British Oceanographic Data Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Autosub Under Ice

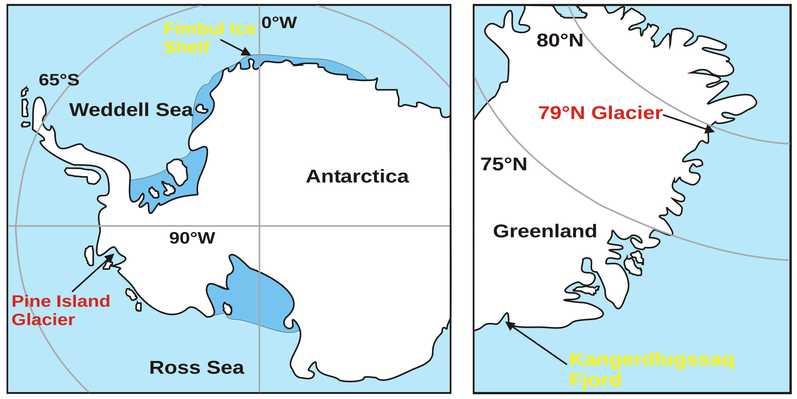
Autosub Under Ice (AUI) is a 5-year Thematic Programme of the Natural Environment Research Council (NERC). The programme was established to investigate the marine environment of floating ice shelves with a view to advancing our understanding of their role in the climate system. The work focused on studying:

The Autosub autonomous underwater vehicle being launched from RRS James Clark Ross (Photo: Ken Collins, NOCS)

- Water masses
- Circulation
- Ice formation beneath ice shelves and in adjacent continental shelf waters
- Seasonal and perennial sea-ice cover
- Air-ice-ocean interactions in sea-ice regions
- Ice-ocean interaction beneath ice shelves
- The structure of the seabed and nature of the sedimentary record left by past and present configurations of the ice sheet and sea-ice.

Fieldwork was carried out during 2003, 2004 and 2005 near Greenland and Antarctica, in the respective summer seasons for each hemisphere. The areas for research were ice shelves and proximate continental shelf areas:

- Near the 79°N Glacier at the east margin of the Greenland Ice sheet
- In the Kangerdlugssaq Fjord system of southern Greenland
- In the eastern Pacific sector of Antarctica, in the vicinity of the Pine Island Glacier, and the Wilkins and George VI ice shelves
- In the Atlantic sector of Antarctica, under and north of the Fimbul ice shelf.



Autosub Under Ice fieldwork sites in the Antarctic (left) and Arctic (right)

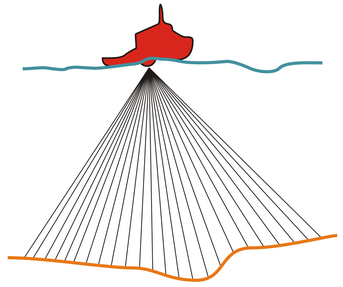
During the fieldwork, Autosub (an autonomous underwater vehicle) was deployed. Autosub had been upgraded since its earlier science missions to achieve 1000 km range and 2500 m water depth, which provided unprecedented access to the ice covered regions. An ice-capable research ship, the RRS James Clark Ross, provided the launch and retrieval platform for Autosub, and also acted as a platform for additional measurements, made in support of the science programme. Measurements made during the programme include:

- **Conductivity**
- **Temperature**
- **Transmissivity**
- **Fluorescence**
- **Water depth**
- **Current velocities**
- **Turbulence**
- **Ice draught**
- **Swath bathymetry**
- **Sub-bottom profiling**

BODC is the NERC designated data centre for all digital information arising from AUI. In particular it has responsibility for the quality control, integration and long-term stewardship of datasets obtained from AUI cruises. As part of this responsibility, BODC has developed systems for the processing of multi-beam swath bathymetry data and sub-bottom profiler data expanding the vast range of datatypes already managed at BODC. These instruments and the systems for processing their data are detailed below.

Multibeam swath bathymetry systems scan the shape of the seafloor using a large number of sound beams simultaneously. The fan of the swath ranges from 90 to 180° across and the recorder typically updates between 1 and 40 times a second. The tightly packed array of narrow individual beams provides very high resolution detail and the wide swath allows the seafloor to be mapped in less time and with fewer passes.

