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Onset of Plate Tectonics in a Compositionally Stratifed Mantle

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The thermal history of the Earth, it's chemical differentiation and also the reaction of the interior with the atmosphere is largely determined by convective processes within the Earth's mantle. We employ numerical models , resembling a scenario shortly after core formation in the Earth. This scenario consists of a compositional stably stratified mantle, resulting from differentiation processes in the earlier magma ocean. The evolution of this system is monitored, as it is heated from the core , by additional internal heat sources and cooled from above. As a generic feature, distinct layers evolve by double diffusive convection, without the existence of ad hoc formulated jumps in material properties. The tendency towards layer formation is strongly enhanced under mantle realistic rheologies, in particular with strongly temperature dependent viscosity. The mechanism works, in 2 and 3 dimensional cartesian geometries, as well as in full spherical geometries. We further employ a Bingham-type of rheology in order to investigate the onset of plate-tectonics. Under mantle relevant parameters, we find a mobilization events of the surface into plate-like motion after about 2.5 Gyears. However, we also find clear evidence that onset of plate tectonics crucially depends on uncertain initial conditions.