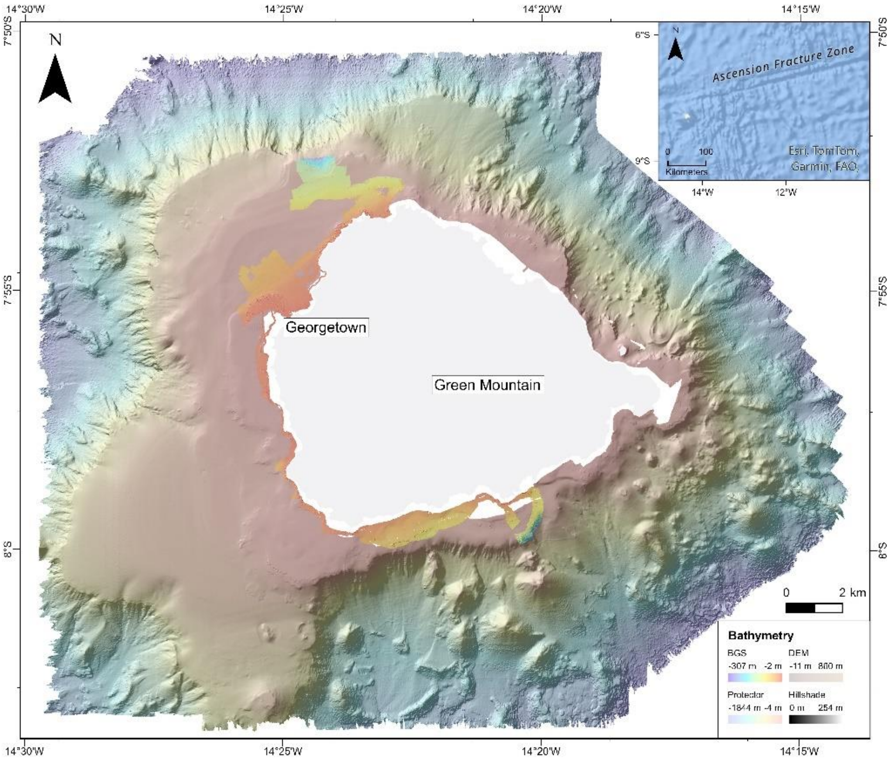
Mapping of Geomorphology, Seabed Substrate and Nearshore Habitats within the Ascension Island Marine Protected Area

Environmental Change, Adaptation and Resilience

Open Report OR/24/015



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ENVIRONMENTAL CHANGE, ADAPTATION AND RESILIENCE

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Front cover Location map and multibeam bathymetry data (collected by BGS and UKHO) within the Ascension Island Area of Interest (AOI).

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Mapping of geomorphology, seabed substrate and nearshore habitats within the Ascension Island Marine Protected Area

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Lyell Centre, Edinburgh British Geological Survey 2025

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Foreword

This open report presents the results of a commissioned study of the nearshore habitats within Ascension Island Marine Protected Area (AI-MPA) undertaken by the British Geological Survey (BGS) on behalf of the Ascension Island Government (AIG).

The aim of this study was to acquire new high-resolution bathymetry data, together with physical and video seafloor data, and through integration and analysis of these data produce new seabed geomorphology, substrate, and habitat maps for the nearshore area of the AI-MPA. These map products were created using a combination of semi-automated and manual mapping methods and will be used to support improved monitoring and management of the AI-MPA.

This report covers the data acquisition and processing of the multibeam echosounder bathymetry (and backscatter) data, as well as ground truthing sample datasets, acquired by both the BGS (BGS NEE7366R) and the Royal Navy (HI 1571). The report also details the production of the derived layers (backscatter intensity, hillshade, slope, aspect, and rugosity) for use in creating the seabed maps.

Acknowledgements

Many thanks to Darwin Plus for allowing completion of this work as part of a Darwin Plus Grant (DPLUS142) awarded to BGS in 2019.

The AIG Department of Conservation are thanked for facilitating two (2) data acquisition campaigns undertaken by BGS staff for this project. These fieldwork campaigns would not have been possible without the willingness and ingenuity of the crew and staff. Of the many individuals who have contributed to the project we would particularly like to thank the following:

- AIG Project Managers: Tiffany Simpson and Diane Baum.
- Boat Skippers: Daniel Simpson, Simon Watkins and Cuen Muller.
- Marine Crew: Pascal Walters, Sheldon Thomas, Cerys Joshua and Marcos Tieppo.
- AIG Communications Manager: Lorna West.

The authors would also like to thank Dayton Dove (BGS) for reviewing the report and maps.

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Summary

Seamounts are important ecosystems as they have a major influence on physical oceanography, which in-turn influences the pelagic and benthic communities found on and around them (e.g., Clark et al., 2010). Ascension Island is a remote volcanic island situated atop one such seamount in the South Atlantic and characterised by its complex geological history and diverse ecosystems.

In 2019, the entire Economic Exclusion Zone (EEZ) surrounding Ascension Island was declared a Marine Protected Area (MPA) (National Protected Areas Order, 2019). The area covered by the Ascension Island MPA (AI-MPA) exceeds 445,000 km^2, making it one of the largest MPAs globally. Nearshore habitats are a key component of the AI-MPA as they support many unique species and are also the area's most at risk from anthropogenic development and climate change.

This study presents the first detailed seafloor mapping of the AI-MPA, revealing a variety of previously unmapped features. These include submerged lava flows, submarine terraces, or palaeoshorelines, that record evidence of previous sea level changes around the island, submarine landslides, and soft sedimented plains. The new maps give unprecedented insight into the variety of habitats associated with this geodiverse seascape.

The resulting maps of seafloor geomorphology, substrate and habitat are based on a combination of semi-automated and manual mapping techniques and expert judgement. Prior to this project, sparce high-resolution bathymetric information was available, therefore these outputs provide urgently needed resources to aide accurate assessment and monitoring of these ecosystems, ultimately supporting improved evidence-based management of the AI-MPA.

This report describes the acquisition and data processing methodology for the following datasets: multibeam echosounder (MBES) bathymetry, MBES backscatter intensity, and sampling data comprising both physical seafloor samples and video transects acquired by the British Geological Survey (BGS) (Cooper and Macdonald, 2024) and the Royal Navy (HMS Protector) (Royal Navy, 2021). Additionally, the methodology to produce derived multibeam echosounder products (bathymetry, hillshade, slope, aspect, and rugosity) for display and interpretation purposes is described. Finally, an overview of the approach and results of the complementary map components (i.e. the seabed geomorphology, substrate and habitat interpretations), undertaken by the BGS on behalf of the Ascension Island Government (AIG), is provided.

Key findings and future recommendations from this study include:

- The higher resolution MBES bathymetry and backscatter intensity data (1 m to 10 m resolution) added significant value to the project allowing for a detailed classification of seabed features and highlighted diverse seafloor features and environment;
- Detailed mapping of the geomorphology down to 1000 m was completed at 1:10,000 scale. Mapping identified a range of volcanic, erosion-depositional and coastal features including volcanic knolls, ridges, gullies, channels, and landslide scars. These features are of international scientific importance for our understanding of seamounts and are intrinsically linked to the conservation interests of the MPA;
- Six geological substrate classes were identified within the MPA including 'Sand', 'Rock', 'Rhodolith' and 'Mixed sediment' which was delineated by estimation of gravel content;
- Features, or areas of high seabed rugosity or slope angles, such as the rocky shore habitats, exhibited a higher abundance of marine species. This was also supported by observations from the drop-camera video analysis;
- The seabed substrate interpretation was converted into a seabed habitat map using different biological zones delineated by water depth and marine zone.
- Future work to ground-truth the physical samples via a dedicated seabed sampling campaign should be considered. Collection of sub-seabed seismic profiles may also provide further insight into the island formation, and morphology of the shelf. Specific studies into the morphometrics and seabed processes, as well as a comparison with other island settings (such as St. Helena) may provide valuable insight into the stability of marine habitats and geohazard potential of the island.

1 Introduction

Ascension Island is a remote volcanic island situated in the South Atlantic, approximately 90km west of the Mid-Atlantic Ridge. Volcanism is thought to have commenced approximately 6 to 7 Ma with the emplacement of submarine lavas at a time when the island was at or near the MAR (Klingelhofer et al., 2001; Bruguier et al., 2003). No historical volcanic activity is recorded on Ascension Island, with the last eruption unknown, however, Jicha et al., (2013) proposes a late Holocene age for the youngest lavas.

The geology of the seabed around the island has never been comprehensively mapped leaving significant gaps in our understanding of the underwater environment. Geological studies have primarily focussed on the onshore geology in part due to the remoteness of the island (e.g., Crummy et al., 2023). However, the island itself is estimated to represent just 1 % of the total volume (Harris, 1983), and the majority of mafic lava flows are noted to reach the coastline (Vye-Brown and Crummy, 2014).

The geological character of the seabed and shallow sub-surface is important to a range of users and stakeholders. Previous studies by Barnes et al., 2015, Brickle et al., 2017, and Bridges et al., 2021 investigated the marine biodiversity of Ascension Island. However, these were reliant on lower resolution multibeam bathymetry data between 100-1000 m depth, ground-truth samples using a benthic camera lander in deeper waters and a lack of seabed geology information.

In 2019, the BGS was awarded a Darwin Grant (DPLUS142) to acquire higher resolution multibeam bathymetry and ground-truth data with a focus on the Nearshore Habitats around Ascension Island. The overall aim of the project was to integrate the processing and interpretation of multibeam echosounder data with physical and video seafloor data to produce Seabed Geomorphology, Substrate Geology, and Seabed Habitat maps for the nearshore areas of the AI-MPA (**Figure 1-1**). An overview of the datasets used for this project is included in **Table 1-1**.

New geological maps such as these are essential for advancing our knowledge of the benthic habitats in the nearshore waters around the island providing critical insights into the structure composition and dynamics of the seafloor. Mapping the geology also informs conservation efforts (Ascension Island Government, 2025) by identifying areas of high biodiversity, potential threats to marine ecosystems, and the interactions between geological features and marine habitats.

Portraying the seabed geomorphology involves describing the morphological character of the seafloor (here using the newly acquired MBES bathymetry), which integrated with further supporting data and contextual information, potentially enables further detailed interpretation of the environmental origin / evolution, compositional character and potential mobility / vulnerability of seabed features. The seabed geomorphology interpretation broadly follows the ‘Two-part’ approach (e.g. Dove et al., 2016; Dove et al., 2020; Nanson et al., 2023) whereby both morphological descriptions of the feature(s) (i.e. size, shape, configuration) and geomorphological interpretation on the genesis of the feature(s) are provided where possible.

The seabed substrate digital map layer shows the dominant geological unit interpreted to be present at seabed. This general approach is followed to characterise the seabed around Ascension Island where seabed habitats may occur but does not account for the geological substrate that may be present below any thin, and/or potentially mobile seabed sediment layer due to the lack of physical samples. At any given location the mapped geological substrate may comprise either a Bedrock or Superficial geological unit.

To meet the objectives the BGS undertook:

- Acquisition of multibeam bathymetry, and backscatter intensity data by the BGS (Cooper and Macdonald, 2024) to fill the gaps in data collected by HMS Protector (Royal Navy, 2021) especially in shallow water areas of interest (<5 m – 10 m).
- Re-processing of multibeam data collected by HMS Protector using QPS Qimera software.
- Collection of ground truth samples (i.e. drop camera videos and stills) required for the BGS to create geomorphology, substrate, and habitat maps of the MPA.

- Production of derived multibeam echosounder raster layers comprising bathymetry, hillshade, slope, terrain ruggedness (VRM) and aspect in WGS84 UTM Zone 28S.
- Expert interpretation of seabed geomorphology to a depth of 1000 m, and seabed substrate and habitats using the EUNIS classification scheme (EUNIS, 2019) to a depth of 300 m utilising all available datasets including multibeam bathymetry and backscatter intensity raster layers, seabed samples and derived raster layers listed above.
- The layers and interpretations produced by the BGS will be used by the AIG to inform various marine management applications.

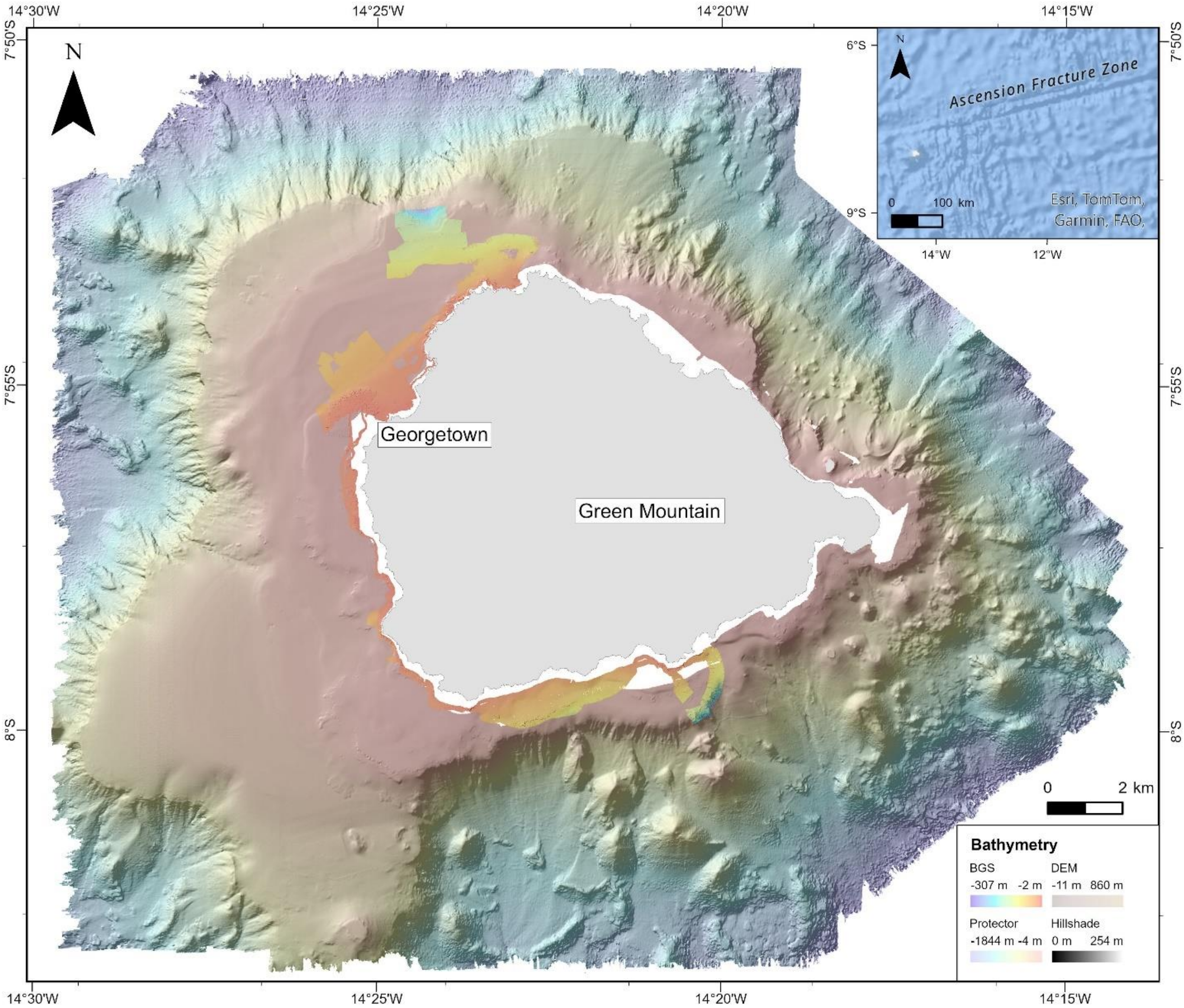

Figure 1-1 Location map and multibeam bathymetry data within the Ascension Island Area of Interest (AOI). This image contains multibeam bathymetry data collected by the HMS Protector / SMB James Cairn and the British Geological Survey. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

Table 1-1 Overview of the multibeam bathymetry, backscatter intensity and seabed sampling datasets used within this report.