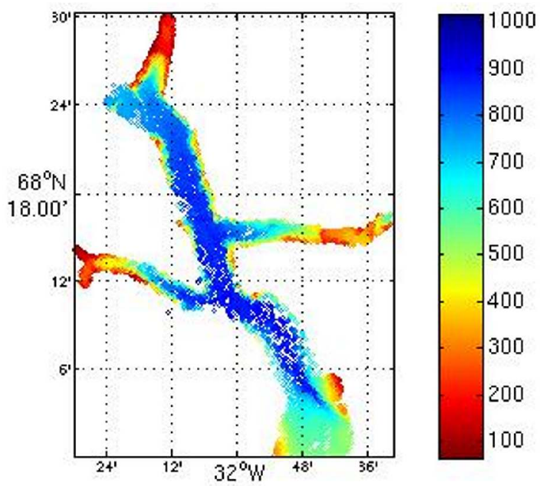
Data arrive at BODC in a series ordered by the time at which they were collected. BODC have developed a system for creating grids of bathymetry data from these time series, which is capable of merging together several overlapping swath surveys to create a unified grid, while still allowing access to the supplied data, if required. Gridding of bathymetric data allows easier comparison between datasets covering the same regions.



Multibeam swath bathymetry survey of the seabed from a surface research vessel. Each black line represents an individual sound beam.

The required swath bathymetry data files are first merged together to create a master file of positions and depths. These data are then visualised using a Matlab mapping function. At this stage the data scientist can alter the projection of the map to create a close to rectangular grid of data points, or use a polar projection for high latitude work. This means that resulting grid has the fewest possible unused data points.

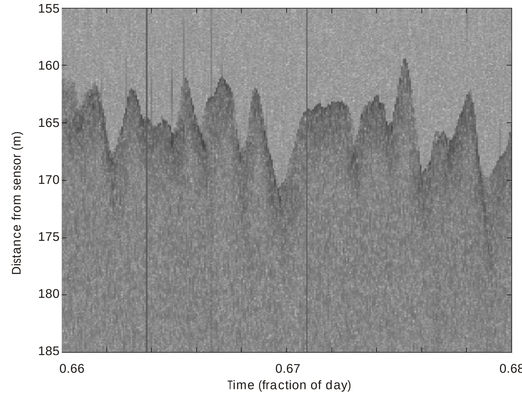
From the master file and the selected map settings, Matlab automatically constructs commands to create a unified grid in the GMT package. The initial grid is coarse (low-resolution) to allow the data scientist to quickly see an overview of what the finished grid will look like. The grid can be made finer, the grid limits altered and the gridding method changed. Once a grid is accepted, Matlab checks the grid points against the raw data and produces a series of statistics describing the grid quality.



Swath bathymetry of the Kangerdlussuaq Fjord, East Greenland)

Sub-bottom profilers operate by emitting a narrow, focused sound pulse towards the seabed. The profiler then listens to the echoes of the pulse and records these reflections. The sound pulse is normally of a high frequency (1 to 24kHz) which means that although the pulse does penetrate below the top few metres of the seabed a detailed picture of the small-scale structures within the sediment can be produced. These instruments are of use in archaeological, geological, geophysical and resource exploration applications. The AUI programme made use of two commercially available sub-bottom profilers - the Edgetech FS-AU and Kongsberg TOPAS systems.

The data arrive at BODC in the raw binary format in which they are collected by the instruments. These data formats are largely undocumented and are therefore not suitable for long-term curation of the data. BODC has developed protocols and tools for the conversion of these raw binary formats to a standard data format (a netCDF subset). This transfer process is common to all data received by BODC. As part of this transfer of data formats, the data are visualised allowing the data scientist to comment on any obviously erroneous data points. An example of these visualisations is given below and clearly shows the seabed-seawater interface and the shape of the seabed. The example also shows some sub-bottom sedimentary features at times 0.662, 0.67 and 0.679.



Sub-bottom profiler data from Autosub mission 382 under the Antarctic ice sheet

The geophysical data described above are archived at BODC in their original binary format, and stored within the National Oceanographic Databank (NODB) system in the BODC in-house QXF format (a netCDF derivative).

BODC's aims in managing the data collected during the AUI programme are:

- **To facilitate the interchange of data within the project community.**
- **To provide advice, and assistance when appropriate, to project scientists in the management, working up and quality assurance of their data.**
- **To assemble the project data into a single high quality coherent dataset, maintaining the spatial and temporal relationships between the data.**
- **To ensure that the data are adequately documented and that reasonable steps are taken to assure their quality.**
- **To ensure the final banking and publication of the dataset (Jan 2008).**

Recovering Autosub after a mission under the ice (Photo: Ken Collins, NOCS)

For enquiries regarding these data please e-mail
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