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Deglaciation dynamics following the Little Ice Age on Svalbard: Implications for shaping of landscapes at high latitudes

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Abstract

The late culmination of the Little Ice Age (LIA) on Svalbard allows a detailed reconstruction of the landscape's response to the subsequent climatic warming. The study area comprises a small glacier (400–1000 m a.s.l.), on the south side of Adventfjorden (78°11′N) that was polythermal during the LIA and turned into a passively down-wasting cold-based ice-mass prior to 1936. Reconstruction of the formation and decay of ice-cored moraines and the shifting courses of glacial meltwater shows that sediment transport during deglaciation occurred in a slow, stepwise fashion with glacial landforms and sediments being slowly replaced by fluvial morphologies and slope-waste products. The key controlling factors are melting rates, aspect and surface gradients. A low melting rate and slow reworking of glacial debris promote the formation of a lag or "pavement" on low-gradient surfaces and debrisfall deposits along steeper slopes. Both products easily may be misinterpreted as a result of weathering and non-glacial processes.

Keywords: Deglaciation; Moraines; Meltwater; Glacial landforms; Little Ice Age; Svalbard

1. Introduction

The Svalbard archipelago (76–81°N, Fig. 1) was inundated by a thick continental ice-sheet during the last glacial maximum (LGM) and nearly 60% of the territory is still glaciated. The large variety of glacial settings here have attracted geologists for more than a century, and are frequently used as a comparative basis for reconstructing Pleistocene glaciations in mid-latitudes (Boulton, 1972; Hambrey and Huddart, 1995; Benn and Evans, 1998). Reconstruction of the local glaciation history, however, has been a challenging task.

The Svalbard landscape has deep glacially eroded fjords and valleys with a relief reaching ~2000 m, but with remarkably few traces of former ice-front position, except for fresh-looking ice-cored moraines bordering the present glacier margins. Fluvial landforms and debris-mantled slopes are widely distributed

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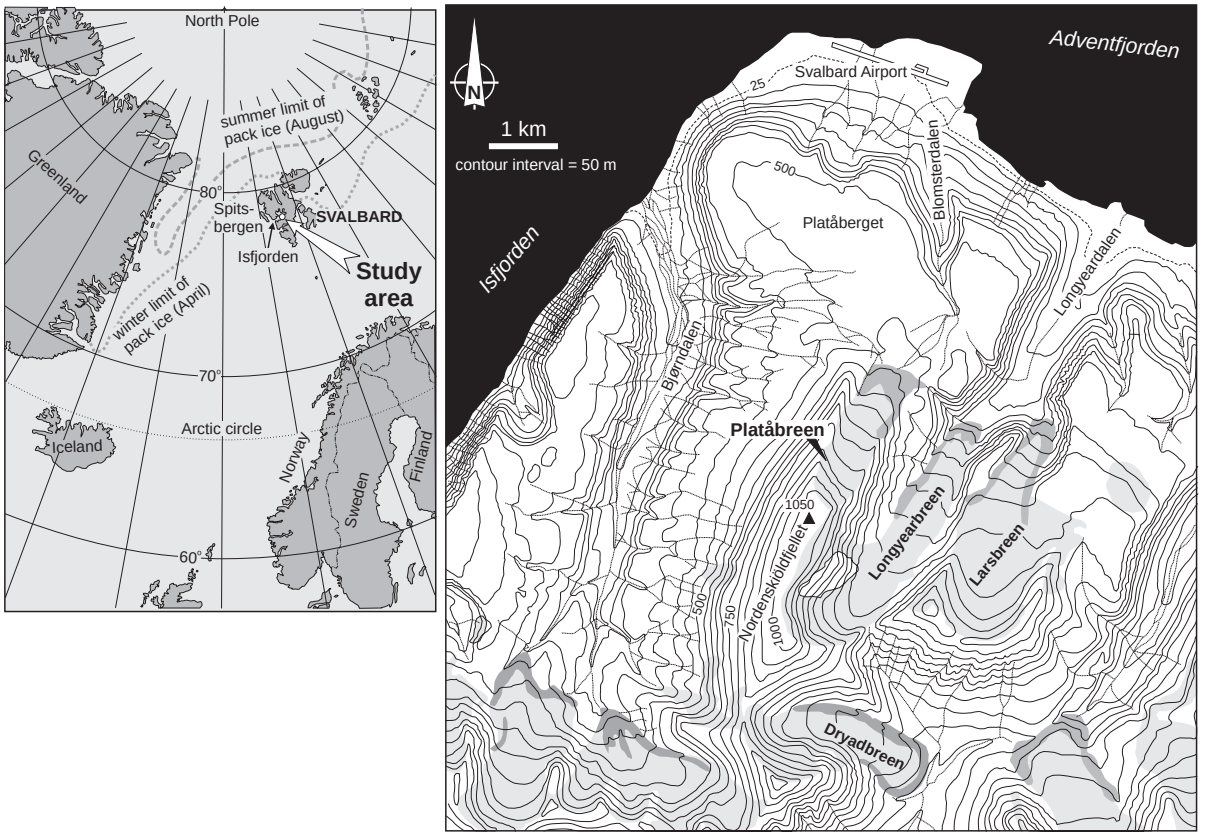

Fig. 1. Location of the study area with the Platåbreen glacier.

(Jahn, 1960; Rapp, 1960; Rudberg, 1986, 1988; Sollid and Sørbel, 1988a,b), and low-lying coastal areas are often occupied by raised marine beach terraces. Infinite radiocarbon dates from several of the well-preserved palaeo-beaches and the scarcity of moraines were the main arguments for postulating large ice-free areas along the Spitsbergen west coast during the LGM (see review in Landvik et al., 1998). ^{10}Be exposure ages for glacial erratics recently have revealed that local nunataks existed in the northwest (Landvik et al., 2003), but fjords and valleys clearly were occupied by grounded, fast-flowing ice-streams extending all the way to the shelf edge (Landvik et al., 2005). The old beach terraces must therefore have been overridden by glaciers that hardly influenced the beach morphology and sediment texture.

Even if the broad outline of the Late Weichselian to Holocene glaciation history on Svalbard now is established, the marine and onshore records have been regarded as contradictory (Mangerud et al., 1992; Svendsen et al., 1996; Landvik et al., 1998; Houmark-Nielsen and Funder, 1999), and the development and decay of glacial landforms and sediment facies is still poorly understood. Other high-latitude regions, as e.g. the Canadian Arctic are facing similar problems (see Miller et al., 2002).

Svalbard has been covered by extensive ice-sheets several times during the last few hundred thousand years (Mangerud et al., 1998), but subglacial deposits are rather thin and mainly restricted to areas below the marine limit (Lønne and Mangerud, 1991; Landvik et al., 1992; Mangerud and Svendsen, 1992). Moraine ridges at the mouths of valleys, fjords and submarine shelf-crossing troughs (Landvik et al., 1998, 2005) demonstrate that the larger glacial pathways were occupied by grounded, warm-based ice during the last glaciation. The glacial activity must, however, have varied spatially and temporally, as low-relief areas