# Underwater 3D Mapping of Ashmore Reef, Australia

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## Background and aims

Ashmore Reef Marine Park was establish in 1983. It hosts Mesophotic Coral Ecosystems (MCEs). To understand these important marine ecosystems further, a Schmidt Ocean Institute cruise (FK210409) of Ashmore Reef's MCEs on the R/V Falkor, led by the Australian Institute of Marine Science (AIMS) and the West Australian Museum (WAM), was carried out in April 2021. As part of this study, vessel-based multibeam echosounder data, and still images captured from a Remotely Operated Vehicle (ROV) were collected around Ashmore Reef (Australia) at depths between 50 and 500 m. This study aimed to create 3D models of the MCEs from the still images, and geo-reference them within the multibeam bathymetry.

## Photogrammetry workflow

*Data collection*

Still images (in raw and jpeg format) were captured using two CurtinRX0Cam-6000 underwater digital still cameras (Figure 1). The CurtinRX0Cam-6000 camera was specially developed by Curtin University to be used on underwater ROVs, for the collection of arrays of images suitable for processing using photogrammetric 3D reconstruction techniques (often known as simply photogrammetry), to generate detailed digital 3D models of subsea objects. The cameras are rated for 6000 m water depth using a titanium housing and sapphire camera port, and have an ethernet interface for camera control and real-time download of images from the camera to the surface via the ROVs umbilical. In the survey of Ashmore Reef, two cameras were fitted to the front of the SuBastian ROV deployed by the R/V Falkor (Figure 1 (b)).

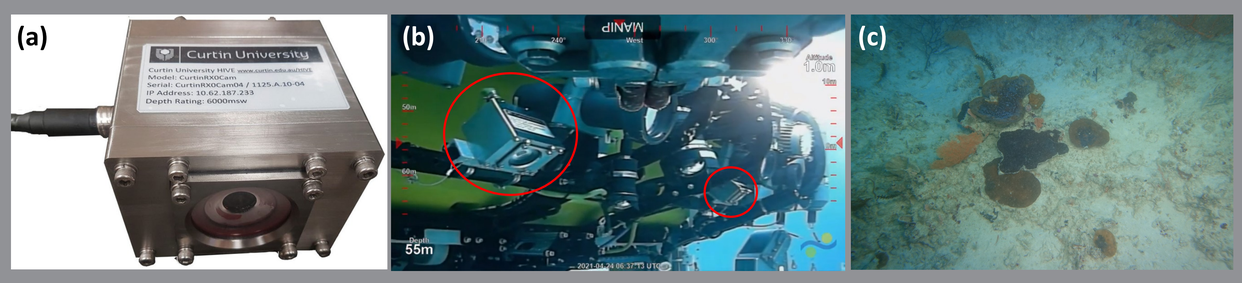


***Figure 1.*** *Still image capture: (a) CurtinRX0Cam-6000 camera, (b) as deployed on ROV SuBastian (seen inside the red circles), (c) example imagery from a mesophotic coral ecosystem at Ashmore Reef.*

*Data processing*

Photogrammetric 3D reconstruction was carried out in Agisoft Metashape Professional. Still images for each area were imported and assigned camera groups, and the physical offsets between the camera and the ROVs navigation centres were entered. The ROV's depth data was corrected for tide, then the ROV's position and attitude data were calculated for each still image and imported in to Metashape. The standard Metashape workflow was then carried out. Photomosaics (Figure 2), 3D models (Figure 3), and Digital Elevation Models (DEMs) (Figure 4) of selected survey areas were generated.

