Using multibeam echo-sounder backscatter to characterise the seafloor of Davis Harbour, Antarctica: preliminary results

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ABSTRACT

A seafloor survey of Davis Harbour and surrounding coastal areas in Antarctica was carried out by Geoscience Australia (GA) between January and March 2010. The survey was conducted using a Konsberg-Simrad EM 3002 multibeam echo sounder (MBES). Processing and analysis of the bathymetry data was carried out by GA. This is a separate desktop study that used CARIS HIPS and SIPS version 7.1 software to process and analyse the acoustic backscatter data collected by the MBES to characterise the seafloor substrate. This paper presents preliminary results of the seafloor backscatter map and the outputs of the Angular Range Analysis model implemented in CARIS.

INTRODUCTION

High-resolution bathymetry and backscatter data collected by multibeam echo-sounders (MBES) have been shown to adequately characterise the seafloor for a range of applications, such as geological, fisheries and benthic habitat (Hughes Clarke et al., 1996; Kostylev et al., 2001; Kenny et al., 2003). Bathymetry provides information about the topography and geomorphological of the seafloor. Backscatter collected from the seafloor can be used to infer the substrate (Fonseca and Mayer, 2007).

A seafloor survey of Davis Harbour and surrounding coastal areas in Antarctica was carried out by Geoscience Australia (GA) between January and March 2010. The survey was conducted using a Konsberg-Simrad EM 3002 multibeam echo sounder (MBES). Processing and analysis of the bathymetry data was carried out by GA, but no analysis of the backscatter data was carried out.

CARIS HIPS and SIPS is one of the most used software to process MBES data. In CARIS version 7.1 there is an implementation of the Geocoder algorithm developed by Fonseca and Calder (2005) and Angular Range Analysis (ARA) developed by Fonseca and Mayer (2007). The Geocoder algorithm produces maps of seafloor backscatter by correcting MBES backscatter data for system settings, transmission loss, insonification area and incidence angle (Fonseca and Calder, 2005). The ARA uses a seafloor backscatter model to predict seafloor properties such as grain size and surface roughness from MBES data (Fonseca and Mayer, 2007). The ARA seafloor backscatter model is based on the effective density fluid model derived from the Biot theory (Williams, 2001) with some modifications for the calculation of the volume scattering contribution. For sedimentary beds, the ARA method has demonstrated some promising results (Fonseca and Mayer, 2007). The aim of this study is to investigate the usefulness of the backscatter data products created by CARIS ver. 7.1 for characterising the seafloor from the Davis Harbour survey. To aid in the evaluation of this study, results are compared to grab samples taken in the area by Franklin (1997). This paper presents some preliminary results of this study.

METHODS

Study area

The Davis research station is the most southerly located Australian Antarctic station, situated on the Antarctic mainland on the coast of the Vestfold Hills. The Vestfold hills are typically ice-free, with the coastline shaped by inlets and numerous islands, and grounded icebergs occurring approximately 5km offshore. The area surveyed includes the coastline around the Davis base between 68.5° to 68.7° S and 77.7° and 80° E. The location of the study area Davis Harbour, Antarctica, is shown in Figure. 1.

Data collection

GA carried out a survey of the coastal waters near Davis Harbour using a dual head Konsberg-Simrad EM 3002 MBES between 25 January and 29 March 2010 (O'Brien et al., 2011). The survey was conducted jointly with Australian Antarctic Division (AAD) and the Deployable Geospatial Survey Team (DGST) of the Royal Australian Navy. For full details see the report by O'Brien et al. (2011).

Sediment samples collected in a study of Prydz Bay by Franklin (1997) was used as ground-truth data.

