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Plume-induced micro-continent formation without cessation of subduction

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Micro-continents are large isolated fragments of continental crust surrounded by oceanic floor. The separation of micro-continental blocks from their parent continent is usually attributed to a ridge jump from the mid-oceanic ridge to the adjacent continental margin. There is an extensive list of studies that have revealed that the upwelling of hot mantle flow plays a key role in the mechanical weakening of the passive margin lithosphere, which is needed to initiate a ridge jump. This ridge jump then results in continental break-up and subsequent micro-continent isolation. In contrast with this purely extensional case, the separation of continental micro-blocks from the main body of the African plate occurred in a convergent tectonic setting, during the continuous northward motion and subduction of Africa below the Eurasian plate. Micro-continent separation in such a setting is still poorly understood. We present the results of 3D thermo-mechanical models where micro-continents form in a convergent setting with continuous contractional boundary conditions. These conditions are necessary to sustain continuous subduction and our models show that the thermal and buoyancy effects of the mantle plume emplaced at the bottom of the continental part of the subducting plate are sufficient to produce continental break-up and the subsequent opening of a new oceanic basin. This basin then separates the micro-continental block from the main body of the continent. Continuous convergence eventually leads to the accretion of the newly formed micro-continents to the margin of the overriding plate.
With these models, we demonstrate that it is physically possible to form micro-continents in a convergent setting without the cessation of subduction. The modelled scenario can be compared to the Paleozoic-Cenozoic development of northern Africa, which is characterised by the separation of several micro-continental blocks while subduction of the oceanic and continental lithosphere below the Eurasian margin was ongoing. In our models, subsequent continental accretion occurs by decoupling of the upper-crustal nappes from the newly formed subducting micro-continent. This is as well in agreement with the Late Cretaceous – Eocene evolution of the eastern Mediterranean, where micro-continents are accreted against the Eurasian margin.