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Stratigraphy, Petrography, and Paleoenvironmental Interpretation of Mississippian-Pennsylvanian Amsden Formation South of La Barge Guard Station, Salt River Range, Western Wyoming

The Amsden Formation, named by N. H. Darton in 1904 during mapping of the Bighorn Mountains, Wyoming, consists of red shales, limestones, sandstones, and cherty beds. The Amsden was later subdivided into four members (in ascending order): the Darwin Sandstone (E. Blackwelder, 1918), the Horseshoe Shale (W. W. Mallory, 1967), the Moffat Trail Limestone (W. J. Sando and others, 1975), and the Ranchester Limestone (W. W. Mallory, 1967). All members crop out in the study area.

The Darwin Sandstone Member is up to 88.4 m (290 ft) thick, disconformably overlies the Mississippian Mission Canyon Limestone, and is conformably overlain by the Horseshoe Shale Member. It is a quartzarenite with minor amounts of feldspar interpreted as being deposited in a nearshore or beach environment.

The Horseshoe Shale Member is 25.9 m (85 ft) thick and conformably overlies the Darwin Member. The Horseshoe Shale Member contains fine-grained terrigenous sediment interpreted to have accumulated in a lagoon or back-reef environment. The lower part is a white to red siltstone with localized areas of pisolitic hematite; the upper part is organic-rich black shale containing palynomorphs.

The Moffat Trail Limestone Member is 29.0 m (95 ft) thick and conformably overlies the Horseshoe Shale Member. The Moffat Trail consists of biomicrites, pelmicrites, and silty micrites. It is interpreted to represent open-marine, low-energy carbonate-shelf deposition.

The Ranchester Limestone Member is 9.4 m (31 ft) thick and conformably overlies the Moffat Trail Member. The Ranchester contains silty dolomite, carbonate, and red siltstone, representing the maximum transgression of the Pennsylvanian sea. The Pennsylvanian Wells Formation conformably overlies the Ranchester Member.

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Structural Control and Fractured Reservoirs in Relation to Oil Production from Green River Formation, Pleasant Valley–Monument Butte Fields, Uinta Basin, Utah

Current exploration activity in the northern portions of the Pleasant Valley-Monument Butte fields has been given great impetus by enhanced fracture permeability in what are generally low-permeability sandstone reservoirs. Associated with the Duchesne fault zone, these fractures trend both parallel to existing faults (approximately east-west), and oblique to structural trends (approximately northwest). Extensive coring has substantiated the existence of fractured reservoirs in both the green shale and black shale facies of the Green River Formation (Eocene), although some fracturing is probably compaction induced.

Gilsonite orientation can serve as a finger post to these fracture systems in that many gilsonite veins parallel fracture traces. Other gilsonites parallel apparent rollovers or open anticlinal features as expressed on the surface. These extremely gentle folds generally trend northeast and may also be a clue to increased production.

Finally, updip truncation of reservoir sandstones by high-angle faults represents another concept related to increased Green River recoveries. Some faulted sequences dip rather severely to the north (15°-30°) compared to the regional dip (2°-3°). These displaced strata may contain a known reservoir whose hydrocarbon contents are trapped against one of these east-west lineaments of the Duchesne fault zone.

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Geometry of Wind River Thrust, Wyoming

A thick wedge of Precambrian crystalline rocks of the Wind River Mountains was thrust far across sediments of the Green River basin during the Laramide orogeny. Dip of the thrust zone decreases with depth to form a broadly curved, convex-downward surface. Seismic data also show strong local curvatures that produce a scalloped pattern in the leading edge of the thrust wedge and divide the wedge into lobate segments that are about 8 mi (13 km) wide along strike. The explanation for this scalloped pattern of folding may be lengthening of the unconfined wedge margin by extension during thrusting. Curvature of the thrust surface confirms that deformation of Precambrian rocks occurred by a foldlike mechanism. Local curvatures can also explain low apparent-dip angles of some other thrust faults in the Wyoming foreland.

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Geology and Economics of Tar Sands

Petroleum in the form of tar sands may occur either as disseminated deposits or as veins or dike-like deposits. Disseminated occurrences may result from inspissation (drying up) of a preexisting pool of liquid and gaseous hydrocarbons into heavier residues with the loss of the lighter fractions leaving behind a fossil oil field. They also may originate as primary mixtures of rock and bitumen. However, such distinctions may seem farfetched compared to some of the largest known deposits in the world like the Athabasca tar sands of Alberta, Canada, which are of Cretaceous or Devonian origin and contain 100-300 billion bbl of oil.

