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Morphodynamics of tidal channels in the macrotidal Yeochari tidal flat, Gyeonggi Bay, Korea: climate and tidal controls on the architecture of inclined heterolithic stratification

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Summary

Morphodynamics of intertidal channels were monitored in order to understand its implication on the architecture of inclined heterolithic stratification in the Yeochari macrotidal flat, Gyeonggi Bay, Korea (Figure 1). Yeochari tidal flat is divisible into narrow salt marshes in the upper intertidal flat, concave-up upper to middle intertidal flat with small tidal creeks, and channelized lower intertidal flat (Figure 2). Channels in the lower intertidal flat are 200-600 m wide and 1-2.5 m deep at bankful stage. They are sinuous in plan form and have well-defined point bars and cutbanks. Inclined heterolithic stratification (IHS) is exposed along the cutbanks. High-precision leveling of tidal channel bank was conducted 21 times from March 2009 to December 2012. The leveling was performed on a 5-km long shore-normal transect (YC-1) using a RTK-GPS with horizontal and vertical accuracy of less than 2 cm and 1 cm, respectively. Leveling observation unveiled that point bars migrated about 400 m in 39 months. Migration rate varies seasonally. Pronounced channel migration occurred during summertime rainy season when point bar migrated as fast as 40 m per month, which led to rapid sediment accumulation of as much as 40 cm per month (Figure 3). In contrast, channel migration rate during wintertime is dramatically reduced down to less than 1 m per month. Point-bar geometry responded to such seasonal changes in channel migration rate, which alternates between a concave-up profile in summertime and a convex-up profile during the rest of year (Figure 4). Heavy precipitation during summertime rainy season is responsible for the rapid migration and concave-up geometry of point bar. Enhanced ebb currents due to increased runoff discharge by heavy precipitation accelerated point bar migration. Remarkable rill erosion induced by heavy precipitation especially during low tide led to rapid accumulation of sediment at the lower part of point bar and channel base, creating a concave-up point bar geometry. During the rest of year, continued sedimentation with little rill erosion resulted in a convex-up point-bar geometry. Present study illuminates the fact that the stratigraphic architecture of IHS of intertidal origin is largely controlled by monsoonal climate change rather than tidal process even in the macrotidal environment. Careful examination of IHS geometry may hint on the depositional setting in terms of tidal frame (intertidal versus subtidal) and climate regime (monsoonal versus non-monsoonal).

Figure 1: Map showing the location of leveling transect YC-1. Study area is macrotidal regime with mean spring tides of 9 m. Due to the presence of strong monsoon, nearly 70 percent of annual precipitation concentrates during summertime rainy season from July to September. DMZ refers to demilitarized zone.

