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TITLE: Deep Water Cycle: its Role in Earth's Thermal Evolution and Plate Tectonics

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ABSTRACT BODY: Earth is unique among the terrestrial planets in our solar system because it has plate tectonics and abundant surface water. It has long been suggested that these two salient features are intimately related. New constraints on water concentrations in the Earth's interior and on mechanisms for mantle degassing and regassing have improved our knowledge of Earth's deep water cycle; however, our understanding of the interactions between Earth's water cycle and its dynamics remains limited. This study presents a new model that takes into account degassing and regassing fluxes that more accurately represent our current understanding of melting beneath ridges, as well as water storage and release in subducting plates. Our improved parameterized convection model incorporates feedbacks between volatile concentrations, rheology, temperature, melting, and mantle flow. The model features mass exchange among key volatile reservoirs (oceanic lithosphere, asthenosphere, transition zone, and lower mantle), and accounts for recent estimates of volatile storage capacities in the different reservoirs that have been neglected in earlier models. The model is based on a new analytic parameterization for thermal convection with a finite-strength plate and depth-dependent viscosity, which captures the lithosphere-asthenosphere mechanical coupling by using both a local lithospheric energy balance as well as a global energy balance. This model is able to reproduce the main characteristics of full 3D numerical convection simulations. We investigate the effects of volatile transfers between the Earth's main reservoirs on plate tectonics and its thermal evolution, and suggest possible thermal and geochemical evolution paths for the Earth through time. Several plausible combinations of physical and geochemical parameters are tested against observable parameters such as heat flow, plate velocities, surface water mass, and inferred water reservoir concentrations.

INDEX TERMS: [8155] TECTONOPHYSICS / Plate motions: general, [8162] TECTONOPHYSICS / Rheology: mantle, [8120] TECTONOPHYSICS / Dynamics of lithosphere and mantle: general, [8125]

TECTONOPHYSICS / Evolution of the Earth.
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Additional Details

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