Reply

Reply to the Comment by Tan Mingxuan et al. (2017), on "A new Discovery of the Early Cretaceous Supercritical Hyperpychal Flow Deposits on the Lingshan Island, East China"

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We thank Tan Mingxuan et al. (2017) for their comments stimulated by our short paper in the recent Acta Geologica Sinica (English edition). We are grateful for the opportunity to expand on the model of the supercritical hyperpycnal flow deposits in the Beilaishi section on the Lingshan Island, and to explain why the model proposed by Tan Mingxuan et al. (2017) cannot explain the bulk of the deposits in the Beilaishi section. We do not dispute that the recognition of supercritical flow deposits remains ambiguous (Ono and Plink-Björklund, 2017). To some extent, the morphology of deep-water supercritical flow deposits is similar to hummocky and swaley crossstratification (Ono and Plink-Björklund, 2017). Besides, distinguishing the deposits laid down by gravity flows in deep-water systems from those produced by storm-related combined flows in continental shelf systems is not an easy task (Ono and Plink-Björklund, 2017). However, a correct interpretation crucial for understanding is the paleogeographic and depositional model.

Tan Mingxuan et al. (2017) pointed out that several features they found "do not match" the supercritical hyperpycnal flow deposits model. These include the interpretation of the suspended/bed-load-dominated hyperpycnites, the interpretation of the supercritical flow related deposits (antidunes, chutes-and-pools, and cyclic steps), and the overall sedimentary environment. All of them are key aspects of the supercritical hyperpycnal flow deposits model we have described and for which we provided explanations (Yang Tian et al., 2017). For the interpretation of the suspended/bed-load-dominated hyperpycnites, Tan Mingxuan et al. (2017) emphasize the interface existing in the lower part of the bed in Yang Tian et al. (2017, fig. 1c therein). It is common to observe this kind of internal erosional surface in hyperpycnites, which is determined by the discharge of the flow (Mulder and Chapron, 2011). As to the bed-load-dominated hyperpycnites (Yang Tian et al., 2017, fig. 1f therein), it's an interesting question to make clear the genesis of this kind of massive pebbly coarse-grained sandstones with floating pebbles (Kenller and Branney, 1995; Zavala et al., 2011; Talling et al., 2013; Cartigny et al., 2013). We agree with Tan Mingxuan et al. (2017) that the high-density turbidity current deposits (according to vertical suspension fallout, traction carpets, and sustained liquefied) is one of the reasons for these massive pebbly coarse-grained sandstones, apart from poorly cohesive debris flow deposits (sandy debris flow) and cohesive debris flow deposits (Cartigny et al., 2013; Talling et al., 2013). For the present authors, the bed-load-dominated hyperpycnal flow is a generalized concept, which contains the mean of high-density turbidity current, or quasi-steady highdensity turbidity current (Kenller and Branney, 1995; Mutti et al., 1996; Mulder and Chapron, 2011). Terminology can be a trap, and this concept may indicate those density flow is mainly caused by flooding rivers. Thus, the massive pebbly coarse-grained sandstones with floating pebbles caused by bed-load-dominated hyperpycnites is acceptable in the Beilaishi section. We have different opinions about the grain size spectrum of hyperpycnites with Tan Mingxuan et al. (2017). As mentioned by Talling (2014), hyperpycnal flows have been monitored directly in only two locations. It is unfair to draw the conclusion that hyperpycnal flows usually have limited run-out behaviors and low sediment-carrying potentials for generating bed-load-dominated deposits, and the flow is dominated by fine-grained sediments (e.g. silt and clay). Instead, we emphasize the source of the sediments may be one of the most important reasons that control the grain size of hyperpycnites (Zavala et al., 2011; Mulder and Chapron, 2011). Additionally,

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numerous published papers also demonstrated that pebbly coarse-grained sandstones are caused by hyperpycnal flows (Mutti et al., 1996; Zavala et al., 2011; Mulder and Chapron, 2011). At last, Tan Mingxuan et al. (2017) also doubt the thickness of bed caused by a single flow event. This confusion may cause by the erosion of the upper part of the bed (Yang Tian et al., 2017, fig. 1f therein).

