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# A numerical model of deformation in an evolving thrust wedge: A case study of the Shogawa anticlinorium

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Frontal structures of thrust systems show large variety (Vann et al.,1986). Recently, it has been revealed that there are wedge-shaped reverse faults in the Neogene sediments in Japan (Sato and Hirata, 2000; Ishiyama et al., 2004 etc.). In order to understand the relationship between active thrusts that can be observed at the surface and concealed main faults, it is significant to clarify the conditions that define the shape of the frontal structure of thrust systems.

To reveal the structural development process and conditions of the wedge thrust, we use the distinct element method (DEM). First, in order to examine the validity of DEM, we performed comparative experiments with Particle Flow Code in two dimensions (PFC2D) and analogue experiments with sand box. The obtained results suggest that the both results are in good agreement. We performed the numerical simulation using PFC2D from simple model to complicated one. Using a simple model, we found that the Young's modulus is strongly influenced by the structure development. In addition, it was confirmed that the formation of detachment, the presence of the layer structure is essential.

Based on above-mentioned results, we constructed a "Sanjo model" which was referring to the geological structure of Shitada hills in Sanjo city, Niigata Prefecture, the presence of the wedge thrust has been confirmed by Kato et al. (2010). Through the numerical simulation, when considering the sediment load during the thrusting, wedge thrusts do not develop. It is due to the sediment loads prevent the development of large amplitude of folding above main detachment. Following the actual subsurface data of Sanjo area, we put a western limit for the detachment. An improved model shows the development of fault-related fold above the detachment, including wedge thrusts. These results suggest that the existence of a tip for detachment is important to produce a wedge thrust. In addition, when the side of the hills in the model was eroded, the development of the thrust has been confirmed.

In the Sanjo model, in spite of the boundary condition is given by constant strain, slip on faults occur intermittently and accommodate on several faults in the sediment layers. With the progress of shortening deformation, the area of shortening deformation becomes wider associated with the propagating a slip on the detachment. This is consistent with the geologic records of fault activity in the Yoshinoya fault (Kobayashi et al., 1995). Further, it was found that there is a difference in time of the activity floor and roof thrust in the thrust wedge. Compared to the amount of slip on a main fault, the amount of slip on a fault near the surface was significantly to be small.

Keywords: fault-related fold, wedge thrust, active blind thrust, distinct element method, detachment, Shogawa anticlinorium