DENUDATION HISTORY OF THE FRENCH MASSIF CENTRAL:

New insights from thermochronology, basement-basin cross-sections and semi-automated planation surfaces mapping

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-1- Introduction

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.

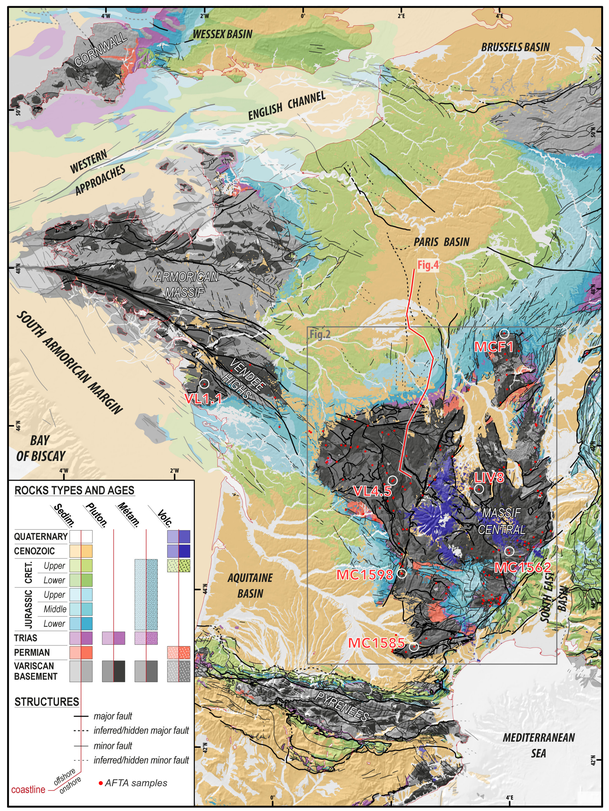

Figure 1: Synthetic geological map of the studied western European Variscan basements and Mesozoic to Cenozoic surrounding basins (data from 1:1.000.000 Geological Map of France (Chantraine et al., 2003) and 1:625.000 Geological Map of Great Britain (BGS, 2007); Projection: RGF Lambert 1993).

-2- Planation surfaces mapping

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 alteration remnants, providing constraints on basement exhumation

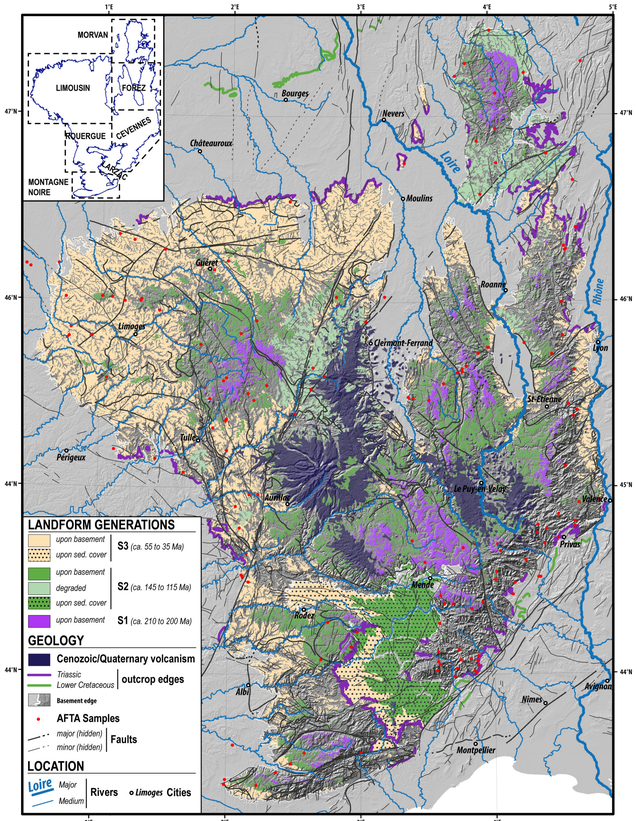

Figure 2: Synthetic map of the French Massif Central planation surfaces and their ages, compiled from a set of more detailed maps (projection: RGF Lambert 1993) and AFTA samples locations.

