basin sagged along basement rift zones by strong east-west extension during the Desmoinesian. The dominant zone of weakness was the northwest-trending Olympic-Wichita basement lineament that lies along the eastern margin of the Paradox salt basin and the southwestern edge of the Uncompahgre-San Luis uplifts. Less prominent northwest and northeast shear zones are ubiquitous, but are especially well developed in basement and Paleozoic rocks underlying the San Juan basin at the southeast termination of the Paradox basin.

J. C. Crowell's classic model of a pull-apart basin along anastomosing transform fault zones is directly applicable to the Paradox basin, with the one exception that the Paradox is an intracratonic basin developed on continental crust. The primary zone of weakness, the Olympic-Wichita lineament, marks the abrupt eastern margin of the basin. The southwestern margin is less well defined along a broad zone of basement faults that trend northwesterly across the San Juan basin, through the southern margin of the salt basin, across the Monument upwarp at the anomalous Fish Creek structure and the Mille Crag Bend fracture zone, and on o the northwest through the Henry Mountains intrusives and the Fremont sag. The northwest termination is the expected irregular compressional (convergent) margin at the Emery uplift (San Rafael swell), and the southeast limit of the basin is an irregular margin of normal faults and stretched attenuated floor (divergence) lying between the Hogback monocline and the House Creek fault. The complex intersections lying at the rhombic corners of the basin are in the San Juan Mountains on the southeast, the Defiance uplift on the southwest, the Fremont sag on the northwest, and the Oquirrh sag on the northeast.

As the Paradox basin episodically deepened during the Middle Pennsylvanian by rejuvenation of basement faults, it was being filled contemporaneously with salt, which may have reached a thickness of 6,000-8,000 ft (1,800-2,400 m), and arkoses of 15,000-20,000 ft (4,600-6,100 m) thickness along the Uncompahgre front. A pull-apart of only about 5% of extension would account for a basin of this magnitude. By about mid-Desmoinesian time, the wrenching pull-apart was nearly completed. Folding caused by minor wrench movements formed shoaling conditions along the southwest shallow shelf of the basin where algal bioherms developed. Meanwhile, pull-apart stretching of the basin floor may have triggered salt flowage and diapirism in the eastern, deepest part of the basin. From the late Desmoinesian through Permian, the basin filled with marine and nonmarine sediments as the wrench tectonism subsided.

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Radio Imaging Method (RIM) Used to Map Coal Seam Thickness Within Developed Longwall Panels

Modern underground coal mines commonly employ retreating longwall mining techniques to increase productivity and resource recovery and decrease mining cost. Although longwall mining is generally the most efficient method used today, its effectiveness can be impaired by intersecting localized areas of coal thinner than the minimum mining height of the equipment.

Coal seams within western coalfields are generally lenticular. Localized areas of thin coal overlain by fluvial sandstone deposits that are scoured into the coal are common on many properties and may be encountered by retreating longwalls. This can severely impact productivity and degrade the run of mine coal quality.

The use of Radio Imaging Method (RIM) is being tested to map coal seam thickness within a developed longwall panel. Although coal seams are poor electrical conductors, electromagnetic signals can be transmitted through the coal within a longwall panel. These signals are attenuated as they pass through the longwall panel. The degree of attenuation for a given distance of signal travel is largely a function of the coal seam height. This relationship enables RIM to detect changes in coal seam height within a longwall panel that may or may not be evident from the development entries.

Initial testing of RIM in a few developed longwall panels has proved successful in identifying at least three areas of thin coal that were later confirmed by drilling and mining.

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Greybull Sandstone Pool (Lower Cretaceous) on Elk Basin Thrust-Fold Complex, Wyoming and Montana

The Elk Basin field in the northern Bighorn basin is a giant structural trap with cumulative production surpassing 500 million bbl, principally from a Paleozoic common pool. Abundant well data and seismic information have been used in a stratigraphic and structural study focusing on the Greybull (Lower Cretaceous) gas pool and on deeper formations along this structural complex. These data support an interpretation of the Elk Basin field as a thrust-fold complex, underlain by a listric thrust fault zone which probably emanates from Precambrian basement at an angle of 45° or less. The fault steepens upward and dies out in steeply dipping Mesozoic clastics that are attenuated and cut by extensional faults at the surface.

The little known Greybull Sandstone pool at Elk Basin field, which is now used for gas storage, was discovered in 1920, and contained estimated primary recoverable reserves of 54 bcf of gas at an average depth of about 2,500 ft (760 m). The Greybull lies stratigraphically between the Dakota and Morrison Formations, and is composed of two distinct sandstone units, called "A" and "B" at the North Clark's Fork field in southern Montana. The lower "B" unit at Elk Basin is a fluvial river-channel deposit which ranges up to 150 ft (45 m) in thickness and nearly 2 mi (3 km) in width. The upper "A" unit is a series of shoreline sandstone deposits oriented northwest-southeast. Individual, porous "A" sandstone bodies range from a few feet to more than 20 ft (6 m) in thickness at Elk Basin. These two Greybull Sandstone units are part of a common gas pool covering about 2,000 acres (800 ha.) of the crestal closure of the Elk Basin anticline. Seismic modeling indicates that Greybull Sandstone channels over 60 ft (18 m) thick may be detected by reflection character changes in CDP seismic data.

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Petrography and Fluorescence Spectral Analysis of Resinite Macerals from Coals of Hanna Basin, Wyoming

Petrographic analysis of coals of the Ferris and Hanna Formations of Wyoming show these coals to have a high total vitrinite content (average 84.2%) and a modest liptinite content (average 5.9%). Compared to coals of similar rank (0.45-0.55% reflectance) from central Utah, these coals have about twice as much pseudovitrinite and about half as much total liptinite. Although sporinite is generally the most abundant type of liptinite maceral, resinite and sporinite occur in about equal amounts in these Wyoming coals, and resinite greatly exceeds sporinite in the central Utah coals.

Results of fluorescence spectral analysis of resinite macerals in the Wyoming coals show that there are five distinct resinite types present. Four types occur in primary globular forms exhibiting scratches and fractures indicating a brittle solid substance. In places, these four types also occur as secondary fracture fillings. Two of the four types fluoresce with a green color; one a dark green peaking at less than 440 nm and the other a yellow-green peaking at 500 nm. The third type fluoresces yellow and peaks at 580 nm, and the fourth type fluoresces orange-brown and peaks at 610 nm. These yellow and orange-brown resinites are similar to those found in central Utah coals except that the Wyoming resinites peak 30-40 nm higher. In the Utah coals, only one green resinite peaks at 460 nm; however, its spectrum has a shoulder at 470-490 nm. The fifth resinite type fluoresces a red-brown and peaks at 690 nm. It occurs only as a void-filling substance showing no brittle properties. It is indistinguishable from a similar resinite type in the central Utah coals.

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Origin of Gilsonite Fractures in Uinta Basin, Utah

The concept of gilsonite fracture and vein evolution is still, by nature, a theoretical argument. A historical review presented with recent observations and conclusions divides this period of origin into five stages of for-