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Enhancing chronological precision: A high-resolution sampling approach to reconcile optically-stimulated luminescence and cosmogenic nuclide data in the Choushui terrace, West Central Taiwan

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The determination of fault slip rates often relies on dating Quaternary geomorphological surfaces that have been deformed by fault activity. Consequently, cosmogenic and luminescence methods are widely employed to date the emplacement of geomorphic markers. However, each method is associated with a different geomorphic process. The Terrestrial Cosmogenic Nuclides (TCN) method generally dates the exposure duration of the material at the surface to cosmic rays, while the Optically Stimulated Luminescence (OSL) method provides the burial duration of sediment after deposition. Age differences between these two methods may be linked to the erosion-transport-deposition processes experienced by the sediment before its final deposition. However, when combined, they offer new insights into the processes affecting alluvial landforms. Our case study is situated in the Western Foothills of Central Taiwan, south of the Choushui River. The Changhua blind thrust fault has caused the eastward tilt of a wide flight of fluvial terraces (Pakuashan Tableland and Touliu Hills). However, slip rates on frontal faults are still debated due to significant uncertainties in dating alluvial surfaces with OSL and TCN methods. To refine the chronology of the deposits, a high-resolution sampling strategy was employed, enabling a direct and unique comparison between OSL and TCN dating methods. Taking advantage of a natural exposure, we collected 10 samples for Be-10 dating, complemented by 11 OSL samples (6 dated) along a 7m-depth profile. The depth distribution of Be-10 concentrations reveals a complex depositional history with at least two depositional sequences. Given the challenges of OSL dating in Taiwan, we paid particular attention to the luminescence characteristics of quartz and potential dosimetry issues. Our OSL analysis aligns well with Be-10 and previous C-14 dating, revealing three depositional units dating between ~9 ka and ~66 ka. ICP-MS and ICP-OES measurements confirm the three alluvial units, and their limits are corroborated by different OSL signal characteristics and variations in dosimetry. These variations likely indicate changes in sedimentary sources over time and in the emplacement of this alluvial surface. This study underscores the importance of an exhaustive, detailed, and direct comparison between dating methods on a single depth profile. It also enhances our understanding of the long-term rates of the Changhua Fault.

Keywords: Optically Stimulated Luminescence, Cosmogenic isotopes, Quaternary dating, alluvial deposits