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What does it change to hydrate the lithosphere? Implications for plate tectonics onset.

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Plate tectonics is the surface expression of mantle convection. Over the last decades, major progresses have been made in our understanding of the links between Earth tectonics and underlying mantle dynamics. However, a remaining major question concerns plate tectonics initiation. A plausible origin of plate tectonics is the initiation of subduction on weak zones where hydrated rocks formed by interactions with the Early Earth hydrosphere.
To test this hypothesis, we perform a parametric study of numerical solutions for mantle convection with a top layer mimicking a hydrated crust. In our calculations, global structure of mantle flow and surface tectonics emerges spontaneously, i.e. in a self-organized manner. We use a 2D convection code (StagYY, Hernlund & Tackley, 2008) with pseudo-plastic rheology for the mantle and the crust. As a first step, we explore the phase space by testing the effect of the crust thickness and its buoyancy. Numerical solutions with a thick (200 km) and very buoyant crust (i.e. more than 50% of the crust is hydrated) show a stagnant lid regime with convection occurring below the thermal boundary layers. Deformation occurs in the hydrated crust too. In contrary, numerical solutions with a thick crust and slightly buoyant crust (i.e. less than 5% of the crust is hydrated) are in a mobile regime with convection of the whole system. For thinner crust ($10 \leq$ crust thickness≤ 100 km), most solutions show mobile regimes, some with one-sided subduction-like geometry.
We will put these results in perspective with the natural processes of hydration of the surface of planets, and discuss how it can help or prevent the initiation of plate tectonics.

Hernlund J.W. & Tackley P.J., 2008. Modeling mantle convection in the spherical annulus. Physics of the Earth and Planetary Interiors, 171, 48-54.