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Reconfiguration of Miocene rivers by passage of the Yellowstone hotspot

A. Whitchurch and S. Gupta
Dept. Earth Science and Engineering, Imperial College London

The topography of the Yellowstone region (western North America) records the interaction of a hotspot with continental crust, the track of which is defined by the time-transgressive passage of volcanic centres that have migrated north-eastward to the Yellowstone volcanic field since 16 Ma (Pierce and Morgan, 1992). The migration of a long-wavelength, dome-like deformation field across the continent during the late Tertiary, is postulated to have major control on large-scale landscape evolution and to influence river drainage systems and their sediment dispersal patterns. However, little is known about landscape response to hotspot evolution.

In order to examine river response to the passage of hotspot-related topography we reconstruct the three-dimensional, syn-rift sedimentary architecture of Miocene fluvial deposits (the Sixmile Creek Formation) preserved in the Ruby Basin half-graben, north of the Yellowstone hotspot track, in south-western Montana. Newly obtained 40Ar/399Ar and 40K-40Ar dates on ash horizons, combined with existing biostratigraphic and radiometric dates help constrain basin chronostratigraphy.

Architectural analysis of the Mio-Pliocene basin fill indicates deposition dominated by an externally-sourced axial fluvial system with only relatively small aprons of coarse-grained clastics, locally-derived from the hangingwall and footwall, recognised. Basin axis deposition reveals distinctive evolution of the vertical facies succession, the key elements of which are (1) vertical grain-size coarsening; and (2) vertical increase in channel deposit density. Initially, axial channel deposits, composed of granule-pebble grade conglomerates, form isolated units incised into fine-grained sand and siltstones. With time, the isolated channel-fill conglomerate bodies exhibit distinct coarsening and become progressively more amalgamated upwards, exhibiting an increase in stacking density, associated with a paucity of floodplain fines. Lateral

expansion of the fluvial system across the basin width is coincident with rapid downstream migration of the cobble-grade facies occurring along the length of the basin, and records a gradual adjustment of the fluvial system to a new steeper slope. This adjustment is characterized by progradation and, since clast provenance indicates extrabasinal sourcing of the axial system, indicates facies migration driven by allogenic factors.

The fluvial reconfiguration observed in the Ruby Basin is shown to have spatial and temporal coincidence with the migration of the Yellowstone hotspot across the western United States. We propose that large-scale axial fluvial reconfiguration was a consequence of source area uplift and exhumation, resulting in gravel progradation and subsequent basin filling, associated with the migration of the long-wavelength deformation field of the Yellowstone hotspot.