The impact of ice sheets on slope sedimentation: a long-term perspective

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In recent years, detailed research on glaciated slope systems has suggested a close relationship between shelf-break ice-sheet dynamics and slope instabilities. Such a link has also been established on the Scotian Slope, where the geological record is used to understand the spatial and temporal variability of slope sedimentation processes during the Quaternary. This record was obtained using high resolution Huntec and lower resolution airgun seismic data: few sediment cores provide ground truth for the shallowest succession and defined areas of plume sedimentation during the last glacial advance.

The general morphology of the Scotian Slope did not change significantly within the glacially influenced Mid to Late Pleistocene, as most canyon systems were initiated during the Early Pleistocene, in many cases inherited from pre-Quaternary morphology: exceptions are found on the Western Scotian Slope and in the Logan Canyon Debris

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Flow Corridor.

The first shelf-crossing ice sheets, previously dated at ~450 ka, resulted in a significant change in slope depositional centres and erosion rates. The stratigraphic section older than 450 ka is characterized by few mass wasting events and slope deposition occurred preferentially on the lower slope and rise. This is in contrast to the younger succession, characterized by more uniform slope deposition and more frequent mass wasting events. Depositional centers since 450 ka moved seawards to the Sohm Abyssal Plain, where the top of a thick glacial section has been cored.

The most complete Quaternary section is found in the offshore Western and Sable island banks, where little erosion occurred on the upper and mid-slope. Below ~2500 m, large scale erosion has removed most of the Late Quaternary section, with the bounding scarp generally muted by younger deposits. The western and eastern parts of the slope are dominated by mass wasting; intercanyon ridges and other local highs show a more complete stratigraphic record. Removal of parts of the glacially-influenced section (<450 ka) result in regional unconformities. Interglacial accumulation rates are generally an order of magnitude lower compared to glacial rates and are greatest on intercanyon ridges offshore Sable Island Bank.

At times when ice sheets frequently terminated at the shelf break, there was an increase in slope instabilities and linked erosion compared to the early Quaternary, highlighting the importance of shelf ice sheets on slope dynamics. More slope failures are found seawards of ice streams, whereas stagnant ice on shelf banks resulted in till tongue formation on the upper slope and only minor erosion, mostly linked to meltwater discharge.

Using published data from other glaciated systems (mainly the Norwegian Slope), dominant drivers for glaciated slope sedimentation are identified. These include the distance from meltwater plume outlets, occurrence of canyons providing pore pressure drainage, slope angle, and the availability of drainage pathways for meltwater.