tification of traps difficult.

The sandbars are composed of fine to medium-grained, cross-bedded, clean, well-sorted quartz arenites. The Aux Vases typically possesses preserved, primary, interparticle porosities of 15-25%, and permeabilities of 40-250 md. Reduction of porosity and permeability in the tidal bars is caused by quartz overgrowths, pressure solution at quartz grain contacts, and authigenic chlorite cement.

The sandbars grade laterally and vertically into interbar and tidal flat sediments composed of fine-grained, bioturbated or ripple-bedded quartz wackes and arenites that typically have 15-20% porosity but are impermeable. The clay matrix of the interbar wacke sediments causes a reduction in permeability, as does the authigenic chlorite and illite cement in the fine-grained arenites associated with the wackes.

Exploration has been hampered because (1) bars of reservoir quality are not easily distinguished from interbar sediments on electric logs; (2) resistivity logs usually show excessively high water saturation; and (3) sandbar trends are difficult to predict. Study of electric logs has shown that a spontaneous potential (SP) of 75 mV or greater is a good indicator of relatively clean, well-sorted, sandbar sediments. An SP less than 75 is an indication of interbar sediments. SEM and x-ray analyses suggest that water adsorbed on mixed layer clays is interpreted on electric logs as free water, accounting for the high water saturation readings. Prediction of sandbar trends is difficult because there are two trend directions: the dominant trend is northwest-southeast, parallel to the shoreline; however, many bars trend east-west, or roughly normal to shoreline. The two trend directions are commonly juxtaposed, thereby adding to the complexity.

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Online Data Base Searching with Microcomputer

More than 500 geologic journals are currently published worldwide. Staying abreast of the outpour of professional information seems insurmountable for any one person. Online data base searching provides rapid access to most of this material; it has better precision and recall than manual searching and can be performed with a microcomputer.

Consumer guidelines exist for selection of microcomputer hardware and software to enable manipulation of search results. A suitable communications interface, appropriate software, and a telephone modem are necessary peripheral equipment; a printer and storage media are useful additions.

Data bases vary in subject coverage, file format, and document coverage. Bibliographic data bases specialize in scientific and technical information, and nonbibliographic data bases are strongest in the area of business, finance, and economics.

Two of the most powerful bibliographic exploration files are GeoRef (online version of the American Geological Institute's *Bibliography and Index of Geology*) and TULSA (online version of the University of Tulsa's *Petroleum Abstracts*). However, problems exist in searching these data bases: complex search protocol, a multiplicity of command languages, and expensive online time. Search expertise can be developed through several alternatives, including formal training, printed search guides, and local online user groups. A petroleum independent or consultant who will devote time to learn the systems will find the effort to be cost-effective. Such a geologist is rewarded with immediate access to a sophisticated research library.

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Microcomputer-Assisted Subsurface Mapping

In subsurface mapping, the productivity of the geologist is a function of the time spent on geologic work and the time spent on purely clerical work such as sorting well logs, and plotting values on maps. In my one-man consulting office, the clerical part of subsurface mapping is largely handled by a microcomputer and peripheral equipment costing $1,900. This same system doubles as a word processor, eliminating the need for secretarial help. Overall productivity is enhanced by 20-30%, paying out the hardware in less than 2 months.

The BASIC software consists of 3 modules. One builds a file of subsurface data elevations, formation tops, net sandstone, etc. A second rearranges data or deletes it from the data base. The third, a mapping module, plots one township at a time, at either 1 in. = 4,000 ft (1:48,000) or 1 in. = 2,000 ft (1:24,000) on a dot-matrix printer. Township plots are taped together and roughly contoured to find errors and possible prospects. After editing, the data is replotted and these new maps are used by the drafter as an underlay for spotting data on a mylar base map.

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Fire and Limestone: Origin of Black Pebbles

The origin and meaning of blackened limestone grains and lithoclasts that occur throughout the geologic record have long been a mystery. The Pleistocene-Holocene unconformity and those within the Pleistocene throughout the Caribbean are often characterized by the presence of blackened limestone lithoclasts. Thoroughly blackened fragments may consist of laminated soilstone crusts (i.e., caliche or calcrete), coral, or oolitic, pelletal and skeletal grainstone derived from the underlying limestone. Blackened fragments occur sporadically or in pockets comingled with nonblackened but otherwise identical fragments. Simple cooking experiments with typical Pleistocene and Holocene limestone fragments showed that only laminated soilstone crusts, poorly cemented pelletal and oolitic grainstone, and aragonitic coral fragments are selectively blackened, whereas well-cemented, nonaragonitic fragments retained their light color. Blackening is caused by charring of organic matter within the rock. Heat from forest fires and smoldering humus accumulations is interpreted to cause the naturally occurring blackened lithoclasts.

Fire-blackened limestone lithoclasts differ from the more well-known salt-and-pepper sands, which typically result from selective blackening of individual Foraminifera, mollusk fragments and other fossils under subtidal conditions. Subtidal blackened grains are associated usually with unconformities and tidal channel deposits where they become mixed with unstained grains. Correct identification of the 2 differing types, when detected in ancient limestone, offers important environmental information, not only to distinguish marine and subaerial unconformities, but for clues to paleoclimate, vegetation, and soil development.

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Origin and Development of Northern Green River Basin: A Stratigraphic and Flexural Study

Two-dimensional profiling of the northern Green River basin using topographic, stratigraphic, and structural information shows that the basin can be modeled effectively as a flexural depression resulting from extrabasinal and intrabasinal loading on an elastically behaving lithosphere. Two distinct approaches were used: present basin geometry profiling and sediment thickness profiling. Present basin geometry profiling involves analysis of predicted present-day basin configuration compared with the observed configuration. Sediment thickness profiling, a procedure based on isostatic compensation for flexural responses to loading, relates stratigraphic thicknesses of basinal rocks to coeval tectonic loading. Results of both methods suggest the lower Tertiary and perhaps some uppermost Cretaceous sediments accumulated as a result of flexure due to loading by the Darby and Prospect thrusts to the west and the Wind River foreland thrust to the east. Moreover, results of the sediment thickness profiling are of predictive value resolving stratigraphic problems and timing structural events. Tentative results imply that (1) the northern Green River basin was essentially full by the end of the early Eocene and subsequent erosion has been negligible, and (2) the first movement on the Wind River thrust in the latest Cretaceous was significant in controlling basin configuration.

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Petroleum Geology and Exploration of Scotts Bluff Trend, Northeastern Denver Basin, Nebraska

Ten J Sandstone oil fields form a long, narrow, northeast-southwest trend in western Nebraska. Except for these fields, this area is nonpro-

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