and 1.1 MMCFGD. This well tested a seismically identified, sub-Jurassic topographic feature. Four unsuccessful confirmation attempts have revealed not only the difficulty in accurately predicting structural position, but also the complex facies relationships present in the upper Smackover.

Conventional cores from 5 wells reveal that in many places original depositional facies are masked by several diagenetic phases of recrystallization and dissolution. Mineralogically, the upper Smackover section is almost entirely dolomite of probably primary origin in the crestal areas, and early secondary origin on the flanks of the structure. Reservoir porosity and permeability are highly variable across the field and are controlled by several interrelated factors. Primary depositional fabric, completeness of dolomitization, and leaching of nondolomitized components were all important in creating reservoir-quality rock. Dolomitization of moderate to high-energy facies in many places resulted in porous and permeable crystalline dolomite with a sucrosic texture. In some places, incomplete dolomitization left remnants of the primary fabric that were later leached, leaving a vuggy texture. The occurrence of nonreservoir-quality rock can be attributed to (1) nonporous dolomite of supratidal origin, (2) occlusion of pore spaces by several later generations of dolomitization, or (3) occlusion of pore spaces by anhydrite.

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Cyclicity and Paleo-Environmental Dynamics of a 1.9 Ga Passive-Margin Carbonate Terrace, Wopmay Orogen, N.W.T.

The 1.90-1.89 billion year old Rocknest Formation in the Northwest Territories is a west-facing, passive-margin carbonate terrace in the foreland of Wopmay orogen. Initial outbuilding of an accretionary stromatolite rim over downslope facies was followed by upbuilding of the rim, local backstepping of the rim, and terminal subduction-related drowning of the entire shelf. The rim was flanked to the west by deep-water slope rhythmite and breccia, and on the east by a carbonate-shoal complex, separating the ocean from a broad (100-200 km wide) lagoon with a siliciclastic eastern shoreline. Concurrently, the shoal complex underwent repeated eastward expansion over the lagoon to form about 150 shoaling-upward cycles (1-25 m thick), consisting of carbonate tidal-flat tufa that overlies storm-dominated, mixed carbonate-siliciclastic lagoonal facies. Correlation of cycles for over 200 km parallel with and 100 km across depositional strike shows that cycle boundaries abut facies boundaries, indicating that complete shoaling of the lagoon to sea level was not required to induce the next submergence increment, suggesting an allocyclic rather than autocyclic mechanism. Radiometric constraints bracket cycle periodicity between 25,000-40,000 yr/cycle. These values are within the range of known earth orbital cycles (periods at 19,000, 23,000, 41,000, and 100,000 yr), the likely cause of Pleistocene glacio-eustatic sea level oscillations, and possibly Rocknest cyclicity. Rocknest cycles can be modeled using period and amplitude of sea level oscillation, and subsidence and sedimentation rates as variables. Resulting computer-generated cyclic stratigraphies are compared to actual Rocknest cyclic stratigraphy in order to constrain variables responsible for cycle development.

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Continuous Fracture Probability Determination as Applied to Monterey Formation

Most open-hole logs can be used for fracture detection. Each petrophysical measurement responds to fractures in a different way, and much literature exists describing the effects of fractures on tool responses. Most fracture detection programs use either one or two logs or many fracture indicators, but make no attempt to tie them together. Since fracture systems appear to provide nearly all the permeability for production in the Monterey Formation, fracture analysis is essential throughout the well. A program has been written to give a continuous output of fracture probability using all fracture information available from well logs, as well as from mud logs and drilling data. It is easily adaptable to local conditions (in particular, the Monterey Formation) through log analyst input. The program computes a composite fracture probability using all available fracture indicators. Each indicator will give an individual probability of fracturing. These probabilities are then weighted and combined to give a composite fracture probability.

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Crustal Rifting and Subsidence of Sirte Basin, Libya: a Mature Hydrocarbon Province

The complex rifting and subsidence history of the Sirte basin serves as an instructive case study of the tectonic evolution of an intercratonic extensional basin. The Sirte basin formed by collapse of the Sirte arch in the mid-Cretaceous. Marine sediments accumulated following initial crustal arching and rifting as the basin was flooded from the north. Upper Cretaceous strata lie unconformably on igneous and metamorphic rocks of the Precambrian basement complex, Cambrian-Ordovician Gargaf Group, or the pre-Cretaceous continental Nubian Sandstone. The most rapid subsidence and accumulation of basinal strata occurred in the early Cenozoic; however, the basin has been relatively stable since the Oligocene. The basin is floored by a northwest-southeast-trending mosaic of narrow horsts and grabens, an important structural characteristic that distinguishes it from the adjacent intracratonic Kufra, Murzuk, and Ghadames basins.

