# Formation of roughness on cliff face: based on high-resolution 3D model of sea cliff on Yonaguni Island, Ryukyus

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Sea cliffs are difficult to approach and survey, so there is little geomorphological knowledge. Although photogrammetry using small UAV has been performed recently, it was necessary to set GCPs around the cliffs if surveying accuracy were improved. Therefore, high-precision surveying was too difficult on unaccessible steep cliffs. In this study, high-accuracy and resolution 3D models of sea cliffs were created by photographing the cliff faces in detail with a RTK-UAV that is capable of high-accuracy surveying without GCPs. We discuss about the factors that affect the geomorphic features of the cliff faces based on the models.

We investigated the sea cliffs composed of alternation of sandstone and mudstone of the Miocene Yaeyama Group in Yonaguni Island. Phantom4 RTK (DJI) was utilized to obtain aerial photographs. The photographs were taken in two steps. First step is to capture whole study site by automatic control with the camera facing down. Second step is to capture cliff face manually with the camera facing the cliff to obtain high-resolution color information and roughness of the cliff faces. In this study, Metashape Professional (Agisoft) was used for creating the 3D models. Geomorphic analysis and lithological observation were performed based on numerical information obtained from the models.

Observations of the sea cliff models showed that notch-like concave features were formed in several steps. No regularity in the altitude of concavities was found as results of extracting concavity and measuring the altitude based on the coordinate data obtained from the model. Correspondence between the profiles and the texture of the sea cliff revealed that the concavities were mainly composed of thick mudstone or mud-dominated alternation. Furthermore, the width and depth of the roughness depend on the thickness of a sand layer and the continuity of a mud layer. Therefore, the present result suggested that the geomorphic features of the cliff surface is controlled by the lithology of the alternating layers of sand and mud on Yonaguni Island.

Keywords: RTK-UAV, Alternation of sandstone and mudstone, Notches, Photogrammetry

 