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Late Quaternary landscape evolution in the Great Karoo, South Africa: Processes and drivers.

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The Great Karoo spans the north-central part of South Africa at a major climatic boundary. The characteristics, sequences, spatial patterns and drivers of river response to Late Quaternary climate changes in this region remain unclear due to the fragmentary alluvial/colluvial stratigraphic record and the lack of dated palaeoclimatic archives. Dendritic gully networks incised into deep deposits (up to 6 m) of colluvium and alluvium in the upper Sundays River catchment expose a legacy of "cut and fill" features. In 1^{st} order tributaries, these are predominantly discontinuous palaeochannels and flood-outs with localised palaeosols, whereas in 2^{nd} & 3^{rd} order tributaries there are: 1) incised palaeo-geomorphic surfaces, 2) semi-continuous inset terrace sequences, 3) buried palaeo-gully topography. Using a combination of field mapping, logging of sediment outcrops, soil micromorphological and grain size analysis, mineral magnetic measurements and radiometric dating (OSL & ^{14}C), we derive a stratigraphic evolution model which demonstrates a) the number of phases of incision, aggradation and pedogenesis, b) the spatial and temporal extent of each phase and c) the drivers of alluviation and associated feedbacks.

Our reconstruction of regional valley alluviation indicates four distinct terrace units of contrasting depositional age. The base of the succession reflects slow aggradation under periglacial conditions associated with the Last Glacial Maximum. Subsequent channel entrenchment, causing terrace abandonment (T1) occurred in the deglacial period when vegetation and rainfall were in anti-phase. Re-instatement of connectivity with deep upland colluvial stores resulted in the injection of a pulse of sediment to valley floors, triggering compartmentalised backfilling (aggradation of T2) which propagated upstream as far as the second order drainage lines. This backfilling restructured the local hydrology, which, in concert with enhanced summer-rainfall, contributed to a major increase in the palaeo-water table, enhanced vegetation productivity and led to the formation of extensive calcified root-mats. Soil micromorphological evidence from this calcrete unit and burial of T2 by up to 1.5 m of alluvium (T3) indicates subsequent aridification, but depth of channel entrenchment was retarded by the blanketing effect of the underlying calcrete. The final terrace (T4) is much younger (Late Holocene), reflecting slow aggradation in a wetland setting. Wider segments of valley preserve a 'cut and fill' phase intermediate in age between regional T3 and T4 which appears to be a function of varying alluvial preservation potential. The research demonstrates that phases of alluviation and pedogenesis in these valleys reflect a complex interplay between Late Quaternary climate change and autogenic-feedbacks relating to abrupt changes in sediment supply and connectivity.