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3D architecture of cyclic-step and antidune deposits in ice-marginal deltas: Integrating outcrop and ground-penetrating radar data

Jutta Winsemann (1), Jörg Lang (1), Julian Sievers (1), Markus Loewer (2), and Jan Igel (2)

(1) LUH Hannover, Institut für Geologie, Callinstr. 30, 30167 Hannover, Germany (winsemann@geowi.uni-hannover.de), (2) Leibniz Institute for Applied Geophysics (LIAG), Stilleweg 2, 30655 Hannover, Germany

Glacigenic depositional environments are commonly characterised by high-energy, sediment-laden, rapidly waning meltwater flows, and thus favour the occurrence of aggradational supercritical flows and the preservation of bedforms. Outcrop examples from Pleistocene glacilacustrine delta and subaqueous ice-contact fan successions indicate that deposits of such flows are characteristic of these depositional systems (Lang and Winsemann, 2013; Lange et al. 2017). The studied Pleistocene glacifluvial Gilbert-type delta-slope sediments are characterised by cyclic-step deposits, alternating with antidune deposits. Deposits of cyclic steps consist of scours infilled by massive or backset cross-stratified pebbly sand and gravel, which may form laterally extensive trains of regularly spaced scours. Perpendicular and oblique to the palaeoflow direction these deposits appear as troughs with concentric or low-angle cross-stratified infill. Downflow transitions from scour fills into sheet-like low-angle cross-stratified or sinusoidally stratified pebbly sand, deposited by antidunes, are common.
Surge-type supercritical turbidity flows deposited small-scale fining-upward sequences of isolated cyclic-step and antidune deposits with fine-grained drapes. In contrast, deposits of cyclic steps and antidunes related to sustained supercritical turbidity flows are thicker, laterally more extensive and show less variation in grain size. Surge-type and sustained supercritical turbidity flows were triggered by slope-failure events or hyperpycnal flows, respectively. Major controlling factors were accommodation-space changes in the delta-brink zone. Low accommodation space favoured sediment bypass and the formation of sustained supercritical turbidity flows, while frequent slope failure events triggered surge-type turbidity flows during slow lake-level rise when high rates of delta-front aggradation occurred.

Lang, J. & Winsemann, J. (2013): Lateral and vertical relationships of bedforms deposited by aggrading supercritical flows: from cyclic steps to humpback dunes. Sedimentary Geology, 296:36-54.

Lang,J. Sievers, J., Loewer, M., Igel, J. & Winsemann, J. (2017b): 3D architecture of cyclic step and antidune deposits in glacigenic subaqueous fan and delta settings: integrating outcrop and ground-penetrating radar data. Sedimentary Geology, 362, 83-100.