lithologies of the Cheyenne field average 8% porosity and 1 md permeability. The field has recovered 499,950 bbls of oil as of May 1983, with estimated total recoverable reserves of 1,744,987 bbls of oil.

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Geology of Abo Gas-Producing Areas of Pecos Slope, Chaves County, New Mexico

The discovery of Abo gas production from continental Permian red beds in north-central Chaves County, New Mexico, resulted in a flurry of drilling activity. Yates Petroleum Corp. reentered the Honolulu 1 McConkey, an Ellenburger dry hole, and completed it from Abo perforations for an initial potential of 2,551 mcf of gas per day and 1 bbl of condensate per day. Although this discovery was completed in September 1977, drilling continued at a slow pace until federal regulations designated the Abo formation as "tight gas sands," in 1980. This stimulated drilling activity to the extent that, as of August 1983, almost 850 wells had been drilled, with a high success ratio.

Lee named the Abo formation for sandstone exposures in Abo Canyon, at the south end of the Manzano Mountains, southeast of Albuquerque. Needham and Bates re-described the Abo and named a type section for exposures in Socorro and Torrance Counties and considered it to be of continental origin because of cross-bedding, plant remains, and other characteristics.

The Abo is generally believed to be Wolfcampian in age; however, in a few areas the upper portion of the Abo is Leonardian. This is based partly on fossils and also on the fact that the Abo in places grades into the overlying Yeso.

The Pedernal landmass, situated to the north and west of the Pecos slope area, provided most of the sediments as siltstones, sandstones, mudstones, and shales. The sandstones are characteristically arkosic in most areas. These Abo sediments were deposited under fluvial-deltaic conditions.

ROBERTS, SALLY MEADER, Harvey E. Yates Co., Midland, TX

McDonald (Devonian) Field, Lea County, New Mexico

McDonald (Devonian) field, north-central Lea County, New Mexico, is an excellent example of the type of deep structure generally found in the Tatum basin, that is, small size, difficult to isolate with seismic, but lucrative when found, producing up to 1.0 million bbl of oil per well. Production is from Devonian rocks, with secondary Pennsylvanian (Atokan) gas potential. Variations in thickness from well to well of Pennsylvanian and Mississippian stratigraphic equivalents provide insight into the complex structural history of the field. McDonald-sized features are most likely to be discovered only by employing a closely integrated exploration program that includes all geophysical and geological parameters.

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Oil Production from Volcanic Rocks of Balcones Fault Region

Igneous rocks associated with the Balcones fault zone, extending from Kinney County in southwest Texas through Travis County in central Texas, have produced oil from more than 40 different fields dating from 1915. These rocks, referred to as serpentine by petroleum geologists, have been the subject of continued debate regarding their origin. Abundant evidence exists to support the conclusion that these igneous bodies are of volcanic origin related to crustal tension. Production is shallow and in many places economic. Most discoveries were made by surface geology or random drilling. Geophysical data have been used in exploration and have proved to be accurate.

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Ferroan Carbonates Formed at Depth Require Porosity Well-Log Corrections: Hunton Group (Upper Ordovician to Lower Devonian), Deep Anadarko Basin, Oklahoma and Texas

Iron in the minerals calcite and dolomite of limestones and dolostones increases bulk densities and probably also decreases resistivities recorded by logging tools. Whereas dolostones alone retain porosity (intercrystalline and moldic) in the deep Anadarko basin of southwestern Oklahoma and Texas, it is particularly important to distinguish variations in the chemical compositions of dolomite (especially of iron). Bulk densities determined by measuring proportions of major minerals (X-ray diffraction) and iron content (X-ray fluorescence) permit improved estimates of true porosities and water saturations. Dolomite densities range from 2.82 g/cm^3 up to 3.02 g/cm^3 for strongly ferroan dolomite.

In the Hunton Group (Upper Ordovician to Lower Devonian) of the Anadarko basin, we have calculated more porosity and hydrocarbons than expected for select zones. Intervals with less than 4% apparent porosity before correction for iron actually have 4 to 10% porosity. Potentially productive intervals have been missed.

