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Flavia Girard, Jean-François Ghienne, J. Moreau, Jean-Loup Rubino, Y. Boujazia

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LATE ORDOVICIAN CLIMBING DUNE ASSEMBLAGES, THE SIGNATURE OF GLACIAL OUTBURST ?

F. GIRARD[1], J.F. GHIENNE[1], J.MOREAU[2], J.L. RUBINO[3] ,Y. BOUJAZIA[4]
[1]CNRS, CGS, Strasbourg, France, ghienne@eost.u-strasbg.fr,
flavia.girard@eost.u-strasbg.fr
[2]Aberdeen University, Scotland, j.moreau@abdn.ac.uk
[3]Total, CSTJF, ISSC, jean-loup.rubino@total.com
[4]NOC, Libya, Y-Boujazia@yahoo.com

Meltwater-related processes have long been recognized as first-order geomorphic mechanisms in both subglacial and proglacial environments. Among them, glacial outburst or jökulhlaups (the Icelandic term for “glacial flood”) represent short-term events (1-15 days, e.g. Snorrason et al., 2002) with major erosional and depositional impacts. They emanate either from the catastrophic drainage of glacially dammed lakes or from the drainage or collapse of subglacial reservoirs.

At the end of the Ordovician, a continental-scale ice sheet extended on present-day West and North Africa, as well as Arabia, possibly joining South Africa. Glacial depositional sequences essentially comprise fluvial, deltaic and shallow-marine sandstones and pelitic facies grading distally into turbidites succession (Le Heron et al., 2006; Ghienne et al., 2007). One of the most striking and conspicuous glacially-related Late Ordovician depositional facies is constituted by recurrent assemblages of aggrading, stoss-depositional 2D or 3D dunes. Based on data of outcrops from the paraglacial successions of the Western Murzuq Basin/ Tassili n’Ajjer area (southern Libya – Algeria boundary), this presentation aims to describe climbing dunes assemblages (facies, geometries and depositional model), and to relate them to outburst events affecting the fluvio-glacial outwash plains at the periphery of the retreating Late Ordovician ice sheet (Ghienne et al., 2003; Ghienne et al., 2007, Ghienne et al., 2010).

Climbing dune-scale cross-stratification depositional facies is comprised of medium-grained to coarse-grained sandstones that typically involve 0,3 to 1 m high, 3 to 5 m in wavelength, asymmetrical laminations. Most often stoss-depositional structures have been generated, with preservation of the topographies of formative bedforms. Climbing-dune cross-stratification related to the migration of lower-flow regime dune trains is thus identified. Related architecture and facies sequences are described from two case studies: (i) erosion-based sandstone sheets; and (ii) a deeply incised channel. The former characterized the distal outwash plain and the fluvial/ subaqueous transition of related deltaic wedges, while the latter formed in an ice-proximal segment of the outwash plain. In erosion-based sand sheets, climbing-dune cross-stratification results from unconfined mouth-bar deposition related to expanding, sediment-laden flows entering a water body. Within incised channels, climbing-dune cross-stratification formed over eddy-related side-bars reflecting deposition under recirculating flow conditions generated at channel bends.

Associated facies sequences record glacier outburst floods that occurred during early stages of deglaciation and were temporally and spatially linked with subglacial drainage events involving tunnel valleys. The primary control on the formation of climbing-dune cross stratification is a combination between high-magnitude flows and sediment supply limitations, which lead to the generation of sediment-charged Stream flows characterized by a significant, relatively coarse-grained, sand-sized suspension-load concentration, with a virtual absence of very coarse to gravelly bedload. The high rate of coarse-grained sand fallout in sediment-laden flows following flow expansion throughout mouth bars or in eddy-related side bars resulted in high rates of transfer of sands from suspension to the bed, net deposition on bedform stoss-sides and generation of widespread climbing dune cross-stratification.

The later structure has no equivalent in the glacial record, either in the ancient or in the Quaternary literature, but analogues are recognized in some flood-dominated depositional systems of foreland basins.

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