ductive of oil and gas. It is proposed that this group of related fields be termed the Scotts Bluff trend. Subsurface mapping indicates that recurrent movement along Precambrian basement faults has enhanced reservoir quality and localized oil migration, favoring oil accumulation along the trend.

The J Sandstone dips gently southwest across the northeastern Denver basin. Low-relief closures and structural noses are critical elements in several structural-stratigraphic traps. However, most of the traps are controlled primarily by an updip facies change from porous, permeable sandstone to siltstone and shale.

Most oil production is from the J_1 member, whose commercial production limits coincide with porous sandstone bodies at least 5 ft (1.5 m) thick. Three fields each have produced over 1,000,000 bbl of oil. The J_1 was deposited in elongate, elliptical, northwest-trending marine bars that are rhythmically separated by laterally equivalent shales. The central-bar facies, which includes most of the reservoir rock, grades into bioturbated bar-margin siltstones which, in turn, grade into interbar shales.

Long-distance lateral migration into the shallow reservoirs of the trend from thermally mature shales of the Dakota and Benton Groups near the basin's axis is indicated. Recognition of the trend's characteristics will reduce exploration risk and help realize the area's considerable economic potential.

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Dolomitization by Thermal Convection in Carbonate Platforms

Thermal convection may be a significant dolomitizing ground-water flow process in active carbonate platforms. In platform margins there is an upward transfer of seawater from the surrounding ocean depths. This motion is induced by the strong horizontal density gradient that exists between the warmer platform interior (warmed by geothermal heat flux) and the cold surrounding ocean waters. The cold dense seawater flows inward displacing the platform pore waters upward. This flow process was discovered and studied in south Florida by Francis Kohout. Here these upwelling waters discharge from well-known submarine springs on the shelf and shelf edge. The waters are of seawater composition but with increased Ca/Mg suggesting that they have acted as dolomitizing fluids. In Florida this flow pattern is distorted by and mixed with the large regional flow of the Floridan aquifer. In isolated platforms this distortion should not occur. To test the idea that this kind of convection might be an important diagenetic agent in platform settings in general, I have used ground-water flow theory to model this process in isolated platforms. Approximate theory suggests that Darcy velocities of 1 m/yr (3 ft/yr) occur. I am using boundary layer theory to determine the fully developed flow pattern and the distance from the margin to which the flow penetrates. The rate of dolomitization that could be developed by this process is comparable to and may exceed that of other flow processes in active platforms. I conclude that this "Kohout convection" is a large-scale flow process that appears capable of pervasive dolomitization of platform margins.

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Bituminous Sandstone Resource Evaluation of PR Spring Deposit, Uintah and Grand Counties, Utah

The Laramie Energy Technology Center (LETC), Department of Energy, completed a seven-corehole drilling program in 1980 at the PR Spring tar sand deposit, southeastern Uinta Basin, Utah. The core data from these locations were integrated with data from 70 other locations to update the following deposit characteristics: vertical and aerial extent, stratigraphy, and rock properties. Oil-impregnated sandstones are found as surface outcrops and to depths of 475 ft (145 m). Three main tar sand zones in the Douglas Creek Member of the Eocene Green River Formation were correlated across the deposit. Up to 27 separate tar sand beds were identified across the deposit, ranging from 1-35 ft (0.5-11 m) thick. These saturated zones and beds are lenticular and discontinuous, both vertically and horizontally. Analytical results from 6 of the LETC cores and 32 other cores were interpreted to further evaluate the deposit. Computer-generated isopleth maps identified the following general trends: the thickest zones are found in the south-central portion of the deposit; extracted permeability and extracted porosity decrease downdip (northwest); oil saturation decreases to the west-southwest; and water saturation decreases to the east.

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Electrochemical Aspects of Hydrocarbon Reservoirs and Surface Seeps

Recent theoretical studies have enabled speculative predictions to be made of likely natural (as opposed to induced) electrical potentials above reservoirs. Due to improved instrumentation, these potentials can now be tested in the field. Most oil and gas traps are somewhat leaky, and the buoyant and highly reducing hydrocarbons create a redox chimney. This inevitably develops a potential field, because subsurface formations are rarely dry, and deeper formation waters may be rich in salts and thus have low resistivities. However, subsurface rock packages are also inhomogeneous and highly anisotropic with respect to electrical and fluid properties. Dissolved salts, rates of fluid flow, charged scale membrane effects, chemical reactions, pH, Eh, etc, affect the electrical current pattern and polarity. Consequently, natural cells can be very complex.

The most important geobatteries to be expected around hydrocarbon traps will be affected by interacting ionic changes, cells of various types, pressure, temperature, concentration changes, and electrokinetic phenomena.

Tectonic, sedimentational, and diagenetic influences will affect electrical potentials and local conductances, both of which are amenable to measurement in the field.

