Active faulting in western Turkey: the challenge of earthquake hazard estimation in a complex extensional regime based on cosmogenic isotope analyses

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In zones of distributed continental faulting, it is critical to understand how slip is partitioned onto brittle structures over both long-term millennial time scales and shorter-term earthquake cycles. Measuring earthquake slip histories on different timescales is challenging due to earthquake repeat-times being longer or similar to historical earthquake records, and a paucity of data on fault activity covering millennial to Quaternary scales in detail. Cosmogenic isotope analyses from bedrock fault scarps have the potential to bridge the gap, as these datasets track the exposure of fault planes due to earthquakes with millennial resolution. In this presentation, we show new 36Cl data combined with active fault maps to document the spatial and temporal complexity of extensional faulting in western Turkey.

Extensional faulting covers an area ~460 x 460 km in western Turkey. The dynamics controlling extension are debated, but there is an overall pattern of anticlockwise rotation superimposed on N-S directed upper-plate extension related to eastern Mediterranean subduction. This has resulted in several major east-west trending extensional grabens along the western coast of Turkey and NE-SW to NW-SE trending conjugate grabens towards the southern coast and central Anatolia. The active fault map of Turkey is well characterised by the MTA (General Directorate of Mineral Research and Exploration), but recent mid-magnitude earthquakes have occurred on some un-characterised fault zones, suggesting that there is further complexity in the trace and locations of active faults. This complexity may indicate recent reactivation of pre-existing structures.

Most of the major bedrock normal fault scarps are well preserved in carbonate and marble successions distributed across the region. These scarps preserve an excellent record of Late Pleistocene to Holocene earthquake activity, which can be quantified using cosmogenic isotopes that track the exposure of the bedrock fault scarps. 36Cl accumulates in the fault scarps as the footwall is progressively exhumed by earthquakes and the concentration of 36Cl measured up the
fault plane reflects the rate and patterns of slip. In this presentation, we utilise Bayesian modelling techniques to estimate slip histories based on new cosmogenic data from several faults across western Turkey. Each sampling site is carefully characterised using field mapping and LiDAR to ensure that fault plane exposure is due to slip during earthquakes and not sediment transport processes. We will compare several neighbouring fault zones with variable slip rates to investigate how they interact over multiple earthquake cycles, and put this temporal complexity into the context of spatial complexity, and the resultant challenges for hazard forecasts in western Turkey.