Abstracts

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Seismic Exploration in Raton Basin

Exploration in the Raton basin has delineated complex mountain-front structure in the asymmetric basin, and defined possible basin-centered gas. Exploration has included subsurface and surface geology, remote sensing, and seismic reflection.

The Raton basin is a north-south-trending structural basin straddling the Colorado-New Mexico boundary. It is bounded on the west by the Sangre de Cristo Mountains, on the north and northeast by the Wet Mountains and Apishapa arch, and the Sierra Grande uplift on the south and southeast. The basin is asymmetric with transcurrent faulting and thrusting associated with the steeper western flank of the basin. Rocks range from Devonian-Mississippian overlying Precambrian basement to Miocene volcanics associated with the Spanish Peaks. Principal targets include the Entrada, Dakota, Codell, and Trinidad Sandstones and the Purgatoire and Raton Formations.

Seismic data include explosive and Vibroseis data. Data quality is good in the basin center and is fair in the thrusted areas. Correlations are difficult from line to line. However, a strike line in the disturbed area would probably be more disrupted by out-of-the-plane reflections than the dip lines would be. Significant stratigraphic changes are seen in both the Trinidad and Dakota intervals.

Integrated seismic and geological studies are keys to exploration in the basin. Subsequent work will rely heavily on improved seismic information.

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"Jelly Bean" Conglomerate (Lower Permian): Record of a Forebulge in Southeastern Arizona?

The most incongruous stratigraphic unit in the Earp Formation (Pennsylvanian-Permian) is the "Jelly Bean" conglomerate (JBC), a unit rarely more than 5 m thick, but occurring over 15,000 km^2. The JBC consists mostly of clast-supported chert-pebble and limestone-clast conglomerate, litharenite, and pebbly sandstone, whereas most of the Earp Formation is marine limestone, siltstone, and shale. The JBC lies on eroded siltstone or limestone, and is capped conformably by siltstone. The JBC is probably a braided-stream deposit as indicated by presence of fluvial dunes and ripples, amalgamated bar and channel conglomerates, imbricated clasts, channeled underbeds, and lack of point bars. Paleocurrents were generally southward. The thinness and widespread occurrence of the JBC suggest a uniform, gentle paleoslope down which the streams flowed.

Deposition of the JBC occurred at about the climax of the Marathon phase of the Ouachita orogeny in west Texas and northern Mexico. The age and location of the JBC, which fringes cratonic North America, indicate that it was related to the late Paleozoic convergence of North and South America, and may have resulted from flexural forebulging caused by thrusting in the Marathon orogene and associated sedimentation in a foredeep.

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Seismic Lithology and Pitfalls in Seismic Porosity Detection

One common method of searching for seismic anomalies associated with increased porosity is to integrate the stacked seismic traces to obtain an "acoustic impedance" section or, if a suitable relation between density and velocity is known, a seismic interval velocity section. Lateral variations in the color-plotted displays can then be interpreted in terms of porosity variation associated with inferred velocity variation. Buried in this procedure is the assumption that the stacked section represents reflectivity at normal incidence.

In the developing technique of "seismic lithology," where variations in reflection amplitude with source receiver offset are used to infer lithologic properties, examples are accumulating that show dramatic changes in reflection amplitude with offset within common depth point gathers. Consequently, after stacking, the stacked section will be poorly correlated with normal incidence reflectivity.

Recent development in seismic lithologic analysis have led to a procedure that allows the normal incidence reflectivity to be estimated from the offset variation. The results of this procedure show greater continuity and geologic interpretability. More important, upon trace integration, the resultant impedance sections show greater stability leading to a higher confidence level in potential porosity anomalies.

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Integrated Geochemical and Paleoecological Approach to Petroleum Source Rock Evaluation, Cretaceous Niobrara Formation, Lyons, Colorado

Studies of the upper Turonian to upper Coniacian or lower part of Niobrara Formation (in ascending order, the Fort Hays Limestone Member and the marlstone, shale, and limestone of the lower part of the Smoky Hill Shale Member) reveal a significant relationship between petroleum source rock potential and paleoclimate. Trends in bioturbation, δO^{18} (oxygen isotopic ratio), and C_{org} (organic carbon content) during lower Niobrara deposition suggest that paleoclimatic factors limited bioturbation of the sediment, favored high C_{org} contents, and resulted in excellent source rock potential in the shale unit of the lower Smoky Hill Member. From the Fort Hays through the overlying marlstone unit, δO^{18} in inoceramid shells shows a gradual shift from nearly normal marine values (-2 to -4‰) to lighter values (-4 to -6‰); over the same interval, C_{org} changes from relatively low values (0.1-1.4%) to moderate values (0.5-2.5%). Bioturbation throughout these units is high. A marked shift toward heavier δO^{18} (-6.0 to -9.1‰) occurs upward into the shale unit and coincides with increase in C_{org} (2.3-4.9%) and an absence of bioturbation. In the limestone unit, δO^{18} shifts to less negative values (-6.2 to -6.5‰), C_{org} decreases (average 1.5%), and bioturbation returns. The trend toward more negative δO^{18} and higher C_{org} values in the shale unit is inferred to reflect a lowering of surface-water salinity in the Western Interior seaway due to climatic warming and increased freshwater imput. Resultant salinity stratification of the water column apparently inhibited vertical mixing and oxgenation of the bottom waters, resulting in limited benthic activity and enhanced preservation of organic matter.

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Facies Control of Mississippian Porosity, Whitney Canyon–Carter Creek Field, Wyoming Overthrust Belt

Mississippian Mission Canyon carbonates are the most prolific Paleozoic reservoir in the Wyoming Overthrust belt. At Whitney Canyon–Carter Creek field, the Mission Canyon Formation holds recoverable reserves of 240 million bbl of oil equivalent. Production comes from a 350-ft (107 m) gross interval of shallow-water shelf carbonates. Capping the reservoir interval is a 300-ft (91 m) section of anhydrite and tight dolomite that represents sabkha deposits that prograded seaward (westward) over the shelf carbonates.

Production from the shelf sequence comes exclusively from sucrosic dolomites that are interbedded with tight limestones and tight crystalline dolomites. Examination of cores spanning the entire reservoir interval reveals that it is composed of a series of nine shallowing-upward sequences, reflecting a history of progradational events across the Mississippian Wyoming shelf. A single complete sequence averages 40 ft (12 m) in thickness and grades upward from open-marine through restricted-marine to intertidal and/or supratidal environments. Open-marine units are predominantly fossiliferous grainstones and packstones—rocks containing little or no carbonate mud. The overlying restricted-marine and intertidal and/or supratidal units are primarily mud-supported carbonates. Petrographic evidence indicates that carbonate mud was dolomitized preferentially relative to grains. The best reservoir-quality dolomite, therefore, usually occurs in the mud-rich, upper portions of the shallowing-upward sequences, and tight intervals separating the porous zones generally represent grain-supported, open-marine units.

Such facies characteristically are continuous for great distances along depositional strike. At Whitney Canyon–Carter Creek field, individual porous zones can be correlated for more than 12 mi (19 km) across the

*Denotes speaker other than senior author.