

HOT: Hadal Zones of our Overseas Territories

Heather A. Stewart¹ and Alan J. Jamieson²



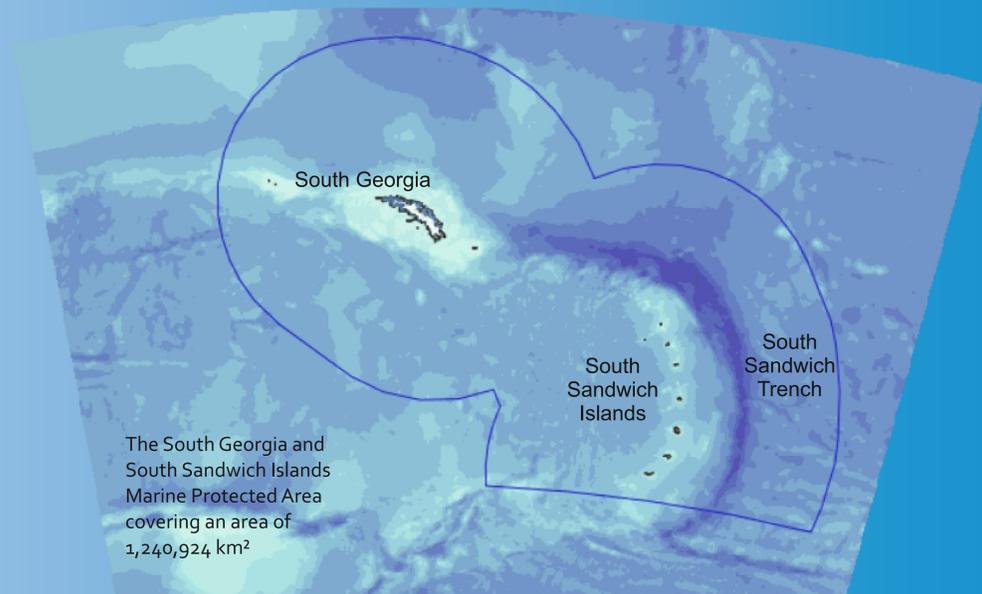
Summary

HOT: Hadal zones of our Overseas Territories is a multi-disciplinary program that will deliver a step-change in our understanding of the fundamental ecological and geological processes in the South Sandwich Trench (SST). The SST reaches water depths of 8266 m ±13m at a location known as *Meteor Deep*, named after the German research vessel who first sounded it in 1926, and uniquely is the only sub-zero hadal environment on Earth. This Darwin Plus (Round 7) funded project will improve understanding of marine biodiversity and geodiversity to fill an identified knowledge gap supporting the existing Marine Protected Area and obligations under the Convention of Biological Diversity.

The South Georgia and the South Sandwich Islands Marine Protected Area (MPA) is one of the largest MPAs on Earth covering >1 million km² and includes the SST. Predicting trench habitats and their fauna cannot be extrapolated from shallower systems as they exhibit stark ecotones and abrupt changes in geology, making MPA management at depths >6000m at best difficult. The MPA is designed to ensure the protection and conservation of the region's rich and diverse marine life, whilst allowing sustainable and carefully regulated fisheries.

Key outcomes of the 5-year review of the MPA (November 2017) included: a need to enhance bathymetric knowledge around the region; recognition there is a lack of data on the abyssal and hadal ecosystems; that more information is needed on assemblages versus biodiversity, ecosystem processes and function; and general information on how to record long-term change to factors such as climate change.

This project will make use of high-resolution bathymetric maps of the South Sandwich Trench acquired using the latest generation full-ocean-depth EM124 by the Five Deeps Expedition (FDE; www.fivedeeps.com). These data form a primary dataset for geological and geomorphological analysis and provide the context for research into the biological communities of these deeps. With the newly collected invertebrate samples from the SST, this project will utilise specimens of scavenging amphipods including: new species from the genus *Hirondellea*, and *Bathycallisoma schellenbergi*. These species are model species for understanding the historical and present connectivity of the hadal zone and its effects on speciation. The remoteness and uniqueness of the low temperatures and high pressures of the South Sandwich Trench makes these recent findings highly important in resolving ultra-deep sea speciation on a large geographical scale.