Exploration and production of synthetic oil from tar sands were reported in many parts of the world, ranging from the Santa Maria field in California to sand asphalt deposits in Utah and around the Oklahoma Panhandle, to other fields in the United States, Canada, USSR, Venezuela, Trinidad, Cuba, and Germany. Experimentation, research, and mechanical design are the keys to commercial recovery of crude oil from tar sands (which are also a matter of supply and demand).

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Road Hollow Unit Gas Field, Utah-Wyoming Thrust Belt

The Road Hollow field, discovered in November 1981 in Lincoln County, Wyoming, is the northernmost field on the Absaroka plate producing trend of the Utah-Wyoming Overthrust belt. The discovery well, the Road Hollow Unit 4, gauged an initial potential of 10 MCFGD and 440 BCPD from the Ordovician Bighorn Dolomite. Chemical analysis of the gas indicates greater than 98% hydrocarbon gases with only 0.3% hydrogen sulfide.

The Road Hollow field is an anticlinal culmination formed during emplacement of the Absaroka plate. The structure is well defined by seismic data. In the discovery well, the Ordovician Bighorn Dolomite contains approximately 150 ft (45 m) of greater than 2.5% porosity, whereas dolomite in the Devonian Darby Formation contains about 10 ft (3 m) of greater than 2.5% porosity. Gas was recovered during a drill-stem test of the Darby, but the formation is not presently considered to be economical. Shales and anhydrites within the Darby Formation appear to form the vertical seal for the Bighorn trap. The source of hydrocarbons for the Road Hollow field is believed to be subthrust Cretaceous shales. Geochemical analysis of these shales indicates a good, mature source for oil and gas.

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Demarcation of a Duplex Zone: Rockport Lake Area, Utah

The structural relationship between the east-trending Uinta axis and the north-trending overthrust systems in Utah and southwestern Wyoming remains a major structural problem with important implications for regional tectonics and petroleum exploration. This relationship is apparent in the Rockport Lake area where a lateral to oblique ramp formed in the Absaroka thrust system and was folded about the Uinta axis. Three northeast-trending subparallel thrusts forming a duplex zone are exposed at the surface in the Rockport Lake area. From north to south, the thrusts place Kelvin Formation over Evanston Formation, Frontier Formation over Kelvin Formation, and Preuss formation over Frontier Formation, respectively. Ubiquitous stylolitic pressure solution cleavage in the hanging wall of the ramp shows major shortening from the west. South of the Weber River, in the foot wall of the ramp, the stylolitic cleavage is less common but still present.

Angular unconformities between the Frontier and Evanston Formations and between the Evanston and lower Wasatch Formations show the Uintas to have risen in two distinct pulses. The earliest rise may have begun by Maestrichtian time and the latest rise, forming the north flank fault system, culminated in the Eocene.

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Possible Volcanogenic Origin of Uranium at Anderson Mine, Yavapai County, Arizona

Uranium mineralization in Miocene sediments at the Anderson Mine, 70 km northwest of Wickenburg, Arizona, is interpreted to have been volcanogenic on the basis of geologic setting, absence of uranium-depleted source rocks in the vicinity, and geologic similarities to the Aurora uranium prospect in the McDermitt caldera, Nevada.

The Anderson deposit formed in moat sediments within the McLendon caldera. The caldera is identified by a sediment-filled basin coincident with a circular, −25 mgal gravity low centered 5 km (3 mi) south of the mine. A thick apron of andesite, near-source lahar, and rhyodacite forms a crescentic outcrop pattern that partially encircles the gravity low. Ash-flow tuff, interpreted to have erupted during caldera collapse, crops out approximately 30 km (18 mi) south of the mine.

Contrary to previous interpretations, the volcanic rocks of McLendon caldera are unlikely source rocks for uranium in the Anderson deposit. The lavas and ash-flow tuff from the volcano have average Th:U ratios of 4.5 and 2.4, respectively. Both ratios are close to or within the magmatic Th:U range of 2.5-5, indicating minimal uranium depletion. If the uranium did not come from volcanic rocks, it could have been provided to the sediments through hot-spring systems from a late-stage, uranium-enriched differentiated source.

The occurrence of the Anderson and Aurora deposits within caldera moat sediments strongly suggests a genetically similar, volcanogenic model. Other geologic similarities include silicified zones, fossil hot springs, thin-laminar bedding, stacked ore bodies, association of anomalous manganese and molybdenum, and the presence of carnotite and coffinite.

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Overview of Petroleum Activities in Utah, 1972-1982

After a decade (1962-72) of relatively slow petroleum activity in Utah, the past 10 years have seen a substantial increase. Although the production of petroleum has steadily declined since 1975, the number of wells drilled has generally increased from year to year.

The petroleum activity is centered mainly in four different areas within the state: the Paradox basin (southeastern Utah); the Uncompahgre uplift (central eastern Utah); the Uinta basin (northeastern Utah); and the thrust belt area (northeast central Utah).

