Five Deeps Expedition: Arctic Mission to Molloy Hole

Cruise Report

24-26th August 2019

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Mapping Operations

The Molloy Hole was surveyed with a Kongsberg EM 124 gondola-mounted to the hull of the 225-foot DSSV *Pressure Drop*. The survey was conducted over the course of three days – August 24-26, 2019. The data meet the requirements for IHO Order 1 standards.

All hydrographic surveys were executed aboard the DSSV *Pressure Drop* built in 1985 (68.28 m long by 13.11 m wide), fitted with a 1° x 2° Kongsberg EM 124 multibeam echosounder (MBES). All MBES data acquisition was undertaken at a typical vessel speed of 8 knots, with a swath width typically 2-3 times water depth or ~ 15-20 km. Survey lines were spaced between 6-7 km to ensure 100% overlap over areas of interest. All raw bathymetry data were processed in QPS Qimera and gridded to 75 m using CUBE algorithms. CUBE algorithms use the surrounding depth information and advanced statistical practices to determine the best estimate of depth while simultaneously calculating the uncertainty of those estimates. The total propagated uncertainty (TPU) was calculated for each dataset.

A total of 1850 km^2 of bathymetric data were collected over the Molloy Hole but did not acquire any new coverage as the area was already well mapped (Stewart and Jamieson 2019) (Figure 1). The relative swath width and line spacings were increased to maximize coverage in the comparatively shallower waters, specifically widening the swath from 55° to 65° on either side of nadir. An XBT was not collected at this site and synthetic sound velocity profiles were used exclusively during the survey. The deepest point was identified as 5551 ± 14 m at 79.194° N, 2.706° E, located almost 7 km NW of the point identified by Stewart and Jamieson (2019). However, the submersible and lander CTD readings of 5577 ± 23 m deviate significantly from this final depth, which is attributed to calibration issues.

The bathymetric data from this expedition is included in the following scientific publication currently review: BONGIOVANNI, C, STEWART, HA, JAMIESON, AJ. (Submitted) High-resolution multibeam sonar bathymetry of the deepest place in each ocean. *Geoscience Data Journal.* The first reviews of this study are expected early December 2020.

The MBES bathymetric data is also registered in an onlne data repository: Caladan Oceanic LLC (2021): Five Deeps Expedition to map the Molloy Hole (Arctic Ocean). British Geological Survey. (Dataset). https://doi.org/10.5285/ee1600be-36d3-4e31-80ed-814d53029562

