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The marine geophysical signature of past ice sheets: a view from the sea (Louis Agassiz Medal Lecture)

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The deglaciation of high-latitude continental shelves since the Last Glacial Maximum has revealed suites of subglacial and ice-contact landforms that have remained well-preserved beneath tens to hundreds of metres of water. Once ice has retreated, sedimentation is generally low on polar shelves during interglacials and the submarine landforms have not, therefore, been buried by subsequent sedimentation. By contrast, the beds of modern ice sheets are hidden by several thousand metres of ice, which is much more difficult than water to penetrate using geophysical methods. These submarine glacial landforms provide insights into past ice-sheet form and flow, and about the processes that have taken place beneath former ice sheets. Examples are given of streamlined subglacial landforms that indicate the distribution and dimensions of former ice streams on the Norwegian and Antarctic continental margins. Distinctive landform assemblages characterise ice stream and inter-ice stream areas. Landforms, including subglacially formed channel systems in inner- and mid-shelf areas, and the lack of them on sedimentary outer shelves, allow inferences to be made about subglacial hydrology. The distribution of grounding-zone wedges and other transverse moraine ridges also provides evidence on the nature of ice-sheet retreat – whether by rapid collapse, episodic retreat or by the slow retreat of grounded ice. Such information can be used to test the predictive capability of ice-sheet numerical models. These marine geophysical and geological observations of submarine glacial landforms can enhance our understanding of the form and flow of past ice masses at scales ranging from ice sheets (1000s of km in flow-line and margin length), through ice streams (100s of km long), to surge-type glaciers (10s of km long).