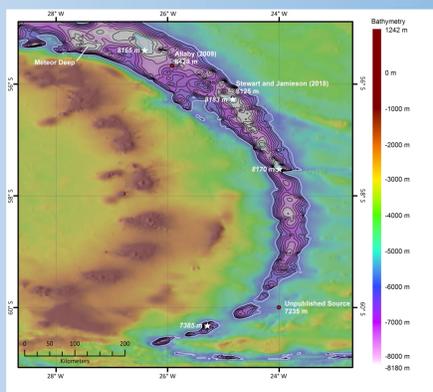
Uncharted Waters

Next to no singlebeam or multibeam bathymetric data had been acquired in the South Sandwich Trench with around 91% of the trench un-mapped prior to the FDE. When the FDE data are compared with the Gebco_2019 global dataset, the greatest surface differences can be found between 57.5° S and 59° S. The deepest point of the entire trench, *Meteor Deep* located in the northern section of the trench sounded a maximum depth of 8264 m in 1926, a depth which is comparable to that sounded by the FDE (8266 m). However, interrogation of the Gebco_2019 global dataset shows a discrepancy whereby Gebco_2019 reveal *Meteor Deep* is 804 m shallower than that determined by the FDE. Furthermore, the Gebco_2019 dataset also indicates a depth 1140 m shallower than the FDE data for *Factorian Deep*.

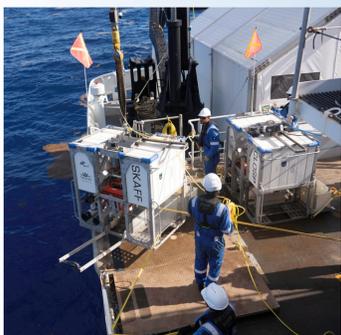
The hitherto completely unknown seafloor morphology of the South Sandwich Trench reveal the area in the vicinity of *Meteor Deep* to host fault escarpments, broadly trench parallel, with vertical offsets of around 200 m and a detachment blocks. Further south the fault escarpments are also present by are oblique to the trench axis with some vertical offsets up to around 500 m. South of 58° S, a number of partitions which reach water depths <6000 m represent fracture zones (e.g. The South Sandwich Fracture Zone and the Bullard Fracture Zone) formed perpendicular to the North Weddell Ridge entering the trench axis. The interaction of these fracture zones with the South Sandwich Trench create confined basin of which the *Factorian Deep* is the deepest. A number of previously unknown seamounts have also been mapped.



Above: The DSSV Pressure Drop on location in the Southern Ocean. Fitted with next generation Em124 full-ocean depth multibeam echosounder.

