Decollement formation mechanism depending on the evolution conditions of accretionary prism

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It is believed in general that frictional property of a decollement, which is assumed to be at the base of an accretionary prism, controls shape and evolution conditions of the prism. Thus all the theories that describe formation of accretionary prism assume the existence of a decollement (e.g. Dahlen, 1990; Mandal et al., 1997). However, results of structural survey in the real subduction zones show that a decollement does not necessarily exist continuously beneath an accretionary prism or cannot be found in a less accreted prism. Since a decollement may not exist in sediment before accretion, it seems to be natural to consider that a decollement is formed during accretion process.

In other words, it is necessary to understand the formation process of accretionary prism in order to discuss present shape or evolution conditions of the prism. Recently we have revealed the mechanical conditions for accretionary prism to develop, based on numerical simulation using discrete element method (Sakaguchi & Hori, 2009). In the simulation, sediment is modeled as tens to hundreds of thousand of particles. We find in the results that a decollement is formed during sediment accretion under some necessary conditions. We will report this process in detail.

In a case that accretionary prism evolves seaward (away from the backstop) with lower slope angle, shear deformation is localized near the plate and a thin fault zone is formed. This fault zone corresponds to the so-called decollement. On the other hand, when accretionary prism has higher slope angle and stays near the backstop, no thin fault zone is formed because whole the sediment layer is shear deformed and subducts beneath the prism. In a moderate slope angle case, a large reverse fault appears from deeper portion near the backstop through the surface at the deformation front. Such presence or style of decollement and its relation to the shape of accretionary prism are consistent with observation in subduction zones. Therefore, accretionary prism is not formed by a decollement but a decollement is formed as a result of accretionary process. The formation mechanism is explained as follows.

Horizontal movement of sediment on the plate is stopped by the backstop. If horizontal shortening goes on within the sediment, horizontal movement of the sediment is limited and shear force by the plate appears at the bottom of the sediment. Shear fracture is localized near the plate and decollement is formed since compaction occurs effectively by horizontal shortening and self-gravity when accretionary prism evolves seaward. For the cases of lower and moderate slope angle of the prism, presence and shape of decollement can be explained by deformability and strength of the sediment that control the shape of accretionary prism.