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Constraining centennial to decadal changes of a deltaic coastline over the last millennia, Mekong River delta, Vietnam

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Empirical understanding of decadal- to centennial-scale deltaic shoreline changes over the last several millennia is essential for distinguishing natural and anthropogenic components of currently observed changes and thus for comprehensively predicting changes in the coming decades and centuries. We tested effectiveness of quartz optically-stimulated luminescence (OSL) dating to beach ridge for constraining past shoreline changes of the Mekong River delta, southern Vietnam. A large OSL age dataset has been compiled from Tra Vinh lobe, which has a 40-km-long shoreline and extends 50 km inland, in the central delta plain. The beach ridges in Tra Vinh are recurved and branching, showing the hierarchy of shoreline changes, which include rapid discontinuous shifts caused by emergence of an offshore barrier spit, and subsequent shoreline rotation and downdrift progradation of spit. Each of the rapid shift that occurred in the past resulted in a cluster of beach ridges. Observation on the modern delta front suggests that the offshore barrier spit is initially formed near the mouth of distributary and receives sand that is discharged from the river and transported by waves and tides. Beach ridge sand has good luminescence properties; age uncertainties are generally c. 5 %, and come mainly from dose rate uncertainties. OSL ages show that the beach ridges have formed since 3600 yr BP, clearly illustrating the coastal progradation. These OSL ages agree well with some reported radiocarbon ages of subtidal deposits from drill cores. Rapid shoreline shifts became pronounced since 2300 yr BP and occurred eight times, suggesting their average recurrence interval c. 300 years. Due to the relatively small OSL age uncertainties, within an individual beach ridge cluster is it possible to discern downdrift ridges to be younger. This is concordant with spit progradation. This trend is recognizable in a cluster that shows OSL ages ranging from 1590 $\pm$ 90 yr BP to 1110$\pm$60 yr BP. Another beach ridge cluster, of which age ranges from 200$\pm$10 yr BP to 400$\pm$20 yr BP, shows the youngest age in its updrift part, but this represents coastal retreat and reworking of beach sediment as evidenced by beach ridge morphology. A major anti-clockwise rotation of the shoreline, which caused downdrift and updrift coasts to move seawards and landwards, respectively, occurred between 400 and 500 years ago, suggesting strengthening of northeasterly winter monsoon related to the Little Ice Age. In summary, detailed OSL dating of beach ridges of the Mekong River delta works well for constraining centennial- to decadal-scale deltaic shoreline changes, which have been associated with climate changes and autogenic deltaic processes during the late Holocene.