

The influence of crustal buoyancy on plate tectonics

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Numerical experiments are carried out to see how the compositional buoyancy of oceanic crusts and the underlying harzburgite layers formed by ridge volcanism influences the plate motion on the earth. The compositional buoyancy has been suggested to make oceanic plates buoyant and to inhibit subduction when the oceanic plates are too young. It has also been suggested that the compositional buoyancy even choked plate tectonics itself in the Archean when the mantle was hotter owing to the stronger internal heating, since the hotter mantle probably induced more vigorous ridge magmatism and the resulting thicker oceanic crusts. The numerical experiments confirm that the compositional buoyancy significantly impedes the plate motion when (a) the internal heat source is as strong as expected for the Archean mantle, and (b) the basalt vs. eclogite transition occurs at great depth (70 km); the veneer of oceanic crusts and the harzburgite layer generated at ridge is as thick as 150 km, comparable to the tectosphere, in this case. The compositional buoyancy, however, does not completely suppress plate motion, even when the veneer is so thick and the plates are less dense than the underlying asthenosphere. Slab pull and the chemical differentiation at ridges make the subduction of such buoyant plates possible.