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Mechanisms of flute formation at a polythermal valley glacier: Midre Lovénbreen, Svalbard.

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Flutes in front of the margin of a small, polythermal valley glacier, Midre Lovénbreen, Svalbard, were described in terms of their morphometry. Flutes, subglacial and proglacial till, debris-rich basal ice and glacier ice were sampled for their sedimentary and isotopic composition in order to investigate mechanisms of subglacial flute formation. Flutes are widespread across the glacier forefield and consistently form in the lee of cobble to boulder-sized clasts ploughed into proglacial till. Physical properties, including mean particle-size-distributions and oxygen isotope compositions show that flutes are enriched in ^{18}O and depleted in gravel-sized particles relative to adjacent subglacial till and overlying debris-rich basal ice. These properties indicate that flutes are formed by the squeezing of partially fluidized subglacial till into incipient basal cavities beneath warm-based ice within interior of the glacier. The formation of flutes beneath relatively thick ($>$120 m) warm-based ice suggests that partially fluidized sediment adfreezes onto the bed of the glacier. Melting on the upglacier side of subglacial boulders is thought to create a heat-pump effect between a zone of relatively high-pressure of the upglacier face and a zone of relatively low-pressure on the downglacier face within incipient basal cavities. The presence of this pressure-temperature gradient across the surface of subglacial boulders is invoked to account the adfreezing of sediment squeezed into incipient basal cavities. The distribution of flutes in front of Midre Lovénbreen may therefore be indicative of the former extent of warm-based ice during periods of active flute formation.