The Nariwa Landslide caused by the pre-existing sheared planes due to flexural-slip folding

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The Nariwa Landslides developed in the Triassic Nariwa Group, Okayama Prefecture, Southwest Japan. The Nariwa Landslides are characterized by landslide in hard rocks. Sedimentary facies analysis and structural analysis of folding of the Nariwa Group supplied the following results on the geological primary cause of landslides.

The formation of the slip surfaces is controlled by the characteristics of lithology and pre-existing shear plane. The non-marine facies of the Nariwa Group is characterized by the fining-upwards cycles that start with sandstones at the bottom and end with mudstones and coals at the top. The slip surfaces formed in coaly beds are intercalated between sandstones and mudstones. A difference in rock strength between sandstone and coaly beds might cause the formation of a pre-existing shear plane. The Nariwa Group was folded by the flexural-slip folding. This type of folding creates shear planes parallel to beddings. The shear planes are inferred to be formed in coaly beds. This pre-existing sheared coaly beds are the fundamental element of the cause of the Nariwa Landslides. Resulting from slope instability, the sheared coaly bed developed into the slip surface of the Nariwa Landslides.

The Nariwa Group is affected by folding and open cylindrical minor folded structures are formed. There is a possibility that the folded structures had effected on the formation of the landslides. Detail observations of landslide distribution and analysis of the structures of landslide mass have been carried out in the Yasunari Landslides Area. Structural analysis of folds of the Nariwa Group is also precisely studied in this area. The landslide which distributed in the hingezone of syncline fold as well as interlimb part was found. The direction of mass movement fits with that of fold axis of the syncline. The shape of the main slip surface is similar to the folded structure representing that the landslide is controlled by the dip slope.

A weak stratum, which was made by a destruction due to a folding, in the Nariwa Group might cause landslides in hard rocks. Many landslides in hard rocks have been roughly grouped as so-called ”Fracture Zone Landslide” . This study reveals one of the mechanisms of the occurrence of landslides in hard rocks, which are different from the common landslides which developed in soft rocks.