prohibited significant cooling. The wide range in $\delta^{13}C$ compositions reflects mixtures of organically derived carbon and dissolved marine carbonate. In reservoir rocks that are extensively fractured, gas generated in situ from carbonaceous and coaly shales and tongues of lacustrine rock may have migrated locally along open faults and fractures.

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Electric Utilities' Stake in Applied Coal Geoscience

Representing 85% of domestic coal consumption, electric utilities are burning more coal under stricter environmental regulations than ever before. Their stake in the application of coal geoscience and related disciplines is urgent and ranges from national issues to local fuel management practices. At a national level, the availability and price of Appalachian low-sulfur coal are critical unresolved questions. Uncertainties in resources in-place are compounded by uncertainties in recoverability, marketability, and transportation. In the face of acid deposition legislation, utility fuel and compliance strategies are influenced by these considerations and a host of other utility-specific factors, none of which are well understood. Day-to-day fuel management practices call for increased attention to coal quality, reliability, variability, and performance in efforts to reduce electricity-generation costs, but the necessary information is rarely available. The role of applied coal geoscience, properly integrated with other disciplines, is enormous and will yield benefits to both coal producers and utilities.

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Seismic-Stratigraphic Analysis of Lanyard–Lost Creek Field Area, Denver Basin, Colorado: Application to Exploration and Field Delineation

The Lanyard and Lost Creek fields are located on the eastern flank of the Denver basin in Weld County, Colorado. Production is from the "D" sandstone interval of the Dakota Group (lower Upper Cretaceous). Combined cumulative production from both fields is in excess of 3.5 million bbl of oil and 6.7 bcf gas. Both fields are currently under secondary recovery operations.

The "D" sandstone in this area is believed to have been deposited within a channel system as part of a westward-prograding coastal plain. In places, the productive channel is no more than 1,000 ft (305 m) wide. The "D" sandstone ranges in thickness from less than 10 ft (3 m) outside of the channel to as much as 40 ft (12 m) within the channel.

An analysis of a detailed seismic grid across these fields reveals a consistent relationship between a seismic-stratigraphic anomaly and the occurrence of thick "D" sandstone. This analysis is supported by a series of seismic models based on known geologic conditions.

Depending upon localized geologic conditions, the seismic signature of a thick "D" sandstone varies across the Denver basin. However, an integrated geologic-geophysical approach can be used for the delineation of field limits as well as support for explanatory prospects or prospect leads.

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Petroleum Source Rock Potential and Crude Oil Correlation in Great Basin

Petroleum source beds in the Great Basin region include marine Paleozoic rocks and nonmarine upper Mesozoic and lower Cenozoic rocks. Potential source beds have been identified in continental-rise deposits of the Ordovician Vinini and Devonian Woodruff formations in the eastern part of the Roberts Mountains allochthon (Antler orogene), in central and north-central Nevada; in flysch-trough and prodelta-basin deposits of the Mississippian Chainman Shale and equivalent rocks of the Antler foreland basin, in Nevada and western Utah; and in lake-basin deposits of the Cretaceous Neward Canyon Formation and the Paleogene Sheep Pass and Elko formations and equivalent rocks, in central and eastern Nevada. Oil fields in the Great Basin are located within Neogene-Quaternary basins that formed during Neogene basin-range block faulting. Most of the oil shows and crude oils analyzed can be correlated with Mississippian or Paleogene source rocks. The Mississippian Chainman Shale is confirmed as the major petroleum source rock, having generated the oil in the Trap Spring, Bacon Flat, and Grant Canyon fields in Railroad Valley and the Blackburn field in Pine Valley. The Paleogene Sheep Pass Formation is the source of the oil in the Eagle Springs field and probably the Current field in Railroad Valley. Oil occurrences in the northern Great Basin are believed to be derived from two or more other Tertiary lacustrine sequences.

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Exploration Applications of a Transgressive Tidal Flats Model to Mississippian Midale Carbonates, Eastern Williston Basin

Midale (Mississippian) production was first established in 1953 in Saskatchewan, Canada. The unit was initially defined in the subsurface as the carbonate interval between the top of the Frobisher Anhydrite and the base of the Midale Anhydrite. That nomenclature is used in this report. During 1953, Midale production was found in the United States portion of the Williston basin in Bottineau County, North Dakota. Later exploration extended Midale production westward into Burke County, North Dakota. Cumulative production from the Midale is approximately 660 million bbl, of which 640 million bbl are from Canadian fields.

Initially, hydrocarbon entrapment in the Midale was believed to be controlled by the Mississippian subcrop, with the Burke County production controlled by low-relief structural closure. Petrographic examination of cores and cuttings from the Midale in both Saskatchewan, Canada, and Burke and Bottineau Counties, North Dakota, indicates that production is controlled by facies changes within the unit. Stratigraphic traps are formed by the lateral and vertical changes from grain-supported facies deposited in tidal channel, subtidal bar, or beach settings; seals are formed by mud-rich sediments. Use of a transgressive carbonate tidal flats model best explains current production patterns and indicates substantial potential for additional production in eastern North Dakota and South Dakota.

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Absaroka Thrust Exploration Plays in Wyoming-Utah-Idaho Thrust Belt

The magnitude of undiscovered onshore oil and gas resources on Federal lands in the United States is an important resource appraisal question that remains unanswered. A new U.S. Geological Survey project to assess the resource potential of these lands relies on play analysis as its method of assessment.

The first result of this project is the delineation of two plays in the Wyoming-Utah-Idaho thrust belt province: the Absaroka Paleozoic (western line of folding) and Mesozoic (eastern line of folding) plays. The two plays are aligned northeast-southwest along two subparallel anticlinal trends formed during emplacement of the Absaroka thrust. Nine fields discovered in the Absaroka Paleozoic play produce sour gas and condensate from Paleozoic carbonate reservoirs in thrust folds in the hanging wall of the Absaroka thrust. Hydrocarbons in this play are believed to be derived from Cretaceous source rocks in the footwall of the thrust. In contrast, 14 fields discovered in the Absaroka Mesozoic play produce mainly oil and sweet gas from Mesozoic clastic reservoirs in thrust folds in the hanging wall of the same thrust. Hydrocarbons in the Mesozoic play are also believed to have been generated from the same Cretaceous source rocks in the Absaroka footwall. The boundary separating the two plays is drawn on the basis of distinct differences of types of hydrocarbons produced, and lithology and age of the producing reservoir.

Preliminary geologic estimates were made of potentially recoverable hydrocarbons from fields in both plays and were based on available field and well data. The estimates were fitted to graphs that show field sizes in millions of barrels of oil equivalent (BOE) by month and year of discovery. The resulting field-size distributions indicate that the largest fields were discovered early in the 10-year exploration period (1975-84) of both plays: Whitney–Carter Creek in the Paleozoic play (1,300 million BOE), and Anschutz Ranch East in the Mesozoic play (1,200 million BOE). It seems likely that future exploratory drilling may discover additional