Effects of topographic and frictional heterogeneity of the incoming plate on deformation processes of an accretionary wedge: Insights from sandbox experiments and image analysis

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Subduction of topographic highs on the seafloor, such as seamounts or ridges, have been thought to cause large-scale deformation of accretionary wedges. These formation processes are generally associated with seismic ruptures along the seismogenic zone, and recent seismic surveys and geodetic data suggest that locations of subducting seamounts coincide with the areas where high creeping ratios and earthquakes smaller than Mw = 6.5 are observed.
The sandbox experiment, an analog experiment using dry sand, has great advantages in reproducing and observing such long-timescale tectonic processes. The experiments in Okuma et al. (*under review*) imply the frictional conditions directly above the subducting seamount contribute significantly to the deformation processes of an accretionary wedge rather than the topography and emphasize the importance of the friction on the seamount surface. Their experiments, however, has the following problems: 1) only the effect of friction was evaluated, and 2) the entire deformation process of the wedge related to the seamount could not be observed due to the short subduction distance of the seamount.
In this study, in order to solve the above two problems, we investigated the effect of frictional heterogeneity on the deformation process of the accretionary wedge by subducting a high-frictional patch with the same bottom shape as the seamount model. Furthermore, we also updated our sandbox experimental apparatus to achieve long displacement, which allows us to observe the mostly entire deformation process from the initiation of seamount subduction to the restitution of deformed wedge. In addition to the three conditions previously studied (Exp A: no seamount “without topography + low-frictional”, Exp B: low-frictional seamount “with topography + low-frictional”, and Exp C: the high-frictional seamount “with topography + high-frictional”), a new subduction study was conducted for Exp D: high-frictional patch (no topographical factor).
The results show that the first stage of the subduction in Exp A-C showed the quite similar pattern of wedge deformation processes of Exp A-C in Okuma et al. (*under review*) as following; Exp A: continuous wedge formation, Exp B: development of the single plate boundary fault along the seamount surface with thin deformed zone, and Exp C: the repetition of the vertical movement of plate boundary fault with thick deformed zone. In the early stages of the Exp D, the location of plate boundary faults is vertically unstable, and the fault moved completely atypical and random. This formation is unlike Exp C, characterized by “fault dancing” phenomena. This phenomena is defined as the systematic repetitive activity of multiple curved faults. In the late stage of Exp D, on the other hand, the fault’s behavior gradually changed to like “fault dancing”.
These results suggest that frictional property on the subducting oceanic plate, rather than topographic effects, significantly control the fault behavior and formation not only during the early stage of seamount subduction but also during the entire process. We will also report other characteristic wedge deformation processes related to frictional and topographic factors on the subducting oceanic plate in the presentation.

Keywords: topographic high, seamount subduction, basal friction, sandbox experiment, accretionary wedge, image analysis