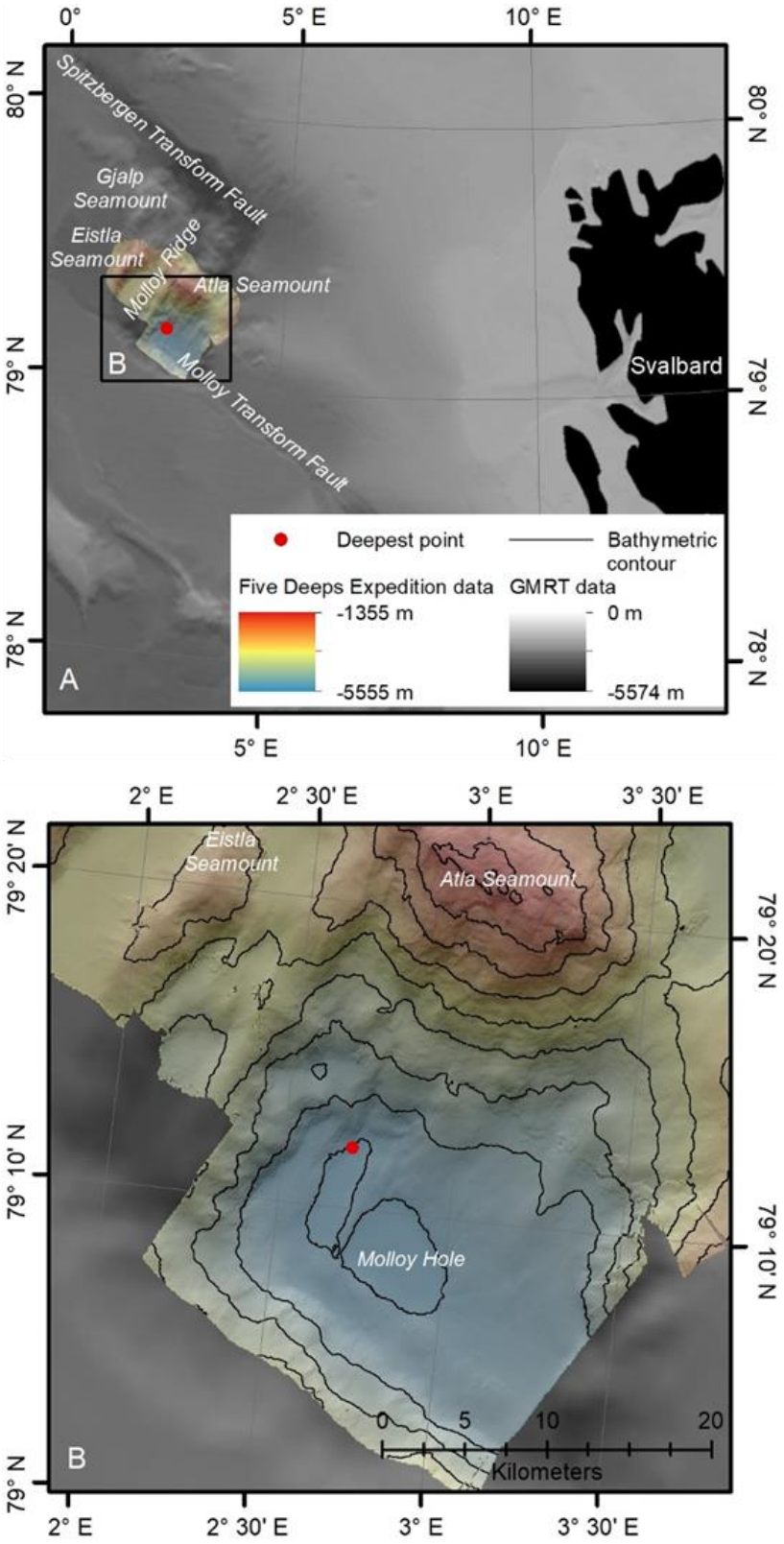

Figure 1. (top) Full extent of the bathymetric survey with the Pressure Drop EM124 MBES, and (bottom) detailed bathymetry of the Molloy Hole noting the position of the deepest point and the Atla Seamount.

Lander operations.

The three identical landers – Skaff, Closp and Flere – were deployed eight times between 1934 and 5591 m. The first set of three were near the deepest point of the Molloy Hole (5547-5591 m) on the 24th of August, and the second and third set were on the southern flank of the Atla Seamount to 1934-4128 (25th August) and 2117-3489m (26th of August) (Table 1).

Table 1. Details of the 8 lander deployments in the Molloy Hole and adjacent Atla Seamount.

Station #	Date	Gear	Latitude	Longitude	Depth
MOL_SK1_5560	24-Aug	SKAFF	79.1880	2.6882	5591
MOL_CL1_5560	24-Aug	CLOSP	79.1973	2.7187	5547
MOL_FL1_5560	24-Aug	FLERE	79.1960	2.7015	5571
MOL_SK2_4000	25-Aug	SKAFF	79.2830	2.7440	4128
MOL_CL2_3000	25-Aug	CLOSP	79.3240	2.5540	3012
MOL_FL2_2000	25-Aug	FLERE	79.3340	3.0050	1934
MOL_SK3_3500	26-Aug	SKAFF	79.2950	3.4250	3489
MOL_CL3_2500	26-Aug	CLOSP	79.3170	3.1870	2117

All deployments acquired surface to seafloor CTD profiles that are available upon request (see Figure 2 for example profile). The bottom water temperature >1000 m was sub-zero, reaching -0.4˚C at the deepest point. Beyond 3000m, the salinity remained relative constant at 34.88 to the deepest point.

