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Geodynamic trends of double subduction.

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Double subduction is a geodynamic process in which two plates following each other are synchronously subducted. Double subduction are known for both modern (Izu-Bonin-Marianas and Ryukyu arcs) and ancient (West Himalaya collision zone) plate tectonics. However, our knowledge about this process is limited to conceptual schemes and some restricted analogue experiments. In order to fill this gap we performed 2D numerical experiments using a coupled petrological-thermomechanical approach based on finite differences and marker-in-cell techniques combined with new thermodynamic database for the mantle. We investigated the influence of convergence rate, intermediate plate length, activation volume of the mantle dislocation creep and age of the lithosphere. Based on these experiments we found the following geodynamic trends in double subduction: (A) Subduction rates at two zones running in parallel differ and vary in time even when the total convergence rate remains constant. Supremacy of either subduction zone depends on physical parameters such as (i) relative rates of the plates, (ii) slab ages and (iii) length of the middle plate. (B) Subduction dynamics of the double subduction system involves several processes unknown in simple subduction systems, such as (i) eduction, (ii) subduction re-initiation, (iii) subduction flip triggered by shallow slab breakoff and (iv) turn-over of detached slabs to up-side-down attitudes. (C) Simulated tomographic structures related to slab propagation account for both penetration and non-penetration of the 660 km discontinuity. Non-penetration is favored by (i) low convergence rate, (ii) faster relative movement of the overriding plate, (iii) young ages of the subducted slab and (iv) turn-over of the detached slab.