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A novel approach to determine the rates of displacement on thrust faults using terrestrial cosmogenic nuclides

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Determining the rates of displacement on faults is crucial to our understanding of fault behaviour and to allow accurate assessment of seismic hazards. Furthermore, rates of fault displacement are needed to allocate strain distribution and allow discrimination between models of deformation in active landscapes. However, the timescales over which faulting occurs are typically longer than can be characterised by direct observations. Cosmogenic nuclide exposure dating has emerged as a tool with which to address this problem. Rates of fault displacement can be obtained by 'dating' the rocks exposed on surfaces that were formed when a fault ruptured, and measuring the amount of displacement which occurred. This method has been successfully applied to determine rates of normal and strike-slip faulting. As thrusting will typically bury rather than expose surfaces, rates of thrust faulting have proved more difficult to measure. Several workers have utilised the vertical offset across faults beneath dated, abandoned, alluvial surfaces to measure rates of displacement on thrust faults. However, abandoned alluvial deposits of known age are typically absent from more mature, active systems. Here we describe a new approach to determine the rates of displacement on thrust faults using cosmogenic nuclides to quantify erosion rates.

Crustal shortening often creates a bedrock escarpment above the surficial trace of a thrust fault. Continued slip on the fault will oversteepen the face of the escarpment which will erode to compensate, maintaining a slope gradient at the threshold angle for failure. The amount of crustal shortening across the fault can then be estimated if the rates at which the overlying topography is eroding are known. Furthermore, if

the dip of the thrust fault is constrained, the rate of displacement on the fault can be estimated. In this simplified mass-balance model the erosion of the face of the escarpment is equilibrated with mass input from crustal shortening and, by inference, the rate of fault displacement is derived. Preliminary detrital samples were collected for cosmogenic ^{10}Be analysis from the eroding bedrock escarpments above a segment of the Chuculay Fault System, northern Chile. The initial results of this analysis are presented and we discuss the application, further testing and potential limiting factors of the new approach.