The contribution of Rob Westaway to the study of fluvial archives

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Robert Westaway was a structural and hard-rock geologist who turned his attention to the study of Late Cenozoic fluvial archives, believing that the preservation of staircases of river terraces, particularly representing the Middle and Late Pleistocene, could only be explained in terms of crustal activity in response to surface processes, the latter affected by climatic change. His entry into this research area coincided with the realisation that such terrace sequences required surface or crustal uplift to have taken place over the time period represented. Workers were unable to explain this in terms of erosional isostasy, a process that could potentially have explained one-way crustal movement of the type observed. Westaway envisaged a mechanism by which mobile lower crust migrated to areas beneath uplifting areas, preventing their future subsidence. The mechanism requires complex mathematics to explain it, as well as lending itself to mathematical modelling of the process based on varying crustal properties and changes in the rates of surface processes in response to climatic fluctuation. Essentially the lower-crustal effect can be envisaged as a positive-feedback enhancement of erosional isostasy.

It became apparent that Westaway's theories could elucidate geomorphological and sedimentary fluvial archives that were otherwise difficult to explain. Mantle-based erosional isostasy could not explain terrace staircases, for example. Many of these occur in regions that are tectonically inactive, and so cannot be attributed to neotectonic activity. A game-changer in terms of persuading the wider community came from the recognition of crustally ultrastable regions in which progressive uplift has not occurred: Archaean cratons. Westway's lower-crustal flow would not be expected in such regions, which have cold, brittle and immobile crust to its full depth. Ancient fluvial deposits are found close to modern valley-floor levels in such areas. Regions showing intermediate situations were subsequently identified. Other particular dilemmas could be resolved, such as the 'back-tilting' of the early-Middle Pleistocene Bytham River in the English Midlands, caused by its drainage crossing crustal blocks with different properties. Although glacio-isostasy, mostly seen in the effects of post-LGM rebound, is largely accommodated in the mantle, and thus is reversed as a response to glacial loading and unloading, in areas of suitable crustal type there is evidently a small lower-crustal component that is not reversible.

Rob's important contribution has yet to be fully integrated into received wisdom in geomorphological and Quaternary circles, although much of it is now widely accepted and more will be explored and published in due course.