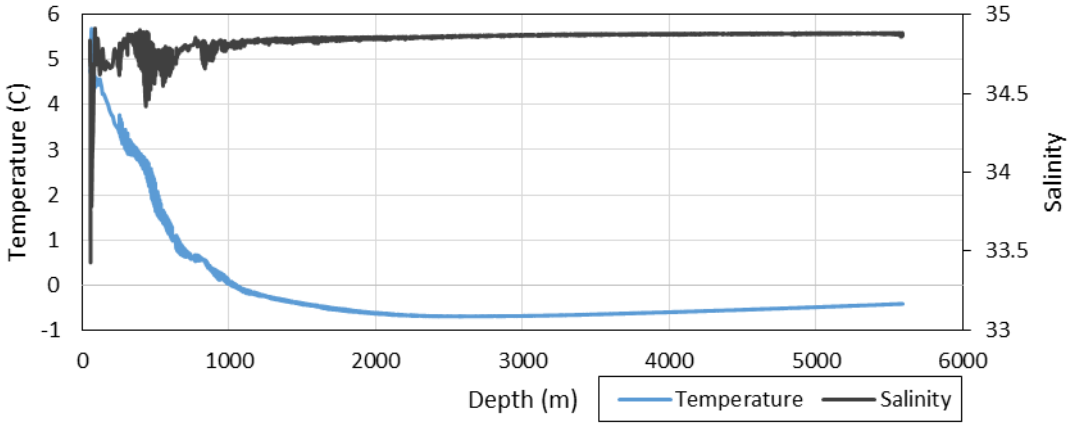

Figure 2. Example CTD profile from Skaff lander deployed to 5591 m on the deepest point of the Arctic Ocean, the Molloy Hole.

Each lander was equipped with a baited camera to film local scavenging megafauna (Figure 3). The only fish to appear in the images was the Glacial eelpout *Lycodes frigidus*, Collett, 1879 (Family: Zoarcidae). This species was recorded in relatively high numbers between the depths of 1934 and

4129 m but no observations of any fish were made at the deepest point. In addition to the glacial eelpout, the deployments on the slopes of the Molloy Seamount where characterised by a very high densities of scavenging amphipods, likely *Eurythenes* cf. *gryllus*. Several hundred of these were recovered in the bated traps and await formal integrated taxonomic identification. Among the large red *Eurythenes* sp. were many other Lysianassoid amphipod species, preliminarily of the *Paralicella* genus.

Figure 3. Examples of the local megafaunal deep sea species of the Molloy Hole, where TL and TR is the Glacial eelpout *Lycodes frigidus* as seen by the baited lander. Similarly large swarms of amphipods aggregated at the lander (BL), the most striking being *Eurythenes* cf. *gryllus* (BR).

The biological results of this expedition are currently included in the following papers in review:

- Swan, J.A., Jamieson A.J., Linley, T.L., Yancey, P.Y. (*Submitted*) Distribution of Decapoda (Penaeoidea and Oplophoroidae) across the abyssal-hadal transition zone of eleven subduction trenches and additional deep-sea features. *Journal of Crustacean Biology.*

- Jamieson, A.J., Linley T.L. *(In press)* Hydrozoans, Scyphozoans, Larvaceans and Ctenophores observed *in situ* at hadal depths. *Journal of Plankton Research*.
- Jamieson, A.J., Linley T.L. *(In prep) Fishes of the Abyssal-Hadal Transition Zone: a global study. Deep-Sea Research Part 1.*

Pending completion of the geological analyses from the videos, and the analysis of the fish populations from the landers, we envisage another two Molloy Hole specific publications in 2021.

Submersible operations.