The details of basin subsidence, sediment accumulation rates, and facies variations have been reconstructed for the northern Sirte basin from a suite of approximately 100 well logs and numerous seismic lines. Subsidence-rate maps for short time intervals from the mid-Cretaceous through the Eocene show a continual shifting of the loci of maximum and minimum subsidence. The nonsteady character of basin subsidence may reflect a periodicity of movement on the major basement-rooted growth faults bounding the underlying horsts and grabens.

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Correlation of Illite Crystallinity and Thermal Maturity in Carboniferous Strata of Ouachita Mountains

Carboniferous shales from the Ouachita Mountains have been studied to determine mineralogy and thermal maturities, the latter ascertained by means of vitrinite reflectance and bitumen/organic carbon ratios.

The less than 2 μm fractions of these shales indicate 2 major clay-mineral components, illite and chlorite, and 2 minor varieties, expandable clays and pyrophyllite. Expandable clays are found at low thermal maturities and pyrophyllite at high maturity. Scanning electron micrographs show differences in clay morphology and texture, which are influenced by the degree of thermal maturity.

Weaver's sharpness ratio for illite and Kubler's crystallinity index are both significantly related to mean vitrinite reflectance. The log of the sharpness ratio increases while the log of the crystallinity index decreases with increasing mean vitrinite reflectance. These relationships suggest that illite crystallinity is controlled by the same geologic agents that control vitrinite reflectance, namely temperature and time.

A plot of vitrinite reflectance and/or crystallinity index versus bitumen/organic carbon ratio shows a maximum analogous to a hydrocarbon window.

These statistically significant correlations provide a useful means of estimating the thermal maturity of these strata where they contain insufficient amounts of vitrinite for thermal maturity evaluation.

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Subcrop-Supracrop Play Concept: Example from Manitoba, Canada

In the Canadian portion of the Williston basin, oil exploration has been based on the concept of the subcrop stratigraphic trap. The truncation of porous Mississippian strata at the Paleozoic angular unconformity, combined with either erosional or Mississippian structure, defines the play. In

such a hydrocarbon trap, the updip reservoir seal is created by a zone of porosity destruction due to diagenetic processes associated with the unconformity and the onlap of impermeable red beds of the Jurassic lower Amaranth (Spearfish) Formation onto the unconformity surface.

In 1980, the traditional play concept was challenged at Waskada, Manitoba, with the discovery of significant oil reserves in the top seal. Oil at Waskada field is obtained from 3 stratigraphic intervals in the Mississippian carbonates. Oil migration was not halted at the Paleozoic unconformity, but continued through the unconformity zone until trapped by permeability barriers within the siltstones and fine-grained sandstones of the lower Amaranth Formation.

This discovery has led to a reexamination of the traditional subcrop play and has added a new dimension to exploration in the region. The key to such a subcrop-supracrop play lies in the identification of major paleotectonic structural disturbances in underlying Paleozoic rocks occurring in conjunction with favorable reservoir facies in the overlying top seal. Such traps may presently exist as bypassed pay in other subcrop stratigraphic pools.

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Bahamas: Future Petroleum Province?

The Commonwealth of the Bahamas and its offshore areas, located off the southeasternmost tip of the United States, have experienced only cursory petroleum exploration in the past. Between 1947 and 1971 only 4 wells were drilled; however, the region warrants extensive exploration. New portions of the Great Bahama Bank, where water depths are relatively shallow, have been licensed recently to multinational companies. Recent seismic surveys have indicated encouraging stratigraphic data for much of the Florida-Bahama basin.

This chain of about 700 islands covers approximately 300,000 km^2 (116,000 mi^2) and is characterized by shallow-water carbonate banks that are separated by deep-water channels. Water depths in the Bahamas range from a few meters in the areas immediately adjacent to the islands to as much as 4,000 m (13,120 ft) along the northeast margin of the archipelago.

The Bahamian carbonate platform is underlain by approximately 6 km (3.75 mi) of carbonate and evaporite sediments, making it one of the world's thickest carbonate sequences. Although the presence of reefs, evaporites, and bank carbonates have made the Bahamas an area of scientific interest to petroleum geologists for many years, very little exploration has been conducted in the region.

New seismic surveys of the region, improved drilling methods, and the application of advanced geophysical techniques and geologic concepts improve the probability that this heretofore neglected region could become a future petroleum province.