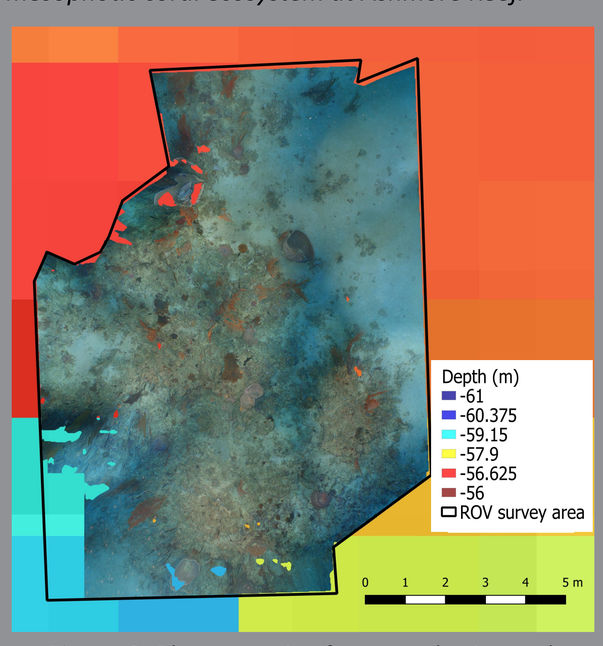


***Figure 2.*** *Photomosaic of a mesophotic coral ecosystem at Ashmore Reef overlaid over multibeam bathymetry.*

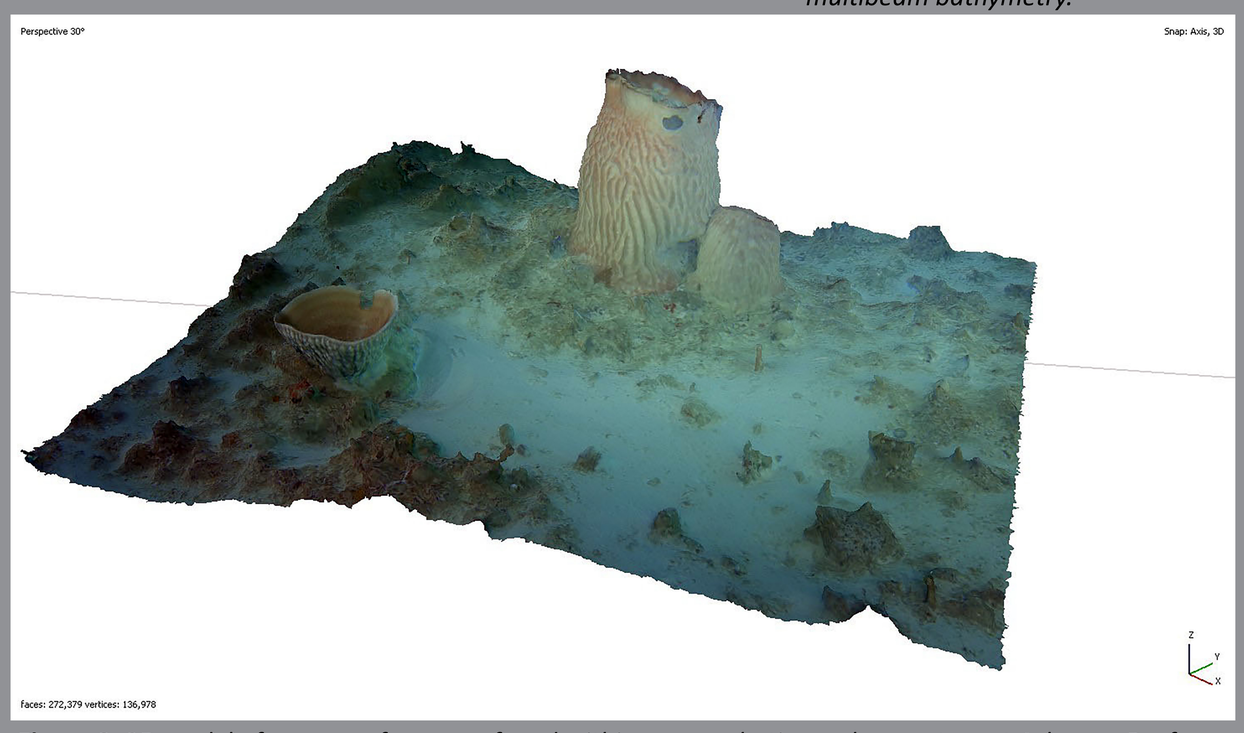


***Figure 3.*** *3D model of a group of sponges found within a mesophotic coral ecosystem at Ashmore Reef, created from still images captured from CurtinRX0Cam-6000 cameras deployed on ROV SuBastian.*

## Multibeam echosounder data workflow

*Data collection*

A Kongsberg EM710 multibeam echosounder and an Applanix POS MV were used to map the seafloor around Ashmore Reef. Raw multibeam data was collected using Kongsberg's Seafloor information System (SIS), and position and attitude data were also logged in Applanix's POS View software. Sound velocity casts were taken on a regular basis and added in real time to SIS during surveying.

*Data processing*

POS MV data were post-processed using POS Pac MMS to produce *Smoothed Best Estimate of Trajectory (SBET)* files. The SBET files were imported, with the Kongsberg multibeam (.all) files, and tide data, to QPS's QIMERA (ver 2.4.8) for processing. Corrected and cleaned depth data (re Lowest Astronomical Tide) were gridded to a cell size based on their depth band. For instance, data between 50-100 m deep were gridded at 3 m grid size, and 100-200 m depth to 4 m (see example shown over a chart in Figure 4 (a)).

