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Human presence at Belle-Roche, in the Ardenne massif (western Europe) : Terrestrial Cosmogenic Nuclides (10Be) dating of fluvial sediments confirms an age of ∼580 ka

Gilles Rixhon (1), Régis Braucher (2), Didier Bourlès (2), Lionel Siame (2), and Alain Demoulin (3)
(1) University of Cologne, Institute of Geography, Cologne, Germany (grixhon@uni-koeln.de), (2) CEREGE, Aix-en-Provence, France, (3) University of Liège, Department of Geography, Liège, Belgium

In the 1980's, artifacts of an early Paleolithic industry were found within a cave filling at Belle-Roche, a site located ∼60 m above the present-day floodplain of the Amblève River, one of the main ardennian subtributary of the Meuse River in eastern Belgium. The most controversial issue about these traces of human presence remains that of their age. Thanks to numerous remains of micro- and macromammals (Dicerorhinus etruscus, Arvicola cantania, etc) associated with the artifacts, an age of 500±70 ka was proposed for the archaeological layers (Cordy et al., 1993), which are underlain by a fluvial gravel of the paleo-Amblève. However, based on geometric correlations between the terrace sequences of both the Amblève and the lower Meuse, where paleomagnetic data were available, Juvigné et al. (2005) assigned the paleomagnetic normal polarity of the Belle-Roche cave gravels to the Jaramillo event, therefore dating them to ∼1 Ma.

This major discrepancy between the archeological and geomorphological dating of the cave filling (and thus also of the archaeological remains) has been resolved by measuring concentrations of in situ produced 10Be in the fluvial deposits of the Amblève terrace located just below the Belle-Roche cave. The great thickness of the terrace deposits (≥8 m) allowed us to collect 10 samples along a depth profile from subsurface (∼0.5 m) down to a maximum depth of ∼6 m. The five surface samples (down to ∼3 m depth) display the theoretically expected exponential decrease in 10Be concentration with depth, so that the modelling of a single episode of exposure to cosmic rays yielded an abandonment time of 222.5±31 ka for the terrace. However, at depths greater than 3 m, the 10Be concentrations unexpectedly increase, witnessing a gradual enrichment with depth.

Here, we propose a model assuming that this high 10Be content at depth was acquired during a long-lasting phase of progressive, slow accumulation of the terrace gravels. During the accumulation, an upper part of constant ∼3 m thickness of the deposit was continuously renewed, hampering the in situ 10Be production, while the deeper part, increasing in thickness with time, was able to store the produced 10Be. At the final stage, just before the Amblève started to incise its floodplain, the gravel layer below the upper 3 m of transit material had accumulated 10Be in proportion to its residence time in the deposit. When incision began, the upper transit material, which was still devoid of in situ produced 10Be,was in turn immobilized in the terrace and started to accumulate 10Be following the usual exponential depth profile. Assuming that the accumulation rate remained constant over the time of formation of the whole sequence, this would provide a "progressive burial" time of ∼360 ka, indicating that the terrace began to form at least around 580 ka, and continued so up to the time of its abandonment at ∼220 ka. The "total" age of ∼580 ka for the terrace situated just below the Belle-Roche cave is thus consistent with the paleontological age proposed by Cordy et al. (1993) for the cave filling, attesting the presence of man in this area about 600 ka ago.

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