Geophysical Research Abstracts, Vol. 9, 01886, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-01886

Archaeoseismology: A New Standardised Methodology Using Logic Trees

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The cultural effects of ancient earthquakes have long been of interest to archaeologists and historians but such archaeologic data have remained largely neglected in seismic-hazard studies. Whilst geologic data derived from palaeoseismology are now widely integrated into formal assessments for the probability of occurrence and severity of future earthquakes in a given area, archaeoseismic data are not, their reliability tainted by the highly subjective nature of cultural interpretation.

However, many of the uncertainties that plague archaeoseismic studies are also inherent in palaeoseismic studies, where field observations of geologic phenomena similarly may satisfy several alternatives. Quantification of uncertainties related to palaeoseismic data in seismic-hazard analysis has been addressed by Atakan *et al*. (2000), who outlined a qualitative method by which the relative reliability of a favoured palaeoseismic interpretation with respect to its alternatives could be described. This method involves a simple logic-tree formalism applied to the palaeoseismic data-interpretation process. Here, we show that the same simple logic-tree approach can be adopted for archaeoseismic studies.

We demonstrate how the palaeoseismic logic-tree scheme can be adapted to fit with the main stages of interpretation in archaeoseismic investigations. In our modified scheme, six interpretative stages (Tectonic setting; Site Environment; Site Potential; Identification of Earthquake Damage; Dating of Damage; Extrapolation to Other Sites) conform to nodes on a logic tree at which different alternatives can be described, along with their associated uncertainties. We adopt the most simple logic-tree ap-

proach whereby each node has only two alternatives, one representing the preferred solution and the other the sum of the remaining alternatives. At the end, a joint probability of the preferred alternatives gives a qualitative measure of uncertainty related to the complete archaeoseismic analysis. The final result of this method is the *Archaeoseismic Quality Factor* (AQF), a measure of the confidence attached to the attribution of seismic damage at an archaeological site.

The logic-tree scheme promotes active collaboration between specialists in different research fields, and can lead to numerical values of data reliability that are amenable for inclusion into seismic-hazards analysis. More importantly perhaps, the approach serves as a way of integrating the remarkably disparate elements of archaeoseismic research (geological, archaeological, geographic, historical, engineering, architecture etc) in a rigorous, workable methodological framework.

. 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 Dyn. & Earthquake Eng.* **20**, 415-427.