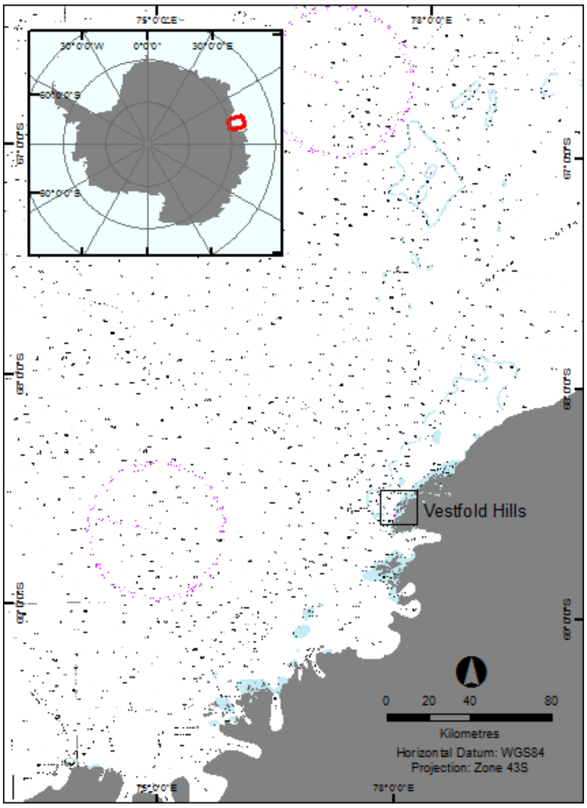

Figure 1. Location of Davis Harbour, Antarctica.

Data processing

The general workflow for creating backscatter mosaics and carrying out ARA in CARIS HIPS and SIPS version 7.1. is shown in Figure 2. For more details about Geocoder see Fonseca and Calder (2005) and for ARA see Fonseca and Mayer (2007).

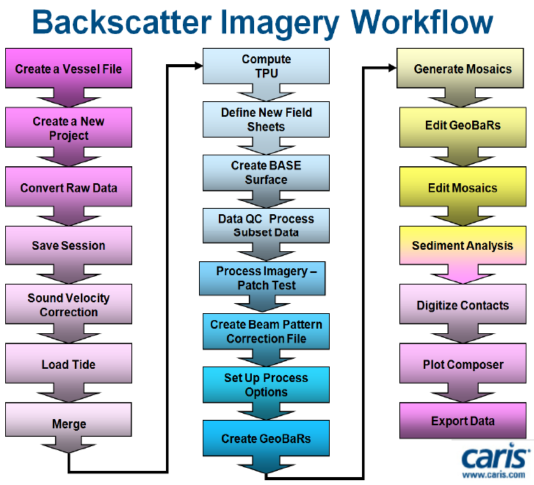

Figure 2. Backscatter imagery and sediment analysis workflow in CARIS HIPS and SIPS version 7.1 (adapted from CARIS, 2012).

Backscatter mosaic data was exported as a geotiff and imported into Matlab for comparison with the grab samples taken by Franklin (1997).

PRELIMINARY RESULTS

An example of the backscatter imagery and bathymetry from the study area produced by CARIS HIPS and SIPS ver 7.1 is shown in Figure 3. There are clearly transitions in the backscatter data that relate to changes in the seafloor properties, i.e. where the backscatter data goes from high to low values. The sediment grabs taken by Franklin are shown as percentage of mud. It is not evident yet whether there is a good correlation between the grab samples and backscatter imagery.

