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Holocene evolution of the Tonlé Sap Lake: valley network infill, connection with the Mekong River and rates of sedimentation in Cambodia's Great Lake

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Tonlé Sap lake, the largest freshwater lake in SE Asia (c. 120km long and 35 km wide), is a vital ecosystem that provides 40-60% of the protein for the population of Cambodia. The lake is largely fed by flow from the Mekong River, causing the lake level to rise by c. 8m during monsoonal and cyclone-related floods, with drainage of the lake following the monsoon. Hydropower dam construction on the Mekong River has raised concerns as to the fragility of the Tonlé Sap habitat due to possible changing water levels and sedimentation rates within the lake.

This paper presents results of sub-bottom profiling surveys of Tonlé Sap lake conducted in October 2014 that detailed the stratigraphy of the lake infill, and which are tied to new and existing core data from various parts of the lake, allowing estimation of changing rates of Holocene sedimentation. An Innomar Parametric Echo Sounder (PES) was used to obtain c. 530 km of sub-bottom profiles, with penetration up to 15m below the lake bed at a vertical resolution of c. 0.20m.

The PES profiles reveal a network of valleys, likely LGM, which have been infilled by a suite of Holocene sediments. The valley surface is picked out as a strong reflector throughout the lake, and displays a series of valleys that are up to c. 15m deep and commonly 50-200m wide, although some of the largest valleys are 1.2km in width. The Tonlé Sap valley network is infilled by sediments that show firstly minor fluvial and/or subaerial slope sedimentation, followed by extensive, parallel-bedded, lacustrine sedimentation. Dating of the cores indicates that sedimentation rates were c. 2.1 mm/year. The top c. 1m of sedimentation is marked by a distinct basal erosional surface that can be traced over the entire Tonlé Sap lake, which is overlain by a series of parallel PES reflections. This erosive surface marks a period of lake level lowering, of at least 1.5 m, which was coincident in time with connection to the Mekong River that established the present flood-pulse hydrology. This upper sediment layer is interpreted to represent sedimentation in a shallower Tonlé Sap lake that was characterized by much lower rates of sedimentation, at c. 0.09 mm/year.

The possible causes of this lake-level lowering, including scenarios of possible river capture, mid-Holocene sea-level fall and a drying climate, will be discussed. This paper will also detail the characteristics and interpretation of the PES facies, their correlation to cores and estimates of sedimentation rates. The PES profiles illustrate the highly variable spatial and temporal rates of sedimentation that are due to position with respect to the palaeovalley network and the stage of lake infill. Dating and PES profiles indicate that infill of the lake was essentially complete by c. 6ka BP and that minimal sedimentation has occurred since then, likely due to sediment reworking by wave resuspension.