Tan Mingxuan et al. (2017) highlight that surge-like turbidity current deposit with usual waves reworking instead of supercritical-flow deposits is the interpretation of the deposits in the Beilaishi section on the Lingshan Island. Tan Mingxuan et al. (2017) pointed out that gently dipping fore- and backsets as the deposits of breaking antidunes are actually concave-up and convex-up sigmoidal profiles in Yang Tian et al. (2017, Fig. 1d therein). The convex-up and concave-up lamina sets in Yang Tian et al. (2017) Fig. 1e can be described as a small hummocky and swaley -scale cross-stratification. Interpreting these fine-grained facies as supercritical flow deposits is highly ambiguous because few studies can compare except Ono and Plink-Björklund (2017). We should realize that the deposits in nature may be different with flume experimental results for different conditions (Mulder and Chapron, 2011). Thus, the diagnose criteria of supercritical-flow deposits should rely on both overall sedimentary structures and sedimentary environments. Different with the conclusions by Tan Mingxuan et al. (2017), we can recognize gently backset lamination, foreset lamination, and planar lamination in Yang Tian et al. (2017, Fig. 1d therein), which are very similar to unstable antidunes deposits in supercritical condition. The backset stratification marked by yellow solid lines are obvious in Yang Tian et al. (2017, Fig. 1e therein), but it will be more obvious change the interpretation of red solid lines as mentioned by Tan Mingxuan et al. (2017). We do not dispute that stormrelated combined flows can form these sedimentary structures, but the companion with cyclic steps forces us to accept the supercritical condition origin. Cyclic steps are the reliable marks for supercritical-flow deposits (Postma et al., 2014; Ono and Plink-Björklund, 2017). Tan Mingxuan et al. (2017) emphasize basal structureless or coarse-tail normal graded deposits with prominent liquefied structures and typical sequence of top-cut-out turbidite bed are the typical sedimentary structures of cyclic steps deposits which are convinced (Postma et al., 2014; Ono and Plink-Björklund, 2017). We do find these sedimentary structures in the cyclic steps deposits in the research area (Fig. 1a). Besides, the lateral association of the massive sandstone with backsets structures is used as a criterion for hydraulic jump deposits (Ono and Plink-Björklund, 2017). Tan Mingxuan et al. (2017) announced



Fig. 1. The palaeocurrent and plant fragments in gravity flow deposits in the Beilaishi section on the Lingshan Island. (a), Pebbly coarse-grained sandstone with coarse-tail normal grading; (b), flute casts in the sole of the sandstone bed; (c), floating coals and plant fragments with parallel arrangement.

that the geometry of the cyclic steps in the Beilaishi section is contradict with the spoon-shaped or lenticular architecture of cyclic step deposits. This contradiction may cause by the erosion of cyclic step deposits by overlying flow in the left part of the section, and the weathering of the right part of the section.

Tan Mingxuan et al. (2017) also suggestthat the paleoflow direction and overall sedimentary environment should be reevaluated. In addition to the paleoflow direction indicated by cyclic steps, well-developed flute casts at the sole of the sandstone bed indicated the paleoflow direction from southeast to northwest clearly (Fig. 1b). Besides, the paleoflow directions indicated by both flute casts and cyclic steps are almost the same. Thus, the paleoflow direction indicated by cyclic steps is correct. The geometry of cyclic steps show lenticular architecture in both longitudinal and lateral directions, which indicate a potential channel-levee complex in the Beilaishi section on the Lingshan Island. The channel-levee complex is the sedimentary environment where supercritical-flow deposits are common (Lang et al., 2017). Thus, the

geometry of cyclic steps correspond with paleoflow indicated that the interpretation of cyclic steps caused by supercritical-flow deposits is acceptable. In addition, the common plant fragments and thinly bedded carbon mudstone interbedded with sandstone imply a hyperpycnal flow sedimentary environment further steps (Fig. 1c), which is also proved by Yang Renchao et al. (2016). However, we only recognized typical supercritical hyperpycnal flow deposits in the Beilaishi section until now, which does not mean other sections have the same origin. What's more, the lack of typical tempestite sequence, the thick massive pebbly coarse-grained sandstones, the common plant fragments, the welldeveloped flute casts in the sole of sandstone beds, the regular geometry of the sandstone bodies, and the deepwater environment are not fit well to the surge-like turbidity current deposit with usual waves reworking model (Yang Renchao et al., 2017). Thus, we believe the model of the supercritical hyperpycnal flow deposits in the Beilaishi section on the Lingshan Island match our interpretation.

In summary, the present authors appreciate Tan Mingxuan et al. (2017) for their comments and solid understanding of our short paper. These comments give us a valuable opportunity to expand our model and clarify the misunderstandings. We do not dispute that some of the sedimentary structures may have alternative process explanations, but the overall sedimentary environments force us to choose the supercritical hyperpycnal flow deposits model in the Beilaishi section on the Lingshan Island. The authors hope these interpretations could resolve Tan Mingxuan et al. (2017)'s doubts. Besides, Tan Mingxuan et al. are very welcome to have a field examination in the Beilaishi section on the Lingshan Island. It will be a great honor for the first author to give a field exhibition for Tan Mingxuan et al.

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