Three submersible dives were completed during the expedition in the DSSV *Limiting Factor*; a solo dive to the deepest point of the Molloy Hole, piloted by V. Vescovo (Caladan Oceanic, LLC, US), a 2400 m deep dive to the slopes of the Atla Seamount with Vescovo and geologist H.A. Stewart (British Geological Survey, UK) and a 2000 m dive to the Atla Seamount with Vescovo ad biologist A.J. Jamieson (Newcastle University, UK). Each dive was about 3 hours long (Table 2).

The deepest dive revealed the seafloor to be fine grained sediment with surficial bioturbation, and largely flat. Very few epifauna was visible except for anemones attached to wood debris. Several items of anthropogenic litter were also observed. The two shallower dives to the Atla Seamount reveal very geologically complex terrain and the local fauna to comprise of anemones, sponges, decapods, eelpouts and high densities of featherstars (Figure 4).

Table 2. Deployment details of the three DSSV Limiting Factor submersible dives to the Molloy Hole and Atla Seamount.

Date	Gear	Latitude	Longitude	Depth (m)
24-Aug	LF	79.2	2.7	5550
25-Aug	LF	79.4	2.9	2400
26-Aug	LF	79.3	3	2000

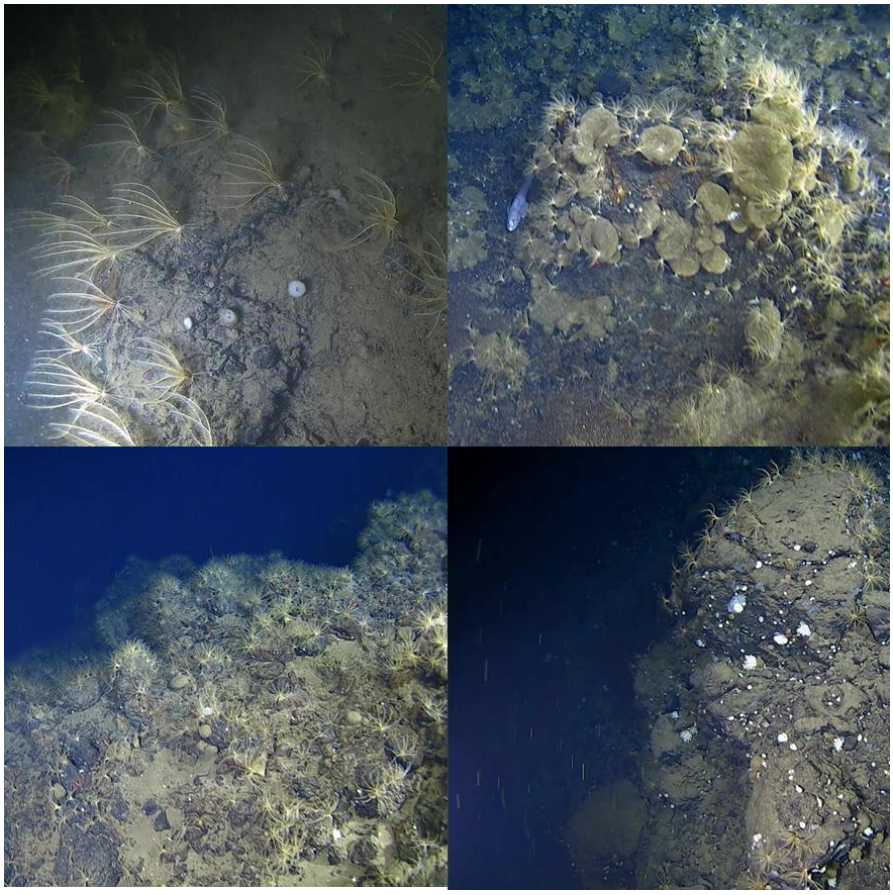

Figure 3. Example images of the seafloor terrain on the Atla Seamount, note the high densities of featherstars and other sessile fauna.