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Grounding-zone wedges (GZWs) on high-latitude continental margins

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The grounding-zone of marine-terminating ice sheets is the area at which the ice-sheet base ceases to be in contact with the underlying substrate. The grounding-zone is a key site at which ice, meltwater and sediment are transferred from ice sheets to the marine environment. GZWs are asymmetric sedimentary depocentres which form through the rapid accumulation of glacigenic debris along a line source at the grounding-zone largely through the delivery of deforming subglacial sediments, together with sediment remobilisation from gravity flows. The presence of GZWs in the geomorphological record indicates an episodic style of ice retreat punctuated by still-stands in the grounding-zone position. GZWs may take decades to centuries to form. Moraine ridges and ice-proximal fans may also build up at the grounding-zone during still-stands or re-advances of the ice margin, but these require either considerable vertical accommodation space or are derived from point-sourced subglacial meltwater streams. We present an inventory of GZWs which is compiled from available studies of bathymetric, shallow acoustic and reflection seismic data from high-latitude continental margins. The objectives are to present locations of and morphological data on GZWs from the Arctic and Antarctic, alongside a synthesis of their key architectural and geomorphic characteristics. We use, for example, newly-available two-dimensional seismic reflection data to show the approximate locations of GZWs off northwest and northeast Greenland. Controls on GZW formation are considered in relation to shelf topography and ice-sheet internal dynamics.
A total of 129 GZWs are described from high-latitude continental shelves. GZWs are only observed within cross-shelf troughs and major fjord systems, which are the former locations of ice streams and fast-flowing outlet glaciers. Typical high-latitude GZWs are less than 15 km long and 15 to 100 m thick. A positive correlation between GZW length and thickness is inferred for GZWs on the Greenland, Norwegian, Canadian and Barents Sea margins. However, no significant relationship between GZW length and thickness exists for the GZWs described from the Antarctic margin. GZWs typically possess a semi-transparent to chaotic acoustic character, which reflects the delivery of diamictic subglacial debris. Many GZWs contain low-amplitude, seaward-dipping internal reflections, which indicate sediment progradation and wedge-growth through continued delivery of basal sediments from the flow of active ice.
The formation of GZWs is inferred to require high rates of sediment delivery to a relatively stable, fast-flowing ice margin. Ice-margin stabilisation, and consequently GZW formation, is dependent on a number of factors, including the ice-sheet mass balance, sea-level fluctuations, and the rate of inland-ice delivery to the grounding-zone. GZWs may be formed preferentially by glaciers with termini ending as floating ice shelves, which restrict vertical accommodation space and prevent the build-up of high-amplitude moraine ridges. The basal topography of the continental shelf can also act as a control on GZW formation. The majority of high-latitude GZWs are located at topographic or lateral pinning points within cross-shelf troughs, which encourage ice-margin stabilisation through reducing iceberg calving and increasing basal and lateral drag.