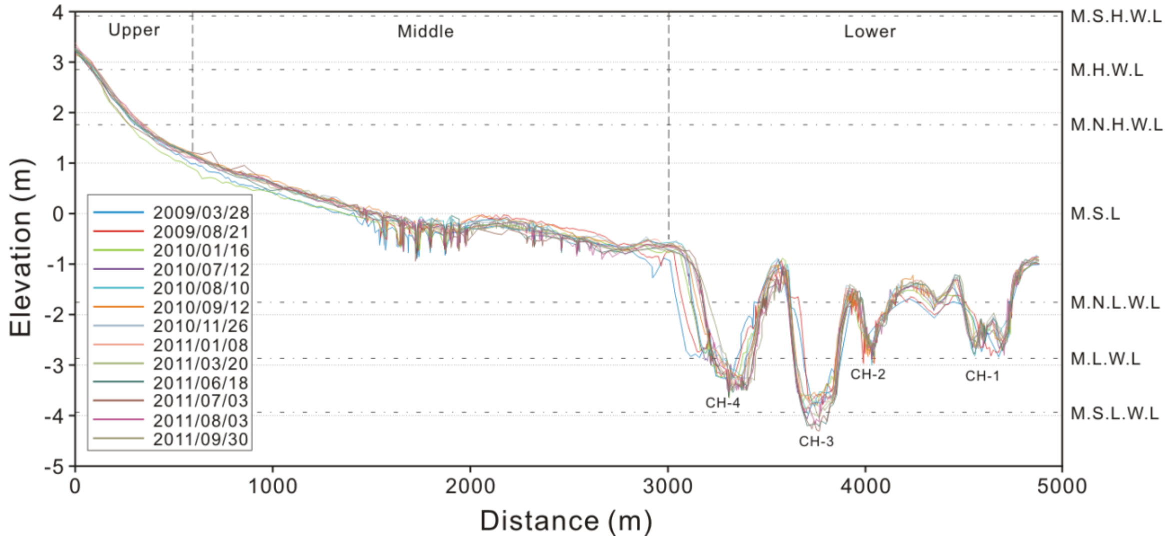

Figure 2: Diagram of transect YC-1 illustrating morphologic features of Yeochari tidal flat. Upper tidal flat has a concave-up profile. Small tidal creeks are present in the concave to convex-up middle intertidal flat. Lower intertidal flat is characterized by channels and interchannel area covered by migrating 2D and 3D dunes.

Figure 3: Photograph showing students who struggled to escape sticky and soupy deposits of a point bar on 12 September 2010. Watery surface at the lower part of point bar indicates the locus of rapid sedimentation (up to 40 cm per month)

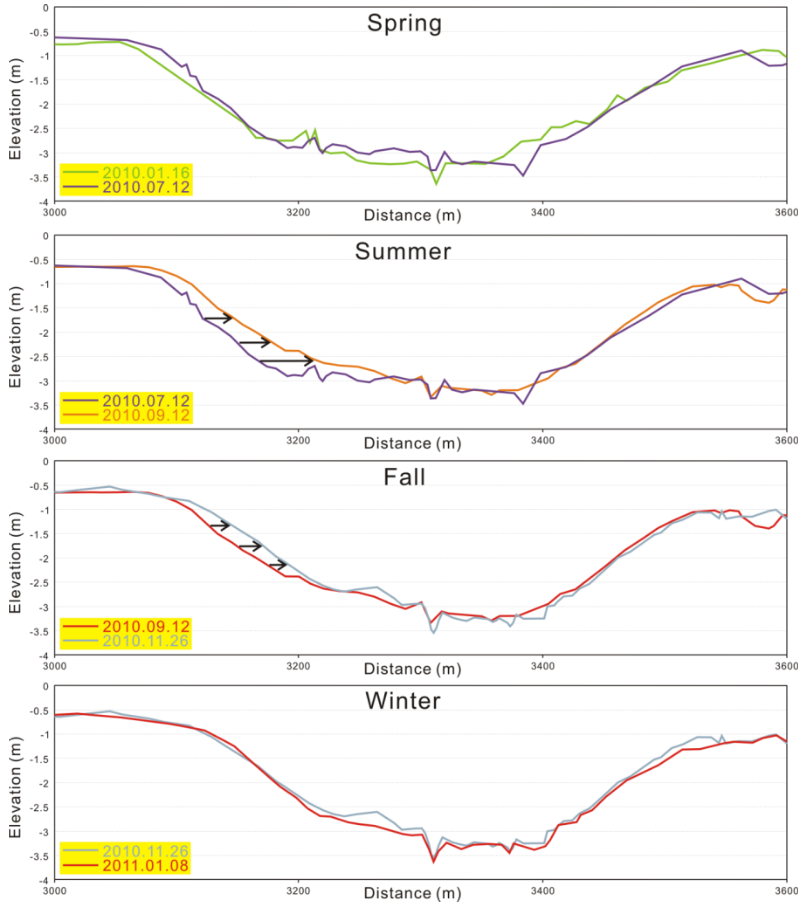

Figure 4: Temporal morphologic variation of channel profiles at CH-4, displaying a distinct seasonality. Point bar attains a concave-up profile during summertime, whereas it has a convex-up profile during the rest of year. Such seasonal morphologic change resulted from monsoon-driven runoff discharge variation.

Acknowledgements

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