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Shelf margin clinothem degradation and slope re-adjustment: an example from the Karoo Basin, South Africa.

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Degradation of basin-margin clinothems around the shelf-edge rollover zone may lead to the generation of conduits through which gravity flows transport sediment downslope. Many studies from seismic-reflection datasets show these, but they lack small-scale (cm-m) sedimentary and stratigraphic observations on process interactions. Exhumed basin-margin clinothems in the Tanqua depocentre (Karoo Basin) provide seismic-reflection-scale geometries plus sub-seismic-reflection-scale depositional architecture and depositional dip and strike control. At Geelhoek, clinothem parasequences comprise siltstone-rich offshore deposits overlain by heterolithic prodelta facies and sandstone-rich deformed mouth bars. At least three parasequences are truncated by a steep (6-22°), 100 m-deep and 1.5 km-wide asymmetric composite erosion surface that delineates a shelf-edge canyon. The fill, from base to top comprises: a) thick-bedded sandstones with intrabasinal clasts and multiple erosion surfaces; b) scour-based interbedded sandstones and siltstones with tractional structures; and c) inverse- to normal-graded siltstone beds. The negative topography acted as a river-supplied shelf-incised canyon that delivered sediment to the deeper basin. An overlying 55 m-thick coarsening-upward parasequence fills the upper section of the canyon and extends across its interfluves. Younger parasequences display progressively shallower gradients during progradation and healing of the local accommodation. The surface is interpreted to result from oversteepening and high sediment supply triggering deformation and collapse at the shelf edge, possibly enhanced by a relative sea-level fall. Previous work identified an underlying highly incised, sandstone-rich shelf-edge rollover zone, 6 km across-margin strike, suggesting that there was migration in the zone of shelf-edge to upper slope incision over time. This study provides an unusual example of clinothem degradation and re-adjustment with 3D control in an exhumed basin margin succession. The work demonstrates that large-scale erosion surfaces can develop and migrate due to a combination of factors at the shelf-edge rollover zone, and proposes additional criteria to predict clinothem degradation in otherwise strongly progradational systems.