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New luminescence chronological tools for dating and tracing sediment movement

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As part of a large research project reconstructing fault slip rates, palaeoseismiology and landscape evolution in New Zealand, we have developed a range of new chronological tools with applications to sediment. These closely related methods are based on Infra-Red Stimulated Luminescence (IRSL) signals of alkali feldspar, and allow us to determine aspects of transport and burial at the scale of individual grains over time periods ranging from 1 to 300,000 years. In particular, we have introduced and tested a method referred to as 3ET-IRSL (Three Elevated Temperature IRSL), and we are also applying a MET-IRSL (Multiple Elevated Temperature IRSL) approach comprising measurement sequences that include five IRSL measurements at different temperatures. These techniques can be used in different ways to filter complex single grain IRSL apparent age distributions that arise from processes including short duration reworking associated with incomplete trapped charge removal during transport. These methods were primarily designed to improve chronological control for sediment dating in contexts where conventional approaches encounter significant challenges owing to the geomorphic setting including high volume, rapid deposition. However, these approaches can provide significant insight into the dynamics of sediment transport routes and rates at the individual grain scale. We will demonstrate the performance of these methods at key test sites, and assess the implications of our findings in New Zealand (NZ), coupling observations of relict fluvial terrace formation with landscape response to the Mw 7.8 Kaikoura earthquake of 2016. At one of our NZ sites, fluvial system response to this event is the opposite of that expected from the literature in terms of sediment deposition and erosion; the degree to which this represents a transient response is assessed. We highlight the amazing potential of these new tools for improving our understanding of source-to-sink sediment transport dynamics.