Paper Number: 658

Tectonics-mineralisation relationships in ancient cratons, a new structural frame

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Field and experimental works on deformation modes of hot continental lithospheres in compressive regimes show major differences compared to modern orogenic belts [1]. These works led to a new tectonic model marked by compression-induced downward motions of pop-downs of upper-crustals that pile up along vertical deformation zones. Downward motion of upper-crustals does not require any gravity-induced processes as has been proposed for sagduction of heavy greenstone belts in the Archaean. The first-order requirement is just a weak lithosphere with a ductile lithospheric mantle (fig. 1). In such a context, pop-downs of upper crust pile up along vertical deformation zones potentially connected with the underlying ductile mantle. These zones are marked by high strains, steeply dipping foliations and steeply plunging stretching lineations. They are particularly favourable for circulations of fluids of various origins from surface to mantle, and long-lived fluid trapping and fluid-rock interactions (Fig. 1).

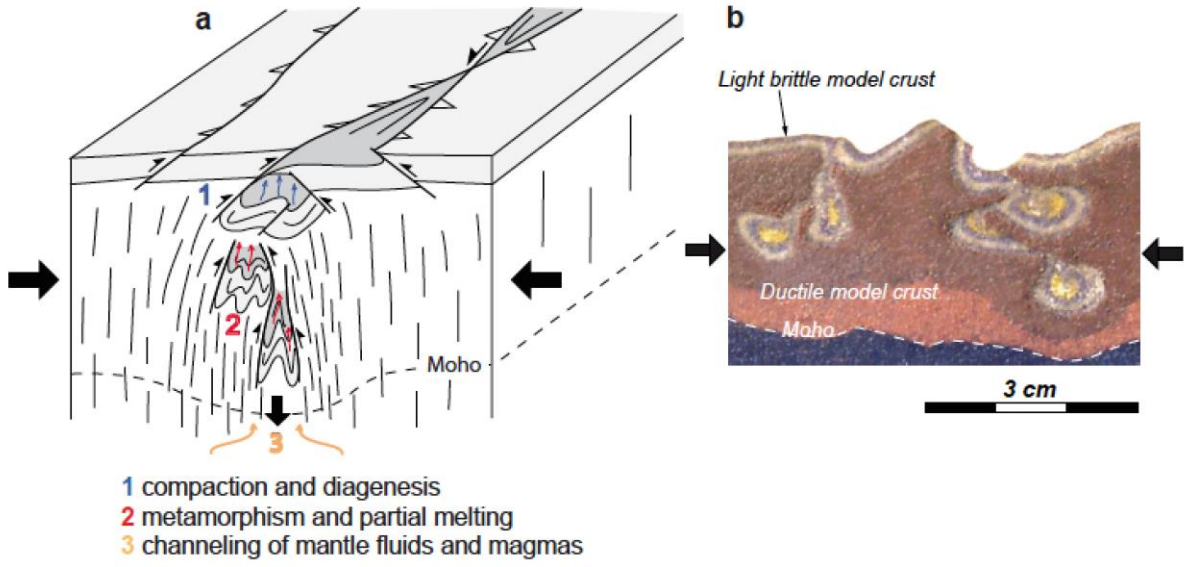

Figure.1. (a) Model of compression of a hot lithosphere where piling-up of upper crustal pop-downs may favour interactions between crustal deformation, fluid transfers, fluid trapping, and potential ore

deposits.(b) Analogue model of shortened weak continental lithosphere showing piling-up of upper-crustal pop-downs within underlying weak crust [1].

We present field examples arguing that pop-down tectonics may be a key for various ore concentrations (Sb, Au, Ni) in various crustal levels (from greenschist facies to partial melting) within hot Archaean and Paleoproterozoic belts (Canada and South Africa). Other examples, including uranium basement settings, are further discussed.
Our Model may constitute a robust structural frame for ore exploration in other cratons like western Africa.

References:

[1] Gapais D et al. (2014) Tectonophysics 618: 102–106.