Facies and stratigraphic architecture of high-frequency shelf sequences in high-latitude settings

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Abstract
High-frequency clastic shelf sequences deposited in high-latitude settings display marked differences, in term of facies and stratigraphic architecture, with respect to their lower latitude counterparts. This is due to the presence of ice which (1) leads to the accumulation of glacigenic and glacimarine deposits; (2) provides an additional control on accommodation; and (3) determines the position of the shoreline. Transgressions and regressions in glaciated settings are controlled respectively by the retreat and advance of the 'ice' shoreline (i.e., the water/ice contact) irrespective of relative sea-level changes; once the ice retreats across the land, the traditional 'land' shoreline is exposed and the control on sequence architecture is exerted by the interplay between relative sea-level changes and sediment supply as in low- and middle-latitude settings.

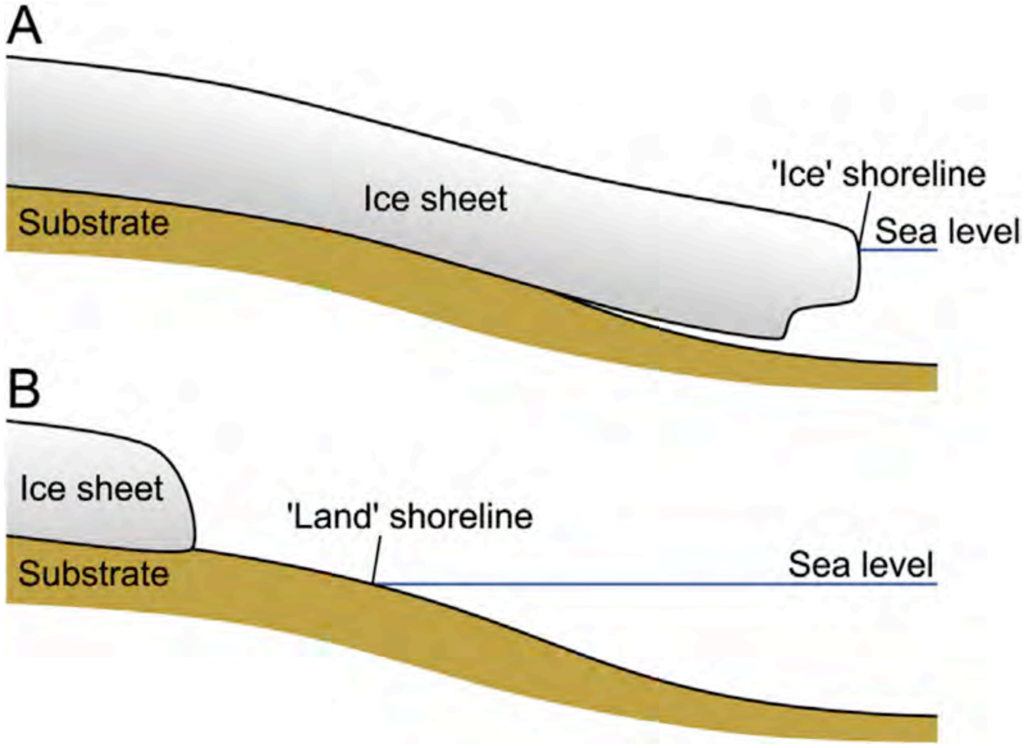

Figure 1: *The concepts of 'ice' and 'land' shorelines. (A) The 'ice' shoreline is represented by the water/ice contact, when ice sheets occupy the shelf. (B) The 'land' shoreline, represented by the water/land contact, is found when ice retreats across the land area.*