Dataset	Type	Task	Area	Resolution (m)	Exports
HI 1571 HMS Protector/SMB James Cairn (Royal Navy, 2021)	Multibeam Echo Sounder (MBES) Bathymetry	Bathymetry data reprocessing, generate associated raster layers, geomorphology/ seabed substrate interpretation	0m – 100 m contour	1 m	CSAR, ESRI Ascii Grids
			100 – 400 m contour	3 m	
			400 – 1000 m contour	6 m	
			>1000 m contour	10 m	
	Backscatter Intensity	Original grids, seabed substrate interpretation	0 - <120 m	1 m	GeoTIFF, ESRI Ascii Grids
			>60 ->1000 m	6 m	
	Grab Samples	Original data from UKHO, filtered for area of interest, seabed substrate interpretation	Nine (9) samples within Clarence Bay	N/A	CSV, SHP
BGS NEE7366R (Cooper and Macdonald, 2024)	Multibeam Echo Sounder (MBES) Bathymetry	Bathymetry data processing, generate associated raster layers, geomorphology/seabed substrate interpretation	All data	3 m	ESRI Ascii Grids, XYZ, BAG, GeoTIFF
			All data <30 m	1 m	
			All data >30 m	3 m	
			Coastal Strip <15 m	0.5 m	
			Long Beach <15 m	0.5 m	
			South Coast	3 m	
	Backscatter Intensity	Backscatter processing, generate associated raster layers, seabed substrate interpretation	All data	1 m	GeoTIFF
	Drop Camera (GoPro11)	Visual Inspection, seabed substrate/habitat interpretation	15 samples (west to north)	N/A	MP4, SHP, CSV
	Drop Camera (STR)	Visual Inspection, seabed substrate/habitat interpretation	34 samples (west to north)	N/A	AVI, SHP, CSV
HI 1773 UKHO / EoMap	Satellite-derived bathymetry	Original data from UKHO, generate associated raster layers, geomorphology/ seabed substrate interpretation	Shallow water zone (HI 1773) <20 m	2 m	ESRI Ascii Grids, CSAR, GeoTIFF, XYZ

2 Multibeam Echosounder (MBES) Bathymetry and Backscatter Data - Acquisition and Processing

2.1 ROYAL NAVY/UKHO HMS PROTECTOR AND SMB JAMES CAIRN DATA PROCESSING

The primary dataset used for the study is the high-resolution MBES bathymetry dataset acquired by the HMS Protector (deep water; approximately >200 m depth) and SMB James Cairn (shallow water; approximately <200 m) in 2021 which is shown in **Figure 2-1**. The United Kingdom Hydrographic Office (UKHO) supplied the BGS with a CARIS project that was then reprocessed to create nested datasets of higher resolutions than previously supplied. The remit of the UKHO is the production of navigational charts primarily for the protection of life at sea. Subsequently, the set-up of the UKHO supplied CARIS project, and the resolution of finalised bathymetric grids, were created and designed with this aim in mind.

The primary focus of this study was to identify geological features and to create substrate and geomorphology maps in less than 300 m water depth. To achieve this, the BGS was able to reassess the density of "good" soundings within the HMS Protector dataset to create a new set of bathymetric grids, maximising the information available (**Figure 2-1**). This reprocessing also required additional editing to remove erroneous data (spikes) created through production of the higher resolution grids. CSAR files (i.e. CARIS Hips & Sips proprietary format) and ESRI Ascii Grid files were made for each depth range outlined in **Table 1-1**. These grids were then combined to create a continuous grid for mapping which is shown in **Figure 2-1**.

The UKHO did not create any backscatter intensity surfaces. Therefore, the BGS used QPS FMGT software to create the following files in the following formats - GeoTiff and ESRI Ascii Grids (**Table 1-1**). An overview of the backscatter intensity data is presented in **Figure 2-2**.

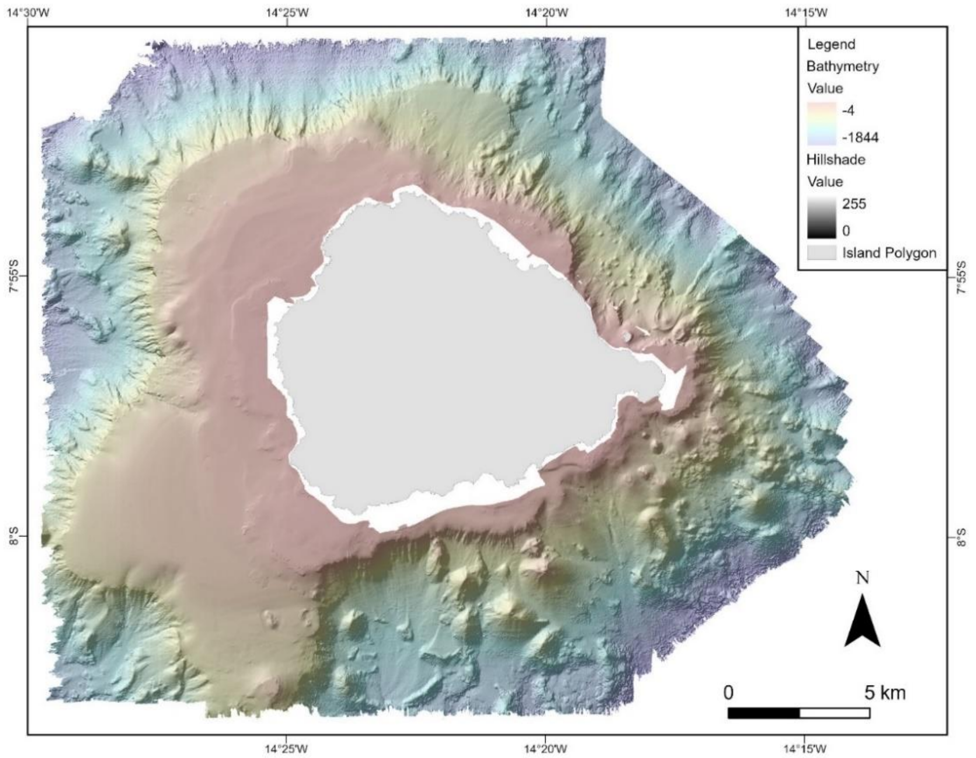

Figure 2-1 Overview of multibeam echosounder bathymetry data collected by HMS Protector / SMB James Cairn and reprocessed by BGS. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

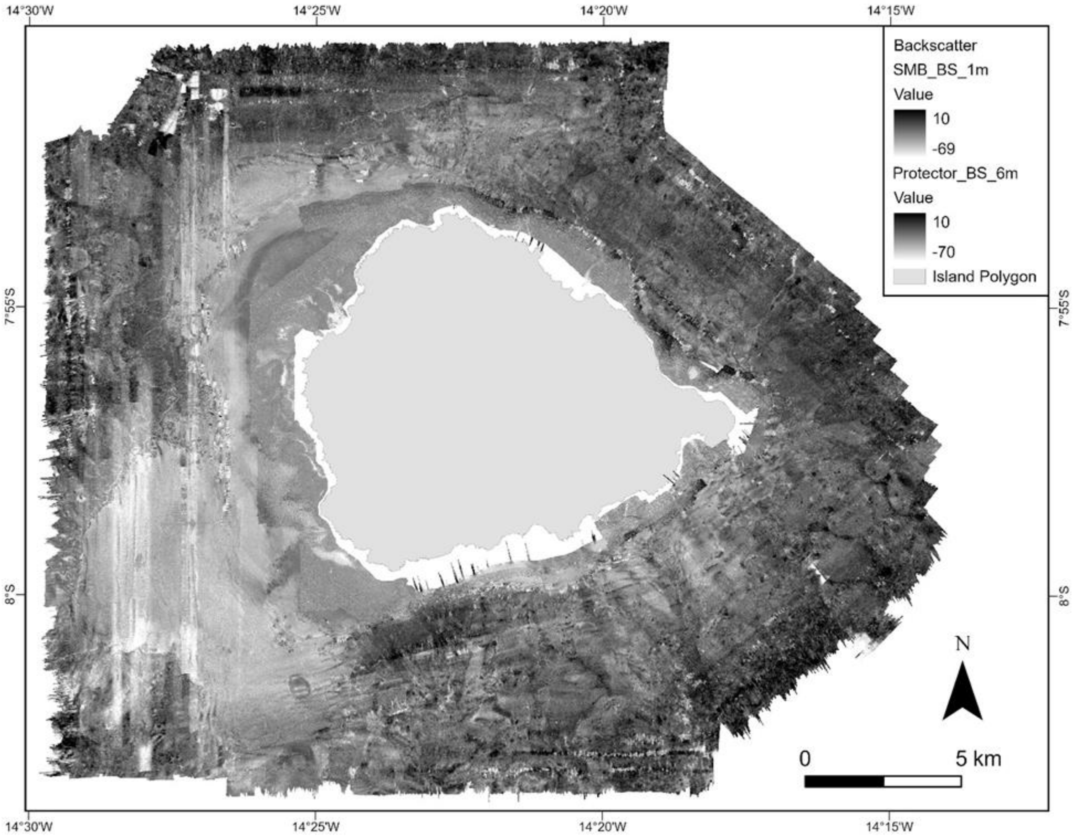

Figure 2-2 Overview of backscatter intensity data collected by HMS Protector / SMB James Cairn. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

2.2 BGS MBES DATA ACQUSITION AND PROCESSING

The BGS collected additional high-resolution MBES data during fieldwork undertaken in November 2023 (**Figure 2-3**). The depth range, geographic location and format of the data is outlined in **Table 1-1**. A full description of the acquisition methodology, and processing workflow and parameters using Qimera, are detailed in Cooper and Macdonald (2024).

The objectives of this survey were to:

- Fill gaps in the data collected by HMS Protector and SMB James Cairn, especially within shallow water areas of interest (<5 – 10 m).
- Improve data quality and density in priority areas around George Town. These areas were identified by the UKHO ahead of the field campaign.
- Acquire higher quality backscatter intensity data in areas of interest for marine geoscience studies and to allow backscatter signature comparison with the HMS Protector data.
- Collect water column data at areas of potential freshwater springs and gas seeps.
- Collect data from the previously uncharted south coast.

Backscatter intensity data were processed in QPS FMGT to create a single Geotiff file (**Figure 2-4**) allowing comparison of backscatter signatures across the full area and with the HMS Protector/SMB James Cairn data where they overlapped. Additionally, Geotiff files were made after each day of survey allowing ongoing quality checks throughout the field campaign.

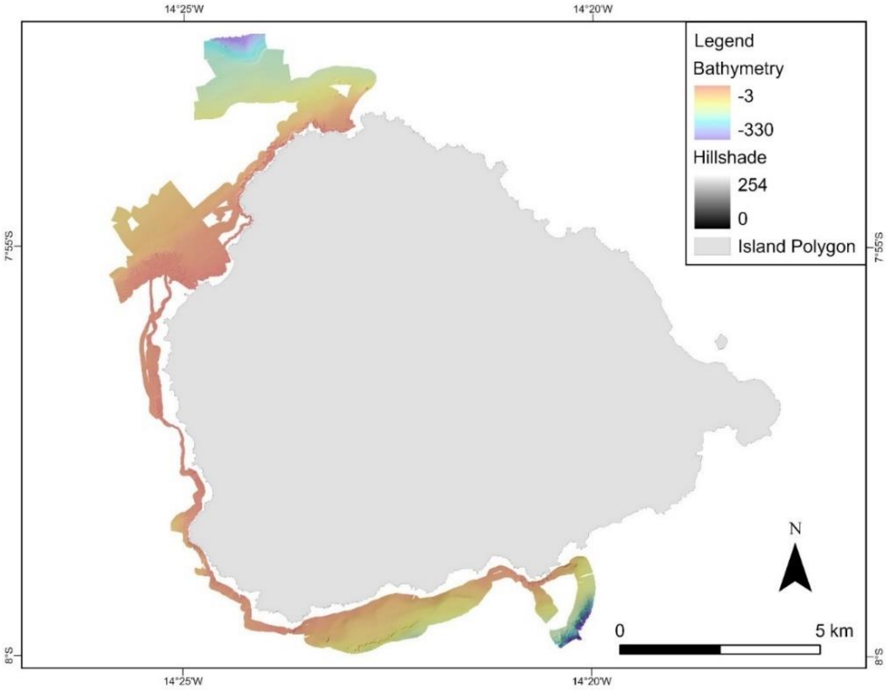

Figure 2-3 Overview of multibeam bathymetry data collected by and processed by BGS.

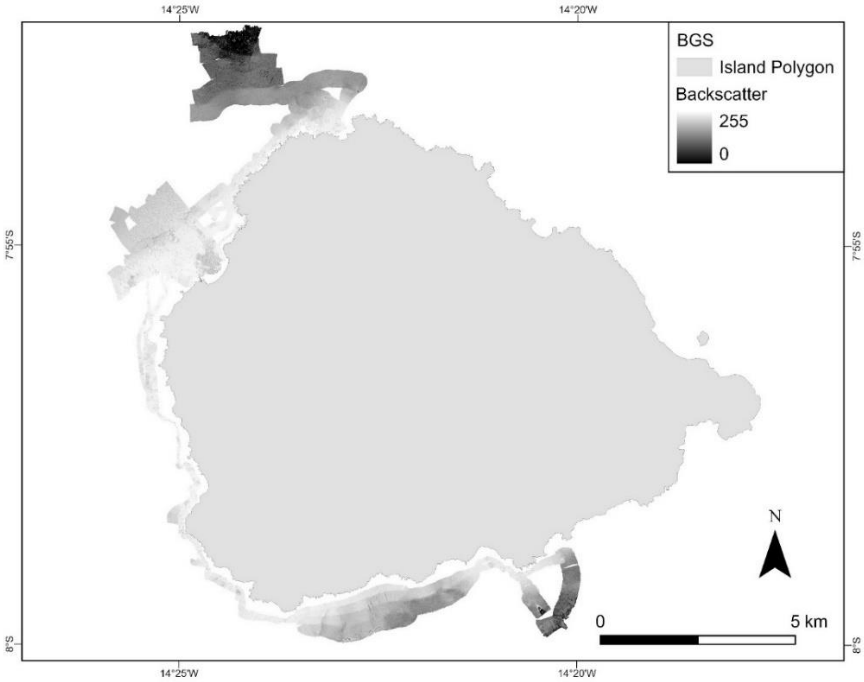

Figure 2-4 Overview of backscatter intensity data collected by and processed by BGS. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

2.3 SATELLITE-DERIVED BATHYMETRY (SDB)

EOMAP was contracted by the UKHO in 2022 to provide Satellite Derived Bathymetry (SDB) for HI 1773 covering all shallow waters of Ascension Island (approximately 0 m to 20 m water depth referenced to Chart Datum). This dataset was supplied to the BGS for the purpose of geological and habitat mapping by the UKHO. The data was received in CSAR and raster format and imported into ESRI ArcGIS Pro version 3.1.2 for interpretation purposes.

3 Ground-truth Sampling Data

The BGS undertook ground-truth sampling part of two survey campaigns in November 2023, and January 2024. During these surveys the BGS successfully deployed two different drop camera systems to collect video transects: Drifto 2000/GoPro11 and STR SeaSpyder Nano. See the Report of Survey OR/24/014 (Cooper and Macdonald, 2024) for more details.

A total of 50 samples around Ascension Island were collected over the two campaigns using both systems – 15 using the Drifto 2000 and 45 using the STR SeaSpyder Nano. The size of the vessel, manual handling of the camera systems, sea state and wind conditions meant these ground-truthing samples were primarily collected to the west and north-west of the island which allowed for more shelter from the prevailing sea and wind conditions.

Only nine physical samples were available within Clarence Bay, acquired by HMS Protector in 2021, and were also used in this assessment. Additional samples were also found in association with the James Clark Ross cruise in 2015 (Cunningham & Mitchell, 2001). However, the conservation team at the AIG were unable to source raw seabed imagery (video or stills) and physical samples for this study.

The 59 samples (**Figure 3-1**) were visually inspected to determine the dominant substrate type at the seabed allowing general, qualitative observations on the composition of the seabed sediments. For the purposes of this project, the seabed substrate interpretation has been converted into EUNIS sediment classes (EUSeaMap 2023). The EUNIS definition of sediment classes is based on the modified Folk (1954) classifcation, which is based on the gravel percentage and sand to mud ratio, of Long (2006). Sediment classes were subsequently sub-divided based on water depth and the biological zone at that particular geographic location to create the seabed habitat map.

