Supercritical-flow structures on a Late Carboniferous delta front: sedimentologic and paleoclimatic significance

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We appreciate this discussion as confirmation of the novelty that cyclic steps (and their recognition) represent for clastic sedimentology, eliciting further research. Kane and Hodgson (2015) interpret centimeter-scale structures, erosional surfaces, and local sediment deformation as evidence of successive depositional events that progressively infilled fluvial scours associated with a channel confluence. While a hypothesis of deposition by separate events is still in consideration on our part, evidence clearly suggests cyclic-step aggradation as the depositional mechanism for the peculiar stratal geometry at Derby Delph. The rhythmic, conformable architecture does not match those described for migrating fluvial confluences, where scouring and the juxtaposition of different facies are common (e.g., Bristow et al., 1993; Best and Rhoads, 2008). The lack of vertical facies transitions fits neither the changing sediment-flow interactions within a deep channel (~15–20 m) nor the internal structure of side bars, which would be assembled by far thinner bedsets. In our article (Ventra et al., 2015), we do interpret cross-bedded deposits immediately superposed to Derby Delph strata as the fluvial “topset,” in agreement with Hampson’s (1997) analysis of the Lower Kinderscout Grit. Hampson (1997, p. 281, 2nd column) understandably noted that “cosets of giant cross-beds and undulatory bedding” would not fit a typical deltaic interpretation, adhering to previously proposed fluvial models. Recent insights on supercritical-flow bedforms support our depositional model. By way of example, we point to the identity in scale and architecture between Derby Delph strata (Figs. 1A and 1B) and those of a glacially fed delta front in Yukon (Gilbert and Crookshanks, 2009; Fig. 1C), where hyperpycnal flows form giant upslope-migrating bedforms with stoss-side deposition, matching our process interpretation.

Regarding small-scale sedimentary structures, reported in our article, we remark again that they are so scarce as to become irrelevant to an interpretation of large-scale depositional mechanics. As mentioned in our paper, fluctuations in flow regime and the migration of ephemeral flow cells associated with hydraulic jumps may superpose ripples and antidunes to the aggrading interface. The whole stratal architecture is conformable, with significant erosion limited to high-angle surfaces we interpret as set boundaries. Ichnofossils are reported from shallow-marine sediments of the Pennine Basin (e.g., Brettle et al., 2002), so their evidence of successive depositional events that progressively infilled Derby Delph strata as the fluvial “topset,” in agreement with Hampson’s (1997) analysis of the Lower Kinderscout Grit. Hampson (1997, p. 281, 2nd column) understandably noted that “cosets of giant cross-beds and undulatory bedding” would not fit a typical deltaic interpretation, adhering to previously proposed fluvial models. Recent insights on supercritical-flow bedforms support our depositional model. By way of example, we point to the identity in scale and architecture between Derby Delph strata (Figs. 1A and 1B) and those of a glacially fed delta front in Yukon (Gilbert and Crookshanks, 2009; Fig. 1C), where hyperpycnal flows form giant upslope-migrating bedforms with stoss-side deposition, matching our process interpretation.

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