

Provenance Analysis of Syn- and Post-Orogenic Strata in the Southern Permian Basin: Marathon Region and Glass Mountains, West Texas

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ABSTRACT

Classic sediment provenance studies, including petrography or heavy minerals analysis, of foreland basin deposits have long been employed to constrain sediment sourcing and supply, as well as evaluation of clastic reservoir quality. The advent of isotopic provenance analysis primarily through detrital zircon (DZ) U-Pb dating has provided critical and detailed process-oriented insights into the dynamic and temporal linkages between basin formation, hinterland tectonics, sediment routing, and basin subsidence and fill history. Carboniferous-Permian outcrops in the Marathon region of West Texas preserve a complete stratigraphic record of early- to late-stage foreland basin evolution of the Marathon fold and thrust belt. These outcrops provide evidence for sediment delivery to the late Paleozoic southern Permian Basin and permit detailed study of provenance evolution in the internal region of a continental collision. This study presents 1720 new DZ U-Pb ages and 88 separate age core-rim relationships from 11 samples within the Marathon Basin and Glass Mountains of West Texas. The DZ age spectra exhibit marked shifts in provenance from the Mississippian to Pennsylvanian early orogenic strata as well as during late orogenic Permian deposition. Specifically, the transition from Mississippian to Pennsylvanian is defined by the abrupt appearance of Neoproterozoic—Early Cambrian DZ grains indicative of inversion and exhumation of the distal Laurentian rifted margin. Changes in provenance become more gradual during late syn- to post-orogenesis, with a notable upsection decrease in the Grenvillian and coeval increase in Paleozoic DZ modes. This subtle provenance shift represents the post-tectonic erosional demise of the Marathon fold and thrust belt and a classic unroofing sequence with drainage systems reaching deep into the hinterland, tapping Gondwanan volcanic arc source terranes. These data indicate a dominantly southern source from the orogenic hinterland for sediment supplied to the southern Delaware Basin during late Pennsylvanian to Permian times. These new provenance data, integrated with previously published structural and tectonic reconstructions of the Marathon fold and thrust belt provide a holistic view of syn- to post-tectonic sediment sourcing and fundamentally changes our understanding of basin fill evolution.

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