In 1978, the presence of shatter cones was documented at the intersection of two major regional faults in the Canadian Slate Islands of Lake Superior. Thus it can no longer be concluded that shatter cones indicate shock metamorphism from meteorite impact exclusively.

These stratigraphic anomalies also support long-term structural growth at Red Wing Creek field. In the three highest wells, the Mississippian Charles Formation has no salt, which indicates that this 100-ac area was positive during deposition. Progressive, orderly absence of Mississippian and Pennsylvanian formations toward the central high of the pre-Amsden subcrop further substantiates major, late Paleozoic structural growth. Lack of breccia or meteoritic material in the Permian-Triassic Spearfish Formation and Jurassic Piper Formation ring-depression fill appears to rule out any explosive event. Instead of the normal gray Piper shales, there is much red shale within the Piper Formation at Red Wine Creek. This implies long-term, continued uplift rather than instantaneous impact and rebound.

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Seismic Definition of Detachment and Basement-Involved Structures Beneath Absaroka Range, Western Big Horn Basin, Wyoming

The subsurface structure of the western margin of the Big Horn basin is obscured by the Absaroka Volcanic Supergroup (Eocene). This volcanic-volcaniclastic sequence, in many places more than 5,000 ft (1,500 m) thick, is dissected into an extremely rugged terrain. This steep terrain and presence of surface volcanic rocks had in the past discouraged petroleum exploration. Recent seismic data, as represented by two lines, have extended the known western limits of the basin far under the volcanic-volcaniclastic rocks of the Absaroka Range.

The Cody platform, an uplifted and eastward-tilted platform containing surface anticlines and associated oil fields such as Oregon Basin, Grass Creek, Little Buffalo Basin, and Hamilton Dome, extends under the eastern third of the range where other similar anticlines have been defined. As shown by an east-west seismic line traversing the North Fork Shoshone River, the northern area of the platform is dominated by structures radiating from the giant Sunlight volcanic center. This line shows that prospective sedimentary rocks and potential structural traps exist as far west as Yellowstone National Park.

New evidence relating to detachment faulting in Mesozoic rocks is illustrated by a north-south portable seismic line through the South Fork Shoshone River valley and Carter Mountain. This line demonstrates that thrust faults exposed on either side of the valley are not traces of the same fault or a window in the "South Fork thrust fault." The new term "Carter Mountain fault" is proposed for the southern fault trace and "South Fork fault" is retained for the northern fault trace.

The seismic data presented show excellent quality in spite of difficult portable operations and complex velocity problems. The area shows promise for future discovery of giant oil fields characteristic of the Big Horn basin.

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Petroleum Geology of Santa Rosa Sandstone (Triassic), Northeastern New Mexico

The Santa Rosa Sandstone (Triassic) occurs at depths of less than 2,000 ft (610 km) over most of northeastern New Mexico. Two major, presently unproductive heavy oil accumulations are known to exist in the Santa Rosa Sandstone in New Mexico: the Santa Rosa tar sands near the town of Santa Rosa in central Guadalupe County and a subsurface accumulation near the town of Newkirk in northeast Guadalupe County.

The Santa Rosa Sandstone is 67-350 ft (20-107 m) thick in northeastern New Mexico. It overlies the Artesia Group (Permian) with regional angular unconformity and is subdivided into three regionally recognizable units: a lower sandstone unit 18-140 ft (5-43 m) thick, a middle mudstone unit 0-144 ft (0-44 m) thick, and an upper sandstone unit 7-150 ft (2-46 m) thick. The lower and upper units are blanket deposits of braided streams and consist mostly of fine to medium-grained porous sandstones and minor red mudstones. The middle unit is lacustrine, consisting chiefly of red mudstones and minor sandstones.

Structures on the Santa Rosa Sandstone are mostly northwest to northeast-trending gentle folds superimposed on a southeast regional dip of 0.4°.

The two heavy oil accumulations occur in the upper sandstone unit. Shows of asphaltic hydrocarbons occur in the lower unit. Stratigraphic and petrographic studies indicate that good reservoirs are widespread in the lower and upper sandstone units in northeastern New Mexico. The blanket geometry of the lower and upper sandstone units indicates that structure should play an important or even dominant role in the trapping of undiscovered hydrocarbons in the Santa Rosa Sandstone.

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Deadwood Formation and Winnipeg Group Stratigraphy of Williston Basin

The Deadwood Formation thins southward and eastward from about 850 ft (259 m) in western North Dakota to an erosional edge in eastern North Dakota and central South Dakota. Thickness variations reflect pre-Middle Ordovician erosion, preexisting topography of the Precambrian surface, and depositional thinning eastward. The lower Deadwood consists of a clean, quartzose basal sandstone overlain by glauconitic carbonates and sandstones with minor shales. The upper Deadwood consists of less glauconitic to nonglauconitic sandstones and carbonates.

The Winnipeg Group consists of the Black Island and Ice Box Formations and Roughlock Sandstone. The Black Island Formation is composed of a lower red-brown and green sandstone and shale unit with a maximum thickness of about 100 ft (30 m) that is confined to the central basin area. The upper Black Island is primarily a quartzose sandstone with a maximum thickness of about 160 ft (49 m) in the central basin area. It thins to less than 20 ft (6 m) in eastern North Dakota and pinches out southward in southern North Dakota. The Ice Box Formation consists primarily of greenish-gray, noncalcareous shale with a thickness of 110-130 ft (34-40 m) in most areas of North Dakota; it thins southward to about 40 ft in the northern Black Hills outcrops and thins northward as it intertongues with the Black Island sandstone in Canada. The Roughlock Sandstone consists of greenish-gray calcareous shale grading upward into interbedded calcareous shale and argillaceous limestone in eastern North Dakota. It grades into a calcareous siltstone and fine-grained sandstone in south-central North Dakota and extends through north-central South Dakota to the outcrops in the northern Black Hills.

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Mustang Flat—Significant New Paradox Basin Field

The Mustang Flat oil and gas field in T36S, R23E, Utah, was discovered by Texas Eastern Skyline Oil through the integration of regional geologic concepts and seismic stratigraphic techniques.

Mustang Flat currently is capable of production from five wells in the Ismay (Des Moines) Member of the Hermosa Formation. The reservoir is developed from limestones and dolomites associated with the deposition of algal (*Ivanovia*) mounds. The porous section ranges from 30 to 104 ft (9 to 32 m) thick, using a 7% porosity cutoff (as indicated on a compensated neutron log). A hydrocarbon column of at least 180 ft (55 m) has been established; a water contact has not been encountered. Developmental drilling is continuing. Two wells are capable of production from the Desert Creek.

The Patterson field in T37S, R24E, served as a model for exploration. Regional seismic and subsurface studies revealed the Patterson field to be associated with a break in the slope of a postulated paleoshelf. In addition, modeling indicated that porosity within the Ismay could be recognized from seismic data. From regional seismic control, the paleoshelf break was traced to the northwest into T36S, R23E. Seismic data revealed a broad northeast-southwest-trending nose that intersected the paleoshelf break, and porosity indicators were noted. Seismic and leasing programs were subsequently begun. Portable shothole seismic equipment was used because of terrain considerations. High-resolution acquisition and processing techniques were utilized. Careful analysis of isochron and time structure maps, and use of porosity indicators resulted in the Mustang 1 discovery location. Subsequent drilling and seismic work have revealed pitfalls of which the seismic interpreter should be aware.