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Incipient subduction interface formation by coupling solid deformation and fluid flow

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Although most of the presently active intra-oceanic subduction zones are relatively young and initiated during the Cenozoic, subduction initiation process associated with an incipient subduction interface formation remains poorly understood. We investigated incipient spontaneously initiating intra-oceanic subduction by exploring new numerical hydro-thermo-mechanical (HTM) model, in which solid rock deformation and fluid percolation are fully coupled. Based on 2-D numerical experiments, we demonstrate that subduction can naturally start
in the presence of porous fluid inside oceanic crust and pre-existing fracture zones. During subduction initiation, fluid percolation is localized along a system of multiple listric propagating thrusts with coalescing nearly horizontal roots forming near the oceanic Moho of the forming subducting slab. These coalescing roots form incipient strongly hydrated subduction interface, which decouples upper and lower plates. High pressure of aqueous fluid flow, which spontaneously focuses along this interface, compensates lithostatic pressure, thus dramatically decreasing friction between the plates. Through the parametric study, we conclude that the most important parameter for the incipient subduction interface formation is the solid matrix permeability. Paradoxical at first, lowering the permeability indeed favors subduction initiation by maintaining high fluid pressure and thus decreasing friction along the active system of coalescent listric thrusts.
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