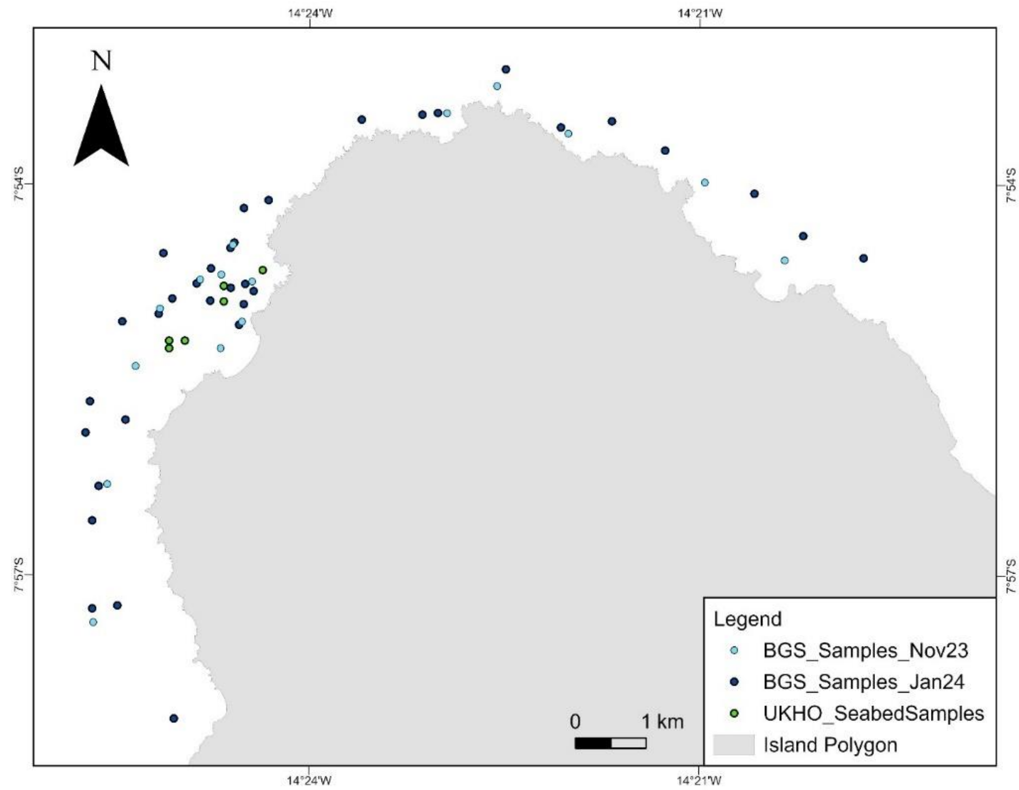

Figure 3-1 Overview of ground truth samples for Ascension Island. Data was sourced from the BGS surveys in 2023/24, and from the UKHO in 2021. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

4 Methodology

All processed bathymetric and backscatter intensity were imported into ESRI ArcGIS Pro version 3.1.2. Additional layers of slope, hillshade and aspect were derived from the processed bathymetry data using the 3D Analyst extension. Hill slope was calculated using an azimuth of 45° and an altitude of 25°. Layers depicting terrain roughness (VRM), or rugosity, were also derived from the bathymetric data using the Benthic Terrain Modeler extension (Walbridge *et al.*, 2018). All geographic maps were also produced in ESRI ArcGIS Pro version 3.1.2.

The final Geomorphology, Seabed substrate and Habitat maps are presented at a presentation scale of 1:10,000, with analysis and mapping being undertaken at generally finer scales, e.g., 1:5k – 1:8k. According to basic principles on the relationship between map scale, data resolution, and detectable feature size (Tobler, 1988) a map presented at 1:5000 may include individual features as small as 5 m x 5 m.

The final map products are based on a semi-automated mapping approach, summarised as entailing an automated, clustering-based method, analysing bathymetric derivatives (relative bathymetric highs and lows at multiple spatial resolutions) to detect and delineate seabed features. This automated step is followed by manual attribution of the predicted line-work, and minor editing, which is then integrated with the visual interpretation of the drop-camera samples. This approach is effective in that it uses computational power to produce detailed linework using consistent rulesets but then employs the expertise of the geoscientist to classify the features, and 'sense-check' the predicted results.

The workflow for the semi-automated method is summarised below.

1. Relative bathymetric highs / lows are determined at multiple spatial scales, and useful for identifying geomorphological features (**Figure 4-1**). An example of an approach used calculates the 'relative deviation from mean value '(RDMV) from the bathymetry data, using the TASSE geospatial toolbox (Lecours, 2015). The RDMV rasters are merged using the "Mosaic to New Raster" function in the "Data Management Tools" toolbox from ESRI ArcGIS.
2. The ISO Cluster Unsupervised Classification Tool uses an iterative clustering procedure, also known as a migrating means technique, to find the natural groupings of cells of shared properties. Clusters of three (3) and six (6) classes were produced for each maximum and minimum merged raster dataset.
3. The classified raster obtained from the above steps was converted to a vector polygon shapefile to produce a final, fully attributed, topologically clean, smooth vector dataset. The user can analyse the resulting map and change the number of classes until satisfied all likely changes in seabed substrate or morphology have been represented.
4. The vectorised output of the semi-automated process was reviewed manually to assign geomorphology or substrate classifications. Knowledge of the geological history of an area means the interpreter can 'sense-check' the outputs. Polygons can be amended, modified, and merged to best represent the acoustic data (taking account of derived layers of slope, topographic roughness or rugosity, and backscatter intensity), available ground-truthing samples and take account of the geological expert judgement.
5. Derivative layers of slope, hillshade, terrain ruggedness (VRM) or rugosity, and aspect were also derived from the processed bathymetry data using the 3D Analyst extension to aid the interpreter during the manual editing of the semi-automated mapping process.
6. The raster and vectorised data went through a spatial data checking procedure, to ensure standardised results that meet the Open Geospatial Consortium (OGC) specifications. This includes eliminating unwanted artefacts that may have formed during the data compilation. Artefacts can include gaps, slivers, duplicates and overlapping layers. Once erroneous data has been addressed, the attributes are reviewed for consistency.
7. The data checking was carried out in ArcGIS Pro, so the results were brought over to QGIS for data delivery. Using the QGIS plugin SLYR, layer files are imported with the appropriate symbology from ArcGIS Pro. Each vector layer is then packaged and each raster layer saved to a GeoPackage.

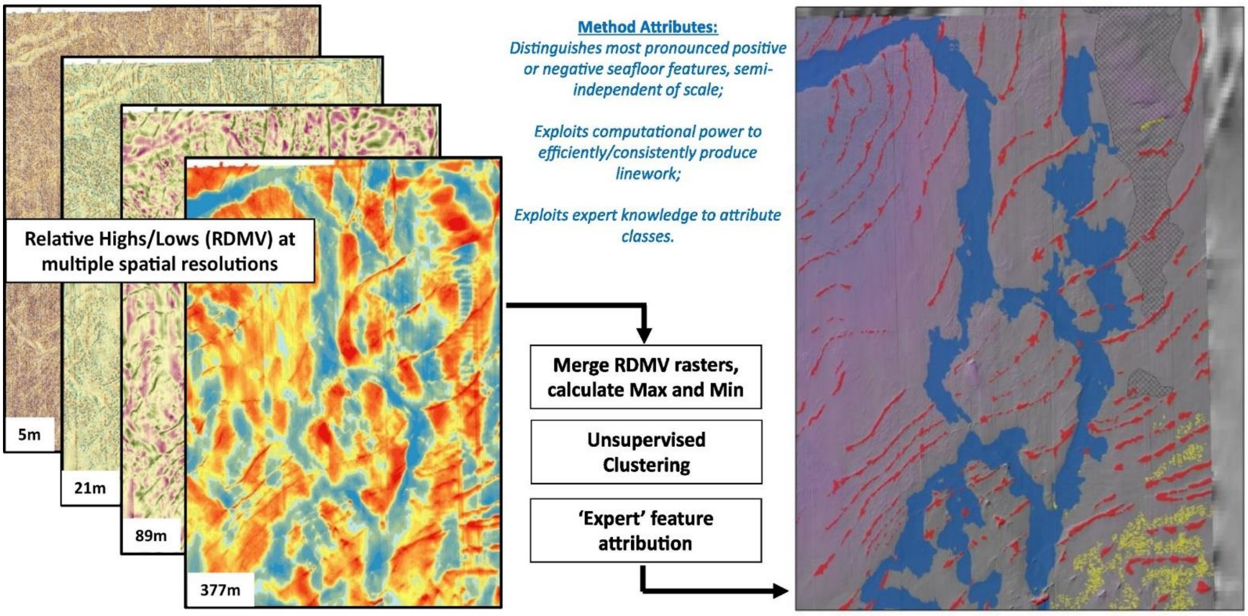

Figure 4-1 Semi-automated mapping of seabed geomorphology summary. Data example from Dove *et al*. (2021) for a study area located East of Orkney. BGS © UKRI 2024.

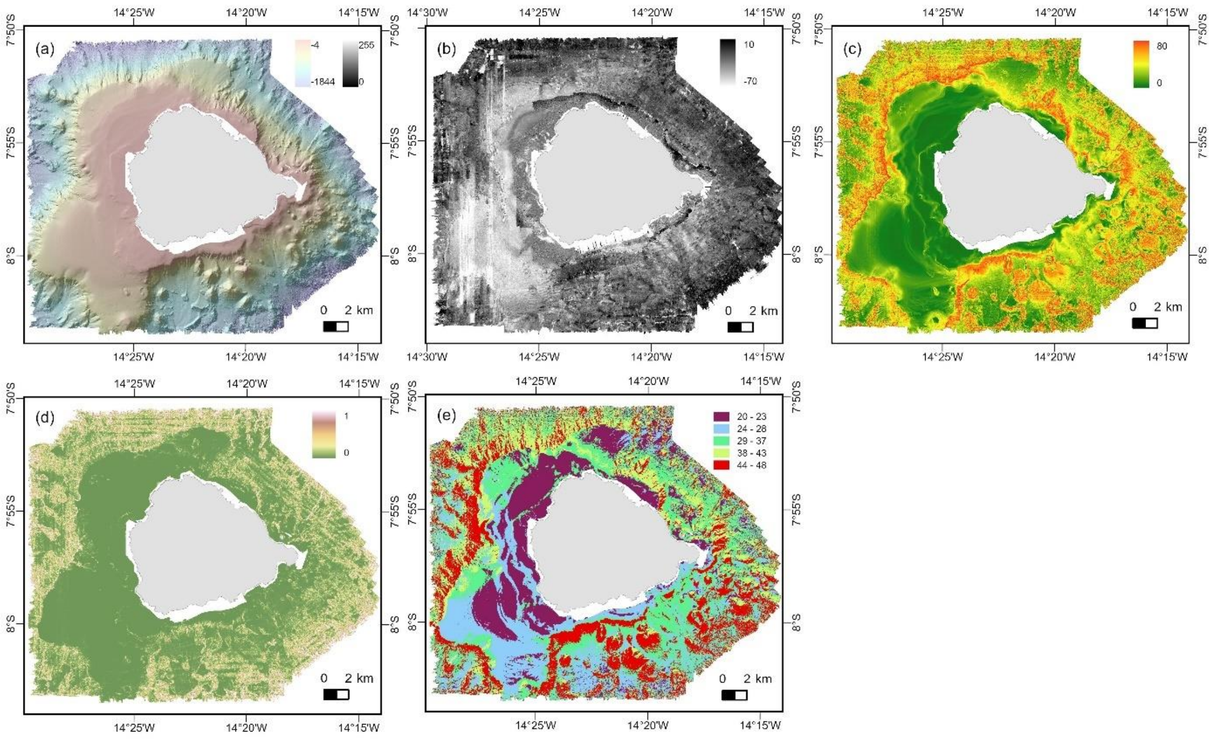

Figure 4-2 Overview of the MBES bathymetry / backscatter intensity data and associated derived layers for the Ascension Island MPA. (a) MBES bathymetry data from HMS Protector from 1 m to 10 m resolution; (b) backscatter intensity data for SMB James Cairn and HMS Protector at 1 m and 6 m resolution respectively; (c) slope angle derived from bathymetry grid; (d) terrain ruggedness (VRM) or rugosity derived from bathymetry data; (e) aspect derived from bathymetry data. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

5 Results - Seabed Geomorphology, Seabed Substrate, and Seabed Habitats

Ascension Island is a remote volcanic island situated in the South Atlantic, approximately 90km west of the Mid-Atlantic Ridge. A narrow insular shelf around Ascension Island was revealed during previous multibeam sonar survey by the James Clark Ross in 2015 (e.g., Cunningham & Mitchell, 2001). The shelf is widest to the north and west of the island where it extends approximately 7 km offshore to a depth of 450 m, as shown in the Seabed Geomorphology map in **Figure 5-1**. It is typically much narrower to the south and east of the island where the slope increases steeply. Beyond the shelf break, the seafloor plunges steeply into the abyssal plain, reaching depths of several thousand meters. The shelf itself is marked by a variety of underwater features, including submerged ridges, volcanic seamounts, and deep valleys that have been shaped by tectonic processes and past volcanic activity.

The new datasets outlined in the sections above means that the geology of the seabed and submarine geomorphological features within the AI-MPA can be mapped in detail for the first time. Here we present and describe the resulting map products: 1) Seabed Geomorphology (extending to 1000 m depth), 2) Seabed Substrate (extending to 300 m depth), and 3) Seabed Habitat (extending to 300 m depth).

5.1 SEABED GEOMORPHOLOGY

5.1.1 Mapping Approach

Seabed geomorphology mapping generally follows the 'two-part' mapping approach developed by BGS together with other international marine mapping groups (Geological Survey of Norway, Geological Survey Ireland, Geoscience Australia; https://www.geomorph.org/international-seabed-geomorphology-mapping-working-group/). The basic approach is outlined below but further information can be accessed via the following publications: Dove et al., (2016), Dove et al., (2020) and Nanson et al., (2023).

The approach involves an independent assessment of 'Morphology' and 'Geomorphology'. The Morphology defines the fundamental physical shape of feature (e.g. Bathymetric High > Mound > Streamlined Mound) or process associated of features and are characterised only by the features form i.e. size, shape, configuration, texture. Geomorphology features are defined by both their form and the environmental and interpreted geomorphological process(es) that created that morphology (e.g. Solid Earth > Volcano > Seamount).

Only seabed features that have discernible morphological expression are mapped, and all have a morphology class assigned. The geomorphology class is only attributed where the mapper feels confident in their interpretation. This includes all polygon, line and point features visible at 1:10,000 scale.

The following sections provides a summary of the main geomorphological features mapped, giving a general description of morphology, distribution, and interpretation, and the scientific findings resulting from the geological mapping presented in the BGS Geomorphology 10k: Ascension Island map products. The section describes the key characteristics mapped, however does not provide a systematic description of all mapped deposits and features, nor an exhaustive description of the area's geological and palaeoenvironmental history. Relevant references are provided within.

5.1.2 Geological Findings

The new high-resolution bathymetry data allows comprehensive mapping of the geology and geomorphological features of Ascension Island for the first time. The seabed around Ascension Island exhibits a highly variable geological character, with geological units and features preserved that show the unique volcanic nature of the island. The bathymetry data showed that the volcanic edifice of Ascension Island extends well below sea level, and the area around the island is characterised by volcanic landforms (e.g., minor eruptive centres, lava flows) and erosional-depositional landforms as shown in the Seabed Geomorphology map in **Figure 5-1**. The features mapped are shaped by different processes including volcanic eruptions, submarine landslides, and erosion.

The below sub-sections provide general geological context and summary descriptions of the key elements observed in the Seabed Geomorphology - Ascension Island mapping. A complete listing of the mapped features may be found in **Appendix 3**.

