Influence of Proterozoic Belt-Purcell Rift System on Phanerozoic Facies, Isopachs, Structures and Hydrocarbon Prospectivity in Montana*

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Abstract

The Proterozoic Belt-Purcell Basin of NW USA and SW Canada originated at a triple-rift junction where three continental rift zones intersected to define a triangular graben. The complex internal structure of the triangular rift basin included two deep grabens and a central horst. The architecture of the rift system influenced Phanerozoic sedimentation and tectonics. Two of the rift arms evolved into the Cordilleran miogeoclinal margin, with separation of a conjugate continent, likely the Siberian craton. The third rift arm defines the ESE-trending Montana-Tennessee lineament (MTL). Segments of the MTL now define the Lewis and Clark line, Helena embayment, and Central Montana trough. Tectonic adjustments along the MTL, evident in isopach and facies maps of Phanerozoic periods, indicate that the cratonic blocks on opposite sides were alternately uplifted or depressed as they responded independently to far-field tectonic loads. At times the system was extended as the blocks separated, and at times it was compressed as the blocks converged. These shifts permitted accumulation of evaporites and hydrocarbon source rocks along the Central Montana trough.

The NE block uplifted in response to the Columbian orogeny, with deep middle Jurassic erosion of a broad fore-bulge, then subsided under the load of the foreland basin as the Rocky Mountain fold-thrust belt propagated eastward. Late Cretaceous granitic batholiths injected east along the MTL into central Montana. The SW block was imbricated into the Rocky Mountain foreland basement uplifts. In detail, the shifting of the rift components of the original Belt-Purcell Basin reactivated old faults and compartmentalized the Montana Rocky Mountain fold-thrust belt. The contrasting geologic histories resulted in significantly different hydrocarbon prospectivity on either side of the MTL.
The diagrams illustrate geological cross-sections with various layers and faults. The section labeled 'A' shows a 130 km displacement with layers labeled 'Tertiary volcanic and sedimentary', 'UK volcanics/sills', 'UK Montana', 'UK Colorado Group', 'Paleozoic', 'Missoula Group', 'Middle Belt carbonate', 'Empire Formation', 'Ravalli Group', 'Lower Belt/Purcell', and 'Mafic sills'.

Section 'B' also depicts a 130 km displacement with similar geological layers.

Section 'C' highlights a 110 km displacement with layers 'Pre-Cambrian', 'Saline Mts', 'Rocky Mts', 'Hungry Horse Reservoir', and 'Lewis thrust, projected'.

Section 'D' features a 80 km displacement with layers 'Blackfoot Trough', 'Wisked Syncline', 'Swan Range', 'South Fork Fault', 'Continental Divide Syncline', and 'Montana Disturbed Belt'.
Triangle zone on Sun River transect

Augusta syncline

Triangle zone on Calgary transect

Alberta syncline
NO BELT SUPERGROUP CLASTS IN LATE K-PALEOCENE FORELAND BASIN
A. MODERN-DAY CROSS-SECTION OF BELT-PURCELL THRUST, SUN RIVER TO MISSOULA MONTANA

B. BELT-PURCELL THRUST WEDGE AT 60 MA
Rogers Pass transect

Belt rocks must remain buried

59 Ma

74 Ma

Eroded and Extended

Garrison

Purcell Anticlinorium

Rogers Pass

Montana Disturbed Belt

Elkhorn Mountains

Belt-Purcell

Mafic sills

Brittle, Dry, Strong

Gabbro

Hi Pore-fluid Pressures

MSL

-10 km

-20 km