inverse modelling allows us to better constrain the thermal histories for each sample in exploring the range of uncertainties and to reconcile a range of possible thermal histories with independent geological information. It also provides new information on the contrasting thermal evolution between different regions of the onshore SE Brazilian margin.

Gallagher, K. 2012, Transdimensional Inverse thermal history modeling for quantitative thermochronology, Journal of Geophysical Research, in press.