Reconstruction of flow condition of large-scale mass transport deposits from internal stress fields

Hajime Naruse[1] and Makoto Otsubo[2]

[1] Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto University, Kitashirakawa Oiwakecho, Sakyo-ku, Kyoto 606-8502, Japan. Phone: +81-75-753-4167. Fax: +81-75-753-4189.

[2] Research Center for Deep Geological Environments, National Institute of Advanced Industrial Science and Technology, Tsukuba Central 7, 1-1, Higashi 1-Chome, Tsukuba-shi, Ibaraki-ken, 305-8567 Japan. Phone: +81-29-861-3620. FAX: +81-29-861-3742

naruse@kueps.kyoto-u.ac.jp and otsubo-m@aist.go.jp

Flow condition of large-scale mass transport deposits was reconstructed from both stress field analysis of the outcrop and numerical experiments of debris-flows. Deposits of gravelly mudstone containing large deformed sedimentary blocks occur in the Upper Cretaceous to Paleocene Akkeshi Formation distributed in the Hokkaido Island, northern Japan. Application of the multiple inverse method to meso-scale faults observed in the blocks reveals possible internal paleostress fields that existed prior to deposition. This analysis suggested two different stress fields: (1) a uni-axial compressional stress field, where the maximum principal compression axis is normal to the bedding surface, and (2) a tri-axial compressional stress field, where the orientation of maximum principal compression axis is parallel to the paleocurrent direction. In addition, the analysis suggested existence of the excess pore-pressure inside the debris flow that could explain the remarkable deformation of internal blocks of the debris-flow deposit.

Numerical experiments on subaqueous mass transport processes were conducted to understand the internal stress field associate with a natural example of a submarine debris flow, which was revealed by detailed analysis of a deposit exposed as a nearly1.6 km continuous outcrop. The results of numerical experiments imply that the first of these stress fields is generated by radial spreading of the flow during its downcurrent movement, while the second stress field results from compression during deposition on the basin plain. A horizontal compression paleo-stress field can be an indicator of the paleocurrent direction of the debris-flow. In addition, it is also suggested that existence of a horizontal compression paleo-stress field can provide a clue for the initial conditions of the submarine landslide.