A new holistic view on the evolution of oceanic lithosphere and its implications for subduction-zone dynamics

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The generation of oceanic plates at mid-ocean ridges and their lateral migration are the directly observable part of global-scale mantle circulation. As a newly formed seafloor moves away from a mid-ocean ridge, it gradually cools down, becomes denser, and thus subsides. The first-order feature of seafloor topography, shallow mid-ocean ridges and deepening ocean basins, can be explained by the simple conductive cooling of the suboceanic mantle. The evolution of the oceanic upper mantle, however, has some nontrivial complications, and it is important to understand how a ‘normal’ oceanic lithosphere would evolve, in order to investigate various processes associated with the subduction of oceanic lithosphere. In particular, it has been shown that even the seemingly simple subsidence of young oceanic lithosphere is difficult to explain without invoking processes such as thermal cracking, radiogenic heating, and secular cooling, all of which have long been absent in the thermal evolution models of oceanic lithosphere, and also that these processes could also explain the so-called seafloor flattening observed at old seafloor. In this contribution, I will review some outstanding issues on the evolution of oceanic lithosphere and how they affect our understanding of subduction-zone dynamics.