-3- AFT thermal modelling

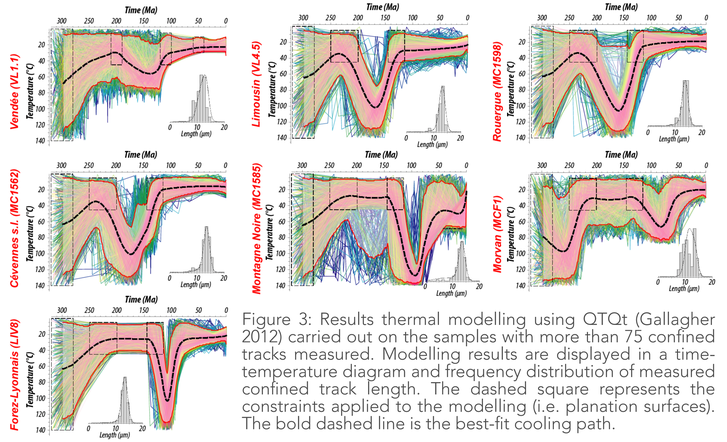

Figure 3: Results thermal modelling using QTQt (Gallagher 2012) carried out on the samples with more than 75 confined tracks measured. Modelling results are displayed in a time-temperature diagram and frequency distribution of measured confined track length. The dashed square represents the constraints applied to the modelling (i.e. planation surfaces). The bold dashed line is the best-fit cooling path.

The thermal modelling suggests a major thermal event during the Mesozoic period.

-4- Basement-basin cross-section

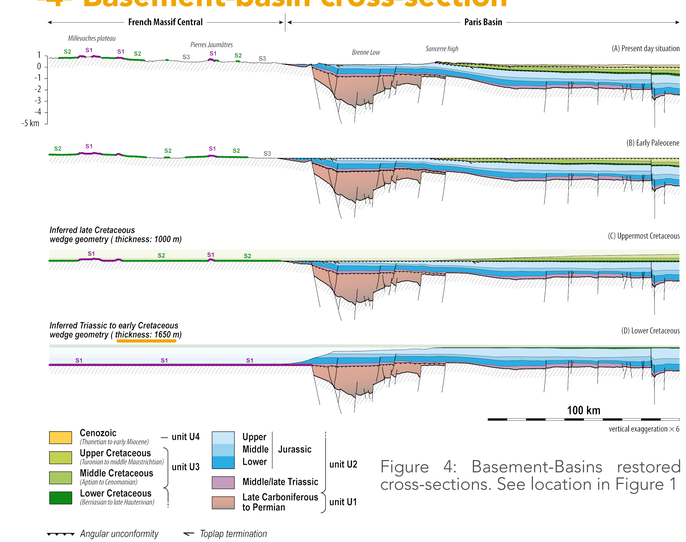

Figure 4: Basement-Basins restored cross-sections. See location in Figure 1

Coupling between AFTA thermal modelling and cross-section reconstruction, allows to estimate a geothermal gradient (i.e. between 30 to 45°C.km-¹) and calculate denudation rates.

-5- Denudation history

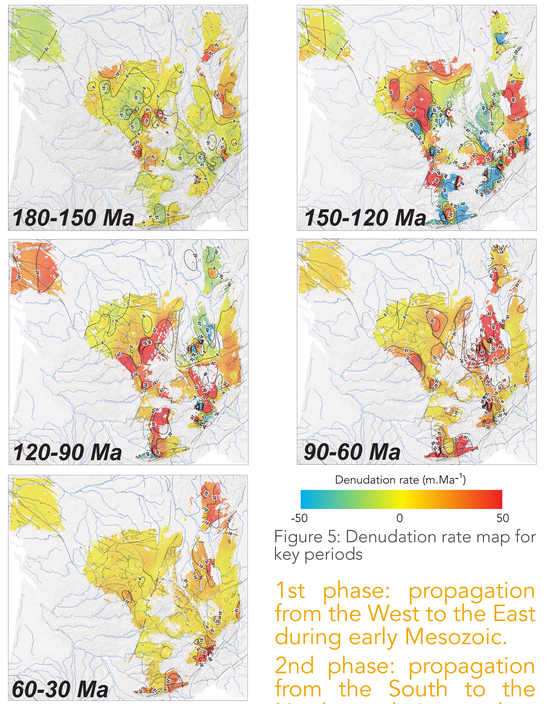

Figure 5: Denudation rate map for key periods

1st phase: propagation from the West to the East during early Mesozoic.

2nd phase: propagation from the South to the North during late Mesozoic to Cenozoic.

-6- Conclusion

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 French Massif Central during the Mesozoic to Cenozoic times.