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A refined model of Quaternary valley downcutting emphasizing the interplay between tectonically triggered regressive erosion and climatic cyclicity

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While climatic models of valley downcutting discuss the origin of terrace staircases in valleys of middle Europe within the frame of alternating cold and temperate periods of the Quaternary, other models, starting from a base level fall imposed by an initial tectonic signal, describe the response of the drainage network mainly as the propagation of an erosion wave from the place of base level fall (the margin of the uplifted region) toward the headwaters, the two types of model being rarely confronted. In the Ardennes (West Europe), cosmogenic 10Be and 26Al ages have recently been calculated for the abandonment of the Younger Main Terrace (YMT) level (Rixhon et al., 2011), a prominent feature at mid-height of the valleysides marking the starting point of the mid-Pleistocene phase of deep river incision in the massif. These ages show that the terrace has been abandoned diachronically as the result of a migrating erosion wave that started at 0.73 Ma in the Meuse catchment just north of the massif, soon entered the latter, and is still visible in the current long profiles of the Ardennian Ourthe tributaries as knickpoints disturbing their upper reaches. At first glance, these new findings are incompatible with the common belief that the terraces of the Ardennian rivers were generated by a climatically triggered stepwise general incision of the river profiles. However, several details of the terrace staircases (larger than average vertical spacing between the YMT and the next younger terrace, varying number of post-YMT terraces in trunk stream, tributaries and subtributaries) show that a combination of the climatic and tectonic models of river incision is able to satisfactorily account for all available data. The cosmogenic ages of the YMT also point out a particular behaviour of the migrating knickpoints, which apparently propagated on average more slowly in the main rivers than in the tributaries, in contradiction with the relation that makes knickpoint celerity depend directly on drainage area. We tentatively suggest a process accounting for such anomalies in migration rates.

Rixhon G., Braucher R., Bourlès D., Siame L., Bovy B., Demoulin A., 2011. Quaternary river incision in NE Ardennes (Belgium) - Insights from 10Be/26Al dating of river terraces. Quaternary Geochronology, 6, 273-284.