
Cross-dating (OSL and ESR) of Pleistocene fluvial sequences in the Garonne and Ariège rivers (central-eastern Pyrenees) and implications for environmental change

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Résumé

On the northern side of the Pyrenees, Pleistocene fluvial terraces have been the subject of detailed relative chronologies, but numerical dating remains sparse and mainly concerns lower terrace levels. To complement the chronological framework of Pleistocene fluvial aggradation phases and better constrain catchment-scale environmental changes, we conducted a cross-dating approach (OSL and ESR) on 19 sites distributed across terrace levels T1, T2, and T3 of Garonne and Ariège rivers (central-eastern Pyrenees).

Our dataset reveals a strong internal consistency for OSL ages, both among themselves and relative to terrace stratigraphy. In contrast, ESR ages tend to be systematically older than corresponding OSL ages and display large uncertainties. These observations prompted a methodological analysis. The older ESR ages can be attributed to the use of Al centers in ESR measurements. They are significantly less photosensitive than the luminescence centers used in OSL (IRSL signal measured at 50°C), and are likely to retain a residual, unbleached signal that cannot be quantitatively assessed. Additionally, Ti-H signal detection in ESR was ineffective due to low signal-to-noise ratios, potentially caused by the low lithium content in quartz grains derived from metamorphic Pyrenean bedrock. In OSL, the high-temperature IRSL signals (150°C for the Ariège and 225°C for the Garonne) show partial bleaching and, in some cases, saturation of the aliquots.

Despite these methodologic challenges, we obtained coherent chronological frameworks through

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Bayesian modelling, applying stratigraphic constraints that higher terraces must necessarily be older than lower ones. This approach enabled the reconstruction of aggradation phases for Pleistocene terrace formation and identification of incision phases when compared with published chronologies (from ^{10}Be vertical profiles) in the same fluvial catchments. Radiocarbon dating of fluvial charcoals within floodplain silts provides robust minimum age constraints for the lowest terrace level.

Our results suggest that temperate interstadials on the north Pyrenean margin during the Pleistocene were sufficiently prolonged and intense to drive significant fluvial transformation. These phases of aggradation and incision do not correspond solely with the 100-ka glacial cycles identified by Milankovitch but are also expressed during interstadial periods—a pattern not previously documented on the northern side of the Pyrenees.

Mots-Clés: fluvial geomorphology, alluvial sequences, Pyrenees, Pleistocene, numerical chronology, paleodosimetric methods, OSL, ESR, ^{14}C