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Holocene Transgressive Stratigraphy and Sediment Dispersal, Eastern Shore, Nova Scotia

Coastal sedimentation along Nova Scotia's eastern shore is dominated by a rising sea level, restricted drumlin sediment supply, and inherited glacial topography. Evolution of barrier systems follows a 500-1,000 year cyclic sequence of: (1) generation from marine erosion of glacial deposits, (2) transgression resulting from ongoing sea level rise and depletion of original sediment sources, and (3) landward removal following an estuarine retreat path to new sites of reconstruction. The dominant sediment transfer mechanism operating during this transgressive cycle is landward dispersal by tidal inlet, overwash, and eolian process.

Vibrocore, surface sampling, marine geophysics, and underwater photography were used to investigate the potential for eastern shore coastal deposits to be incorporated into the shelf stratigraphic record. High-resolution seismic profiles from the inner continental shelf reveal a lower acoustic unit interpreted as Wisconsinan glacial deposits. Overlying the lower unit is a discontinuous upper unit 1-2 m thick, which occupies topographic depressions and is composed of sand, silty sand, and a coarse gravel lag. Side-scan sonar and underwater photographs show large gravel ripples covering the upper acoustic unit in water up to 30 m deep. The upper acoustic unit is interpreted as the remnants of reworked coastal barriers, drumlins, and till.

Transgressive sedimentation on the eastern shore of Nova Scotia, therefore, conforms to the concept of shoreface retreat. Coastal sediments here are poorly preserved, except in linear shelf valleys, because of a high-energy wave climate and prior landward transfer into tidal deltas, washovers, and associated back-barriers deposits.

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Radiaxial Fibrous Calcite as Early-Burial, Open-System Cement: Isotopic Evidence from Permian of China

The Nanpanjiang basin of south China occupies about 100,000 km^2 in southern Guizhou and eastern Yunnan Provinces and northwestern Guangxi Autonomous Region. The basin contains a thick Paleozoic carbonate sequence overlain by about 3,000 m of Triassic basinal deposits. Permian carbonate rocks comprise a large portion of the Paleozoic strata and form several platforms separated by basins containing dark, thin-bedded limestones, siliceous shales, and cherts. The platform margins are rimmed by sponge or algal reefs.

Radiaxial fibrous calcite (RFC) is the most abundant cement in very coarse sponge or algal debris of Upper Permian reef and fore-reef sediments exposed along the western margin of the Nanpanjiang basin. Small volumes of syndepositional cements, interpreted to have been fibrous magnesian calcites and botryoidal aragonite, predate RFC. Coarse, blocky burial calcite postdates RFC. Evidence that RFC was precipitated during sediment deposition was not found. RFC occurs as isopach layers up to 15 mm thick and exhibits white, gray, and black bands about 1 mm wide. The presence of microdolomite inclusions in these cements indicates that they were originally magnesian calcites. $\delta^{18}O$ of RFC cements are more positive than any of the earlier or later components of the reef and fore-reef facies. Analyses of successive bands reveals the most positive $\delta^{18}O$ near the center of the isopach layers. $\delta^{13}C$ of successive bands reveals generally more negative values toward the centers of layers.

RFC layers are interpreted to have precipitated during early burial of the platform margin while reef and fore-reef sediments were in communication with seawater. Cement layers recorded isotopic characteristics of seawater as platform-edge sediments subsided through the water column at the basin margin. $\delta^{18}O$ of successive bands records cooler water at depth in the basin followed by geothermal warming. $\delta^{13}C$ records increased incorporation of light carbon as the platform subsided through the oxygen minimum zone, followed by a return to normal values at depth.

These data and interpretations suggest RFC layers precipitated very slowly during time spans commensurate with those of subsiding platforms (millions of years). Isotopic characteristics of RFC may not reflect shallow seawater. Rather, they may reflect burial environments where $\delta^{18}O$ is affected by cooler water and $\delta^{13}C$ is affected by biologic activity.

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Practical Use of Inverted Seismic Data

Reliable initial reservoir estimates can be made for a prospect without the benefit of reservoir engineering information. This is done by combining petrophysical data such as sonic, gamma-ray, density, and resistivity logs with inverted seismic profiles and geologic models.

To delineate and appraise the reservoir volume adequately with seismic data, the reduction, processing, and display must be subject to strict quality control. The wavelet must be converted to zero phase, contracted and centered on the reflection coefficient that corresponds to the target beds. The useful spectrum of the data must be as broad as possible to define the geologic boundaries properly. There must be a good estimate of the amplitude spectrum of the wavelet and a successful deconvolution to remove effects of the source signature. Noise maintenance or reduction must precede inversion of seismic data to pseudo-sonic logs. The low-frequency gap in seismic records must be restored deterministically by the use of a geologic model with interval velocities specified. Time-variant processes should be minimized or avoided. A reliable calibration of absolute transit times must be obtained given that the inversion algorithm was stable and satisfied all assumptions involved in its use. Finally, results