Deep Wilcox structure and stratigraphy are controlled by regionally extensive shale anticlines. These shale uplifts control deep Wilcox sand distribution, create large anticlines, and cause regional growth faults which frequently influence local structure. Each regional uplift presents a new exploration frontier holding the promise of vast reserves in the deep Wilcox.

The history of Frio-Vicksburg exploration is analogous to the deep Wilcox trend of today. It took 40 years to expand Frio exploration from shallow stratigraphic traps down into the enormous reserves in the Gulf of Mexico, because each new fault block extension was considered to mark the downdip limit of Frio production. This assumption was not true, and is not true in the deep Wilcox today. The deep Wilcox trend remains virtually unexplored, and it is my belief that continued work will prove the existence of much more deep Wilcox potential than is currently thought to exist.

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Are Our Oil and Gas Resource Assessments Realistic?

This paper reviews the results of assessments made in the past of United States oil and gas resources, including bidding in OCS lease sales (which are considered to reflect industry estimates of resources). It concludes that most estimates tend to be overly optimistic and suggests that the problem may be partially in the assessment of risk and partially in errors in the assumed resource distribution. It recommends that more use be made of the historical record in making these assessments.

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Electron Microscopy and Microanalysis of Uranium Phases in Primary Ores, Eocene and Miocene of South Texas

Two contrasting types of roll-front uranium deposits occur in south Texas. In the barrier-bar sands of the Eocene Jackson Group, organic matter was essential to uranium reduction, whereas in the fluvial sands of the Miocene Oakville Formation, epigenetic pyrite was the reductant.

In a sample of reduced Oakville ore, a uranium phase with grains ranging in diameter from < 1 to $20\mu m$ was recognized by SEM back-scattered-electron imaging and wavelength-dispersive spectrometer (WDS) elemental-dot mapping. Quantitative microprobe analyses indicated that the phase is a uranium-calcium silicate-phosphate with molar Ca/P approximately equal to 1.0, U/P equal to 2.8 ± 0.4 ($n = 27$), and U/Si approaching 1.0 in samples uncontaminated with quartz, feldspar, or clay minerals. Highest uranium content is 59%. Oakville ore is typically easy to leach by in-situ methods.

Jackson ore contains 2 uranium phases. Sulfur-rich organic matter contains $4.1 \pm 1.6\%$ uranium ($n = 27$). Although individual grains of a possible uranium mineral within the organic matter are too small to be resolved by electron imaging, a consistent molar U/Fe (0.5 ± 0.1) suggests a uranium-iron oxide phase. Alternatively, uranium is adsorbed by or otherwise bound to the organic matter. The second phase is a uranium-calcium silicate-phosphate that differs from the Oakville ore. Molar Ca/P equals 0.8 ± 0.2 ($n = 13$), and U/P equals 4.7 ± 0.4. Small grain size (generally less than $1\ \mu m$) prevented analysis of samples uncontaminated with quartz and pyrite. The grain with highest uranium content (43%) has U/Si equal to 0.34. Jackson ore is less favorable for in-situ leaching than Oakville ore in part because the organic-associated uranium is difficult to extract.

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Sedimentary Sequence of Offshore Southeastern United States: Preliminary Study Based on Exploration Wells

In 1982, geologic data from the exploratory wells in the offshore southeastern United States were released to the public. Prior to this time, well data were limited to the COST (Continental Offshore Stratigraphic Test) GE-1 well, the first deep-penetration well, which was completed in 1977. Six additional exploration wells were completed thereafter. Although these wells were dry holes, information provided by them has contributed to the geologic interpretation of the Atlantic margin.

The oldest rocks penetrated by these wells are Paleozoic indurated shale and argillite, sandstone and weakly metamorphosed quartzite, and igneous rocks. The post-Paleozoic section ranges from 2,220 to 3,660 m (7,280 to 12,000 ft) thick at the well sites, but seismic data indicate that the equivalent section thickens to 10–12 km (6–7 mi) beneath the Blake plateau. The Lower Cretaceous through Cenozoic section represents a progression from nonmarine and marginal marine to marine sedimentation. Three main units are recognized: lower siliciclastic, middle calcareous mudstone, and upper limestone. The siliciclastic unit consists of interbedded gray to red-brown sandstone, siltstone, and shale with some conglomerate, coal, evaporites, and carbonate rocks. Based on petrographic examination, the sandstone compositions vary between arkose, litharenite, and quartz arenite.

Calcareous clay and shale (grading to shaly limestone) overlie the siliciclastic rocks. The upper limestone contains chert, oolites, and shell fragments and ranges in composition from micrite to sparite. By comparing these units to the onshore Georgia sedimentary section, regional lithofacies trends that can be useful for future exploration are recognized.

