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## High-resolution multibeam bathymetric surveys of outer reef slope

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The complex topographies of outer reef slopes such as spurs and grooves are hard to visualize by single-beam echo sounder because of their three-dimensional shape. This study attempts to observe 3D measuring and mapping of outer reef slope using high-resolution multibeam bathymetric sonar.

We introduced R2Sonic 2022 Broadband/Wideband Multibeam Sounding System to Okayama University in November 2010. This system is a shallow-water multibeam echo-sounder with selectable operating frequencies within the 200 to 400 kHz band and variable swath width from 10 to 160 degree. Within the acoustic sector, 256 receiver beams were formed using 1 degree across beamwidth x 1 degree along beamwidth. It may also rotate the swath sector either port or starboard side of the vessel. The main part of the sonar has a vertical resolution of 1.25cm.

The system is operated with Hemisphere VS111 GPS Compass and Teledyne TSS Dynamic Motion Sensor DMS-10. The accuracy of VS111 GPS Compass is 0.6m in distance and 0.15 degree in direction when placing A30 and A20 antennas at 1m interval. The accuracy of DMS-10 Motion Sensor is 0.07 degree in roll and pitch, and 5cm in heave. The vertical accuracy of the system is around 5 to 10cm.

The survey and data processing are carried out by the hydrographic survey software Hypack 2010. The visualization of the 3D bathymetry model is conducted by IVS 3D Fledermaus.

A preliminary survey was carried out off the southern coast of Kume Island in November 2011. The maximum depth in the survey area is 280m. The precise reef topography is measured and visualized by this system. The high-resolution (between 0.7 to 1m mesh-size) image is observed above the depth of 60m and the highest-resolution (between 0.1 to 0.5m mesh-size) image is observed around the 10m depth line. The bathymetric result was confirmed by underwater surveys using SCUBA. The high-resolution multibeam bathymetric sonar will be an effective tool to improve shallow water geomorphology.

Keywords: bathymetric survey, multibeam sonar, coral reef, reef slope, Kume Island, Ryukyus