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STP-02 Deducing nature and magnitude of paleoearthquakes: Finding paleoevents and quantifying them

A standardised procedure for earthquake archaeology: The archaeoseismological logic tree

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Archaeoseismology is currently at the centre of some controversy, with criticisms over the extent to which this research field can contribute to seismic-hazard analysis, and indeed, as to whether or not man-made structures can be used as earthquake indicators at all. Addressing these concerns - in other words, refining the utility of archaeologically-derived earthquake information to permit its inclusion in earthquake-hazard assessments - requires first a systematic, quantitative and interdisciplinary approach to the seismo-cultural record.
We propose that a semi-quantitative logic-tree approach developed for palaeoseismology (Atakan *et al.*, 2000) can be modified to suit archaeoseismological purposes (Sintubin & Stewart, submitted). We define six interpretative stages of archaeoseismic analysis: (1) Tectonic setting, (2) Site environment, (3) Site potential, (4) Identification of earthquake damage, (5) Dating of damage, and (6) Regional correlation to neighbouring sites. Each of these stages conforms to nodes on a logic tree at which different alternatives can be described with their associated uncertainties. Following the palaeoseismological example, we adopt the most simple logic-tree formalism whereby each node has only two alternatives, one representing the preferred solution and the other the sum of the remaining alternatives. The varying levels of uncertainty that are assigned to these different nodes in the logic tree allow investigators to identify key weaknesses in their evidence base for an archaeoseismological hypothesis.
The end-result of our logic-tree formalism - the joint probability of the preferred alternatives - is a qualitative measure of uncertainty related to the complete archaeoseismological analysis. Taking into account the nature, status and purpose of the archaeological excavation, this can be converted to an Archaeoseismic Quality Factor (AQF) to express numerically the confidence attached to the attribution of a 'seismic hypothesis' at an archaeological site. A meaningful population of AQF values must await the systematic application of the logic-tree methodology to a range of ancient cultural sites where earthquake evidence has been described. Nevertheless, we contend that the logic-tree approach offers the potential of a standardised procedure to compile, categorise and evaluate archaeoseismological information in a form that might, with refinement from wider earthquake archaeology studies, be appropriate for seismic-hazard analysis.

Atakan, K., *et al.* 2000. Seismic hazard in regions of present day low seismic activity: uncertainties in the paleoseismic investigations along the Bree Fault Scarp (Roer Graben, Belgium). *Soil Dynamics and Earthquake Engineering* **20**, 415-427.
Sintubin, M. & Stewart, I. S. (submitted) A 'logical' Methodology for Archaeoseismology. A Proof of Concept at the Archaeological Site of Sagalassos (southwest Turkey). *Bulletin of the Seismological Society of America.*