Geophysical Research Abstracts
Vol. 18, EGU2016-14508, 2016
EGU General Assembly 2016

Potentials and pitfalls of depth profile (10Be), burial isochron (26Al/10Be) and palaeomagnetic techniques for dating Early Pleistocene terrace deposits of the Moselle valley (Germany)

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Throughout the river network of the Rhenish Massif the so-called main terraces complex (MTC) forms the morphological transition between a wide upper palaeovalley and a deeply incised lower valley. The youngest level of this complex (YMT), directly located at the edge of the incised valley, represents a dominant geomorphic feature; it is often used as a reference level to identify the beginning of the main middle Pleistocene incision episode (Demoulin & Hallot, 2009). Although the main terraces are particularly well preserved in the lower Moselle valley, a questionable age of ca. 800 ka is assumed for the YMT, mainly based on the uncertain extrapolation of controversially interpreted palaeomagnetic data obtained in the Rhine valley.

In this study, we applied terrestrial cosmogenic nuclide (TCN) dating (10Be/26Al) and palaeomagnetic dating to Moselle fluvial sediments of the MTC. To unravel the spatio-temporal characteristics of the Pleistocene evolution of the valley, several sites along the lower Moselle were sampled following two distinct TCN dating strategies: depth profiles where the original terrace (palaeo-) surface is well preserved and did not experience a major post-depositional burial (e.g., loess cover); and the isochron technique, where the sediment thickness exceeds 4.5-5 m. One terrace deposit was sampled for both approaches (reference site). In addition, palaeomagnetic sampling was systematically performed in each terrace sampled for TCN measurements. The TCN dating techniques show contrasting results for our reference site. Three main issues are observed for the depth profile method: (i) an inability of the modeled profile to constrain the 10Be concentration of the uppermost sample; (ii) an overestimated density value as model output; and (iii) a probable concentration steady state of the terrace deposits. By contrast, the isochron method yields a burial age estimate of 1.26 +0.29/-0.25 Ma, although one sample showed a depleted 26Al/10Be ratio, presumably related to a former burial episode. Moreover, a reverse-to-normal polarity change was recorded in the same terrace level. Given the burial age, it corresponds to the boundary between the reverse Matuyama chron and one of two normal subchrons in the 1.55-1.0 Ma time span, i.e. either Cobb Mountain (MIS 38) or Jaramillo (MIS 31). These results demonstrate the usefulness of cross-checking age information from independent methods, and also suggest that the MTC in the Moselle valley might be older than in the Rhine valley. This might imply a reexamination of the chronological framework of the terrace staircase in the main trunk.

Reference:

Demoulin, A., Hallot, E. (2009): Shape and amount of the Quaternary uplift of the western Rhenish shield and the Ardennes (western Europe). – Tectonophysics 474, 696–708.