Origin of slope gullies in Flemish Pass: evidence for an ice cap on Flemish Cap

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New seafloor multibeam bathymetry data in water depths of 600 to 2000 m has been collected by the Spanish research vessel Miguel Oliver from Flemish Pass and Flemish Cap. This study compares the style and distribution of slope gullies on the Grand Banks flank (GBf) and Flemish Cap flank (FCf) of Flemish Pass and relates them to the Quaternary geological history of the area revealed by previously acquired piston cores and seismic-reflection profiles.

Most gullies head at ~600 m water depth and terminate at the floor of Flemish Pass at roughly 1100 m. The GBf has a slope of 7.6% in the south, gradually decreasing towards the north and a density of 0.4 gullies/km. Main types are: (1) asymmetric, U-shaped, linear gullies with headscarps; (2) gullies that terminate in a depositional lobe; and (3) regularly spaced, infilled, linear gullies with little relief and no headscarps, found only in the north. On FCf, most gullies are on a slope of 4.5–8.2%, with a density of 1.7 gullies/km. Types are: (1) parallel to sub-parallel linear, with two or more gullies merging where gully densities are high. A few gullies have headscarps; (2) in places, several gullies lead into a channel on a low slopes that cuts through a field of sediment waves; and (3) many smaller closely spaced gullies on ~13% slope in an amphitheatre-like depression.

The upslope limit of gullies at ~600 m on GBf corresponds to the previously recognized limit of glacial till from marine isotope stage (MIS) 6. Gullies of this region resemble ice margin gullies observed elsewhere. Similar gullies on FCf and Beothuk Knoll suggest glacial ice was grounded in these areas. Sparker reflection profiles show apparent till that pinches out at about 600 m, passing seawards into stratified sediment that is different seismically from iceberg-turbated marine sediment. A core on SE Flemish Cap shows that these till deposits date from MIS 6. Gullies on the GBf overlie buried gullies that date from MIS 6 and have been modified by southward Labrador Current flow resulting in asymmetry and by retrogressive sediment failure, in some cases resulting in depositional lobes. Sediment waves at the end of some gullies on FCf imply turbidity current flow. Amphitheatre-like depressions result from sediment failure.

The presence of MIS 6 ice on both Flemish Cap and Beothuk Knoll is unexpected, given that their least depths at present are at 126 m and 487 m, respectively. Glacially lowered sea-level exposed enough of Flemish Cap for an ice dome to develop, which eventually merged with ice that crossed the Grand Banks, grounding on Beothuk Knoll and creating an ice shelf across Flemish Pass. This may be the cause of the large differences in paleoceanographic circulation previously recognized in the Labrador Sea between MIS 2 and MIS 6.

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