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Diagenetic Capping of Carbonate Reservoir Facies

Submarine cementation commonly forms a narrow zone of low permeability within a carbonate unit that may act as a diagenetic seal over potential reservoir facies. Although the process of submarine cementation still is not clearly understood, it does appear to be a near-surface, rock or sediment/water interface phenomenon. The diagenetic model proposed here involves the effect of submarine cementation on previously lithified carbonates, such as submerged relict shelf-margin buildups (e.g., drowned reefs, ooid shoals) or previously subaerially exposed formations (e.g., dune ridges) that were submerged by later sea level rise. These deposits generally have pronounced topographic relief (visible on seismic), good reservoir geometries, and high internal porosity of either primary or secondary origin.

Petrologic studies on examples of both of these situations—a submerged early Holocene barrier reef off Florida and a 175-km (110-m) long submerged Pleistocene eolian ridge in the Bahamas—show that their exposed surface and uppermost facies (0-1 m, or 0.3 ft, below top) are further infilled and cemented, creating an extensively lithified, low porosity/low permeability zone or "diagenetic cap rock." Quantitative mineralogic studies of occluding cements reveal an exponential reduction in porosity while moving upward into the seal zone. Submarine cements effectively infill and form a surficial permeability barrier that acts to impede further diagenesis and porosity reduction within underlying potential reservoir facies.

To form this diagenetic seal only requires that the original carbonate buildup be resubmerged for some brief period of time prior to subsequent burial by sediments. If buildup accumulation later resumes without intermediate sediment burial—a common stratigraphic situation—the diagenetic seal would represent a disconformity separating two similar facies.

The early formation of a diagenetic cap rock lends support to models of early hydrocarbon migration and emplacement. Prediction and recognition of submarine diagenetic seals will aid in exploration and development of obvious buildup reservoirs as well as subtle intraformational traps.

LINEBACK, JERRY A., Robertson Research (U.S.) Inc., Houston, TX, and MARK S. ROTH and MARY L. DAVIDSON, Consultants, Houston, TX

Contrasts Between Ordovician and Mississippian Carbonate Depositional Styles in Williston Basin

Upon superficial comparison, the Madison Group (Mississippian) and the Bighorn Group (Ordovician) in the Williston basin appear to be similar sequences of carbonate mudstones and wackestones capped by evaporite-carbonate alternations. Detailed studies demonstrate significantly different depositional styles.

The Madison Group is an example of a deep-water sediment-starved basin that was filled in by turbidites derived from a ringing carbonate shelf. As the basin filled, the Madison was capped by a basinward prograding sabkha sequence. Correlation of log markers demonstrates considerable bottom topography along prograding clinoform ramps in the lower Madison and the irregularity of the advancing evaporite complex in the upper Madison. Many marker horizons pinch out against the clinoform slopes or the prograding evaporites, leaving few regionally traceable markers below the Polar interval. The Madison has a high potential for multiple reservoir development and for multiple stratigraphic traps where pinch-outs and lateral gradations occur.

In contrast, log markers in the Bighorn Group extend regionally. The lithologies represented by the markers are also consistent regionally. Several discrete, nonlaterally intergrading events in the upper Bighorn are marked by sharp transitions upward from burrowed, mud-rich carbonate through laminated dolomudstone to anhydrite. The regional persistence of lithofacies, their relatively uniform thickness, and the long distance correlation of log markers indicates both long and short term depositional stability over nearly uniform bottom topography. Deposition took place in a very shallow sea that graded to a carbonate marsh or swamp environment over the entire Williston basin region. Reservoirs are developed at consistent stratigraphic horizons, and the possibility of stratigraphic traps is limited under these conditions.

Just as Madison starved-basin depositional styles in the Williston basin are consistent with Mississippian depositional styles in the Illinois basin and elsewhere in North America, Ordovician depositional styles, representing shallow stable conditions, extended across the Transcontinental arch into the Illinois basin and elsewhere. Contrasting styles of sedimentation and reservoir development in the same basin at different times require different exploration strategies. These contrasts must be considered when developing multiple objective programs.

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Walker Lake, Nevada: Sedimentation in an Active, Strike-Slip Related Basin

Walker Lake, Nevada, is in an active fault-controlled basin related to the right-lateral, northwest-trending Walker Lane Shear Zone on the western side of the Basin and Range province. The lake occurs in a half graben bounded on its west side by a high-angle normal fault zone along the Wassuk Range front. This fault zone may merge to the north into the Walker Lane fault system, which forms the northeast boundary of the basin. To the south of Walker Lake, the Wassuk front fault merges with an east-northeast trending left-lateral fault. The Walker Lake basin is interpreted to be a pull-apart basin formed within the triangular zone bounded by the Wassuk front, the Walker Lane, and left-lateral faults.