## Results

DEMs created from the multibeam data, and photogrammetric 3D reconstruction of the ROV images, were overlaid in QGIS (Figure 4(b) and (c)), and compared using a profiler tool (Figure 4 (d)). There was good agreement between the depth profiles in the centre of the ROV survey area (RMS < 30 cm), but could differ at the edges where there were less overlapping images.

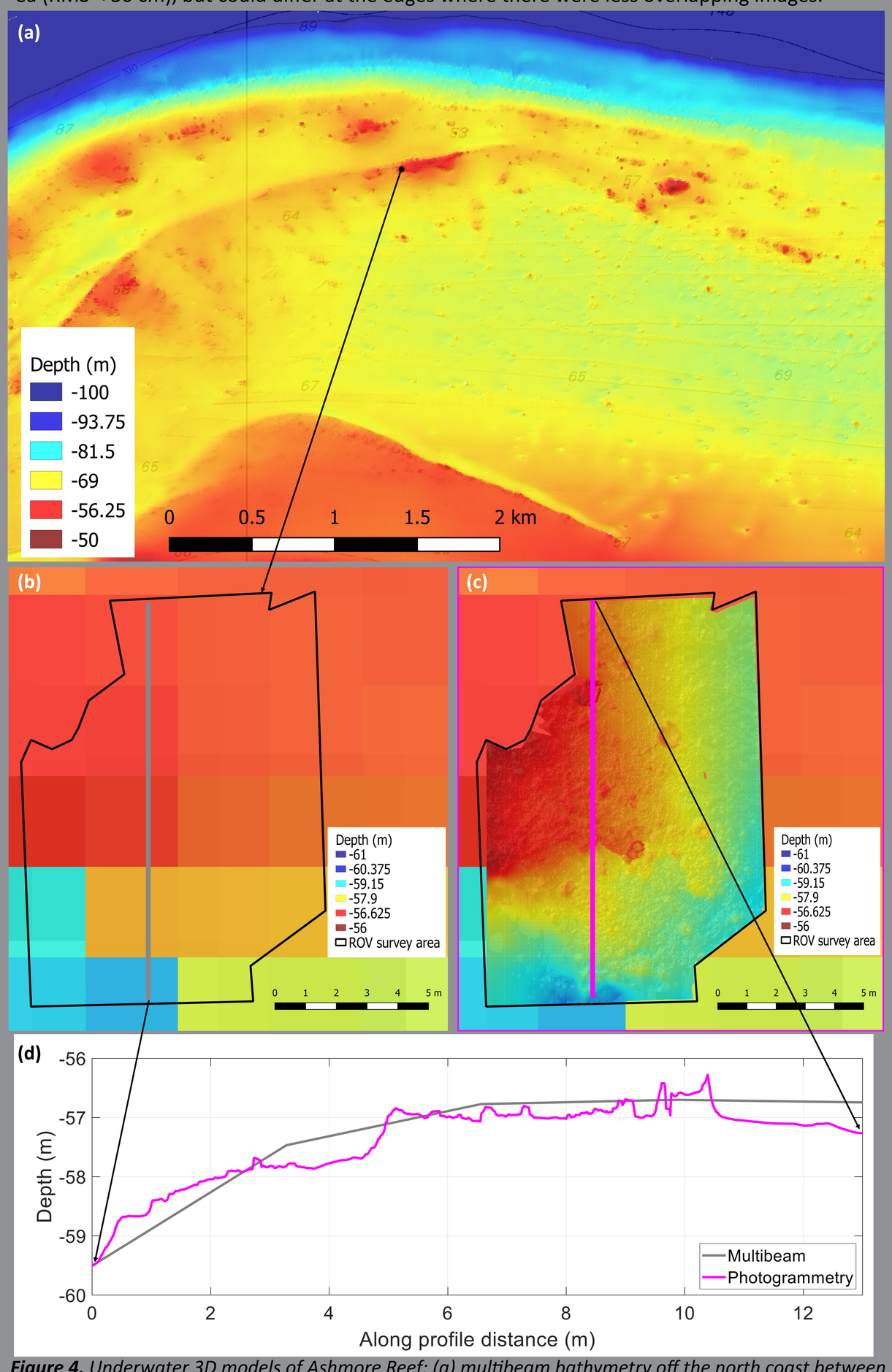


***Figure 4.*** *Underwater 3D models of Ashmore Reef: (a) multibeam bathymetry off the north coast between 50-100 m depth, (b) location of one of the ROV surveys, (c) a photogrammetry generated DEM, and (d) depth profiles comparing multibeam and photogrammetry DEMs.*

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