The Paradox basin includes 43 oil and gas fields that primarily produce from the Paradox Formation. The Uncompahgre uplift includes 23 fields, most of which produce gas from the Dakota-Cedar Mountain formation. The Uinta basin includes 58 fields with over 95% of the production coming from the Green River and Wasatch Formations. The thrust belt area includes nine fields that produce condensate and gas almost entirely from the Twin Creek and Nugget formations.

Drilling activity in the first three areas has been relatively constant, with in-fill operations within known fields accounting for most of the drilling. The thrust belt has been the center of increasing activity since the initial Pineview discovery in 1975.

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Extensional Tectonics of Eastern Basin-Range/Overthrust Belt: Inferences on Structural Style from Reflection Data, Surface Geology, and Rheologic Models

Interpretations of over 1,500 km (900 mi) of industry-related reflection data in the Cordillera have revealed the following styles of late Cenozoic deformation: (1) the widespread development of asymmetric eastward-tilted basins that are bounded by low to moderate-angle planar and listric faults, and (2) five en echelon, low-angle reflections interpreted as regional detachments. Some steeply dipping planar and listric normal faults may be partly controlled by the presence of Mesozoic thrust structures, but this hypothesis is not applicable universally. In some cases, ends of normal fault segments are apparently determined by the positions of sidewall ramps and other cross-strike displacement transfer zones of Mesozoic age. Alternatively, several major normal faults, particularly those in Tertiary volcano-tectonic complexes, have no obvious relationship to Mesozoic structures. The low-angle reflections interpreted as a set of detachments extend east-west at least 200 km (125 mi) and dip gently westward from 3 km (2 mi) beneath the western Colorado Plateau to over 10 km (6 mi) at the Utah-Nevada border. The structural style of low-angle and listric faults cannot be reconciled easily with classic brittle failure theory, but the interpreted termination of normal faults at or above the frictional/quasiplastic transition may occur as shallow as $\approx$ 7 km (4 mi). Rheologic models of an extending upper crust suggest a vertically stratified model: brittle from the surface to as shallow as 7 km (4 mi), then variably ductile. The shallow depth of the upper ductile layer has important implication for controlling fault geometry and therefore the locations of fault-related basins.

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Paleoenvironmental Interpretation Based on Foraminifera of Coal-Bearing Almond Formation, Little Snake River Coalfield, Wyoming

The Upper Cretaceous Almond Formation (Mesaverde Group) in south-central Wyoming represents deposition in a variety of marginal marine environments. Foraminiferal assemblages recovered from cores and outcrops of the Almond in the Cow Creek area reflect this environmental diversity.

The Almond Formation is about 450 ft (135 m) thick and is divided into 2 informal members, both of which contain coal. Coals in the upper 100 ft (30 m) of the upper member are thin, but the lower member contains several thick beds. The coal-bearing parts of both members are characterized by repetitive coarsening-upward bay-fill deposits of mudstone and sandstone, commonly overlain by coal. A major coarsening-upward sequence in the lower part of the upper member is capped by sandstone interpreted to be a marine shoreface deposit. Fine-grained rocks in both members contain foraminifera.

Three foraminiferal assemblages are defined on the basis of faunal density, diversity, dominance, and taxonomic composition. A low-diversity agglutinated benthic assemblage interpreted as a hyposaline salt-marsh fauna occurs in the fine-grained rocks of the lower member. A high-diversity mixed agglutinated and calcareous benthic assemblage interpreted as a hyposaline bay to lagoon fauna occurs in shales in the lower part of the upper member. A moderate-diversity agglutinated benthic assemblage that occurs in fine-grained rocks in the upper part of the upper member is interpreted as an intermediate hyposaline salt marsh to interdistributary bay fauna.

These variations in benthic foraminifera populations provide significant insight into water characteristics in otherwise homogeneous sediments. The combination of lithologic and faunal studies provides improved paleoenvironmental interpretation over either method used independently.

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Marine Sandstone "Rolls" in a Coal Mine in Northern Wasatch Plateau, Utah

Coal seam undulations, locally called rolls, are a common but poorly understood geologic feature in underground coal mines of the Wasatch Plateau coal field of central Utah. Rolls may detract from coal mineability by: (1) creating steep grades that are difficult for mining machinery to negotiate, (2) providing low areas where mine water pools, and (3) adding diluting material which decreases coal quality. Rolls found in Skyline Mine 3 involve local, abrupt changes in elevation of the top and base of the lower O'Connor A coal seam. The change in elevation ranges from 5 to 30 ft (1.5 to 9 m) along a horizontal distance of 30-150 ft (9-46 m) and may exceed 3,000 ft (915 m) along strike. Mapping indicates the rolls are