Rates of reverse fault displacement from cosmogenic nuclide derived scarp erosion

Steven Binnie*[1], Ariane Binnie[1], Gabriel Gonzalez[2], Stefan Heinze[3], Finlay Stuart[4], Volker Wennrich[1], Niklas Leicher[1], and Tibor Dunai[1]

[1]Institute of Geology and Mineralogy, University of Cologne – Germany
[2]UCN Antofagasta – Chile
[3]Institute of Nuclear Physics, University of Cologne – Germany
[4]Scottish Universities Environmental Research Centre (SUERC) – United Kingdom

Abstract

Modeling and field observations suggest that reverse fault scarps erode in response to slip events on the underlying fault. Here, we present a study testing the utility of this relationship for determining rates of faulting using cosmogenic nuclide measurements of scarp erosion. We apply this approach to the Chuculay Faults, a suite of reverse faults in the Atacama Desert of northern Chile that have developed steep, high bedrock scarps. Erosion rates of the fault scarps from cosmogenic Be-10 are derived from direct sampling of the bedrock scarp face and from sediment samples of the debris slopes below the scarps. We test the validity of the cosmogenic nuclide scarp erosion rates by comparing them to volumes of talus deposited on top of a dated tephra horizon. The rates of faulting that our erosion rates predict are compared to a fault slip rate from a dated paleochannel, offset by faulting. Rates of scarp erosion vary _˜ 30-fold between faults, which is difficult to explain by non-tectonic processes. The scarp erosion rates are comparable to the long-term fault slip rate from the offset paleochannel. Furthermore, our results display patterns of scarp erosion that imply slip rate variability along-strike, as well as between faults. Provided certain geomorphic conditions are met, scarp erosion has the potential to reveal both rates of fault slip and regional patterns of reverse faulting. We discuss potential applications of this approach and the conditions under which it could be applied.

Keywords: Fault scarp erosion, Fault slip rate, Chuculay Faults, Atacama Desert

*Speaker