Early Cretaceous to Paleocene North American Drainage Reorganization and Sediment Routing from Detrital Zircons: Significance to the Alberta Oil Sands and Gulf of Mexico Petroleum Provinces

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Abstract

Detrital zircons (DZs) represent a powerful tool for reconstructing continental paleodrainage, and predicting scales of linked downdip depositional systems. This paper uses new DZ data from Lower Cretaceous strata of the Alberta foreland basin, and Upper Cretaceous and Cenozoic strata of the Gulf of Mexico passive margin, to reconstruct paleodrainage and sediment routing, and illustrate significance to giant hydrocarbon systems.

The Lower Cretaceous Mannville Group of the Alberta foreland basin system represents a truly giant petroleum province, with estimated reserves of 1.7 trillion barrel equivalents. DZ populations from fluvial sandstones show the Mannville Group represent the axial and downdip tributary system of a continental-scale river system that routed sediment from the eastern 2/3rds of North America to the Boreal Sea. Aptian McMurray Formation fluvial sands were derived from a drainage sourced in the Appalachians that was similar in scale to the modern Mississippi or Amazon. Albian fluvial sandstones of the Clearwater and Grand Rapids Formations were derived from the same Appalachian-sourced drainage area, which had expanded to include tributaries from the Cordilleran arc of the northwest US and southwest Canada.

The Gulf of Mexico is also a prolific petroleum province, although an order of magnitude smaller than the Alberta foreland basin. DZ populations from the US Gulf of Mexico coastal plain complement the view of drainage evolution established in the Alberta foreland, showing that only the southern US and Appalachian-Ouachita cordillera was integrated with the Gulf through the Late Cretaceous. However, by the Paleocene, drainage from the US Western Cordillera to the Appalachians had been routed to the Gulf of Mexico, establishing the sediment fairways that produced the Paleocene-early Eocene Wilcox deepwater fans that consist of laterally extensive sands that extend >400 km from the coeval shelf margin, as well as the template for sediment routing that, in the broadest sense, continues to this day.

The paleodrainage reorganization and changes in sediment routing described above played key roles in establishment of the Alberta foreland and Gulf of Mexico as giant petroleum provinces. Early Cretaceous routing of a continental-scale fluvial system to the Alberta foreland provided large and contiguous fluvial point-bar sand bodies that became economically viable reservoirs, whereas late Cretaceous drainage reorganization routed greatly increased sediment loads to the Gulf of Mexico, which loaded the shelf, matured source rocks, and drove the gravitational and salt tectonics that helped establish working hydrocarbon systems.