Topographic signature of cold, dense water overflow in the Hillary Canyon, Ross Sea, Antarctica

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Abstract

The rate of ice loss from the West Antarctic Ice Sheet has increased during the last few decades. The reasons for this increase are likely to stem from changes in both ocean and atmospheric circulation. There have been increased observations of intruding warm water masses (Circumpolar Deep Water) onto the Antarctic shelf in recent years. The intrusion of this warm water leads directly to increases in basal ice melting causing rapid ice stream grounding line retreat. This is due to a reduction in the buttressing effect of the ice leading to potentially irreversible effects. Another major change is in dense water production and regime. In the Ross Sea, these dense water masses flow downslope and ventilate the deep ocean and eventually feed the global thermohaline circulation. Constraining the signature of these flows on the seafloor therefore provides huge potential in understanding how ocean circulation has changed in the past, for example, when climatic conditions resembled 'worst-case' future climatic scenarios and may provide important clues as to how they may change in the future; and what effects this may have on ice retreat and sea-level rise. Here, we present newly collected data from the Hillary Canyon, Eastern Ross Sea, in an area of previously documented cascading flows of cold, dense water. We attempt to constrain whether the episodic pulses of outflowing currents are precursors / triggers for turbidity currents on the slope. New multibeam bathymetric, single-channel seismic and subbottom profiler data collected during the EUROFLEETS-funded ANTSSS expedition on OGS Explora (February 2017) show deeply incised gullies and channel systems feeding the canyon head, at the mouth of the Glomar Challenger Basin. Conversely, a distinct lack of gullies and channels are observed on the western side of the canyon, at the shelf edge of the Pennell Basin. Here, new Acoustic Doppler Current Profiler, Conductivity Temperature Depth and XBT data collected over a 1-month period show sustained high-velocity cold, dense bottom currents reaching velocities of 1 m/s. Turbidity measurements indicate that these bottom currents are associated with increased turbidity. The absence of gullies and channels where sustained bottom currents are observed in modern times suggests that the origin of the gullies is most likely related not to bottom currents, but to the presence of ice grounded near the shelf edge during previous glaciations. In fact, the new single channel seismic data from the shelf edge show that the gullies likely evolved over multiple glacial cycles, filling and reforming with subsequent glacial

advances. We suggest that the evolution and spatial distribution of the channels likely originated from sediment-laden subglacial meltwater released during previous glaciations, although are likely modified by the velocity and duration of the bottom flows.

Keywords: Cold dense water, slope processes, gullies, Hillary Canyon