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3D inverse modeling of multiple system thermochronology data

K. Gallagher (1), J. Stephenson (1), R. Brown (2), C. Holmes (3) and P Ballester (1)
(1) Dept. of Earth Sciences and Engineering, Imperial College London (kerry@imperial.ac.uk)
(2) Dept. of Earth Sciences, University of Glasgow (3) Dept. of Statistics, University of Oxford

Thermochronological methods such as apatite fission track analysis and (U-Th)/He provide indirect constraints on long term landscape evolution. Generally, quantitative modelling of such data focusses on individual samples, and cooling histories inferred from these data are typically used to infer a site specific quantitative denudation chronology. Regional denudation chronologies can be constructed by spatial interpolation of the location specific results. These may be visualized through computer animations, showing the time evolution of denudation in a sequence of maps, or by a single denudation history, averaged over a given region. However, most modeling approaches do not explicitly model the two different radiometric systems together, although they do appear to share common thermal history information. Furthermore, these approaches do not allow for common thermal history information to be shared between different samples. Intuitively, we expect that combining different data from a given sample, and multiple data from multiple samples is preferable. As we then need to satisfy more data with a single model, this approach will yield less complex denudation chronologies and also the quantitative uncertainty is reduced. The problem then is how to combine the data from irregularly distributed samples, i.e. we do not know a priori which samples should be grouped together. In the real world, the presence of geological structures (e.g. faults) means that geographically close samples may have quite different denudation histories, while within a given region the thermal histories may be similar. We address the overall problem using Bayesian Partition Modelling. This allows us to model the data from multiple samples in spatially discrete groupings, without needing to specify these regions. We can specify the thermal history to be constant within a given region, or assume some simple spatial variation with a region We give an overiew of the approach and demonstrate its potential with examples

using primarily synthetic data.