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Dome and Keel dynamics in the hot Archaean lithosphere, a numerical approach

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The long-term interactions between greenstone belts and adjacent granitoids domes is key for understanding hot lithosphere rheology, crustal evolution and major ore deposits formation in Archaean terrains.
Some few tectonic processes have been proposed to explain both local and regional granite/greenstone finite deformation patterns observed in Archaean terrains such as the West Australian Pilbara or Yilgarn cratons, including crustal extension following gravitational collapse, metamorphic core complex formation, folding interferences, and gravity driven deformation associated with exhumation of granitoids relative to a supracrustal cover.

We propose to assess gravity driven deformation processes from simplified 2-D and 3-D thermo-mechanical numerical experiments using Underworld. A series of visco-plastic experiments under controlled boundary conditions have allowed us to identify three distinct stages in the hot lithosphere tectonic evolution: (1) an internal heating phase, (2) an inversion phase where dense mafic materials fall toward the lower crust while mid-crustal granitoids raise toward the surface, and (3) a freezing phase where the system stops. The relative duration of these phases is dependent on models initial geometries and inherited structures, materials thermal properties and rheologies, and the rheological contrast between granitoids and greenstones.

We compare our experimental results with field observations and geophysical data from the Yilgarn craton in order to validate the gravity driven tectonic model, and eventually constrain the range of thermal and mechanical parameters that best capture Archaean crustal dynamics.