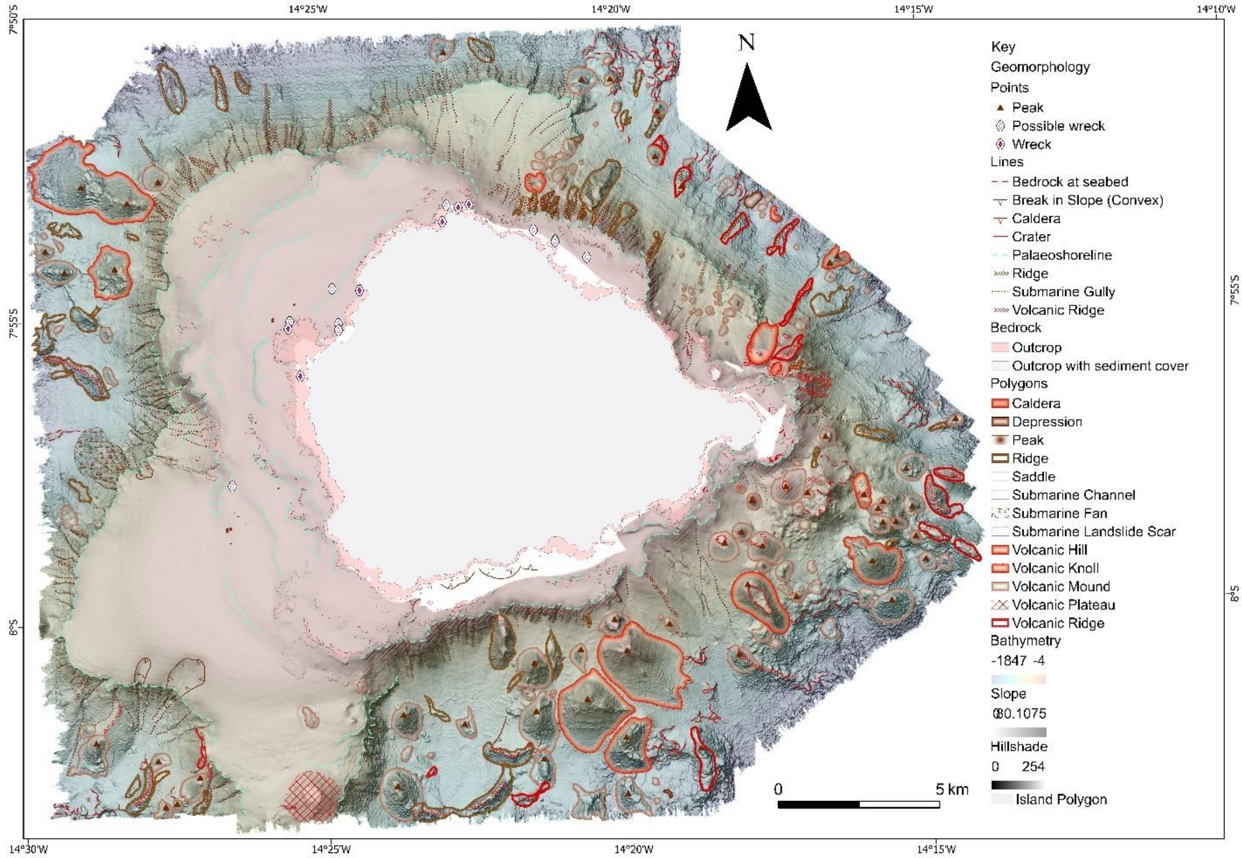

Figure 5-1 Seabed Geomorphology map of the Ascension Island MPA to 1000m, interpreted at 1:10,000 scale. Bathymetry data from the UKHO. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

5.1.2.1 PALAEOSHORELINES

The bathymetry data around Ascension Island reveals a narrow insular shelf, which is widest to the north and west of the island and is marked by variety of features which reveal insights into the formation of the island. The shelf width and depth can provide indication of the development of the volcanic edifice, with larger widths being indicative of older volcanism, and narrower shelves relating to younger volcanic products which have been exposed to fewer cycles of marine erosion (Romagnoli et al., 2018).

The new bathymetry data presents several linear concave or convex morphological break in slopes features, as shown in **Figure 5-2**. These are interpreted to represent palaeoshorelines and typically are mapped around the shelf edge or in relation to exposed bedrock. Palaeoshorelines are relict shorelines, indicated by preserved coastal landforms (e.g. escarpments with shore platforms). These palaeoshorelines may also represent a set of submarine depositional terraces (erosive surfaces of insular shelves) formed due to a seaward transport of sand from the shoreface during storms and affected by wave erosion (Romagnoli et al., 2018). However, future work should be done to analyse the shelf width, depth and coastal morphology.

Previous studies also indicated that these may represent marine terraces including the example mapped in **Figure 5-2** around the shelf edge at approximately 200 m depth on the westerly side, and at 700 m depth in the NE slope (e.g., Klingelhöfer et al., 2001; Minshull et al., 2010, etc). These features may have formed due to several geological and oceanographic factors such as uplift of the island (Nielson & Sibbett, 1996) or subsidence (Minshull et al., 2010). Other factors which have been noted at other volcanic islands in the Atlantic (e.g., Azores Islands) include changes in sea level, hydrodynamic regimes or shelf gradients, morphology of the shelf and the intensity of marine erosion (e.g., Ricchi et al. 2018; Quartau et al., 2014).

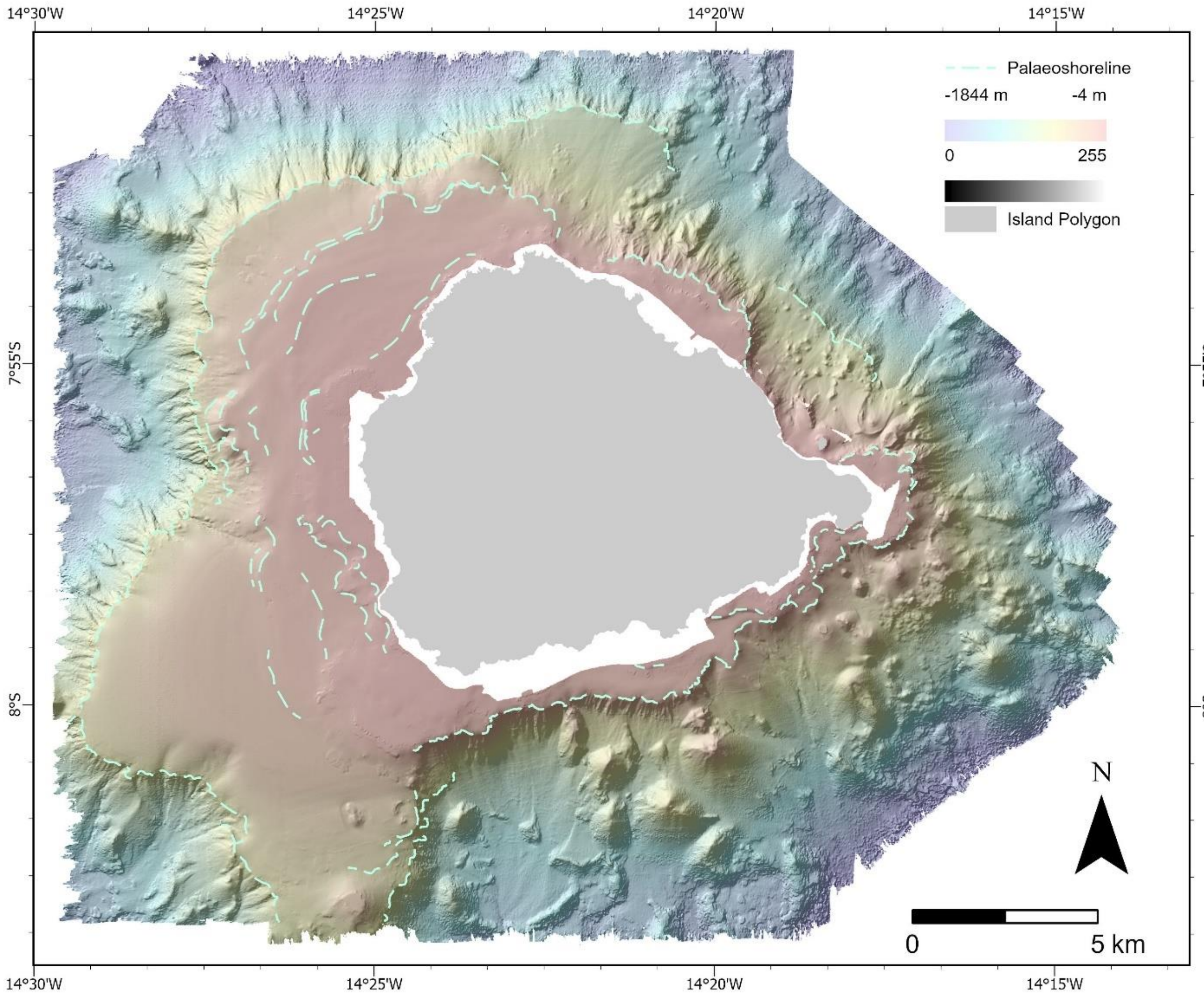

Figure 5-2 Multibeam bathymetry map of island and surrounding shelf. Coloured lines (light blue) represent the submerged palaeoshorelines around Ascension Island. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

5.1.2.2 Volcanic Features

Bedrock

Much of the coastline around Ascension is comprised of rocky coastal cliffs. Rocky coasts, formed by volcanic processes, are characteristic of young oceanic islands with no fringing reefs (Rodriguez-Gonzalez et al., 2022). The bedrock which forms these cliffs can be traced offshore around most of the island and is mapped as 'Bedrock at seabed'. The bedrock is primarily composed of mafic and silicic lava flows (Vye-Brown and Crummy, 2014). This is in keeping with other young volcanic islands (e.g., the Canary Islands; Rodriguez-Gonzalez et al., 2022) where the flanks of submarine volcanoes are typically formed through emplacement of multiple phases of lava flows which stack on top of each other.

Figure 5-3a presents an example of a mapped bedrock section which extends off the coast of Georgetown to the northwest of the island. The bedrock is highly rugose (**Figure 5-3b**), characterised by variable slope, and appears to be constructed of multiple lobate flows which may be fractured to form ridges and slopes. Many of these coastal sections may represent an area where the lava flows continued over a palaeo-cliff edge on to the shore platform, facilitating progradation of a lava delta (Rodriguez-Gonzalez et al., 2022).

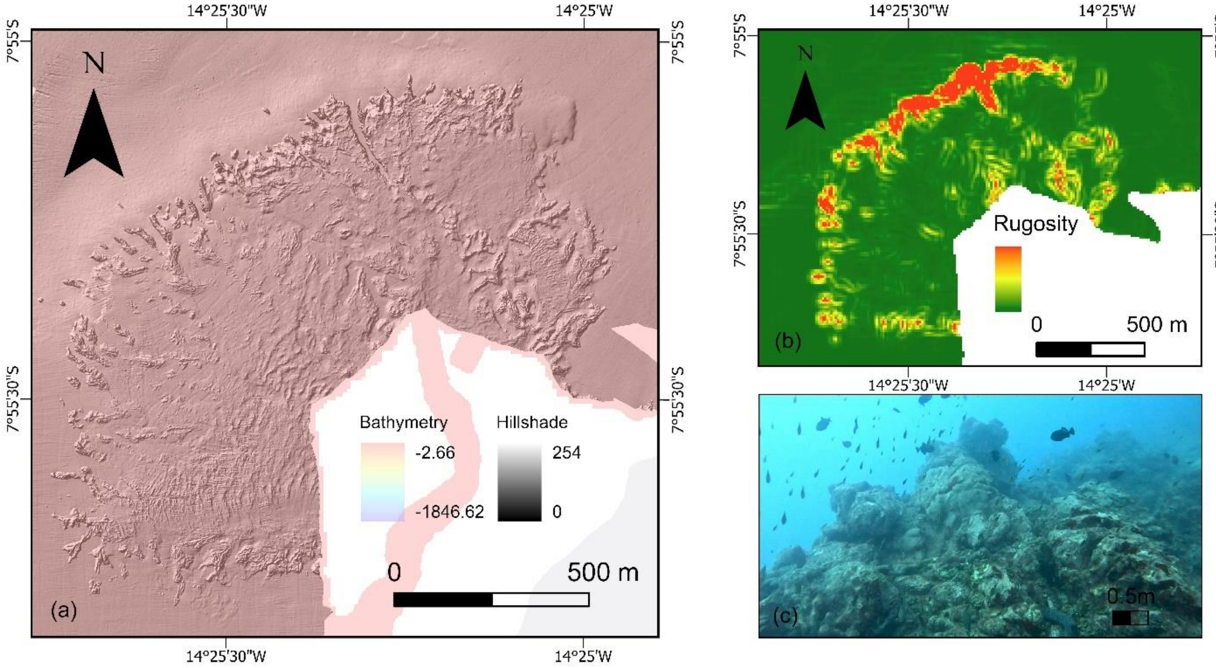

Figure 5-3 (a) Multibeam bathymetry data, gridded at 1 m x 1 m resolution, displaying lava flows which extends offshore from Georgetown in the northwest of the island; (b) terrain ruggedness (VRM) or rugosity derived from 1m grid; (c) example of "bedrock at seabed" from the drop-camera video. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

<u>Volcanic Landforms</u>

Volcanic landforms mainly include primary volcanic constructs (cones, lava flows and delta, undifferentiated bedrock outcrops), but also volcano-tectonic features, such as caldera collapses, shown in **Figure 5-4a**. Previous studies revealed the presence of at least five seamounts around Ascension including the only known actively growing seamount named Proto-Ascension (Klingelhöfer et al., 2001; La Bianca et al., 2018). However, the new bathymetry data reveals many previously unmapped volcanic features around the island, displaying a range of different morphologies and textures as shown in **Figure 5-1** (e.g., lava flows, calderas, craters, ridges, hills, knolls, mounds and plateaus).

Image (a) in **Figure 5-4** displays a volcanic complex off the east of the island where the shelf is much narrower. Two ridges extend off a smooth mound with central depression which sits next to a large, elongated depression with a flat floor bounded by a steep scarp. The mound may represent a submerged scoria cone, whilst the depression is interpreted as a collapsed caldera with the steep scarp interpreted as the rim.

Image (b) in **Figure 5-4** shows three volcanic knolls which occur in isolation and have relatively steep flanks. The northern two volcanic knolls are pointed with a relatively smooth texture, whilst the southernmost volcanic knoll is also pointed but displays a more rugose and terraced appearance, particularly on the south and western flanks. Terraced or stepped areas such as this are commonplace around the island with much of the seabed in the deeper sections of the island having a rugose texture. This geomorphology suggests that the mapped bedrock off the western flank of the volcanic knoll in **Figure 5-4b** is constructed of multiple lobate flow units and was likely emplaced during successive lava sheet flows which may be related to the volcanic edifice. Other mounds around the island also occur as isolated edifices or a clustered mound with lava flows or small debris flows off the flanks (Sánchez Guillamón et al., 2015).

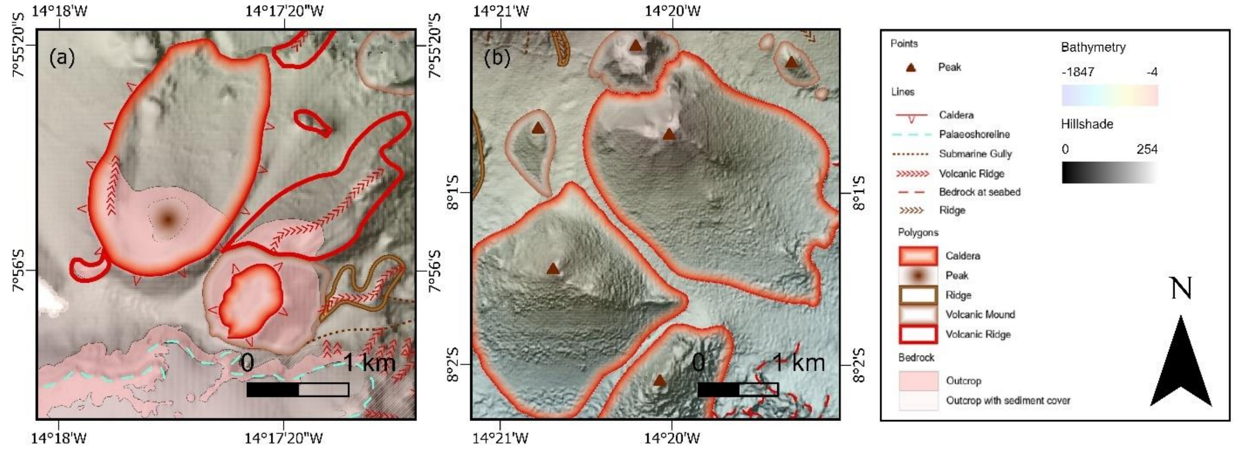

Figure 5-4 Extract from the BGS Seabed Geomorphology map of Ascension Island. (a) displays a steep slope topped with bedrock, a collapsed caldera and scoria cone to the east of Ascension Island. (b) shows three volcanic knolls, and associated ridges, to the south of the island. BGS © UKRI 2024.

