Unveiled bathymetry in front of glaciers in Lützow-Holm Bay, East Antarctica

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The East Antarctic Ice Sheet (EAIS) is recently the focus of much attention because basal ice shelf melting driven by intrusions of relatively warm circumpolar deep water into the ice shelf cavities cause a destabilization in some portions. One of the hot spots of basal melting in EAIS is the Shirase Glacier Tongue (SGT) in Lützow-Holm Bay (LHB), where higher fast ice velocity, high basal melt rates, and huge drowned trough (namely Shirase Submarine Canyon) in front of the SGT have been observed (e.g., Hirano et al., 2020). In order to understand ice–ocean interaction and ice sheet instability, further exploration of the coastal bathymetry is required (e.g., Kusahara et al., 2021). While the survey of the submarine topography of the LHB has been conducted since the 9th Japanese Antarctic Research Expedition (JARE9) in 1968 (Moriwaki and Yoshida, 1983), these point bathymetry data of on-ice soundings are spatially limited and sparse. In addition, their position by triangulation at that time had significant errors up to 1 km, resulting unrealistic distributions of depth values.

By the present day, heavy land-fast sea ice has prevented shipboard observations even in summer; therefore, no direct acoustic evidence of a well-positioned shipboard echo sounder to determine bathymetry has not been collected. In austral autumn 2016, however, large areas of fast ice broke up (Aoki, 2017), allowing us to access the unexplored area of the LHB to make the first comprehensive shipboard observations in front of the SGT. Here, we firstly present shipboard acoustic-sounding data of detailed bathymetry off glacier tongues in LHB.

Shipboard observations using the Japanese icebreaker “Shirase” (AGB-5003) were conducted from December 2016 to February 2017 (JARE58) and December 2017 to February 2018 (JARE59). Data were acquired by a high-resolution chirp sub-bottom profiler system (SyQwest Bathy-2010). The seafloor depth was initially obtained by automatic peak signal detection including receiver gain adjustment, bottom tracking, pulse length, and power level control of the Bathy-2010 operating system. Then, the redefining of the seafloor bottom was conducted as a post-acquisition processing to remove the extreme depth detected due to the noise. The SonarWiz software was used for this data processing. The sound velocity correction was performed by using the observational profiles of conductivity and temperature in each depth.

Obtained results of new surveys reveal several bathymetric features that facilitate the transport of warm deep water to the glacier tongues. Sub-bottom features such as sedimentation layers were not observed in most locations, probably due to rough grains in bed environment strongly affected by glacial activities. The obtained pattern of topography change is generally consistent with previous submarine topographic data of Moriwaki and Yoshida (1983). A broad and deep (600–1200 m) trough extends from the continental shelf to near the SGT. Closer to the western coast of the LHB, the depression shoals to depths of <400 m. The continental shelf break has a bottom depth of ~600 m, which is much shallower than previously recognized depth values. The new bathymetric data also reveal the detailed structure of deep troughs off Honnør, Skallen, and Telen glaciers. The troughs range in depth from 600–1100 m and in width from 10–20 km. Remarkably, there are several shallower topography (<500–600 m depth) among troughs that may act to partially block the flow of warm water along the seafloor. This topography may be relatively firm basements, making Honnør, Skallen, and Telen submarine troughs less connected to the deep waters of the main trough of the Shirase Submarine Canyon in front of the SGT.

References

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