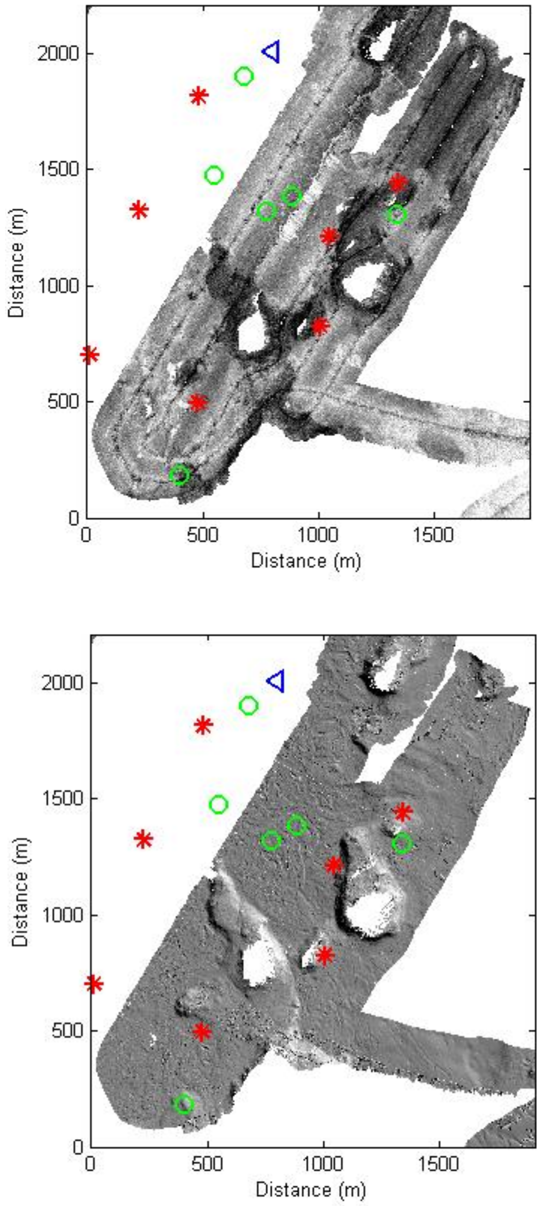

Figure 3. An example of backscatter (top – grayscale where white is high backscatter values) and sun-illuminated bathymetry (top) derived from the multibeam echo-sounder data. Sediment grab samples recorded by Franklin (1997) are overlayed: blue triangles (40-60% mud), red stars (60-80% mud) and green circles (>80% mud).

Figure 4 shows an example output from the ARA model implemented in CARIS. The red and green lines are the measurements. The blue data shows the model prediction which has been calibrated using a homogenous area of known substrate. The difference in level between the model and the measurements indicates the MBES data requires calibration for the ARA model to be successful. The yellow lines shows the backscatter data normalised for angle used in the backscatter imagery.

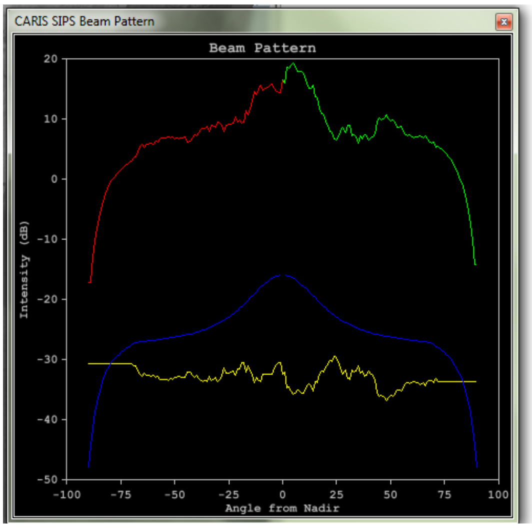

Figure 4. An example output of the ARA model in CARIS: Backscatter intensity versus Angle from Nadir. The red line is the port measurement, green the starboard measurement, the yellow is the normalised backscatter and the blue line the model fit.

FUTURE STUDY

Results shown in this paper are preliminary in nature. Once the full dataset has been processed and analysed the following will be carried out:

- Analysis of the backscatter imagery data and grab samples to assess what seafloor transitions can be identified.
- Comparison of the ARA grain size prediction with grab sample data.

Future studies will also include comparison of the backscatter processed with CARIS and the:

- Backscatter data and mosaics produced with the methods developed by Parnum and Gavrilov (2011a and 2011b).
- Classification of angular backscatter data using the methods detailed in Hamilton and Parnum (2011).
- Prediction of sediment properties carried out using the methods of Parnum and Gavrilov (2012).

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