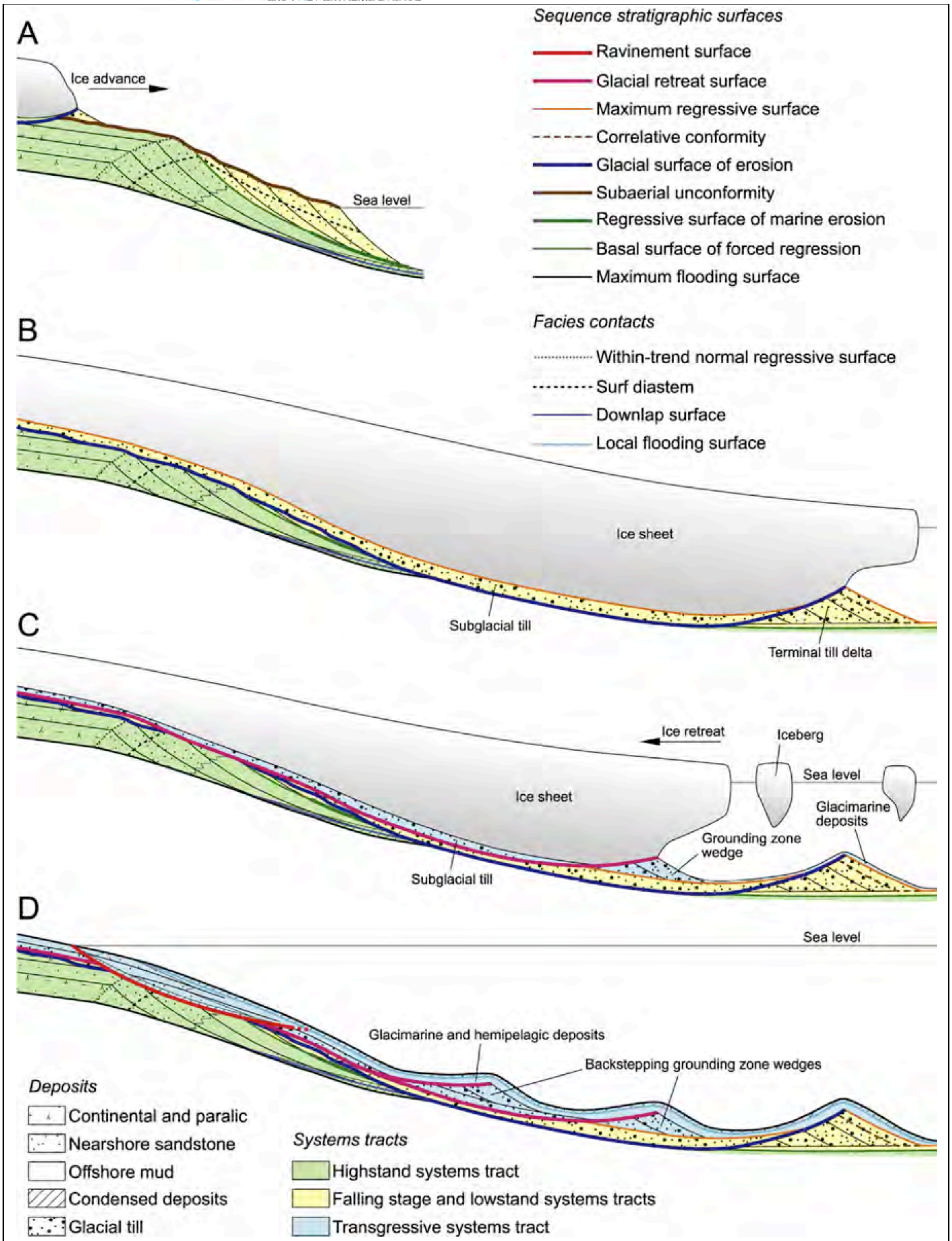

Figure 2: *Sequence stratigraphic model for high latitude shelves typified by periodic advance and retreat of ice sheets. (A) After the accumulation of highstand (interglacial) marine and continental deposits, a phase of relative sea-level fall, driven by glacio-eustatic lowering, leads to the accumulation of FSST shallow-marine deposits, which is concomitant with the onset of ice advance. (B) The glacial surface of erosion (GSE) develops at the base of the ice sheet until the glacial maximum. Part of the previously accumulated deposits areeroded by the GSE, which is overlain by the subglacial till and terminates seaward onto a terminal till delta or a trough mouth fan. (C) The phase of eustatic sea-level rise and ice retreat is punctuated by episodes of ice stationarity, during which the glacial retreat surface (GRS) develops and reworks older deposits. Grounding zone wedges accumulate in front of stationary ice sheets. A drape of glacimarine deposits starts to accumulate above glacigenic deposits. (D) When ice retreats across the land area, the wave action leads to the development of the ravinement surface, and shoreface/shelf deposits accumulate.*

A general model that includes both glacial and non-glacial climatic regimes is provided by this paper. In this frame, the classic sequence stratigraphic model represents one (ice-free) end member, which is opposed to an ice-permanent end member. Between these end members, sequences may accumulate in part under ice-free conditions and in part under conditions dominated by ice on the shelf. The main implication of this is that the classic sequence stratigraphic model may be viewed as only a possible scenario in the stratigraphic record rather than the rule.

