# Convective stresses and lithospheric faulting on Venus and exoplanets

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Although Venus and Earth have very similar mass and radius, one major difference is the presence of plate tectonics on Earth whereas convection in Venus occurs in the so-called conductive lid regime. The present study describes 3D simulations of convective heat transfer in a spherical shell. These simulations use a strongly temperature dependent viscosity and mixed heating conditions with prescribed temperatures at the top and bottom boundaries and internal heating to simulate the decay of radiogenic elements. First, these simulations allow us to compare the values of convective stresses below the stagnant lid with those determined by scaling laws. The lithosphere can be faulted if the normal fault becomes larger than the yield strength. The normal fault is calculated assuming balance with the horizontal shear stress applied at the base of the stagnant lid. The distance between upwellings and downwellings is another parameter that must be parameterized. Previous studies have used the horizontal velocities to assess the distance at which the thickness of the thermal boundary layer becomes unstable and to use that distance as the convective cell width. A second result of the present study is to compare the spacing between plumes with that necessary for the thermal boundary layer to reach its maximum thickness. This study shows that the ratio of normal stress to yield strength weakly depends on the size of an Earth-like planet. Other parameters such as presence of water, heating per unit mass, upper mantle thickness, etc., may actually determine the occurrence or not of plate tectonics.

This study also investigates the parameters that are important for the transition from a plate tectonic regime to a stagnant lid regime. The scaling laws for the plate tectonic regime are different and seem to depend more strongly on the size of the planet. It suggests that once plate tectonics started, the larger the planet, the more likely it will remain on long periods of time.

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