



Step-wise subglacial deposition and deformation of glaciofluvial sediments along a palaeo-ice stream corridor: glacier bed decoupling-recoupling cycles controlled by basal water pressure.

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Sediment exposures near the margins of a postulated palaeo-ice stream corridor (Baltic Ice Stream) on the Island of Funen, Denmark, reveal a 2.5-4 m thick sequence of stacked and folded glaciofluvial sediments overlain by a 2-3 m thick basal till. Glaciofluvial sediments consist of tabular beds of planar-stratified, massive and cross-stratified sand and gravel with localized channel fills of open-work gravel. These beds exhibit curvilinear sheath folding often leading to eye folds. Sand and gravel beds are typically separated by silty clay beds and laminations recording slackwater deposition within subglacial cavities.

Folds frequently display attenuated upper limbs reflecting shearing associated with ice movement. On lower fold limbs, only localized thrusting is observed, suggesting water saturation of sands and gravels during deformation, and relatively low strain rates. Folds are frequently truncated by overlying sand and gravel beds. No evidence of shearing is found along these contacts which are interpreted as erosional surfaces. We propose that glaciofluvial sediments record incremental, step-wise subglacial deposition and deformation rather than wholesale deformation following emplacement of the entire glaciofluvial sequence. Specifically, we envisage that individual beds were deposited and folded subglacially, with deposition occurring during ice-bed decoupling followed by recoupling and shearing of the upper bed surface by the ice base to produce folds with attenuated upper limbs. Silty clay beds helped to maintain elevated porewater pressure by acting as local aquitards. Tabular sand and gravel beds and open work gravel filling scours within single beds suggest broad sheet-like subglacial flows (10-100s m wide) that become increasingly channelized. We propose that the sedimentary sequence records a highly dynamic glaciohydraulic system characterized by repeated localized subglacial cavity development, and storage and release of meltwater leading to glacier decoupling that may have facilitated fast flow of the Baltic Ice Stream. These findings have two important implications for reconstructions of subglacial processes, understanding of rapid ice flow mechanisms, and the sedimentologic criteria used to recognize rapid ice flow in the geologic record: 1) if repeated basal decoupling facilitated rapid ice flow, then the record of this rapid ice flow consists of glaciofluvial sediments. This contrasts strongly with conventional perceptions of ice stream beds, often assumed to be composed of till, and bears on the criteria used to recognize rapid ice flow in the geologic record; 2) extensive glaciofluvial deposition can occur subglacially in sheet-like configurations that are more commonly associated with proglacial environments. Differentiating between sub- and proglacial deposition is critical to palaeoenvironmental reconstructions and inferences of ice sheet dynamics.