Strain localization for subduction initiation.

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It is still unclear what controls the location and nucleation of subduction zones, in particular, how subduction initiates in oceanic domain or at passive margins. It is widely accepted that it critically depends on the rheology of the oceanic lithosphere and can occur upon failure of the load-bearing crustal and mantle layers. Inference from the field such as ophiolites highly suggest that subduction initiates in oceanic domain. However, when the oceanic lithosphere is too strong, shear strength is too high to permit failure. The balance between lithosphere strength and the required negative buoyancy, corresponding to ca. 30 Ma age oceanic lithosphere for subduction initiation is difficult to obtain. Therefore, subduction initiation is more realistic at passive margin where high density and rheology contrast is observed. This modelling study aims at exploring favourable rheological and kinematic conditions for subduction initiation either in oceanic domain or at passive margin. A selection of experiments, involving both oceanic a continental lithospheres in compression, is used to investigate the role of lithospheric age of oceanic lithosphere, thermal weakening processes, and crustal scale weak zones for scenarios where convergence is orthogonal to the passive margin. Model results show that crustal deformation occurs at passive margin but strain localization during under-thrusting depends mainly on the strength difference between the lower crust of the oceanic and continental lithosphere. It can happen either in oceanic domain at ocean-continent transition. This boundary of rheologic conditions may change in response to weakening processes such as plumes or weak zones. However, realistic weakening processes don’t facilitate subduction initiation in cold and strong lithosphere such as the Atlantic ocean. Then, depending of the thickness of the oceanic lithosphere, weak-zone in the oceanic crust have a strong effect on subduction location. This shows the importance of thermo-mechanical feed-backs and geological inheritance for subduction initiation.