The models that we propose are simplistic, because only these are readily amenable to theoretical analysis; chemically "dirty" natural systems are much more complicated. However, it is hoped that this approach will stimulate dialogue and criticism that will benefit this too-long-ignored subject.

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Comparison of Predrilling Predictions with Post-Drilling Outcomes, Using Shell's Prospect Appraisal System

Since 1975 Shell Internationale Petroleum Maatschappij has used a Monte Carlo simulation model for worldwide prospect appraisal. The input parameters to this model describing charge (oil and gas available for trapping and retention), structure, reservoir, and retention (seal characteristics) are given in the form of probability distributions. For the estimation of charge and retention, the model follows a scheme of Bayesian update, using equations derived from calibration studies, i.e., statistical analysis of extensive data sets with a worldwide distribution.

Comparison of predrilling predictions with postdrilling results shows that the underlying calibration procedure is statistically sound and also demonstrates the importance of assessing geologic uncertainty in a quantitative manner. Geologists appear to have been fairly successful in describing the geologic setting of prospects in respect to hydrocarbon charge and retention (the calibrated parts of the system), but serious overestimation/overconfidence have occurred in respect to reservoir parameters and such risks as existence of trap (the uncalibrated parts of the system).

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Fluid Inclusions in Burlington Limestone (Middle Mississippian)—Evidence for Multiple Dewatering Events from Illinois Basin

Syntaxial calcite cements and dolomite from crinoidal limestones in the Burlington formation, southeastern Iowa and western Illinois, contain 2-phase fluid inclusions which represent samples of the diagenetic fluids. A U.S. Geological Survey-type heating/freezing stage was used to determine the homogenization temperatures, bulk salinities, and major dissolved salt compositions of the inclusions. The calcite- and dolomite-hosted inclusions have mean homogenization temperatures of 85°C (185°F) and 109°C (228°F), respectively. Mean bulk salinities are

19.4 wt. % total salts for calcite-hosted inclusions and 20.0 wt. % for dolomite-hosted inclusions. Eutectic and intermediate melting data indicate that NaCl and $CaCl_2$ are the principal brine components. The significantly higher mean homogenization temperature for dolomite-hosted inclusions suggests that the dolomitizing fluids were warmer than the fluids from which calcite cement precipitated. Petrographic relationships shown dolomitization preceded calcite cementation. The presence of high-temperature, high-salinity fluids conflicts with previously proposed low-temperature, freshwater diagenetic conditions. The shallow (< 1,500 ft, 450 m) burial history of the Burlington sediments is incompatible with the generation of elevated temperature and salinity fluids intraformationally, and suggests a more deeply buried source, such as the Illinois basin. Cathodoluminescent cement stratigraphy and fluid temperatures indicate that the diagenetic history of the Burlington Limestone was complex, with several generations of hydrothermal brine migration into the porous Burlington carbonates along the northwestern edge of the basin. Two basinal brine expulsion models can account for the temperature variations seen during diagenesis, either an episodic, compaction-driven flow system or a gravity-driven ground-water flow system.

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Mechanical Compaction and Porosity Reduction of Miocene Sandstones, South Louisiana

Porosity reduction of 3 compositionally mature Miocene sandstones from Louisiana was determined petrographically. These sandstones were the S Sand at Weeks Island field, R_Z Sand at East Bayou Postillion field, and Planulina 6 Sand at Jeanerette field. The S Sand attained a maximum burial depth of 15,800 ft (4,800 m), the R_Z Sand 15,700 ft (4,800 m), and the Planulina 6 Sand 14,710 ft (4,485 m), all prior to structural uplift.

Porosity reduction caused by mechanical compaction ($\Delta\phi$) was determined by: $\Delta\phi = 40 - (C + \phi)$, where 40 is porosity prior to mechanical compaction, C is cement (petrographically determined), and ϕ is porosity (petrographically determined), all in volume percent. The term $(C + \phi)$ is the porosity remaining after reduction caused solely by mechanical compaction. The S Sand (with the greatest maximum burial depth) has an average $\Delta\phi$ of 11.5%, the R_Z Sand 16.0%, and the Planulina 6 Sand 17.5%. The difference in $\Delta\phi$ between these sandstones is due to differences in the depths at which calcite cementation began to hinder compaction.

By comparing the term $(C + \phi)$ of each sandstone to the porosity expected from the Atwater and Miller porosity reduction rate, it appears compaction-arresting cementation occurred at approximately 9,000 ft (2,750 m) in the S Sand, 12,500 ft (3,800 m) in the R_Z Sand, and 14,000 ft (4,270 m) in the Planulina 6 Sand. At greater depths, this calcite cement dissolved, resulting in secondary porosities up to 35 vol. %. Therefore, many deep hydrocarbon reservoirs may exist in the Gulf Coast with porosities greater than expected.

