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Numerical modeling of the subduction initiation after accretion of oceanic island.

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Accretion of the large terrains leads to the temporal blockage of subduction and accumulation of the oceanic slab material. New subduction front started in the thickened contact zone. This process is modeled numerically in 2D. We apply constant velocity condition at the inlet vertical boundary. Another vertical boundary is treated as a free slide one, Winkler boundary condition is applied to the lower boundary. Sticky air used to represent stress free upper boundary. Scenario of the new front initiation depends on the assumed rheology of oceanic slab and docked island. At the application of the purely viscous rheology of all components of the system: island viscosity 10^{23} Pas, upper mantle viscosity $3{\cdot}10^{19}$ Pas and slab viscosity in the range $6{\cdot}10^{20}$–$6{\cdot}10^{22}$ Pas, we find a variety of dynamic styles. At low slab viscosity in the time scale of several millions years plate is thickened and experienced RTI instability. New subduction front is started after plate break up near the island edge. At the more realistic $\eta=6{\cdot}10^{22}$ Pas oceanic slab is folded before plunging into the mantle. In the intermediate range thickening of the oceanic slab takes place with low angle subduction followed by accelerated submergence of the widen slab tip. Too large time of the transient process and too large scale of oceanic slab accumulation contradict to the observations. Visco-plastic rheology of the crustal rocks brings model closer to the real world. At the early stage of deformation conjugate “viscous faults” form in the oceanic slab in respond to the shortening. Later on sliding along these faults doubles oceanic plate thickness at the contact with docked island. Permanent fault (with dip away from island) was created to accommodate bending of oceanic plate. Thickened plate tip starts to descend with low angle of ca 35^o. The most important observation is breakage of island edge that is carried downward with subducted oceanic plate. We compare our results with data on the current stage of the subduction in Kamchatka. This region is known for the unsteady geodynamic state (Levin et al., 2002) connected with recent accretion (5-10 Myrs BP) of the Kronotsy-Komandorsky island arc. Three peninsulas (Shipunsky, Kronotsky and Kamchatsky mys) correspond to this Cretaceous-Eocene paleo island-arc. Kamchtka subduction zone is characterized as erosive one with gradual wearing down of the overriding plate edge (Clift and Vannucchi, 2004). However, only breaking of the island edge at the initiation of subduction may produce fragment of crustal material large enough to ascend as a diapir in the mantle wedge. Such floating island edge may represent unknown seismically contrasted object found at the depth 100 km under Kluchevskoy volcano (Nikulin et al., 2011).

Literature.

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