

METACRATON - *METAsomatism and CRATON destabilization*

(Proposer: Prof. Manuele Faccenda)

Cratonic lithospheric roots represent some of the oldest and most stable domains of Earth's mantle lithosphere. However, growing geological and geophysical evidence indicates that these keels can be chemically modified (metasomatized), thermally weakened, and ultimately destabilized or removed. Subduction-driven fluid and melt infiltration is thought to play a key role in altering the composition, density, and rheology of cratonic roots, potentially preconditioning them for later destabilization during continental rifting or plume impingement.

This project aims to investigate the coupled processes of metasomatism, weakening, and removal of cratonic lithosphere using high-resolution geodynamic numerical modelling. The models will simulate the interaction between subducting slabs and overlying cratonic mantle, tracking the transport of fluids and melts, their impact on mineralogy and density, and the resulting feedbacks on mantle flow and deformation.

A second objective is to assess how pre-metasomatized cratonic roots respond to subsequent tectono-thermal perturbations, such as continental rifting or mantle plume upwelling. The models will explore conditions under which cratonic lithosphere undergoes thinning, delamination, or thermo-chemical erosion (Fig. 1).

Model predictions will be compared with geophysical observations (e.g., seismic velocities, anisotropy) and geochemical/petrological signatures from mantle-derived rocks. The project will provide new insights into the long-term evolution of continental lithosphere and the mechanisms driving craton stability and destruction.

The ideal PhD candidate has a strong computational background, with demonstrated experience in numerical modelling and scientific programming. Familiarity with geodynamics, continuum mechanics, or thermodynamics, as well as experience with high-performance computing, will be highly valued. The candidate should be highly motivated, capable of independent problem-solving, and able to effectively collaborate within an interdisciplinary and international research environment.

Collaborations: Dr. Jun Ren (UNIPD), Prof. Jianfeng Yang, Prof. Lijun Liu (IGGCAS – Beijing, China).

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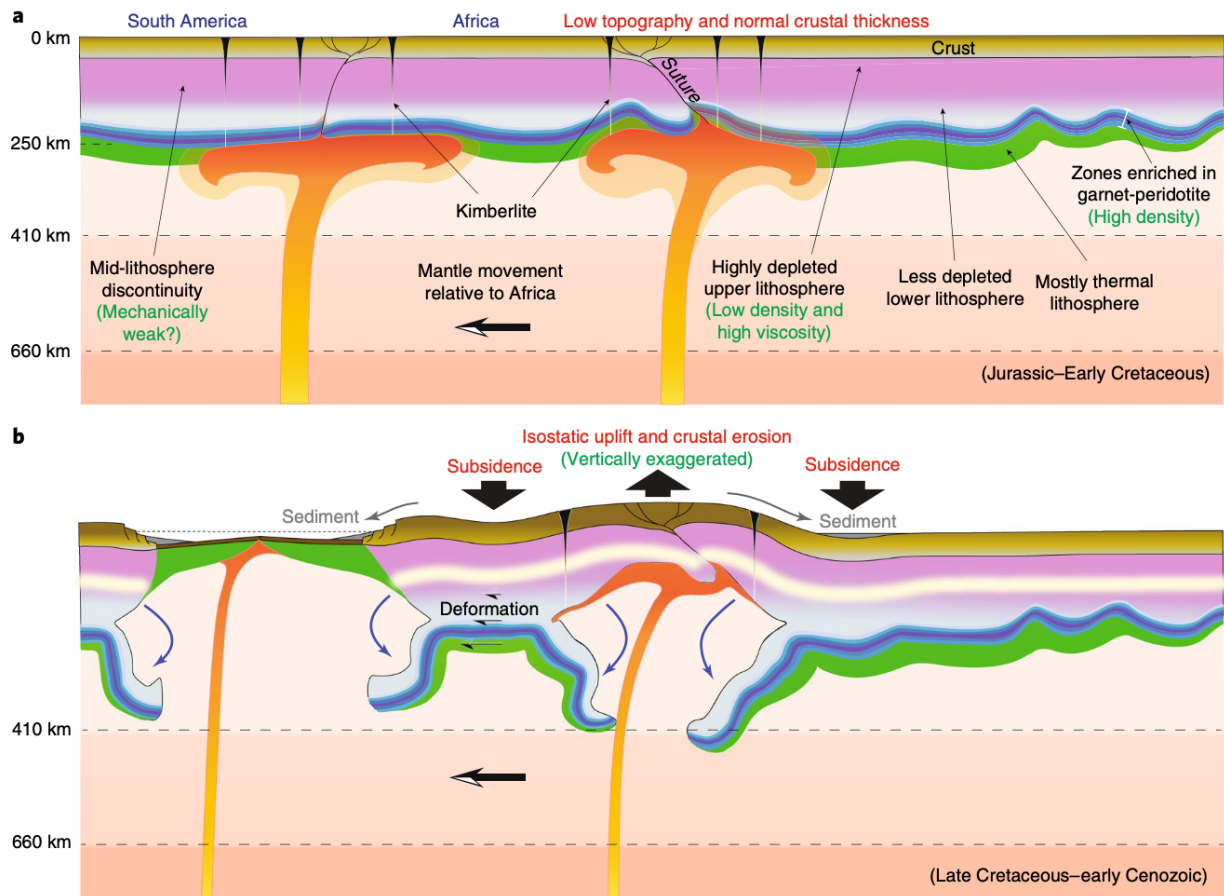


Figure 1 - Schematic illustration of proposed cratonic lithosphere evolution since the Cretaceous for the Africa and South America continents. a) Sustained plume activity weakens the intact cratonic lithosphere by warming and metasomatism, forming kimberlites. b) Removal of deep mantle lithosphere including the garnet-peridotite layer and some harzburgite lithosphere. Both the surface and the Moho uplift isostatically, with erosion causing crustal thinning. From Hu et al., 2018, *Nature Geoscience*.