5.1.2.3 EROSIONAL-DEPOSITIONAL FEATURES

The coastline around Ascension is shaped by a variety of physical forces, including erosional and depositional processes, significantly due to the high-energy hydrodynamic environment around the island. Erosive-depositional landforms include features related to wave erosion and sea-level fluctuations (e.g., insular shelves), gravity-driven instability processes (e.g., landslide scars), and density gravity flows (e.g., gullies, fan-shaped features) (Micallef et al., 2018).

Narrow, irregular and infrequent coarse sandy beaches are confined to the north and west coast of the island with no enclosed bays or sheltered lagoons present. Where present, the beaches display an erosional profile which are constantly being reworked due to the strong hydrodynamic regime. Also, submarine cables installed around the island have typically failed at or near the shoreline (e.g., Thomson et al. 2002).

Current-induced bedforms are typically absent from the AOI, which may be related to the hydrodynamic regime, and but likely also due to low volumes of sediment available around the island. The main factors which influence sediment supply and transport rate are the location and area of the island, volcanic activity, climate change and sea-level change (Krastel et al., 2001), as well as the relative age of the island and precipitation rates.

<u>Submarine fans, channels and gullies</u>

Submarine channels and gullies are a common feature mapped around Ascension Island, which are mapped as both morphological and geomorphological features. The insular shelf edge is incised by many gullies which are narrow, channelised features that commonly have a V-shape. These are also present around the flanks of some of the volcanic mounds and knolls. A submarine channel system which extends to the edge of the insular shelf edge is shown in **Figure 5-5**. The channel is approximately 2000 m length, and two headwall scars is also mapped beneath the shelf edge.

A potential fan-shaped system is also present along the shelf edge to the west of the island, which may be associated with an unconfined gravity flow. The feature is approximately 1000 m wide, and nearly 1800 m long, and is characterised by a ridge and trough morphology indicating that it may have formed because of stacking of gravity flows (Micallef et al., 2018).

<u>Submarine landslides</u>

Evidence of past submarine landslides is present in the multibeam bathymetry data around Ascension Island. **Figure 5-5** presents an example of two small-scale submarine landslide scars along the shelf edge to the west of Ascension Island (<1 km wide). These are features of the source zone; however, no evidence of debris deposits from the landslides is noticeable on the multibeam bathymetry data at the resolution available. This is a common characteristic of these types of scars as the landslide mass either lost cohesion during failure or failed as a cohesive mass and disintegrated downslope (Micallef et al., 2018).

Data from the Royal Navy (as shown in Mitchell,2003) suggested the present of two embayment's on the NE and NW slopes where the shelf is very narrow. Little is known about the failure of these events (Mitchell, 2003), and smaller sized landslides such as these are a yet unquantified tsunami-risk of mid-ocean islands (Tinti et al., 2005). In addition, these features typically have smaller collapse heights and runout distances so factors (such as weak underlying pelagic sediment layers) may be different to deep-basin island collapses which have been studied extensively in the Hawaiian and Canary Islands.

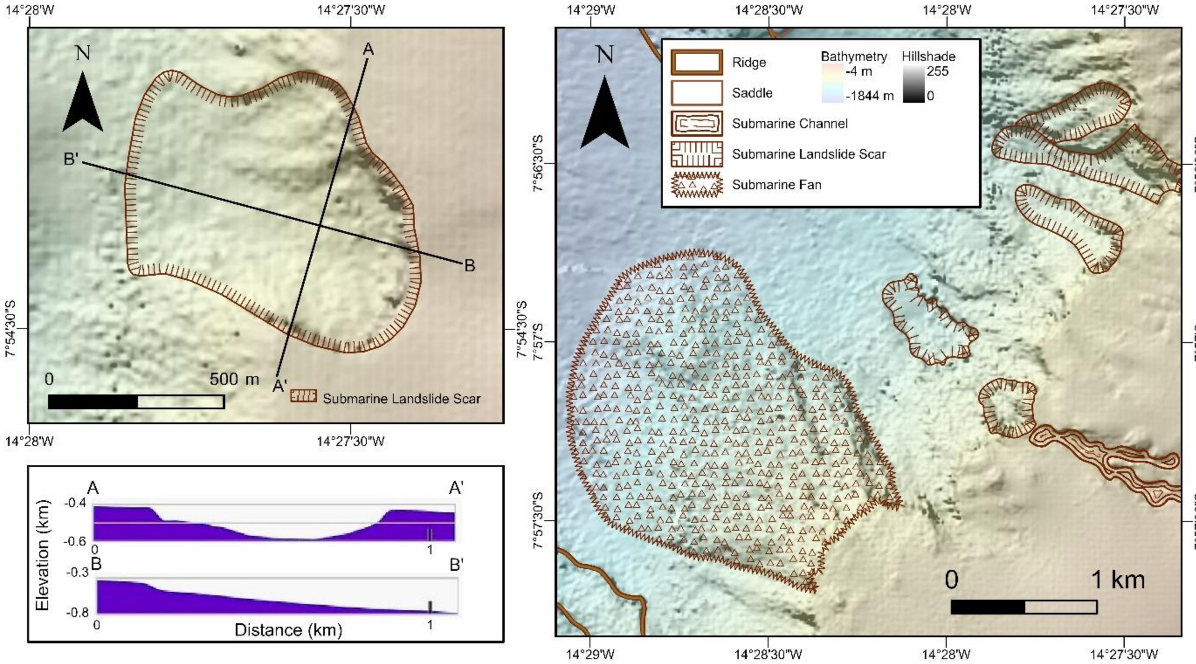

Figure 5-5 Map showing erosional-depositional features from Ascension Island. The image on the left displays a submarine landslide scar from the edge on the insular shelf edge, and slope profiles from northeast to southwest and east to west are shown below. The image on the right shows an example of a submarine fan, submarine landslides scars and a submarine channel. BGS © UKRI 2024.

5.1.2.4 Anthropogenic Features

Anthropogenic Features are mapped where they have a clear bathymetric expression, and/or impact the immediately surrounding seabed morphology (e.g. scour). These features are mapped here to provide an indication of the interactions between anthropogenic features and natural seabed processes.

Wrecks

Numerous Wrecks are mapped as point features within the map area. Wrecks are only mapped where either the wreck or surrounding seabed (e.g. scour) has a clear morphological expression. This geomorphology map should not be used as an official geospatial source for location data of any wreck (or other anthropogenic features. For further information of wrecks around Ascension Island please consult the International Wreck Database (https://www.wrecksite.eu/).

5.2 Seabed Substrate

Superficial deposits include all unlithified deposits such as modern marine sediment, mass movement or bedrock rubble/talus (Stoker et al., 2011). Interpretation is largely based use of a predictive backscatter interpretation tool to map observable changes in seabed texture on the bathymetry and backscatter intensity data which was then tweaked manually using video analysis of the drop camera samples. The seabed substrate is only mapped where backscatter intensity information is available (as shown in **Figure 2-2** and **Figure 2-4**). The seabed geomorphology (**Figure 5-1**) and rugosity layers (**Figure 4-2**), were also used to guide boundaries (e.g. bedrock). Using this information a simple six class system has been adopted with undefined proportions of Sand and Gravel (after Folk, 1954).

The following six sediment classes were identified via video analysis of the drop-camera imagery outlined in **Section 3**. The sediment classes are shown in **Figure 5-6** and are as follows: (a) Sand (with minor gravel i.e. c. 5 %); (b) Gravelly Sand (Mixed sediment – Sand dominant with 5-30 % gravel); (c) Sandy Gravel (Mixed sediment - Gravel dominant with 30-80 % gravel); (d) Rhodolith and Mixed Sediment (Gravel to Cobbles – minor sand); (e) Bedrock with superficial sediment cover, and (f) Bedrock Outcrop. The resultant map of the Seabed Substrate between 0 to 300m depth is shown in **Figure 5-7**.

The dominant sediment class across the entire area is 'Mixed sediment', found with varying proportions of sand and gravel (i.e. Sandy Gravel or Gravelly Sand). This was split based on a visual inspection of grain size on the video analysis and guided by the predictive linework. "Sand" only areas also contain minor gravel (c. 5 %) but were mapped primarily in the nearshore beach areas and was characterised by occurrence mobile bedforms and visible mobility of the sediments on the videos. Visual ground-truthing of the "sand" on the beach areas around the island showed it to be coarse-grained with shell fragments. Rhodolith is defined as "colourful unattached calcareous nodules composed of marine red algae". It may be present in other areas, (for example around Sample 18, 5 and 39), however, it was mapped only in areas where it was easily identifiable on the video transects and no predictive mapping has been attempted. The areas mapped as "Rhodolith" also contains varying quantities of mixed sediment, and so may be classed as "Sandy Gravel" where ground-truthing information is not available.

Bedrock is split into two classifications. "Bedrock outcrop" (assumed to be mainly volcanic in origin) is dominantly mapped along the coastline, and is linked directly to the "Bedrock at seabed" layer on the Seabed Geomorphology map (**Figure 5-1**). The "Bedrock with discontinuous sediment cover" is primarily based on predictive linework from the backscatter and rugosity layer.

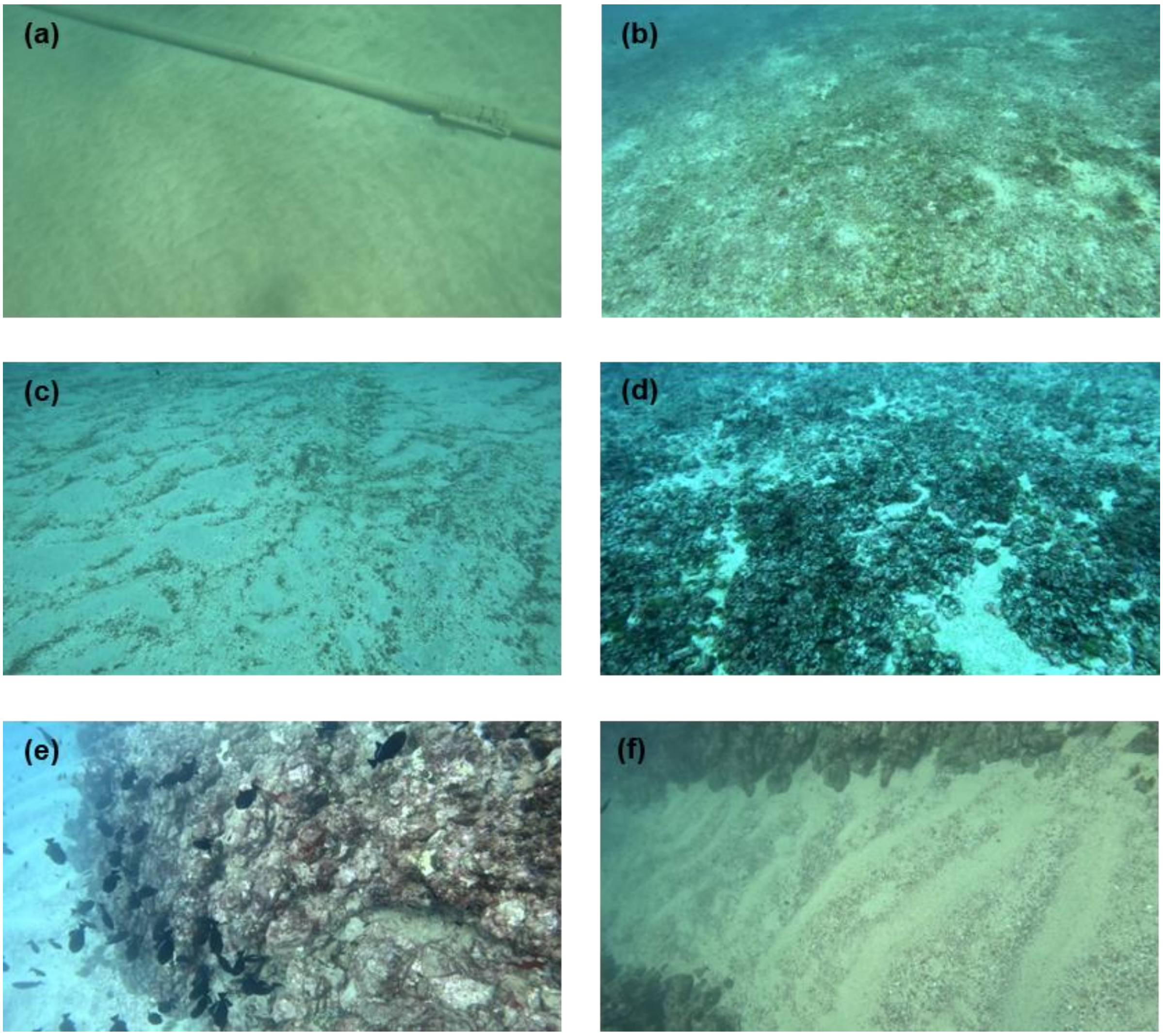

Figure 5-6 Seabed sediment images taken from video stills of drop-camera data from BGS in November 2023. (a) “Sand and pipe on seabed”; (b) “Sandy Gravel (Mixed sediment – Gravel dominant)”; (c) “Gravelly Sand (Mixed sediment – Sand dominant)”; (d) “Rhodolith and mixed sediment (Gravel to Cobbles – minor sand)”; (e) “Bedrock Outcrop”; (f) “Bedrock with discontinuous sediment cover” (sediment between bedrock ridges are interpreted as “Sand” (Image a)). BGS © UKRI 2024.

