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Numerical validation of the 'Pop-Down tectonics' as a structural frame for hot lithospheres with particular reference to the Hearne craton (Canadian Shield)

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The formation of the architecture of the main cratons of the Canadian Shield has been debated over the past three decades. Understanding the role of tangential Vs. vertical tectonics in the Rae craton is of great interest as the role of inherited structure is fundamental for the subsequent drainage of fluids and the formation of high to ultra-high grade unconformity-type uranium deposits. These deposits are located in the vicinity of the intersection between the unconformity at the base of the Paleoproterozoic Athabasca sedimentary basin (1.75-1.5 Ga) and the graphite-rich metasediments of the Wollaston-Mudjatik transition zone, one of the main fault system of the Rae Craton related to the Trans-Hudson orogeny (1.82-1.78 Ga). A new tectonic model, Pop-down tectonics, was proposed as the primary driving process to concentrate supracrustal materials, strains, fluid transfers and metal transport in permeability enhanced deformation zones. The sub-vertical structural patterns with regional horizontal shortening seen in the tectonic model appear to be consistent with field evidences and has the potential for sustaining strong fluid-rock interactions. In the light of previous analogue modelling studies, we test the viability of the Pop-down tectonics model in a thermo-mechanical framework.

The numerical experiments are based on a series of 2D visco-elasto-plastic thermo-mechanical models. We employ various thermal and rheological parameters derived from laboratory experiments. The geometry, thermicity and kinematics of the models are further constrained by applying existing geophysical and geological data. We impose a fixed upper mantle temperature of 1330 °C and a thin crust ranging from 30 – 40 km. The outcome of the models will provide insights into the mechanical processes controlling the deformation of hot lithospheres in convergent settings.