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# Phase Transitions and Thickness of the Oceanic Lithosphere

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The time evolution of the thickness of young oceanic lithosphere is well described by the half-space cooling model up to 50 My. For oceanic lithosphere older than this, the observed thickness can only be reproduced by an adapted model, the plate cooling model, where a rigid lithosphere is prescribed in order to produce the observed thickness. We developed a dynamical numerical convection model where an oceanic plate forms simply due to the strong temperature-dependence of viscosity on the cold top boundary. The velocity boundary conditions at one lateral side of the box model induce motion of this coherent top boundary layer away from an imposed "spreading center" (hot anomaly) at the other side, located on the top boundary. We are interested to find out whether phase transitions in the lithosphere play a role in stabilizing the thickness of old oceanic lithosphere. We investigate the inherent layering of the lithosphere that is caused by mantle phase transitions and the depth level at which the lithosphere-asthenosphere boundary is established. The garnet-spinel phase transition is located at ca. 90 km depth at 1330 ˚C in fertile mantle and is associated with one percent change in density. This density contrast is large enough to trigger gravitational instabilities and aid delamination of the garnet-peridotite part of the lithosphere. At the same time, the lower density of spinel-peridotite acts as a barrier to ascending small scale convection. Inherited compositional layering re-enforces this barrier. In addition to the density contrast the garnet- spinel boundary might also influence the rheology due to changes in the modal proportion of olivine relative to pyroxenes and changes of the homologous temperature. The amount of pyroxene is reduced in the spinel-peridotite to garnet-peridotite reaction. Pyroxenes can host about 10 times more water than olivine, and redistribution of water between the minerals due to the

phase transition will increase the water content in olivine and thereby cause a reduction in viscosity of garnet-peridotite relative to spinel-peridotite. The development of gravitational instabilities depends on contrasts in densities and viscosities, which can possibly be both provided by the layering caused by the phase transition. We furthermore investigate the scaling of stagnant lid mode of convection taking into account the effects of phase transitions near the cold boundary.