Wind-induced waves and storms in fan-delta lacustrine successions: New observations from Tanan Depression, Tamtsag Basin, Mongolia

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Existing fan-delta depositional models for lacustrine basins do not adequately address significant wave- and storm-related processes. However, in many lakes, such high-energy processes can be effectively driven by winds. As such, the prevailing wind direction determines the progradation direction of wind-induced waves. Observations from modern cases show that wave-dominated deposits commonly exist on one side of the lake, and their sedimentary processes are completely distinct from those on the opposite side, such as in Qinghai Lake in China. However, equivalent deposits have seldom been identified from subsurface data. We present an ancient example from the Upper Tongbomiao Formation in the Tanan Depression (Tamtsag Basin, Mongolia), which was previously interpreted as a fan-delta depositional system. Based on extensive core investigations, eighteen lithofacies, six lithofacies associations and two genetic deposition systems are identified, and a new sedimentological interpretation is proposed for the Upper Tongbomiao Formation containing a wave-dominated clastic shoreline system in the western half-graben dip slope (W-DS) and a fluvial-dominated fan-delta system in the eastern half-graben (E-HG). Sediments within the E-HG unit are grouped into the three lithofacies associations of braidplain, fan-delta front and prodelta, while those within the W-DS unit comprise dominantly alluvial fan, wave-reworked beach, storm-affected shoreface and offshore sediments. Several factors contribute to the preservation of these two distinct sedimentary systems that developed on opposite shores of the lake: (i) the southeast to northeast prevailing wind direction during the deposition period; (ii) a gentle paleotopographic slope in the W-DS unit, while a steep one in the E-HG unit; (iii) a climate shift toward more humid climatic condition from Lower to Upper Tongbomiao Formation intensified hydrodynamic conditions that were able to rework the sediments distributed in the W-DS unit. Finally, we discuss their implications for the future development of shoreline morphology of continental lakes affected by a monodirectional prevailing wind.