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Subaqueous ice-contact fans: Depositional systems characterised by highly aggradational supercritical flow conditions

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Subaqueous ice-contact fans are deposited by high-energy plane-wall jets from subglacial conduits into standing water bodies. Highly aggradational conditions during flow expansion and deceleration allow for the preservation of bedforms related to supercritical flows, which are commonly considered rare in the depositional record. We present field examples from gravelly and sandy subaqueous ice-contact fan successions, which indicate that deposition by supercritical flows might be considered as a characteristic feature of these depositional systems. The studied successions were deposited in deep ice-dammed lakes, which formed along the margins of the Middle Pleistocene Scandinavian ice sheets across Northern Germany. The gravel-rich subaqueous fan deposits are dominated by large scour-fills (up to 25 m wide and 3 m) deep and deposits of turbulent hyperconcentrated flows, which are partly attributed to supercritical flow conditions (Winsemann et al., 2009). Scours (up to 4.5 m wide and 0.9 m deep) infilled by gravelly backsets are observed above laterally extensive erosional surfaces and are interpreted as deposits of cyclic steps. Laterally discontinuous beds of low-angle cross-stratified gravel are interpreted as antidune deposits. Downflow and up-section the gravel-rich deposits pass into sand-rich successions, which include deposits of chutes-and-pools, breaking antidunes, stationary antidunes and humpback dunes (Lang and Winsemann, 2013). Deposits of chutes-and-pools and breaking antidunes are characterised by scour-fills (up to 4 m wide and 1.2 m deep) comprising backsets or gently dipping sigmoidal foresets. Stationary antidune deposits consist of laterally extensive sinusoidal waveforms with long wavelengths (1-12 m) and low amplitudes (0.1-0.5 m), which formed under quasi-steady flows at the lower limit of the supercritical flow stage and high rates of sedimentation. Humpback dunes are characterised by divergent sigmoidal foresets and are interpreted as bedforms related to transcritical flow conditions. Deposits of aggrading stationary antidunes and humpback dunes represent a characteristic facies association of the distal zone of flow transition. Downflow the succession passes into deposits of large 3D dunes and climbing ripples. The large-scale lateral and vertical successions of bedforms are interpreted as representing the temporal and spatial evolution of the supercritical meltwater jets, which was affected by hydraulic jumps. Small-scale facies changes and the formation of individual bedforms are interpreted as controlled by fluctuating discharge, pulsating unstable flows and bed topography.

References:
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