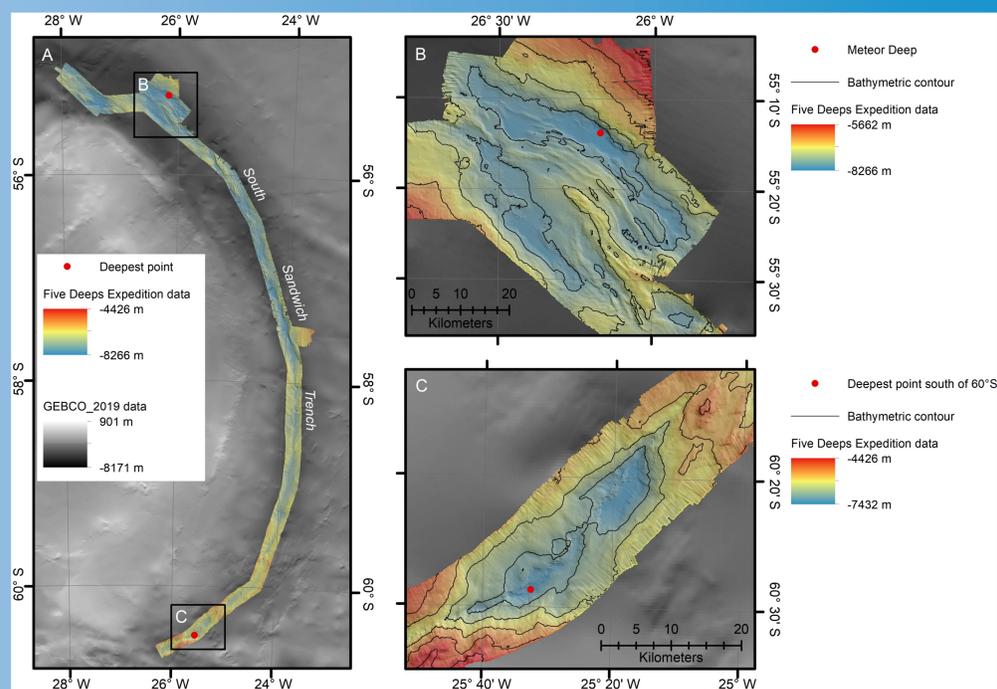


Above: Map showing previously known bathymetry of the South Sandwich Trench (sourced from Gebco_2014) with the published 'deep' locations (red circles). The 6000 m depth contour is shown in white, the 8000 m contour in blue, all other contours at 200 m intervals (between 6000 and 8000 m water depth). Illumination from 270° at an altitude of 35°.



Left: The fleet of scientific landers comprising a scientific payload including CTD sensors, underwater cameras, baited capture traps, and water samplers.

Right: (A) Map of the South Sandwich Trench spanning the southernmost Atlantic Ocean and the Southern Ocean, the boundary of which is located at 60° S. (B) Inset map showing the deepest portion of the South Sandwich Trench, named the *Meteor Deep*, with the deepest point determined during the Five Deeps Expedition. Bathymetric contours are at 500 m intervals (between 8000 m and 6000 m water depth). (C) Inset map showing the deepest point of the South Sandwich Trench located south of 60° S, and technically within the Southern Ocean, informally named here '*Factorian Deep*'. Bathymetric contours are at 500 m intervals (between 7000 m and 4500 m water depth). All other data sourced from the GEBCO_2019 dataset.



Ultra-Deep Sea Species

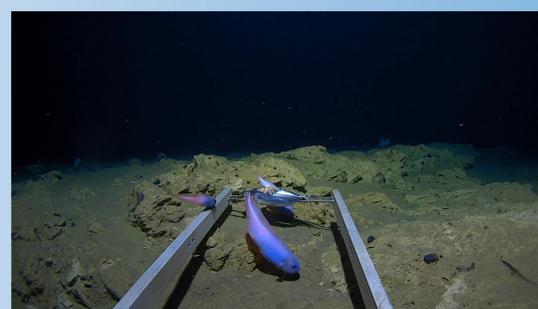
The South Sandwich Trench is biologically unique in that it is the only sub-zero hadal zone in the world.

It is remote from most of the other major trenches and is situated beneath the highly productive waters of the Southern Ocean.

In the trench we discovered four new species of snailfish (Liparidae) between 6000 and 6500 m. The morphological characteristics are strikingly similar to similar Liparids in the Atacama Trench.

The amphipod community is largely dominated by *Eurythenes* sp. in the upper trench depths and the *Bathycallisoma* sp. in the deeper depths. The trench also hosts a new species of *Hirondellea* which is a trend common to most major trenches.

The benthic community between 6000 and 7000 m also included dense populations of brittlestars, glass sponges and gastropods while at the deepest points (7500 to 8400 m) there was an extraordinary high density of Elpididae Holothurians.



New species of snailfish (Liparidae) from 6000 m water depth.



Specimen of *Eurythenes* sp. from 6500 m water depth.



Specimen of a new species of *Hirondellea* sp. from 8300 m water depth.

¹British Geological Survey; ²Newcastle University



Acknowledgments

Multibeam echosounder data and biological samples acquired as part of the Five Deeps Expedition supported by Caladan Oceanic LLC. The authors would like to thank Victor Vescovo, Rob McCallum, Cassie Bongiovani and the officers and crew of the DSSV Pressure Drop. This project has funded by the Darwin Initiative Project DPLUS093.

Contact Heather Stewart: hast@bgs.ac.uk