At depths exceeding 10,000 ft (3 km), ferroan dolomite and calcite in the Hunton Group carbonates are predictably associated with interbedded argillaceous zones and with the underlying marine Sylvan Shale. In the deepest of the 50 wells studied, well logs show high densities in the lowermost Hunton (above the Sylvan Shale) which can only be interpreted as the presence of iron-rich dolomite. Detailed fossil correlations by Amsden have established the relatively constant age of a single lithostratigraphic horizon locally present at the base of the Hunton Group conformably overlying the Sylvan Shale, leading us to conclude that increased temperature with depth is the predominant factor for dolomitization. The smectite-to-illite transition in the Sylvan Shale is suggested as a possible source of magnesium and iron. Preliminary shale analysis and stable-isotope-ratio analysis support the above conclusions.

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Dolomitization, Sulfate Solution, and Porosity Development, San Andres Formation, Howard-Glasscock Field, Howard County, Texas

Facies of the Permian San Andres Formation, Howard-Glasscock field, Howard County, Texas, consist mainly of thick shelf carbonates topped by a carbonate-evaporite sabkha unit. Clastics are present as thin shale beds occurring sporadically throughout the sequence. Carbonate facies reflect a broad progradation across a promontory of the Eastern shelf bordering the Midland basin, punctuated by minor transgressions and onlap due to differential subsidence.

Core examination demonstrates that the carbonates have been pervasively dolomitized and plugged by sulfates, principally anhydrite. Dolomite crystal size shows a broad increase downcore, while anhydrite content decreases. Anhydrite precipitation appears to increasingly postdate the onset of dolomitization with depth. Reflux processes are felt to be largely responsible for the ubiquitous dolomitization and sulfate precipitation.

Porosity developed as a result of a sulfate solution event, producing vuggy, moldic, and intercrystalline dolomitic porosity due to leaching of sulfates from the dolomite fabric. Lateral solution pathways developed, particularly through the leaching of sulfates from packstone allochem replacements and void fills. Insoluble residue content was a major inhibiting factor in solution, especially because of stylolite development in shaly dolomites, which created low-porosity horizons. Hydrocarbon shows are primarily intercrystalline.

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Cycle Correlation in Late Pennsylvanian Strata of Midland Basin

Cyclic sedimentary units composed of successions of shales, limestones, and sandstones have long been reported from the Eastern shelf of the Midland basin, but recognition that cycles are of regional extent has been hindered by the lateral variability encountered in lithologic characteristics of shoal-water portions of the cycles. Most cycles are vertically asymmetric, with a thin transgressive sequence and a much thicker regressive sequence, and have lithologic asymmetry, in which carbonates are more common in the transgressive parts of the cycle, whereas sandstones are much more prevalent in the regressive parts of the cycle. Many cycles of the Canyon Group and lower portion of the Cisco Group can be shown to be of regional extent on the eastern shelf by tracing the deeper water deposits of the cycle. These consist of phosphate nodule-bearing black shales containing many ammonoids, and can be distinguished from deposits of all other environments by either the phosphatic lithologic character or the ammonoid content.

Phosphatic black shales in most cycles are thin, 1 to 2 m (3 to 6 ft), but laterally as extensive as the subjacent sheet-like limestones that are used for subsurface correlations. This couplet of limestone and overlying black shales is the most reliable means of identifying cycles. In the upper Canyon and lower Cisco Groups, couplets include the Ranger Limestone and basal Colony Creek Shale, Home Creek Limestone and basal Finis Shale, Bunger Limestone and basal Necessity Shale, and upper Gunsight Limestone and basal Wayland Shale. The entire interval consists of regular cycles. The remainder of the interval not included in the couplets consists of shoal-water and terrestrial deposits.

Basinwide correlation potential for these cycles is shown by the similarity of Midland basin cycles to Mid-Continent cyclothems, and by great similarity to the mapped extensions of these cyclothems into the eastern Oklahoma basins and Ouachita front areas. Variations occur in the basic cycle pattern owing to variable rates of sedimentation and local tectonic control, but the cycles can be identified and mapped across facies boundaries. Cycle correlation is a reality in the Mid-Continent and is also possible in the Midland basin with the mapping of transgressive limestone and phosphatic black shale couplets, or other indicators of deepest water deposition even in lithologically dissimilar strata. A cycle correlation system could be determined in the Midland basin, and a standard cycle chronology established for this region.