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Detrital geochronology of unroofing magmatic complexes

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Tectonic reconstructions performed in recent years are increasingly based on petrographic (Dickinson & Suczek, 1979; Garzanti et al., 2007) and geochronological (Brandon et al., 1998; DeCelles et al., 2004) analyses of detrital systems. Detrital age patterns are traditionally interpreted as a result of cooling induced by exhumation (Jäger, 1967; Dodson, 1973). Such an approach can lead to infer extremely high erosion rates (Giger & Hurford 1989) that conflict with compelling geological evidence (Garzanti & Malusà, 2008). This indicates that interpretations solely based on exhumational cooling may not have general validity (Villa, 2006). Here we propose a new detrital geochronology model that takes into account the effects of both crystallization and exhumational cooling on geochronometers, from U-Pb on zircon to fission tracks on apatite. This model, specifically designed for unroofing magmatic complexes, predicts both stationary and moving mineral-age peaks. Because its base is the ordinary interaction between endogenic and exogenic processes, it is applicable to any geological setting. It was tested on the extremely well-studied Bregaglia-Bergell pluton in the Alps, and on the sedimentary succession derived from its erosion. The consistency between predicted and observed age patterns validates the model. Our results demonstrate that volcanoes were active on top of the growing Oligocene Alps, and resolve a long-standing paradox in quantitative erosion-sedimentation modelling, the scarcity of sediment during apparently fast erosion.

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