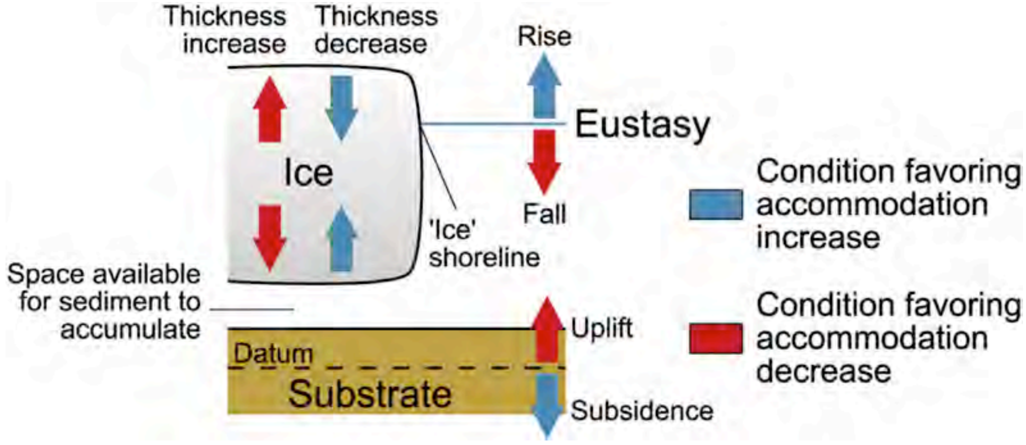

Figure 3: *On high-latitude shelves, accommodation depends on the interplay between eustasy and subsidence/uplift, as well as on variations in ice thickness: an increase in ice thickness reduces accommodation; a decrease in ice thickness generates accommodation*

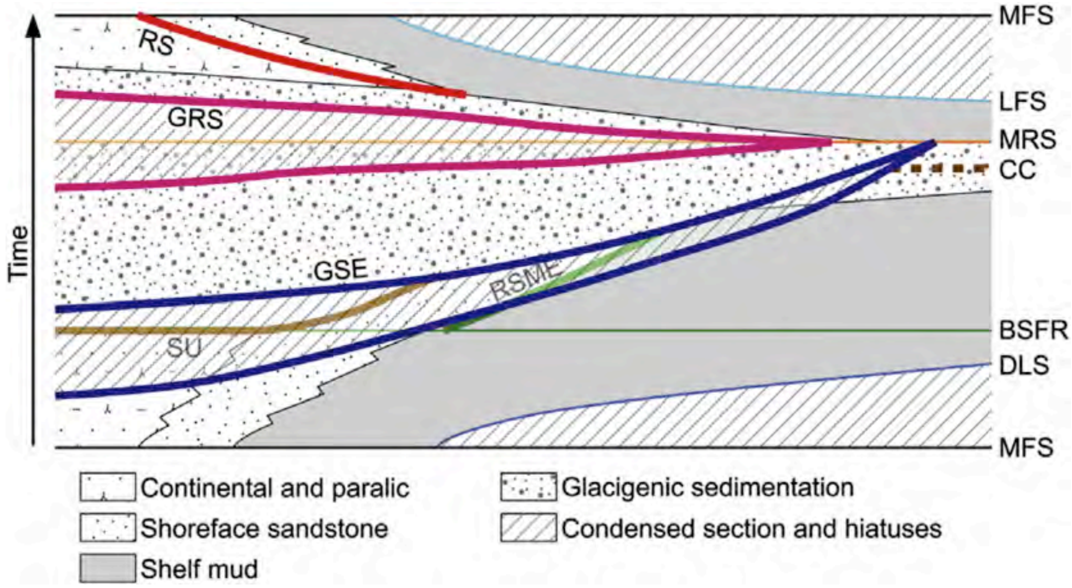

Figure 4: *Wheeler diagram for high-latitude shelves, showing sequence stratigraphic surfaces and facies contacts. Note the erosional hiatus associated to the GSE and GRS, the extent of which can vary significantly. Abbreviations: BSFR - basal surface of forced regression; CC - correlative conformity; DLS - downlap surface; GRS - glacial retreat surface; GSE - glacial surface of erosion; LFS - local flooding surface; MFS - maximum flooding surface; MRS - maximum regressive surface; RS – ravinement surface; RSME - regressive surface of marine erosion; SU - subaerial unconformity*

References

Zecchin, M., Catuneanu, O., Rebesco, M., 2015. High-resolution sequence stratigraphy of clastic shelves IV: High-latitude settings. Marine and Petroleum Geology 68, 427-437.