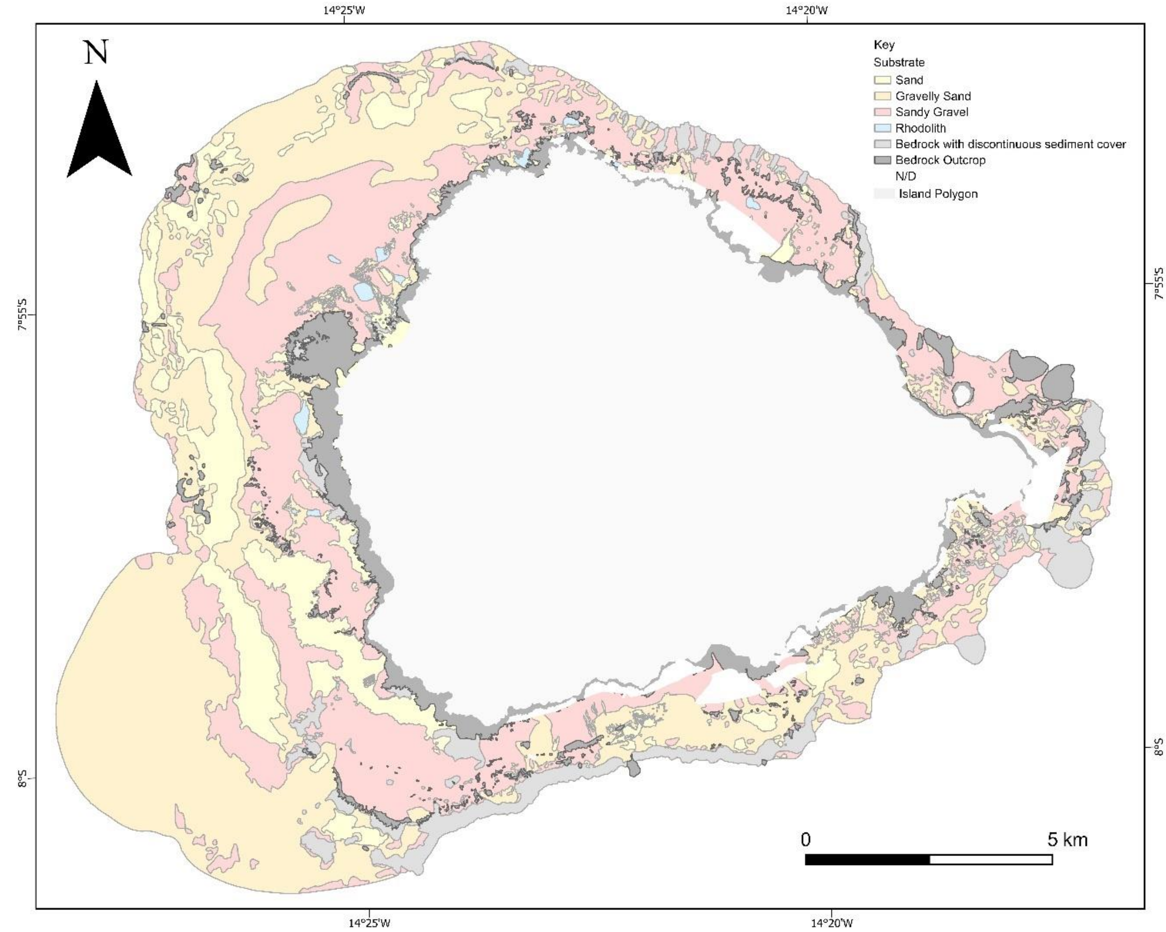

Figure 5-7 Overview of the seabed substrate interpretation undertaken for this project using EUNIS sediment classes. This work is undertaken primarily using the 0.5 m resolution multibeam bathymetry, derived terrain ruggedness, and 1.0 m resolution backscatter intensity datasets. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

5.3 SEABED HABITATS

Due to its isolation, position within ocean circulation and relative geological youth, Ascension Island harbours a unique marine environment, representing species from both the East and West Atlantic Oceans. These factors are also thought to have contributed to the relative low species numbers recorded around the island, and high abundance of species and level of endemism (Brickle et al., 2017). A study by Barnes et al., (2015) recorded 594 marine species around Ascension, including marine vulnerable marine environments, with the richest and densest biodiversity observed between 200 to 500 m depth.

The nearshore habitats, particularly the sub-tidal rock areas, also hold the highest species richness with an array of benthic and pelagic species. The seabed substrate along the coastline around Ascension Island (as shown in **Figure 5-7**) is primarily composed of volcanic rocky substrate (formed by lava flows which have fragmented to form slopes and ridges with infrequent and irregular beaches of coarse sand.

To map the nearshore seabed habitats, the seabed substrate interpretation (**Figure 5-7**) was converted into EUNIS habitat type (EUNIS, 2019). To achieve this a map of five biological zones were defined (following consultation with the AIG Marine Conservation department), where each zone was delineated by water depth (e.g. infralittoral <20 m) or broad region (e.g. abyssal) at that particular geographical location (

Figure 5-8) (EUSeaMap, 2023).

To convert the Seabed Substrate Map to a Seabed Habitat Map, five biological zones were defined following consultation with the AIG Marine Conservation Department. These zones were then used to clip and reclassify the symbology with the appropriate attribution (i.e. substrate type and zone) to allow the EUNIS classification system to be applied for the Seabed Habitat map. By creating a copy of the sediment map and creating a new field in the attribute table, the corresponding EUNIS classification values were assigned, based on where the substrate intersected each biological zone. Thus, "*gravelly sand"* becomes "*mixed sediment"*, "*sandy gravel"* becomes "*coarse sediment"*, "*Rhodolith"* becomes "*biogenic habitat"* while sand and rock followed the same naming convention. An additional entry (not specified by the EUNIS classification system) was created for the habitat map, to account for "*bedrock with discontinuous sediment cover"*, hence, the "*rock and other hard substrata"* entry.

Each zone was delineated by water depth (e.g. infralittoral <20 m) or broad region (e.g. abyssal) at that particular geographical location () (EUSeaMap, 2023). Therefore, the zones are defined as follows: Infralittoral (0 to 20m depth); Circalittoral (20 to 30m); Deep Circalittoral (>30m to shelf edge); Bathyal (Shelf edge to foot of slope) and Abyssal (> base of slope). Using these zones the following EUNIS Seabed Habitat Classifications (**Figure 5-9**) were defined: "Infralittoral Superficial Deposits"; "Circalittoral Superficial Deposits", "Offshore Circalittoral Deposits", "Upper Bathyal Circalittoral Deposits", and "Abyssal Superficial Deposits". The subsequent Seabed Habitat map is presented in **Figure 5-9**.

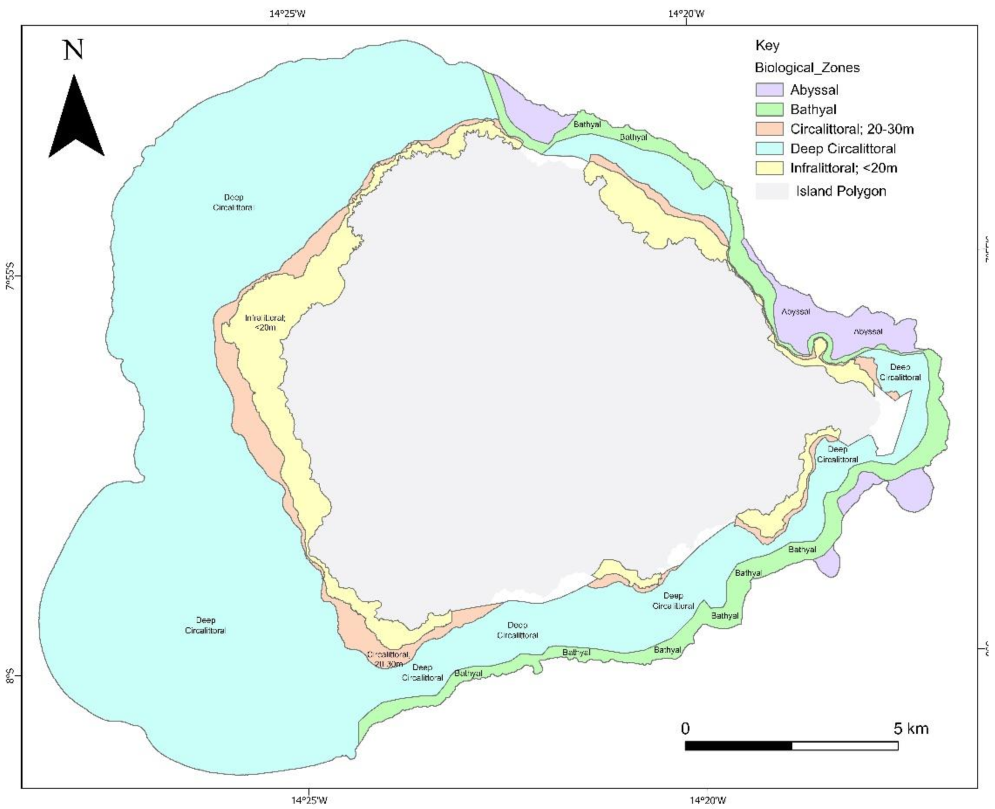

Figure 5-8 Biological zones within less than 300 m water depth around Ascension Island. Biological zones were delineated by water depth or broad region at that particular location.

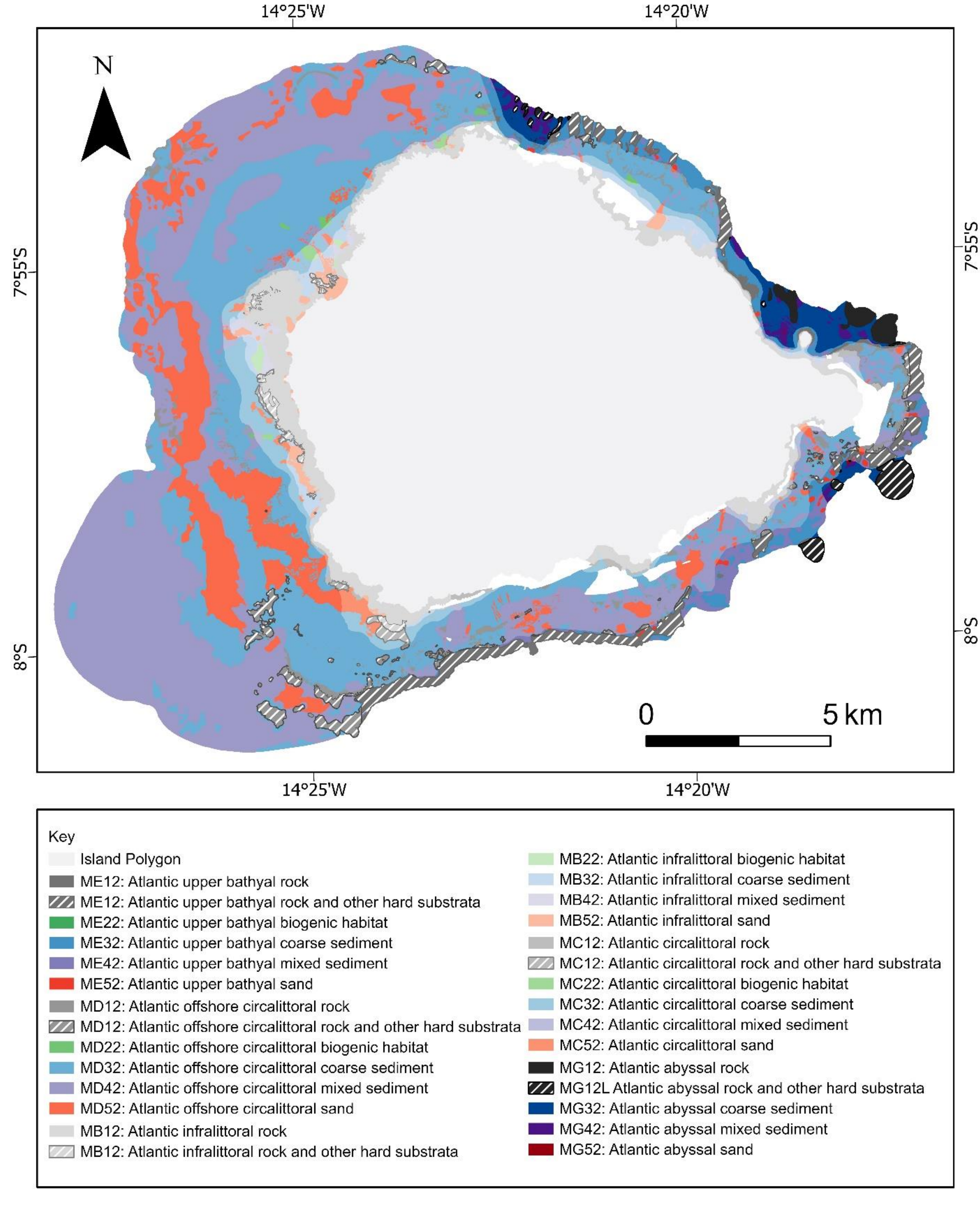

Figure 5-9 Overview of the seabed habitat interpretation for the Ascension Island MPA undertaken for this project using EUNIS classification scheme. Coastline shapefile provided by AIG Conservation Department. BGS © UKRI 2024.

6 Potential geoconservation considerations for the Ascension Island MPA

The components of the geodiversity were formed during periods of volcanic activity and sea-level fluctuations over the last 1 million years or so (e.g., Klingelhofer et al., 2001; Bruguier et al., 2003 Jicha et al., 2013). They are entirely natural in origin and are not considered to have been modified by human activity. The eruption history of the volcanic features is unknown, and so this dataset provides a baseline for monitoring of the volcanic hazard potential of Ascension Island in the future.

Seamounts and ocean islands, such as Ascension, provide suitable habitats for a range of marine life including many endemic and vulnerable species. Seamounts are typically associated with increased production in surface water activity which attracts a high density of species due to a variety of oceanographic phenomena. These include but are not limited to localised upwelling, formation of Taylor cones, tidal rectification, eddy shedding and enhanced turbulent mixing leading to a higher availability of food resulting in a higher biomass of organisms compared to neighbouring regions (e.g., abyssal plains and the continental slope) (White et al., 2008). Pelagic and benthopelagic fish including tuna, billfish and sharks, as well as other large pelagic organisms such as squid, turtles, and mammals have been quantitatively shown to have a higher abundance and/or biomass on seamounts than in comparable environments (e.g., Bridges et al., 2021; Campanella et al., 2021).

6.1 GEOMORPHOLOGICAL FEATURES

Seamounts, and associated smaller-scale volcanic features, are regions of high habitat heterogeneity because of the variable topography and oceanographic conditions. The summit may be flat, and sediment covered, while the flanks may consist of steep rocky slopes and near vertical cliffs. Bridges et al., (2021) discussed the major large-scale drivers of seamount benthic assemblage structure in the South Atlantic which include latitude (linked to surface primary productivity), depth (linked to temperature and water mass structure), longitude, FBPI and slope. Other environmental factors which also influence the composition and distribution of assemblages include the local hydrodynamic regime, topography, distance from shore, substrate type and the amount of dissolved oxygen.

Slope is an important driver as steeply sloping areas are typically characterised by fast flowing bottom currents that can scour the seabed revealing bedrock which slower currents on top of seamounts create soft substrate environments or accumulations of cobbles (Stephens and Diesing, 2015). This leads to increased surface heterogeneity increasing the macrofaunal diversity and ultimately means that a wider range of filter feeding taxa can survive.

In addition, submarine hazard risk relating to volcanic islands such as Ascension include explosive volcanic eruptions, landslides and lava flows which may impact marine habitats and marine life within the MPA. The hazard potential of Ascension Island is currently unquantified (Crummy et al., 2023), and this dataset now serves as a baseline for future monitoring.

6.2 SEABED SUBSTRATE AND HABITATS

Nearshore habitats are a key component of the AI-MPA as they comprise high biodiversity, including at least 30 endemic species, and are also the area's most at risk from anthropogenic development and climate change(Ascension Island Government, 2025).

The nearshore habitats, particularly the sub-tidal rock areas, hold the highest marine richness with an array of benthic and pelagic species. The seabed substrate around Ascension Island is primarily composed of volcanic rocky substrate (formed by lava flows which have fragmented to form slopes and ridges) with infrequent and irregular beaches of coarse sand. Many of the expected tropical coastal habitats (e.g. mangroves, seagrass beds, coral reefs) are also absent around Ascension Island (Barnes et al., 2015).

Importance of substrate type in driving assemblage structure is represented in the identification of slope and Bathymetric Position Index (BPI). Steeper or more rugose areas result in more exposed hard rock and reef communities; whilst depressions become filled with finer sediments. Depth and substrate type are therefore a primary driver of soft substrate benthic assemblage distribution (Bridges et al. 2021).

7 Conclusions and next steps

7.1 CONCLUSIONS

The newly acquired high-resolution multibeam bathymetry and backscatter intensity data (1 m to 10 m resolution) will add significant value to multiple future marine projects within the Ascension Island MPA (AI-MPA), and within this project have enabled the mapping of Seabed Geomorphology, Seabed Substrate, and Nearshore Seabed Habitats within the AI-MPA.

Detailed mapping of seabed geomorphology was conducted down to 1000 m and identified a range (many previously unidentified) of volcanic, erosion-depositional and coastal features including volcanic knolls and mounds, ridges, submarine gullies and channels, and submarine landslide scars. These features comprise a range of geodiversity features that are of international scientific importance for our understanding of volcanic ocean islands, and associated geomorphology features. The geodiversity interest is intrinsically linked to the conservation interests of the MPA.

Mapping of the Seabed Substrate and associated Seabed Habitats using the EUNIS classification (EUNIS, 2019), was completed down to 300 m water depth. Six sediment classes were delineated for the Seabed Substrate Map including “Sand”, “Rock”, “Rhodolith” and “Mixed Sediment”, which was separated by estimation of gravel content. Validating the mapping layers was limited due to the sparse availability of physical samples. However, the backscatter intensity data and derived layers of terrain ruggedness and slope were essential in delineating between the substrate class boundaries where no visual drop-camera or sediment grabs were available.

