



Deposition and erosion patterns under the Fennoscandian ice sheet: A Quaternary perspective

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Three scientific developments during the last decades lead us to think that it is now meaningful to seek a credible explanation for the present spatial pattern of Quaternary glacial deposits and zones of significant glacial erosion in Fennoscandia; i/ major progress in our understanding of basal thermal conditions of paleo-ice sheets, ii/ improvement in the understanding of climate and ice sheet volume evolution through the Quaternary, allowing for reasonable inferences regarding ice sheet extents for glacial periods before the last glacial cycle, and iii/ the recent recognition and dating of relict surfaces and landforms within formerly glaciated areas, which has provided some precise insights regarding erosion and deposition patterns during sub-stages of the last glacial cycle.

We apply a 3 Myr perspective, because of the evidence for climatic deterioration and onset of significant glaciation in Fennoscandia within this time frame. The problem is potentially extremely complex for two reasons. First, ice sheets in Fennoscandia have grown and shrunk during approximately 40 glacial cycles in this time period, with corresponding migrations of ice divides and locations of erosional and depositional zones. Second, these ice sheets additionally had important intra-cycle dynamics which, on a smaller scale, dictated the location and extent of basal thermal zones, something which strongly impacted both erosion and deposition patterns. What we see today is the accumulated result of this complex chain of events, where each subsequent event has potentially either preserved or remobilised deposits that were available at the close of the previous event.

We use an approach where the evolution of Fennoscandian ice sheets during sub-stages of the last glacial cycle, for which we have reasonably good knowledge of con-

figurations, flow patterns, and basal thermal regimes, is used as a model for older Quaternary events of corresponding magnitude. Based on the two modal ice sheet styles that can be discerned during the last glacial cycle, mountain ice sheets (MIS) and full-grown Fennoscandian ice sheets (FIS), a first order deposition pattern is constructed, based on a model in which deposition occurs as a function of dominant modes of ice margin location through the Quaternary and erosion as a function of location between the ice divide and the ice sheet margin. We compare this predicted deposit pattern with the actual pattern of glacial deposits today, and seek glaciologically plausible explanations for deviations caused by subsequent erosion. These explanations elaborate on the glaciological and topographical controls on the erosion pattern. We conclude that the presence of widespread thick till in central Sweden, east of and parallel to the mountain chain, likely reflects that this zone was a depositional zone for MIS ice sheets, while constituting a low erosion zone in a frozen bed ice divide area during FIS events. Regions dominated by areal scouring in west- and east-central Sweden are located in areas that experienced one or multiple transition(s) from sheet flow to stream flow, i.e. they were formed underneath ice flow convergence zones (heads) of the Norwegian Channel and Baltic ice streams, respectively.