powered by subductive closing of the Ural–Proto-Atlantic ocean system, but distinct styles and kinematic sequences are imposed through gravity spreading by synorogenic topography, and by 1.5 to 4.5 km of foreland subsidence succeeding 2.5 to 6 km of cratonic shelf subsidence. Traditional exploration prospects are surface folds and frontal thrusts within a Silurian to Mississippian clastic wedge thinning southward from 6.5 to 0.5 km. Future prospects are in lower Paleozoic carbonate rocks involved in subthrust structures and, perhaps, in rift fill below the regional decollement. Risk is related to porosity distribution and to surface-water invasion. Overthrust styles include: detached folds and bed-parallel decollements; sled-runner thrusts, folded-fault structures, and polyphase thrusts; and fold-discordant thrust sheets. Some styles predominate regionally: folded-fault structures in the north and the south, imbricate stacks in the middle, and fold-discordant thrusts in the south. There is no hard evidence of eastward migration of thrusting. Kinematic sequences suggest that a frontal subbelt of detached folds or decollement always was located west of a subbelt of thrust imbrication. Basement subsidence, thrust pileup, erosion, and foredeep sedimentation caused the subbelts to shift position and width, thereby generating kinematic sequences essential for the definition of prospects.

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Zenith Field—Significant Dakota (Muddy) "D" Sandstone Discovery, Adams County, Colorado (Secs. 17-20, T3S, R62W)

Zenith field is located on the moderately-dipping, eastern flank of the Denver-Julesburg basin, approximately 43.4 km east of Denver. The field was discovered in March 1979, with the completion of Empire Drilling Company 1 Hilton for 1,285 bbl of oil per day and 750 Mcf of gas per day from the Lower Cretaceous (Muddy) "D" sandstone from 2,222 to 2,234 m. Development drilling by Empire, Champlin Petroleum Inc., and Amoco Production Co. has increased the number of producing wells in the field to five "D" sandstone wells and one Muddy "J" sandstone well. The initial potentials of the additional wells range from 50 to 500 bbl of oil per day with 1,000 Mcf of gas per day. Cumulative production for the field to November 1, 1979, was estimated at 96 thousand bbl of oil and 64 MMcf of gas. Several other wells are in the process of being drilled and completed. Six wells in the field have been plugged and abanonded.

The "D" sandstone throughout the D-J basin is developed as marine-bar and distributary channel sandstones, and hydrocarbon accumulations are found primarily in stratigraphic traps. Zenith field is part of an east-west trending distributary channel which is also productive at Strasburg field, 3.2 km to the east, and Bennett field, 5.6 km to the west. The channel averages less than 1.6 km in width. The productive limits of all three fields are controlled by the pinch-out of porosity and permeability associated with facies changes within the channel. At least three distinct facies can be identified from well logs in Zenith field.

The "D" sandstone of Zenith field is predominantly fine grained, poorly sorted, and very shaly. The sandstone ranges in thickness from less than 6 m to greater than 15 m. The "D" sandstone thickness in producing wells is usually greater than 12 m. The average porosity and permeability in the "D" sandstone are low.

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Oil-to-Source Correlation—Pineview Field, Overthrust Belt, Utah

The Pineview field, discovered in 1975, started the recent expansion of exploration in the Overthrust belt and produces mainly from the Jurassic Nugget and Twin Creek formations. Mass spectra, gas chromatographs, and carbon isotopes show that oils from the two formations are geochemically similar, which suggests that they were generated in the same or similar source rock. Source evaluation data indicate that Cretaceous shales and the Phosphoria Formation are the best potential source rocks in this part of the Overthrust belt. An oil-to-source correlation shows that the Pineview oils are related to the Cretaceous source rocks rather than the Phosphoria. A Cretaceous source is geologically reasonable at Pineview because Cretaceous shales of the subthrust section underlie the Jurassic reservoirs. The geochemistry of the different Cretaceous formations is quite similar, probably because of their generally similar depositional environments. Therefore, it is not possible to determine which Cretaceous formation is actually the source of the Pineview oils.

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Facies Control on Bitumen Saturation, Peace River Oil Sands Deposit, Alberta, Canada

In the Peace River oil sands deposit an estimated 75 billion bbl of heavy oil are trapped at the updip pinchout of the Lower Cretaceous Bluesky and Gething Formations, at depths of 1,500 to 2,500 ft (457 to 762 m). The principal oil-saturated sand body occurs near the updip edge of the reservoir and averages 80 to 100 ft (24 to 31 m) in thickness. Downdip, the Gething Formation thickens to over 250 ft (76 m) but becomes mainly shale with a few thin sands. Throughout the area it is capped by thin marine sands of the Bluesky Formation. Based upon palynology and sedimentary structures, this sequence grades upward from continental through brackish to marine.

Sedimentary structures of a channel sequence are clearly displayed in the main sand body. From bottom to top the sequence is: a channel lag deposit containing abundant disoriented detrital carbonaceous fragments, plane-bedded or structureless sand, large scale cross-bedded sand, smaller scale cross-bedded sand, and structureless or bioturbated sand containing abundant glauconite. Laterally this sequence commonly grades into thinly interbedded oil-saturated sand and shale.

Reservoir properties vary between the facies. The channel lag deposits have coarser grain size, less inter-