To convert the Seabed Substrate Map to a Seabed Habitat Map, five biological zones were defined following consultation with the AIG Marine Conservation Department. Each zone was delineated by water depth (e.g. infralittoral <20 m) or broad region (e.g. abyssal) at that particular geographical location (

Figure 5-8) (EUSeaMap, 2023). Using these zones the following EUNIS Seabed Habitat Classifications (**Figure 5-9**) were defined: “Infralittoral Superficial Deposits”; “Circalittoral Superficial Deposits”, “Offshore Circalittoral Deposits”, “Upper Bathyal Circalittoral Deposits”, and “Abyssal Superficial Deposits”.

Features or areas which exhibited high rugosity or slope angles including the rocky shore habitats in the Infralittoral and Circalittoral Zones (**Figure 5-9**) exhibited a higher abundance of marine species which was also supported by observations from the drop-camera video analysis.

7.2 FUTURE WORK

- The new bathymetry data allows for a complete geomorphology map of the submarine flanks of Ascension Island for the first time. Future studies could be conducted to investigate links between the subaerial morphology with the submarine flank morphologies, and provide an in-depth look at how the volcanic, gravitational, depositional and erosional processes are intrinsically linked above, and below the sea surface. In addition, work to compare Ascension with other island settings in the Atlantic Ocean (e.g. Azores, Canary Islands, St. Helena) may provide greater insight into the formation of Ascension Island;
- Specific studies using morphometric analysis of seabed features such as seamounts, knolls and mounds (e.g., Smith, 1988), and formation of different geological processes, such as the morphology of volcanic features, evidence of landslides, etc., may provide valuable insight into the stability/vulnerability of marine habitats and the geohazard potential of the island;
- Limited physical samples are available to ground-truth the seabed substrate interpretation, and so a detailed sampling campaign should be considered in future. Additionally, seismic profiles may also provide further insight into the island formation and morphology of the shelf and coastline around the island, as well as give greater detail on the mapped features presented in the geomorphology map.

8 Limitations

8.1 DATA CONTENT

The new BGS Mapping Products (i.e., the Seabed Geomorphology, Seabed Substrate and Seabed Habitat maps) for Ascension Island portrays the distribution of the different bedrock and unconsolidated superficial deposits and includes the distribution of the main seabed morphological features and structural features observed at rockhead. Some features will identify only by a subset of selective, representative digitisation. The mapping, description, and classification of the seabed geology are based upon the interpretations and evidence available at the time.

8.2 SCALE

This digital map at 1:10,000 scale is generalised, and the geological interpretation should be used only as a guide to the geology at a local level, not as a site-specific geological plan based on detailed site investigations. Do not over-enlarge the data; for example, do not used 1:10,000 nominal scale data at 1:5,000 scale.

8.3 DATA RESOLUTION

Data resolution does not allow a precise identification of some volcanic and sedimentological features existing around Ascension Island. For some features it is sometimes difficult to clearly differentiate between (e.g. volcanic mounds).

The lack of multibeam data is some shallow areas, does not allow a full accurate map of the morphologies observed in the entire submarine portion of the island, such as the uncharted south coast.

The lack of both seismic profiles and cores/grab samples to understand the internal morphologies and to develop the sedimentological and stratigraphic framework, prevents further interpretation of the various structures observed from the bathymetric data.

The scarcity of previous work often forces a reliance on morphological interpretation.

8.4 ACCURACY/UNCERTAINTY

Linework provided within this digital map has been interpreted from multibeam bathymetry data, with a grid size ranging from 1m to 10m and a working scale of 1:10,000. It is not possible to provide a consistent level of accuracy for all objects in a geological map.

The Seabed Geomorphology layer inherently supports finer-scale mapping that the substrate mapping as linework and boundaries are based only on seabed morphology (i.e. high-resolution bathymetry). There is greater uncertainty with the Seabed Substrate layer, as while boundaries and classification are informed by the high-resolution bathymetry and backscatter data, interpretation is also based on discontinuous, sub-surface and further seabed data with lower and sometime disparate sample density.

Marine sampling (e.g. drop camera video analysis) reveal detailed information of the seabed substrate and provide, in general, an accurate representation of the seabed. However, this dataset was collected at reconnaissance level and therefore the data is spread sporadically throughout the MPA and so may not always be sufficient to represent the sediment heterogeneity. Backscatter and texture analysis of the bathymetry data also indicate the boundaries between sediment type. However, it will depend heavily on the relationship between different seabed substrates being mapped. For example, a sharp boundary separating two contrasting sediment types is likely to be more accurately mapped with greater certainty than a gradational boundary between two similar sediment types (e.g., sand and gravelly sand).

In addition, the used of this digital map should also be aware that it should be considered a snapshot in time of a transitory reality due to the dynamic seabed environment around Ascension. Within the most dynamic areas, the spatial distribution over time due to the local hydrodynamic regime plus the seafloor may be subjected to a range of natural (e.g. volcanic activity or landslides) or anthropogenic disturbances (e.g., dredging of sediments).

8.5 DISCLAIMER

The use of any information provided by the British Geological Survey ('BGS') is at your own risk. Neither BGS or the Natural Environmental Research Council (NERC) or United Kingdom Research and Innovation (UKRI) gives any warranty, condition or representation as to the quality, accuracy or completeness of information or its suitability for any use or purpose. All implied conditions relating to the quality or suitability of the information, and all liabilities arising from the supply of information (including any liability arising in negligence) are excluded to the fullest extent permitted by law. No advice or information given by BGS, NERC, UKRI or their respective employees or authorised agents shall create a warranty, condition or representation as to the quality, accuracy or completeness of the information or its suitability for any used or purpose.

9 Frequently Asked Questions

Q: What does this map show?

A: The BGS Ascension Island digital map products comprised three complimentary map components: 1) Seabed Geomorphology, classifying the physical morphology and interpreted geomorphic character (if possible) of the seabed; 2) Seabed Substrate, showing the distribution of bedrock and superficial geology units interpreted to be present at seabed; 3) Seabed Habitat, showing the type of marine habitat as per the EUNIS Habitat classification list.

Q: What are the different colours and symbols on the map for?

A: The different colours and symbols are to show the different types of seabed substrate, and geomorphologic features mapped around Ascension. Further classification of seabed geomorphology terms is included in Appendix 1.

Q: How accurate is this map?

A: The geological interpretation that was undertaken to create this map was intended to be viewed at a scale of 1:10,000 scale. Users should be aware that geological maps are a compilation of inferred features. It is not possible to provide a consistent level of accuracy for all objects in a geological map. Further details are provided in Section 8.

Q: In what formats can these data be provided?

A: This data is available in a range of GIS formats including ESRI ArcGIS (.shp) and QGIS.

Q: I think the geology map might be wrong. What can I do?

A: We make every effort to ensure that our mapping reflects the best understanding of the geology of Ascension Island. Sometimes our interpretations need to be revised as new evidence (such as new multibeam data) are obtained. Simple errors may also get through our quality assurance procedures. We are currently working on a web service to improve notifications of errors that have been found and corrected; we hope to make this available soon. If you think you have spotted a problem with our datasets, please let us know.

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British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: https://of-ukrinerc.olib.oclc.org/folio/.

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Appendix 1 Deliverables

The following folders and files have been delivered to AIG:

SMB James Cairn/HMS Protector

- Bathymetry
  - Asc_100m_1m.asc
  - Asc_100m_400m_3m.asc
  - Asc_400m_1000m_6m.asc
  - Asc_1000m_Down_10m.asc
  - Asc_comb_10m.asc
- Backscatter
  - SMB_BS_1m_BTS.tif
  - Protector_BS_6m.tif
- Grab Samples
  - H575_hi_1751.csv
  - UKHO_SeabedSamples_AscensionOnly.shp

BGS Survey

- BGS Bathymetry (ESRI Grids, XYZ, BAGS and Geotiffs).
  - All data collected - 3m resolution.
  - All data <30m 1m
  - All data >30m 3m
  - Coastal strip <15m – 50cm resolution
  - Long beach <15m – 50cm resolution
  - Uncharted South Coast – 3m
- BGS Backscatter
  - All Backscatter – 1m Geotiff.
- BGS Video Transects
  - November 2023: Transect Start/End Points as shapefiles, and MP4 files.
  - January 2024: Transect logged points as shapefiles, and AVI files.

BGS QGIS Project (Ascension_data.gpkg)

- Protector Combined Bathymetry, Backscatter Intensity and Derived Layers
  - Ascension_Data – Protector_Bathymetry
  - Ascension_Data – SMB_BS_1m_BTS
  - Ascension_Data – Protector_BS_6m
  - Ascension_Data – Protector_Slope
  - Ascension_Data – Protector_Aspect_Slope
  - Ascension_Data – Protector_Rugosity
- BGS Combined Bathymetry, Backscatter Intensity and Derived Layers
  - Ascension_Data – BGS_Bathymetry
  - Ascension_Data – BGS_BS_2m
  - Ascension_Data – BGS_Slope
  - Ascension_Data – BGS_Aspect_Slope
  - Ascension_Data – BGS_Rugosity
- Seabed Samples
  - Ascension_Data – BGS_SS_Nov23
  - Ascension_Data – BGS_SS_Jan_2024
  - Ascension_Data – UKHO_SS_AscensionOnly
- BGS Seabed Geomorphology Map
  - Ascension_Data – Geomorphology_Points
  - Ascension_Data – Geomorphology_Lines

    - Ascension_Data – Geomorphology_Polygons
- BGS Seabed Substrate Map
    - Ascension_Data – Substrate
    - Ascension_Data – Bedrock
- BGS Seabed Zones
    - Ascension_Data – Infralittoral
    - Ascension_Data – Circalittoral
    - Ascension_Data – Deep_Circalittoral
    - Ascension_Data – Abyssal
    - Ascension_Data – Bathyal
- BGS Seabed Habitat Map
    - Ascension_Data – InfralittoralSuperficialDeposits
    - Ascension_Data – CircalittoralSuperficialDeposits
    - Ascension_Data – OffshoreCircalittoralSuperficialDeposits
    - Ascension_Data – AbyssalSuperficialDeposits
    - Ascension_Data – BathyalSuperficialDeposits

Derivative layers of slope, hillshade, terrain ruggedness (VRM) or rugosity, and aspect were derived from the processed bathymetry data using the 3D Analyst extension. Hill slope was calculated using an azimuth of 45° and an altitude of 25°. All Rugosity (VRM) files are created using a neighbourhood cell size of 3.

Appendix 2 Seabed Sample Table

Number	Shape	UKHO Substrate	BGS Substrate	Latitude	Longitude
1	Point Z	Sand	Gravelly Sand	-14.406	-7.911
2	Point Z	Gravelly Sand	Sandy Gravel	-14.411	-7.913
3	Point Z	Sand	Gravelly Sand	-14.411	-7.915
4	Point Z	Rock/Sediment Absent	<Null>	-14.416	-7.92
5	Point Z	Gravelly Sand	Sandy Gravel	-14.416	-7.92
6	Point Z	Rock/Sediment Absent	<Null>	-14.418	-7.921
7	Point Z	Rock/Sediment Absent	<Null>	-14.418	-7.921
8	Point Z	Rock/Sediment Absent	<Null>	-14.418	-7.92
9	Point Z	Rock/Sediment Absent	<Null>	-14.418	-7.921

Line	Start or End	Substrate	Date	Time	X_LONG_DD	Y_LAT_DD	Notes
0E	E	Sand	13/11/2023	12:21:00	-14.41103	-7.91902	
0S	S	Bedrock with discontinuous sediment cover (SAND)	13/11/2023	12:13:00	-14.41142	-7.92097	Miss fire - dragging on bottom - maybe - aborted
13E	E	Rhodolith and mixed sediment	12/11/2023	13:31:00	-14.38442	-7.88922	
13S	S	Bedrock Outcrop	12/11/2023	13:08:00	-14.38240	-7.89087	English bay - inshore to out. Very shallow.
15E	E	Sandy Gravel	11/11/2023	12:13:00	-14.42697	-7.93580	Approx bearing 340
15S	S	Sand	11/11/2023	11:58:00	-14.42592	-7.93837	Transit to south of George town - short one 300m Attempt to go N- S, but swell wrong so S- N
1E	E	Gravelly Sand	13/11/2023	12:39:00	-14.40882	-7.91563	
1S	S	Gravelly Sand	13/11/2023	12:29:00	-14.40865	-7.91758	
32E	E	Gravelly Sand	12/11/2023	10:54:00	-14.34317	-7.90943	Long run-ish - normal bearing 340 is with swell 600m-ish
32S	S	Sand	12/11/2023	10:25:00	-14.33908	-7.90967	Northeast of island - porpoise point.
33E	E	Gravelly Sand	12/11/2023	11:49:00	-14.35245	-7.89760	Towards English Bay - close to coast - lines followed coastline
33S	S	Sandy Gravel	12/11/2023	12:31:00	-14.34935	-7.89970	Missed start? 200m needed to extend line
35E	E	Bedrock Outcrop	12/11/2023	11:32:00	-14.36915	-7.89205	
35S	S	Gravelly Sand	12/11/2023	12:31:00	-14.36687	-7.89347	400 m long - lots of rock
39E	E	Rhodolith and mixed sediment	11/11/2023	12:18:00	-14.43233	-7.95072	Approx. bearing 340- all ran with the swell & wind
39S	S	Gravelly Sand	11/11/2023	13:18:00	-14.42770	-7.95603	Long one 900m - further south than 15 and long run up
3E	E	Gravelly Sand	21/08/2024	11:30:00	-14.41255	-7.90975	
3S	S	Gravelly Sand	13/11/2023	11:11:00	-14.41133	-7.91155	Clarence Bay

45E	E	Gravelly Sand	12/11/2023	13:05:00	-14.37878	-7.88672	
45S	S	Bedrock Outcrop	12/11/2023	12:49:00	-14.37598	-7.88740	Lots of fish - seeing and getting caught.
47E	E	Gravelly Sand	13/11/2023	11:58:00	-14.41528	-7.91070	<Null>
47S	S	Sandy Gravel	13/11/2023	11:43:00	-14.41405	-7.91218	Clarence bay
4E	E	Rhodolith and mixed sediment	13/11/2023	11:01:00	-14.40755	-7.91178	Clarence bay
4S	S	Rhodolith and mixed sediment	13/11/2023	10:54:00	-14.40738	-7.91245	Really far from way point
5E	E	Sand	11/11/2023	11:32:00	-14.42090	-7.91555	Approx bearing 320
5S	S	Sandy Gravel	11/11/2023	11:15:00	-14.41918	-7.91592	Clarence bay - started deep 20m-ish
6E	E	Sandy Gravel	11/11/2023	10:48:00	-14.42790	-7.92108	Approx bearing - 340, approx. distance 1.1
6S	S	Bedrock Outcrop	11/11/2023	10:15:00	-14.42230	-7.92327	Clarence bay - heading out on drift. Water 5m start getting deep to max 30-ish
8E	E	Rhodolith and mixed sediment	13/11/2023	10:42:00	-14.41197	-7.90647	Clarence bay
8S	S	Rhodolith and mixed sediment	13/11/2023	10:11:00	-14.40983	-7.90773	20m away from waypoint - a malfunction day of skipper age

