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Svalbard surging glacier landsystems

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The percentage of Svalbard glaciers thought to be of surge-type is somewhere between 13-90% according to different sources variously based on statistical analysis and observations of diagnostic glaciological and geomorphological features, e.g. looped moraines. Developing a better understanding of which of these figures, if either, is most realistic is important in the context of glacier dynamics and related contributions of small glaciers and ice caps to sea level change in the immediate future. We present detailed geomorphological assessments of the margins of several known surge-type glaciers in Svalbard in order to update and improve the existing framework by which they are identified, and to provide a foundation for future reassessments of the surge-type glacier population based on distinct landform-sediment assemblages. Three landsystems are proposed: (1) Surges of small valley glaciers produce a prominent ice-cored latero-frontal moraine at their surge maximum and are characterised by an inner zone of ice stagnation terrain (hummocky topography, kettle lakes, debris flows) with no or only very few poorly-defined bedforms (crevasse squeeze ridges, eskers and flutes) and no recessional moraines. Many of these glaciers may have surged in the past but show no signs that they have the capability to do so again in the future. (2) Larger land-terminating glaciers, often with several tributaries, typically produce a push moraine complex which contains evidence for multiple advances, as identified from ridge-meltwater channel relationships. The inner zone often contains a large lagoon, partly dammed by the push moraine complex, and widespread ice stagnation terrain. Crevasse squeeze ridges, eskers and flutes are well-defined but small and limited in number and distribution. (3) Surges of large tidewater glaciers produce distinctive, often multi-generational, landform assemblages both in submarine and lateral terrestrial positions. The well-preserved submarine record is characterised by large cross-fjord push moraines of fjord floor sediments with lobe-shaped debris flows on their distal slope, glacial lineations, dense rhombohedral networks of crevasse squeeze ridges, and eskers. Annual push moraines associated with the quiescent phase are also observed and are unique to the submarine record. The terrestrial record consists of large lateral moraine systems alongside the fjord which contain outer push ridges composed of shallow marine sediments and an inner zone of ice stagnation terrain. Eskers, flutes and large, sharp-crested crevasse fill ridges in dense networks are superimposed on this inner zone; the latter are similar in character to their submarine counterparts but typically higher. We suggest that these three landsystems broadly characterise the geomorphology of the vast majority of known Svalbard surge-type glaciers and may allow previously unknown surge-type glaciers to be identified, both in the field and from aerial photographs and sea floor imagery.