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Denudation history of the French Massif Central: new insights from thermochronology, basement-basin cross-sections and semi-automated planation surfaces mapping

Thomas François¹, Guillaume Baby², Paul Bessin³, Julien Baptiste⁴, Jocelyn Barbarand¹, François Guillocheau², Éric Lasseur⁴, Justine Briais⁴, and Cécile Robin²

¹GEOPS, UMR 8148 – CNRS, Université Paris-Sud, Université Paris-Saclay, 91405 Orsay, France (thomas.francois@u-psud.fr)

²Géosciences Rennes, UMR 6118 – CRNS, Université Rennes 1, 35042 Rennes, France

³Laboratoire de Planétologie et de Géodynamique (LPG), UMR 6112 – CNRS, Le Mans Université, 72085 Le Mans, France

⁴BRGM, 45100 Orléans, France

Documenting surface uplift of basement areas is challenging, usually due to large gaps in the sedimentary record. In order to address this issue for the French Massif Central, we here investigate its denudation history through an integrated study that involves planation surface mapping, Apatite Fission-Track (AFT) Analysis and basement to basin cross-sections.

First, Planation surfaces were identified using a semi-automated fuzzy classification of pixels based on relationships between DEM derivatives (slope, curvature, ruggedness and incision) and field-recognized training samples. Then, their different generations and age ranges were discriminated from hypsometry, fault partitioning and relationships with dated sedimentary and/or volcanic remnants, providing constraints on basement exhumation. Afterwards, integrating the previous planation surface analysis, geological cross-sections were produced from the Massif Central basement to the surrounding basins (Aquitaine Basin and Paris Basin). These sections provide local thicknesses estimates of the missing sedimentary cover over basement domains. These local thicknesses and exhumation phases were finally used as constraints to produce a thermal history modelling and a denudation map of different areas of the French Massif Central estimated from AFT inversion.

Our results show different burial and exhumation patterns with i) a main burial of its western parts (Limousin, Rouergue) during Jurassic times followed by an important regional denudation (1 to 2 km of missing cover and crystallized basement) during the early Cretaceous and ii) an Upper Cretaceous burial of its northeastern parts (Morvan, Forez) followed by an uppermost Cretaceous to Paleogene exhumation (<1 km of missing cover and crystallized basement). This further illustrates the different behavior of each units of the Massif Central during the Mesozoic to Cenozoic times. These results will ultimately be discussed and placed back into the western European deformation framework.

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