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Emergence of plate tectonic during the Archean: insights from 3D numerical modelling.

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In the plate tectonic convection regime, the external lid is subdivided into discrete plates that move independently. Although it is known that the system of plates is mainly dominated by slab-pull forces, it is not yet clear how, when and why plate tectonics became the dominant geodynamic process in our planet. It could have started during the Meso-Archean (3.0-2.9 Ga). However, it is difficult to conceive a subduction driven system at the high mantle potential temperatures (**Tp**) that are thought to have existed around that time, because **Tp** controls the thickness and the strength of the compositional lithosphere making subduction unlikely. In recent years, however, a credible solution to the problem of subduction initiation during the Archean has been advanced, invoking a plume-induced subduction mechanism[1] that seems able to generate plate-tectonic like behaviour to first order. However, it has not yet been demonstrated how these tectonic processes interact with each other, and whether they are able to eventually propagate to larger scale subduction zones.

The Archean Eon was characterized by a high **Tp**[2]**,** which generates weaker plates, and a thick and chemically buoyant lithosphere. In these conditions, slab pull forces are inefficient, and most likely unable to be transmitted within the plate. Therefore, plume-related proto-plate tectonic cells may not have been able to interact with each other or showed a different interaction as a function of mantle potential temperature and composition of the lithosphere. Moreover, due to secular change of **Tp,** the dynamics may change with time. In order to understand the complex interaction between these tectonic seeds it is necessary to undertake large scale 3D numerical simulations, incorporating the most relevant phase transitions and able to handle complex constitutive rheological model.

Here, we investigate the effects of the composition and **Tp** independently to understand the potential implications of the interaction of plume-induced subduction initiation. We employ a finite difference visco-elasto-plastic thermal petrological code using a large-scale domain (10000 x 10000 x 1000 km along x, y and z directions) and incorporating the most relevant petrological phase transitions. We prescribed two oceanic plateaus bounded by subduction zones and we let the negative buoyancy and plume-push forces evolve spontaneously. The paramount question that we aim to answer is whether these configurations allow the generation of stable plate boundaries.

The models will also investigate whether the presence of continental terrain helps to generate plate-like features and whether the processes are strong enough to generate new continental terrains or assemble them

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