

3D geomorphological analysis method for sea cliff: A case study of Miocene sedimentary rocks in Yonaguni Island

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The sea cliffs are the zones hard to research geomorphologically because there are difficult to approach and survey. The topographic change has been measured in the areas of high cliff erosion rate with the development of surveying methods using the aerial laser scanner and the small UAV. However, there have been few applications in the sea cliff of low erosion rate. In this study, we investigated the geomorphological analysis method suitable for the inaccessible sea cliffs and performed the analysis as an example of the Miocene sedimentary rocks 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 coastal zone by automatic control with the camera facing down. Second step is to capture the cliff face manually with the camera facing the cliff to obtain the high-resolution model. Metashape Professional (Agisoft) was used for SfM-MVS processing. The lithology of the cliffs was classified in the model based on the observations in the accessible coastal zones. The geomorphological analysis using the general Digital Elevation Model (DEM) isn't suitable for the cliff face. We created the geomorphological data sets suitable for 3D analysis by using the 3DCAD software Rhinoceros (McNeel). The profiles created by calculating the intersection of the mesh model and an arbitrary face represented the complex shape of the cliff including the overhang zones. The cliff face DEM was created by transforming the coordinates of the model, which the detailed shape of the cliff was visualized and quantified.

By calculating the slope and longitudinal curvature of the cliff face DEM (5cm meshed grid), the correspondence between the cliff face shape and the lithology was quantified. In the cliffs consisting of the tidal deposits, the tendency of roughness of the cliff face and the weathering and erosional process depends on the lithology. Therefore, in Yonaguni Island the lithology of the sedimentary rocks is considered to control the recession process of the sea cliff. The geomorphological analysis method adopted in this study is effective for the sea cliffs composed of the sedimentary rocks.

Keywords: Drone, RTK-UAV, SfM-MVS, Photogrammetry, DEM, Yaeyama Group