The Walker River drainage basin occupies about 10,000 km^2 (3,800 mi^2) in western Nevada and parts of California and is essentially a closed hydrologic system that drains from the crest of the Sierra Nevada in California and terminates in Walker Lake. Walker Lake trends north-northwest and is 27.4 km (17 mi) long and 8 km (5 mi) wide with water depths exceeding 30 m (100 ft). Lake Lahontan (Wisconsinian) shorelines ring Walker Lake and suggest water depths of 150 m (500 ft) above the present lake level. The lake is situated in an asymmetric basin with steep alluvial fans flanking the western shoreline (Wassuk Range) and gentle, areally more extensive fans flanking the eastern shoreline (Gillis Range). The Walker River delta enters the lake from the north and is a major sediment point source for the basin. Older dissected shoreline, alluvial fan, Gilbert delta, and beach ridge deposits were built largely of coarse-grained, locally derived materials. Stromatolites, oncolites, and tufas formed along the shorelines, whereas mud and organic sediments accumulated in the lake on the west side of the basin. Extensive submerged sand flats and local sand dunes occur on the east side of the basin.

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Tectonic Evolution of Sevier-Laramide Foreland Structures from Latest Jurassic Through the Eocene

Sevier-Laramide overthrusting was generated by both relative North American (NA)-Farallon and absolute NA plate motions. The magmatic arc thermal axis (MATA), adjacent thermally weakened hinterland metamorphic "core" (HMC), and mechanical anisotropies in the upper crust contributed to variations in thrust belt development. Latest Jurassic to earliest Cretaceous west-northwest-directed absolute motion of NA plate collapsed the Cordillera toward the east-southeast, causing southeast to east vergent thrusting along the hinterland and Sevier thrust belt. Relative NA-Farallon and absolute NA plate motions increased dramatically in the mid-Cretaceous between 105 and 85 m.y.B.P. causing the MATA-HMC to migrate eastward. Rapid west-northwest absolute motion of NA collapsed the Cordillera toward the east-southeast, causing major southeast to east vergent thrusting along the Sevier thrust belt. Absolute NA motion slowed after 85 m.y.B.P., but increasing relative NA-Farallon motion forced shallowing of Farallon subduction angle and further eastward migration of the MATA-HMC. This allowed relative plate convergence stresses to be transferred into the Laramide foreland (LF). Latest Cretaceous-Paleocene (72-56 m.y.B.P.) rapid (13 cm/yr, 5 in./yr), east-northeast-directed NA-Farallon plate convergence created northwest to north-trending, southwest to east or west vergent overthrusting and west-northwest-trending sinistral faulting in the LF from southern Arizona to northern Montana. Extremely rapid (15 cm/yr, 6 in./yr), north-northeast-directed NA-Farallon plate convergence in the Eocene (56-43 m.y.B.P.) generated intense northwest-trending, southwest vergent overthrusting in southern Arizona, north-trending dextral faulting in the southern LF, and east-west-trending north to south vergent overthrusting in the northern LF.

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Dedolomitization, Dolomitization, and Chertification in Fort Payne Formation: Relative Timing and Mechanism

Samples of the Fort Payne Formation (Lower Mississippian) of central Tennessee typically contain 50% or more chert, with the bulk of the balance consisting of replacive dolomite. Low-iron calcite and ferroan calcite are common and minor ankerite is also present. The relative sequence of diagenetic replacement was established by cross-cutting relations as: low-iron calcite replaced by chert replaced by dolomite, introduction of ankerite, and finally, replacement by ferroan calcite of both chert and dolomite (dedolomitization). Thus dedolomitization was the last diagenetic phase. Complete replacement, rim replacement, and replacement of cores of dolomite rhombs by ferroan calcite was observed. Ferroan calcite fills veins, vugs, and intergranular pores and replaces sponge spicules. Dedolomite occurs in both surface and subsurface samples, and there is no evidence for an unconformity within or adjacent to the Fort Payne, suggesting that the dedolomite is not related to exhumation and weathering. Minor mineralogy and sedimentary structures suggest a subtidal shelf, quiet-water environment of deposition. Stratigraphic relations suggest shallow burial. Dedolomitization of the Fort Payne occurred after lithification, probably during shallow burial, when ferrous iron was derived from indigenous minerals.

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A Microcomputer-Based Borehole Engineering System

This paper describes a microcomputer system designed to take raw drilling data combined with measured rock properties such as porosity and permeability to produce output in the form of depth plots. User-selected parameters include porosity, permeability, formation pressures such as pore, fracture, or overburden, rock properties such as Poisson's ratio or bulk modules, and bottomhole and formation temperatures.

Data entry can be done via multiplexor from a data gathering system, through a data communication link, or by manual input. The system allows either raw or partially processed data to be supplied, and can be run either online in real time at the wellsite or offline at a remote location.

The data is processed sequentially by the system, with each calculation or processing module performing a specific operation on the data. The calculation modules used for any data set are selected by the user from a base menu. These modules can be removed, added or changed as desired by the client or operator, allowing easy tailoring and expansion of the system.

Output from the system goes to disk for storage and to a drum plotter. This enables continuous monitoring of the borehole parameters as the well is drilled, and enhances the value of the data.