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Porosity Development and Dedolomitization in Bass Islands Dolomite of Kentucky

A 33-m (108-ft) core of the Upper Silurian Bass Islands formation from a well in Johnson County, Kentucky, consists mainly of finely crystalline dolomite and intraclastic dolomite. These rocks reflect low-energy, hypersaline coastal environments which bordered the Cincinnati arch. Environments included the supratidal mud flat (evaporite minerals and desiccation features), intertidal flat (algal stromatolites), tidal channels (intraclasts), and beach ridges (peloids and intraclasts). The original lime sediments are believed to have been totally dolomitized penecontemporaneously with deposition.

Several shows of natural gas were reported from the formation in this well. The entire "Corniferous" group, including the Bass Islands carbonates, was treated and had an initial production of 464 MCFGD. Porosity is generally poor throughout the formation, but it is as high as 9% in some zones. Porosity occurs as micropores (50μ) associated with dedolomitization, and mesopores (up to 5mm) interpreted to be solution-enlarged molds of carbonate grains and evaporite minerals, horizontal fractures along bedding planes, and incompletely filled vertical fractures.

Dedolomitization probably occurred with the development of an Early Devonian paraconformity, when the Bass Islands was buried to a depth less than 40 m (130 ft). Evaporitic sulfate minerals were attacked by anaerobic bacteria and replaced by silica in this near-surface diagenetic setting. Both reactions released calcium to the pore water. As the calcium/magnesium ratio increased, calcite began to replace dolomite. The dedolomitized calcite generally has a poikilotopic texture but also has a porphyrotopic texture. At some later time, outside pore water entering through fractures in the carbonate formation partially leached some of the dedolomitized calcite, thus creating most of the porosity preserved in the Bass Islands.

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Validity of Spontaneous-Potential Curve Shape for Interpretation of Sandstone Depositional Environments

Many explorationists employ the spontaneous-potential (SP) curve shape as an aid in interpretation of sandstone depositional environments and prediction of subsurface sand-body occurrence. The bell, cylinder, and funnel-shaped SP profiles are among the most widely used. The basic assumption of users of these curve shapes is that decreasing deflection of the SP curve from the baseline is due to decreasing quartz grain size and/or increasing clay content in a reservoir sandstone. However, theoretical, experimental, and actual field data indicate that quartz grain size bears no relation to the amount of SP deflection. Clay content does show a relation, but is often overshadowed by a number of variables which affect SP.

Hydrocarbons can also influence SP, often yielding a false bell profile. In addition, borehole or formation-pressure differentials, variations in mud-filtrate resistivity, and regional differences in formation-water salinity can greatly alter the SP curve shape. Bed thickness, especially when less than 3 ft (1 m), also exerts some control over the SP response.

Field examples in which these factors influence SP in Gulf Coast sandstones demonstrate that the SP curve shape is often misleading. Paleoenvironmental reconstructions and predictions of subsurface sand-body occurrence based on such shapes would therefore be in error.

Curve shapes derived from the micro-resistivity tool (expanded dipmeter curve) are suggested as alternatives to SP curve shapes. Unlike the SP, the micro-resistivity tool is immune to the effects of hydrocarbons, variations in mud-filtrate resistivity and formation-water salinity, pressure differentials, and bed thickness.

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Relationship of Benthic Foraminiferal Biofacies to Lithofacies in Phosphatic Miocene Sediments, Mid-Atlantic Continental Shelf

Changes in benthic foraminiferal assemblages accompany changes in total sediment texture and mineralogy (primarily percent phosphatic grains) throughout the Pungo River Formation in Onslow Bay, North Carolina. Only Burdigalian (late-early Miocene) deposits have been cored in southern Onslow Bay. Basal phosphorite sands (30% phosphate) are overlain by phosphatic (8%) muds and slightly phosphatic (4%) quartz sands. Elongate buliminaceans (*Bolivina, Bulimina, Buliminella, Uvigerina*) comprise over 50% of the benthic assemblage in phosphorites. They also predominate (43%) in phosphatic muds where *Siphogenerina* and *Florilus* become conspicuous faunal elements. Diverse trochospirally coiled forms (mainly *Hanzawaia*, also *Valvulineria* and *Cibicides*) become predominant in quartz sands; buliminaceans decline to 30% of the fauna. Pungo River deposits in northern Onslow Bay are Burdigalian, Langhian (early-middle Miocene), and Serravallian (middle Miocene) in age. Burdigalian deposits are nonphosphatic, muddy quartz sands in which *Hanzawaia* predominates and buliminaceans comprise only 22% of the fauna; *Florilus* accounts for 5%. *Hanzawaia* remains the dominant genus in the slightly phosphatic (4%) quartz sands of the Langhian and the phosphatic (10%) sands of the Serravallian; buliminaceans increase to 29% of the fauna, but *Florilus* nearly disappears. Both vertically and laterally through the Miocene of Onslow Bay, nutrient-loving buliminaceans thrive where phosphate content increases. *Florilus* and *Siphogenerina* are associated with the influx of fine-grained terrigenous sediments. The *Hanzawaia*-dominated assemblage thrives in clean,