The Stability and Instability of Continents

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Although ancient continents are commonly described as stable, many of them underwent major perturbations, not only on their margins, but also within their interiors. As they occurred far from oceans basins and they are not related to other tectonic events, such perturbations have been explained as consequences of mantle plumes, or, relying on plate tectonics analogies, as processes due to forces applied at continental boundaries. The difficulty in interpreting these events relies on a lack of competing explanations and limited knowledge on the dynamics of the continent-mantle system.

In order to better constrain conditions for continental stability, we conduct numerical simulations in which we consider a two layered system and use active tracers to track lithospheric evolution. Lithosphere density, intrinsically lower than mantle density, is allowed to vary as well as its thickness, temperature gradient and viscosity which depends on tracers concentration and temperature. Therefore we investigate a wide range of values for the governing parameters.

Our results are in good agreement with laboratory experiments which show that convective stability of lithosphere depends strongly on both the critical Rayleigh number, Ra_c, and the buoyancy number, B. We are particularly interested in (B, Ra) values close to the instability threshold to reveal the underlying dynamic processes.

In parallel, laboratory experiments are carried out to characterize the processes affecting continental lithosphere of finite horizontal extent. Experiments and numerical simulations allow us to study the geometry of lithospheric instabilities and compare the observed behaviour (e.g. uplift/subsidence, magmatism, heat flow variations) to geological and geophysical observations.