morphic rock fragments (4%), mostly slate and phyllite. Feldspars are conspicuously absent in the sandstone. This detrital suite, and the overall decrease to the southwest in the grain size of the sandstone, indicate that the sands of the formation were derived from a northern landmass, exposed in the Late Permian and Early Triassic, which consisted of Precambrian schists and quartzites overlain by early Paleozoic marine sandstones and deep-water cherts and argillites.

After deposition, the reservoir facies of the Ivishak sandstone underwent 4 consecutive diagenetic phases: (1) early carbonate cementation that prevented mechanical compaction, (2) dissolution of pore-filling carbonate and carbonate inclusions within chert grains, (3) precipitation of quartz as overgrowths, and (4) precipitation of authigenic kaolinite. At present, the intergranular porosity of the formation is high, averaging 11.5%, and is present in the forms of elongate and oversized secondary pores. Porosity also occurs as micropores associated with leached chert grains and with the kaolinite. In the more matrix-rich nonreservoir facies of the Ivishak, the clay matrix prevented complete carbonate cementation which allowed for greater mechanical compaction of the sandstones; in some places, this mechanical compaction, coupled with the precipitation of quartz overgrowths, reduced porosity to irreducible levels.

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Compaction in Sandstones—Influence on Reservoir Quality

Primary porosity that is lost during burial through cementation by carbonate, evaporite, and some clay minerals can be regenerated during the stage of secondary porosity development that is typical of most basins. However, primary porosity that is lost through compaction is forever lost and cannot be regenerated. Thus, it is desirable to be able to predict the amount of porosity loss expected in sandstones buried to given depths.

During progressive burial, terrigenous sandstones compact by (1) packing readjustments without changes in grain shape, (2) ductile deformation of clayey and micaceous grains, chiefly rip-up-clasts, fecal pellets, and fragments of shale, mudstone, slate, and schist, (3) bending of flexible micas, (4) pressure solution, and (5) fracturing of feldspar, quartz, and chert grains. Process 1 generally results in a 7-10% porosity loss and is independent of sandstone composition; processes 2, 3, and 4 are strongly dependent on framework composition and each by itself is responsible for producing tight sandstones; and process 5 is generally not important. Process 3 was modeled by Rittenhouse, who showed that sandstones with 35% ductile grains can compact to produce tight sandstones.

Pressure solution becomes important at depths greater than 8,000 ft (2,400 m). Pressure solution at quartz grain contacts is enhanced where thick illite or chlorite clay coats develop and is most common in quartz-rich sandstones that lack much quartz cement. Quartz dissolved from grains generally exits the formation instead of being precipitated as cement. Stylolites develop at mica-rich and clay-rich laminae and develop conspicuous vertical permeability barriers. Wholesale dissolution of quartz grains leaves a residue of clay, micas, organic matter, and feldspar.

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Influence of Strike-Slip Movement on Terrestrial Sedimentation in Upper Carboniferous of Nova Scotia and New Brunswick

Lower Pennsylvanian (Namurian and lower Westphalian) sediments of maritime Canada were deposited in alluvial and lacustrine environments. Thick (>3.5 km, 2.1 mi) sequences of these sediments accumulated within structural basins formed between strike-slip faults.

Movement of the faults during the Namurian caused uplift in compressional areas. These positive areas, consisting of crystalline rocks and older Carboniferous sediments, provided a local supply of coarse sediment to the basin. In some cases, the positive areas excluded the introduction of sediment from large rivers sourced well outside the depositional basin. Large lakes were common in the Namurian and were probably a result of the relatively small amount of sediment that entered the basins. This sediment-starvation is also indicated by sequences of stacked paleosols that provide evidence of slow rates of sedimentation.

A detailed study of the sediments indicates a progressive climatic change from arid conditions, with evaporites, in the lower Namurian to humid conditions, with coal deposits, in the Westphalian. This climatic change is reflected by an increase in the size of the extra-basinal river systems in younger formations. By the mid-Westphalian, the influx of sediment to the area was so great that the topographic basins were essentially infilled. Westphalian lakes were shallow and of limited lateral extent. Anomalously thick sequences of overbank sediments and stacked point-bar deposits are present, suggesting that tectonic movements were still sufficiently strong to influence the style of fluvial architecture.

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Cenozoic Epeirogenic Uplift of Palo Duro Basin, Texas, and Its Influence on Structure, Salt Dissolution, and Topography

Sufficient data are available to interpret a general history of Cenozoic epeirogenic uplift and its influence on structure, salt dissolution, and topography in the Palo Duro basin. Much of the structural warping and deformation of Middle and Upper Permian rocks in the Palo Duro basin occurred during Cenozoic epeirogenic uplift. Cretaceous marine strata in the Texas and Oklahoma Panhandles and eastern New Mexico were uplifted 3,000-4,000 ft (914-1,219 m). The "Tubb Sand" (Permian) exhibits about 4,000 ft (1,219 m) of structural relief over the Amarillo uplift and Bravo dome.

Differential uplift of the margins of the basin caused draping, fracturing, and faulting, which increased the amounts and rates of erosion and salt dissolution coincident with fault-bounded structures. Structural control of topography around the southern high plains is indicated by the coincidence of the Caprock escarpment and structural highs in Permian rocks, as well as the coincidence of many stream segments and segments of the Caprock escarpment with subsurface fault trends.

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Role of Submarine Canyons in the United States Atlantic Continental Slope and Upper Continental Rise Development

Three areas of the United States Atlantic continental slope and rise (seaward of Georges Bank, Delaware Bay, and Pamlico Sound north of Cape Hatteras) have been studied using seismic reflection profiles and mid-range sidescan-sonar data. The continental slope in all three areas is dissected by numerous submarine canyons. The general sea floor gradient of the slope and the morphology of the rise, however, vary among the areas. Submarine canyons are dominant morphologic features on the slope and have an important function in sediment transport and distribution on the rise. In the study area north of Cape Hatteras, however, the low relief of the rise topography indicates that ocean currents flowing parallel to the margin may also affect sediment distribution on the rise. Morphology and sedimentation patterns suggest that differences in canyon ages exist both within each area and among the areas. Spatial and temporal variability of canyon activity is important in determining sediment sources for the construction of the rise. Although the United States Atlantic slope and rise are relatively sediment-starved at present, mid-range sidescan data and submersible observations and samples suggest that periodic sediment transport events occur within the canyons.

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Interpretive Seismic Modeling in Anadarko Basin

Seismic forward modeling is a powerful aid when interpreting seismic profiles of complex structure. Considered here is the frontal fault system that is the boundary between the Anadarko basin and the Wichita Mountains.

COCORP deep seismic reflection data collected across the basin may reveal new evidence of thrust faulting in the frontal fault system. North-south lines 2 and 2a of the COCORP survey are interpreted using AIMS™ (Advanced Interpretive Modeling System) installed on the University of Oklahoma's IBM 3081 computer. Line 2a stretches southward from the relatively undisturbed sedimentary rocks in the basin across the N85°W-trending frontal fault system to the south. The modeling begins at the north end of line 2a because of the relatively simple structural geometry and well control in that area.