The thermal signature of depth-dependent extension in the continental lithosphere

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Juvenile crust is formed when continents are broken apart. This is thought to be caused by uniform stretching and thinning of the lithosphere [1]. For the last thirty years depth-dependent thinning has been proposed as an addition to this model to explain the anomalously shallow environment of deposition along many continental margins [2] [3]. A critical prediction of this modification is that the lower crust and sub-continental lithospheric mantle undergo a phase of increased heat flow, potentially accompanied by heating, during thinning of the lithospheric mantle. Here, we present rutile thermochronologic data from two exposures of attenuated lower continental crust (*i*. Ivrea Zone, Southern Alps; *ii*. Mauléon granulites, Pyranees) that we interpret as recording thermal pulses in the lower crust and the continental mantle, coincident with the onset of continental breakup. The temperature sensitivities of Pb, Zr, Hf, Nb and Ta diffusion [4—6] in rutile afford the opportunity to recover continuous thermal history information from the lower-crust. Rutile from the Ivrea Zone exhibit U-Pb and HFSE diffusion profiles that are consistent with reheating of the Adriatic margin to temperatures of ~730 °C over 100,000 years at ~180 Ma. Such transient reheating was likely driven by refertilization of the lithospheric mantle by plagioclase peridotites. Rutile from the Mauléon granulites exhibit partial resetting of primary Variscan crystallization ages at ~130 Ma. Topologies of the U-Pb age profiles are consistent with reheating of the lower crust by 150—200 °C at the onset of continental necking. Combined with numerical experiments of extending continental lithosphere, these observations confirm that preferential removal of mantle lithosphere during continental thinning is an important component of the rifting process.

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