Shape	SampleNo	Start or End	Substrate	Day	Time	Latitude	Longitude
Point	1	S	Bedrock Outcrop	20/01/2024	09:09:34	-7.92777	-14.4282
Point	1	E	Sand	20/01/2024	09:11:55	-7.92724	-14.4283
Point	3	S	Gravelly Sand	20/01/2024	10:04:51	-7.88717	-14.3992
Point	3	E	Gravelly Sand	20/01/2024	11:04:00	-7.89044	-14.3954
Point	4	S	Sandy Gravel	20/01/2024	11:28:18	-7.90203	-14.4053
Point	4	E	Sand	20/01/2024	11:45:52	-7.90224	-14.4077
Point	5	S	Sand	20/01/2024	11:49:44	-7.90304	-14.4084
Point	5	E	Rhodolith and mixed sediment	20/01/2024	11:51:07	-7.90279	-14.4086
Point	7	S	Rhodolith and mixed sediment	22/01/2024	14:17:55	-7.90748	-14.4097
Point	7	E	Rhodolith and mixed sediment	22/01/2024	14:28:52	-7.90825	-14.4117
Point	8	S	Rhodolith and mixed sediment	22/01/2024	14:33:20	-7.90816	-14.4101
Point	8	E	Gravelly Sand	22/01/2024	14:43:52	-7.90905	-14.4119
Point	9	S	Gravelly Sand	22/01/2024	14:57:45	-7.91366	-14.4072
Point	9	E	Gravelly Sand	22/01/2024	15:07:27	-7.91419	-14.4091
Point	10	S	Gravelly Sand	22/01/2024	15:16:03	-7.91274	-14.4083
Point	10	E	Sandy Gravel	22/01/2024	15:26:32	-7.91339	-14.4104
Point	11	S	Gravelly Sand	22/01/2024	15:30:26	-7.91325	-14.4101
Point	11	E	Gravelly Sand	22/01/2024	15:40:49	-7.91383	-14.412
Point	12	S	Rhodolith and mixed sediment	22/01/2024	15:48:05	-7.91533	-14.4085
Point	12	E	Gravelly Sand	22/01/2024	15:55:57	-7.91593	-14.41
Point	13	S	Sandy Gravel	22/01/2024	16:06:53	-7.91076	-14.4127
Point	13	E	Gravelly Sand	22/01/2024	16:17:05	-7.9114	-14.4146

Point	14	S	Rhodolith and mixed sediment	22/01/2024	16:19:37	-7.9127	-14.4145
Point	14	E	Rhodolith and mixed sediment	22/01/2024	16:29:26	-7.9135	-14.4163
Point	15	S	Rhodolith and mixed sediment	22/01/2024	16:34:20	-7.9149	-14.4127
Point	15	E	Rhodolith and mixed sediment	22/01/2024	16:45:07	-7.91566	-14.4146
Point	16	S	Sandy Gravel	23/01/2024	10:26:57	-7.90936	-14.329
Point	16	E	Sandy Gravel	23/01/2024	10:37:07	-7.90822	-14.3307
Point	17	S	Rhodolith and mixed sediment	23/01/2024	10:49:23	-7.90654	-14.3367
Point	17	E	Rhodolith and mixed sediment	23/01/2024	10:59:51	-7.90502	-14.3385
Point	18	S	Rhodolith and mixed sediment	23/01/2024	11:04:51	-7.90114	-14.343
Point	18	E	Rhodolith and mixed sediment	23/01/2024	11:13:17	-7.89986	-14.3446
Point	19	S	Gravelly Sand	23/01/2024	11:24:08	-7.89562	-14.3544
Point	19	E	Sandy Gravel	23/01/2024	11:32:13	-7.89455	-14.3563
Point	21	S	Rhodolith and mixed sediment	23/01/2024	11:52:42	-7.89268	-14.3678
Point	21	E	Rhodolith and mixed sediment	23/01/2024	11:57:34	-7.89233	-14.3686
Point	24	S	Rhodolith and mixed sediment	23/01/2024	12:08:09	-7.88526	-14.3749
Point	24	E	Rhodolith and mixed sediment	23/01/2024	12:15:14	-7.88453	-14.377
Point	28	S	Bedrock Outcrop	23/01/2024	12:31:09	-7.89086	-14.3836
Point	28	E	Rhodolith and mixed sediment	23/01/2024	12:42:26	-7.89059	-14.3855
Point	29	S	Rhodolith and mixed sediment	23/01/2024	12:44:37	-7.89109	-14.3856
Point	29	E	Sandy Gravel	23/01/2024	12:56:14	-7.89066	-14.3877
Point	31	S	Sandy Gravel	24/01/2024	09:36:13	-7.96836	-14.4173
Point	31	E	Sandy Gravel	24/01/2024	09:50:25	-7.96674	-14.4185
Point	35	S	Gravelly Sand	24/01/2024	10:05:02	-7.95428	-14.4278

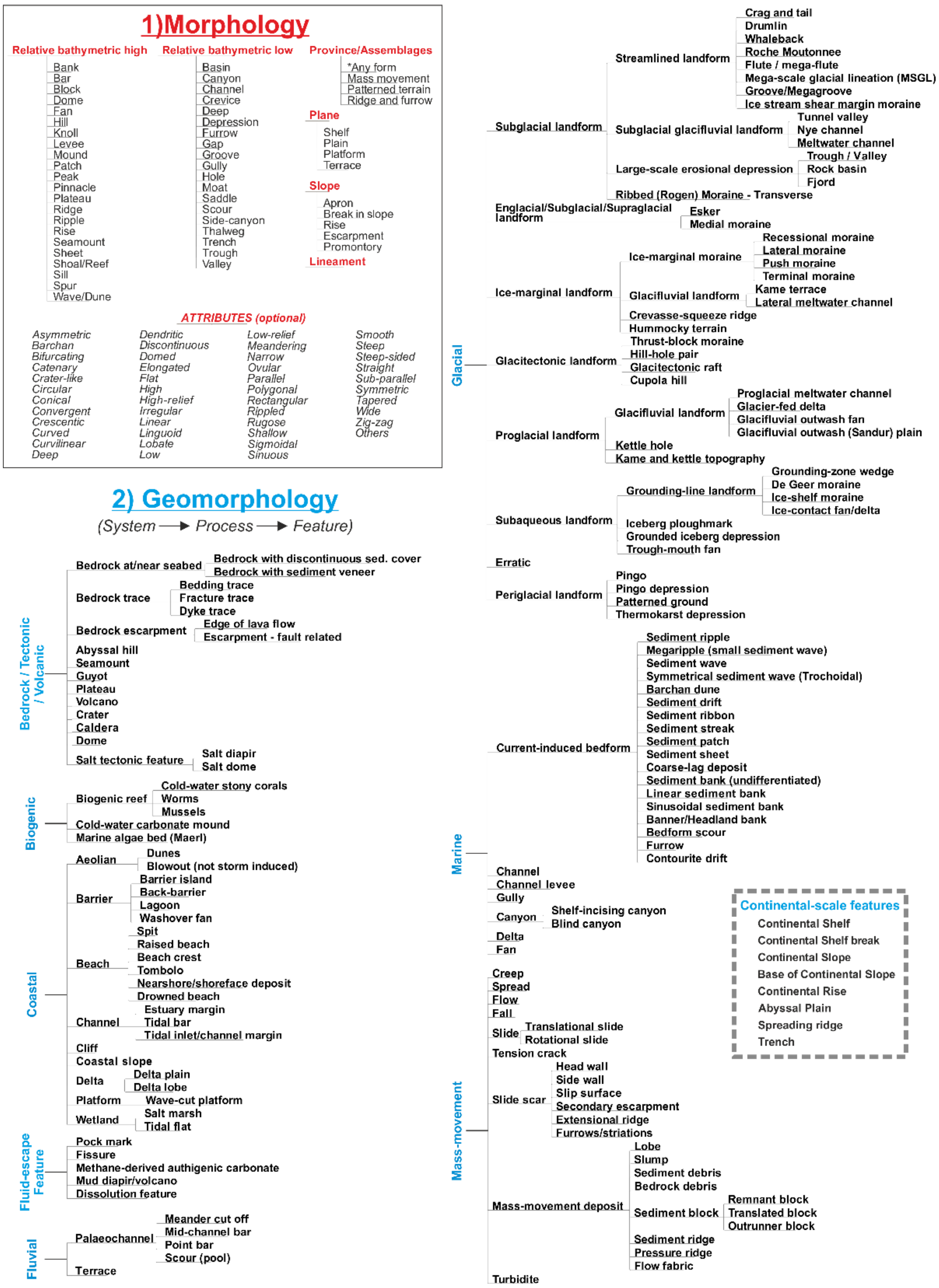
Point	35	E	Sandy Gravel	24/01/2024	10:16:22	-7.95242	-14.4288
Point	36	S	Rhodolith and mixed sediment	24/01/2024	10:24:02	-7.95389	-14.4246
Point	36	E	Gravelly Sand	24/01/2024	10:32:22	-7.95228	-14.4254
Point	37	S	Sandy Gravel	24/01/2024	10:39:42	-7.94303	-14.4278
Point	37	E	Rhodolith and mixed sediment	24/01/2024	10:47:42	-7.94122	-14.4287
Point	38	S	Sand	24/01/2024	10:50:42	-7.93861	-14.427
Point	38	E	Rhodolith and mixed sediment	24/01/2024	10:57:02	-7.93685	-14.4277
Point	39	S	Gravelly Sand	24/01/2024	10:59:42	-7.93178	-14.4287
Point	39	E	Sand	24/01/2024	11:05:42	-7.92993	-14.4293
Point	40	S	Gravelly Sand	24/01/2024	11:19:02	-7.93013	-14.4236
Point	40	E	Bedrock Outcrop	24/01/2024	11:27:02	-7.92854	-14.4243
Point	41	S	Sandy Gravel	24/01/2024	11:33:22	-7.91758	-14.424
Point	41	E	Sandy Gravel	24/01/2024	11:45:02	-7.91598	-14.425
Point	42	S	Sandy Gravel	24/01/2024	11:51:02	-7.9166	-14.4193
Point	42	E	Gravelly Sand	24/01/2024	12:02:42	-7.91508	-14.4205
Point	43	S	Sandy Gravel	24/01/2024	12:06:42	-7.91463	-14.4176
Point	43	E	Gravelly Sand	24/01/2024	12:19:42	-7.91334	-14.4185
Point	44	S	Rhodolith and mixed sediment	24/01/2024	12:24:22	-7.90882	-14.4187
Point	44	E	Rhodolith and mixed sediment	24/01/2024	12:39:22	-7.90766	-14.4205
Point	45	S	Sand	24/01/2024	12:52:02	-7.91797	-14.409
Point	45	E	Sand	24/01/2024	13:01:42	-7.91721	-14.4098

Appendix 3 Seabed Geomorphology - Classification

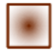
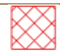
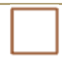
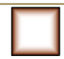
Features are mapped in accordance with the 2-part classification scheme developed by BGS together with marine mapping organisations in Norway (http://www.mareano.no/en), Ireland (https://www.infomar.ie/), and Australia (http://www.ga.gov.au/scientific-topics/marine) (Dove et al., 2016).

Report:
http://nora.nerc.ac.uk/id/eprint/514946/1/Seabed_Geomorpholgy_classification_BGS_Open_Report.pdf

Two-part geomorphological classification system



Morphological / Geomorphological Defined Features	Description	Symbol
Bedrock at seabed	Bedrock mapped where the geologist can observe characteristic morphologies and features within the bathymetry data, particularly along the coastline. No classification of the bedrock is provided but is assumed to be igneous/volcanic in origin.	
Break in Slope (Concave)	A marked and/or abrupt change in slope curving inwards.	
Break in Slope (Convex)	A marked and/or abrupt change in slope curving outwards.	
Caldera	Circular depressions typically with a flat floor, with diameters ranging from few up to tens of kms (Submarine Geomorphology).	
Channel	A general term for an elongated bathymetric low.	
Crater	A large bowl-shaped cavity.	
Crest	A line of highest elevation along a bathymetric high, the lateral position of which can vary longitudinally.	N/A
Depression	General term for a closed-contour bathymetric low of variable scale.	
Escarpment	A steep slope separating areas of relatively lower slope.	N/A
Gully	A steep-sided, low sinuosity, relatively high-gradient feature.	
Hill	A distinct elevation generally of irregular shape, less than 1000 m above the surrounding relief as measured from the deepest isobath that surrounds most of the feature. Hills have more irregular profiles than knolls, and their length generally exceeds their height.	
Knoll	A distinct elevation generally of a smooth, commonly rounded profile, less than 1000 m above the surrounding relief. Knolls have	

	more regular profiles than hills, and their width generally exceeds their height.	
Mound	A distinct elevation with a variable sometimes rounded profile which is generally <500m above the surrounding seafloor.	
Palaeoshoreline	Relict coastal depositional and/or erosional landscape formed during periods of sea-level stillstand.	
Peak	A prominent, commonly pointed elevation rising from a larger feature (may be point or polygon feature).	 
Pinnacle	A spire-shaped pillar, either isolated or rising from a larger feature.	N/A
Plateau	A generally closed contoured, relatively flat-topped bathymetric high with one or more relatively steep side.	
Platform	A generally broad, planar surface that is at least partially elevated, and lower gradient, than the surrounding areas.	N/A
Ridge	An elongated elevation of varying complexity, size and gradient (length > width).	 
Saddle	A broad pass in an elevated feature.	
Seamount	A prominent feature rising more than 1000 m above the surrounding relief.	
Slope	An inclined surface.	N/A
Submarine Fan	An elevated feature which expands (and typically descends) from a locus to a commonly curved outer margin.	
Submarine Landslide Scar	Crescent-shaped scar on the side of a steep-slope where soil and/or rock has detached from the surface.	
Thalweg	A line of lowest elevation along an elongate bathymetric low, the lateral position of which can vary longitudinally.	N/A

Wreck	Remains of a vessel and/or debris which remains visible or partially visible on the seabed.	

Glossary

Jargon	Explanation
AIG	Ascension Island Government
ArcGIS	Geographic Information System (GIS) software for working with maps and geographic information maintained by the Environmental Systems Research Institute (ESRI).
Attribute	Named property of an entity. Descriptive information about features or elements of a database. For a database feature like census tract, attributes might include many demographic facts including total population, average income, and age. In statistical parlance, an attribute is a variable, whereas the database feature represents an observation of the variable.
Backscatter Intensity	Backscatter' is computed by measuring the amount of sound that is reflected by the sea floor and received by the multibeam echosounder sonar. It is used as a proxy to derive information on the 'hardness' of the sea floor and is used to differentiate between different types of sea floor, such as hard rock or soft sediment.
Bathymetry	The measurement of the water depth in oceans, seas, or lakes over an area of seabed. In other words, bathymetry is the underwater equivalent to topography.
Bedrock	The main mass of rocks forming the earth, laid down prior to 2.588 million years ago. Present everywhere, whether exposed at the surface in rocky outcrops or concealed beneath superficial deposits, artificial ground or water. Formerly called solid.
BGS	British Geological Survey
ESRI	Environmental Systems Research Institute (ESRI) is an international supplier of Geographic Information System (GIS) software, web GIS and geodatabase management applications.
Geophysical data	Data that has been acquired by recording and analysing measurements of the Earth's physical properties, such as electrical, gravity, magnetic, radioactivity and seismic properties.
Geospatial data	Data that has a geographical component to it. This means that the records in a dataset have locational information directly linked to them, such as geographic data in the form of coordinates, address, city, or postcode.
Lithology	Rocks maybe defined in terms of their general characteristics of appearance: colour, texture and composition. Some lithologies may require a microscopical or chemical analysis for the latter to be fully determined.
MCA	Maritime and Coastguard Agency

Multibeam data	Data that was acquired with a multibeam echosounder. This type of sonar system emits sound waves in a fan shape. Multibeam systems acquire both bathymetry (depth) and backscatter (intensity) data. The amount of time taken for the sound waves to bounce off the seabed and return to a receiver is used to determine water depth. Whereas the return intensity (i.e. how much of a transmitted acoustic signal is bounced back) reflects the nature of the seabed and can be used to determine the type of material or sediment on the seafloor.
Polygon	Polygons are a representation of areas. A polygon is defined as a closed line or perimeter completely enclosing a contiguous space and is made up of one or more links.
Scale	The relation between the dimensions of features on a map and the geographic objects they represent on the Earth, commonly expressed as a fraction or a ratio. A map scale of 1/100,000 or 1:100,000 means that one unit of measure on the map equals 100,000 on the earth.
Sediments	Mud, sand, gravel, boulders, bioclastic material (shells, plants), and other matter carried and deposited by water, wind, or ice.
Shapefile	The shapefile format is a geospatial vector data format for geographic information system software. It is developed and regulated by ESRI as a mostly open specification for data interoperability among ESRI and other GIS software products.
Superficial	The youngest geological deposits formed during the most recent period of geological time, the Quaternary. They range in age from about 2.6 million years ago to the present.
UKHO	United Kingdom Hydrographic Office
Vector	A representation of the spatial extent of geographic features using geometric elements (such as point, curve, and surface) in a coordinate space.