

## Distribution and annual-origin of De Geer moraines in Sweden with insights from LiDAR

JOHNSON, MARK D.<sup>1</sup>, BOUVIER, V.<sup>1</sup>, AND PÄSSE, T.<sup>2</sup>

<sup>1</sup>*Department of Earth Sciences, University of Gothenburg, Sweden 40530, markj@gvc.gu.se*

<sup>2</sup>*Sveriges Geologiska Undersökning, Göteborg, Sweden 41320*

De Geer moraines (DGMs) were first identified in Sweden by Gerard De Geer in 1889. Using airborne Light Detection and Ranging (LiDAR) data, we have mapped DGMs over the entire country, and we show that they occur predominantly in two distinct areas: in south-central Sweden north of the Middle Swedish end-moraine zone and in northeast Sweden. DGM formation occurs predominantly where the local relief is low, the ice-margin retreat rate was high and the sedimentation rate low. Formation of DGMs occurred over short time spans of a few hundred years – between 11 500 and 11 000 cal years BP for the southern group and from 10 700

and 9900 cal years BP for the DGMs in the north. DGMs have been suggested to be made by a number of processes at subaquatic ice margins, including pushing during winter readvance, squeezing into subglacial crevasses, deformation during calving events and deposition as subaquatic fans. Therefore, we recognize DGMs to be equifinal landforms, made by several related mechanisms. However, we observe that the most common occurrence of DGMs in Sweden are as regularly spaced even ridges below the highest shoreline whose spacing closely corresponds to independently determined ice-margin retreat rates. We therefore suggest that where regular evenly spaced DGMs occur, their spacing likely represents the local ice-margin retreat rate, and that the majority of these ridges were made annually by winter advances.