sion Canyon and overlying Charles Formations, in conjunction with cross sections through the field showing both formations, reveal timing of compaction and quantitative compensation by overlying deposits. Curves from 3 wells show percent compaction versus overburden. With 250 m of overburden, mechanical compaction is essentially complete and, on average, marine sections have been compacted 31%.

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Genesis of Mississippi Valley-Type Lead and Zinc Ore Deposits and Consequent Exploration Thinking

Mississippi Valley-type ore deposits provide most of the lead and a large part of the zinc presently mined in the world. They are stratabound epigenetic precipitates largely in dolostone host rocks that occur on the flanks of deeply subsiding sedimentary basins or between two sedimentary basins along an axis of reduced subsidence. They were commonly emplaced at or close to the platform-to-basin facies front, well removed from igneous or metamorphic influences. Sulfides commonly infill interstitial or intramoldic porosity in collapse breccias, and are formed by the intrastratal solution of evaporites and/or carbonates either by downward-percolating meteoric waters or by upward-escaping basinal fluids. In a few places, karstic caverns were precursors to ore precipitation; more commonly, lower grade deposits occur in intergranular or intercrystalline space. The strong force of crystallization of sulfide minerals may cause local pressure solution encroachment on the carbonate host rock, but the vast bulk of any deposit is void-filling and, therefore, the average porosity (% voids) determines the likely grades.

The mineralogy is simple: galena and/or sphalerite, marcasite and/or pyrite, accompanied by only a white sparry dolomite, in places calcite and/or quartz gangue.

The host rocks have many of the attributes of a carbonate rock petroleum reservoir of recognizable anticlinal or stratigraphic trap type. Residues of hydrocarbons and former evaporites are common characteristics.

The metals probably migrated considerable distances as soluble chloride complexes in low-temperature, high-salinity brines and precipitated where these brines encountered host-rock brines with abundant reduced sulfur. Lead and sulfur isotopic and trace-element compositions of the ores and host rocks are complex and the brines strongly resemble petroleum-associated basinal fluids, but, so far, geochemical criteria have failed to impose a consensus on metal(s) source(s). Some Mississippi Valley-type deposits appear to be little younger than their host rocks; others may lag by long periods of time.

Genetic models lead to consequent exploration thinking that mimics many aspects of oil finding.

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Exploration Along Lower Cretaceous Shelf Margin—Golden Lane, Mexico, to Louisiana

Exploration for hydrocarbons from Lower Cretaceous shelf-margin carbonates began more than 40 years ago and continues today along the Gulf Coast of Mexico, Texas, and Louisiana. The early discovery of the oil-rich Golden Lane and Poza Rica fields of Mexico provided encouragement for exploration for similar fields in Texas and Louisiana. Exploration along the shelf margin of the U.S. Gulf Coast has resulted in the discovery of smaller gas fields in south Texas.

Detailed core studies along the shelf-margin indicate the existence of a nearly continuous trend of rudist banks and associated tidal bars. Seaward, argillaceous carbonate mud was deposited in deeper water; landward, shallow-water lagoon and shelf sediments were diverse and resulted in the accumulation of a wide variety of facies.

In the Mexican fields, extremely high early secondary porosity in the Golden Lane is believed to have formed when the carbonates were exposed to subaerial weathering during early stages of the Laramide orogeny. In the Poza Rica field, production is from intercrystalline dolomite porosity. Along the U.S. Gulf Coast, most porosity is primary within the preserved rudist shells and permeability is very low. Originally high intergranular porosity in the grainstone facies was destroyed by several layers of calcite cement deposited during subsequent burial. The source rocks for the hydrocarbons of the entire area are probably the argillaceous, dark-colored mudstones and wackestones of the Gulf basin.

The Mexican fields have been prolific and have produced a billion barrels of oil. In contrast, the south Texas fields have produced 150 bcf of dry gas and are estimated to have reserves of 1 to 1.5 tcf of gas. Major differences in postdepositional burial history account for these extreme differences in hydrocarbon production.

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Structural Evolution of Chihuahua Tectonic Belt

The Chihuahua tectonic belt is a Laramide foreland fold and thrust belt that is in the initial phase of exploration. It can be compared to the Southern Overthrust belt prior to the Pineview discovery in 1975. The part within the United States is approximately 300 mi (483 km) long and extends from southeast of El Paso to Presidio, Texas. The frontal thrusts of the belt lie against the Diablo platform.

The stratigraphic sequence involved in thrusting is Permian to Lower Cretaceous. Thrusting has been accomplished by decollement of Jurassic and Permian evaporates. The Malone Formation (Jurassic) is the proximal part of a fan-delta complex and contains marine, subtidal, intertidal, and supratidal facies.

Two distinctive locally derived conglomerate facies are present: (1) clast-supported, bimodal, dolomite-pebble conglomerate (sheet-flood facies); and (2) a matrix-supported, dolomite-pebble conglomerate that lacks sorting (debris-flow facies). Probable correlatives of the Malone Formation occur at Sierra del Kilo and Sierra de la Alcaparra in Chihuahua 60 mi (97 km) to the southwest.

By using new surface-mapping and surface-sampling plus interpretation of seismic and gravity data, a sequence of tectonic events can be inferred: (1) Late Triassic(?) faulting and formation of the Chihuahua trough; (2) Laramide folding and thrusting; (3) late Laramide en echelon left-lateral strike-slip folding; and (4) basin-and-range faulting.

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A Three-Dimensional Seismic Study of Challenger Knoll

Several intersecting multichannel seismic lines shot by The University of Texas Marine Science Institute in the deep Gulf of Mexico provide a three-dimensional grid in the vicinity of Challenger Knoll. Seismic stratigraphic sequences identified on the lines include the Sigsbee, Cinco de Mayo, Upper and Lower Mexican Ridges, Campeche, and Challenger units. Isotime maps document a detailed growth history of the Challenger diapir. DSDP drill holes 2, 3, and 87 provide age data for the grid.

Differences in the style of diapirism between the northern (Louann) salt province and the Sigsbee salt province to the south are due to the influence of the basement. Both the original distribution of evaporites and subsequent diapirism in the vicinity of Challenger Knoll are controlled by basement fault blocks of transitional crust that formed during the initial opening of the Gulf of Mexico.

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Subsurface Temperatures, Sacramento Valley, California: Guide to F-Zone (Forbes) Gas Accumulations

A complicated hydrodynamic system exists in the Sacramento Valley. Abnormally high fluid potentials are present regionally owing to regional tectonic forces, as shown by previous studies. Certain parts of the Colusa basin in the Sacramento Valley have significant near-vertical fractures which permit the rapid ascent of deep waters under channel-flow conditions, thus with a minimum loss of fluid potentials. The traps for the erratic F-zone (Forbes) gas accumulations are critically dependent, both laterally and vertically, upon the existence of these high fluid potentials as barriers to gas migration.

Advective water transport occurs along these near-vertical fractures under nearly isothermal conditions. The magnitude of the thermal anomalies caused by this transport is so large that the fracture-high potential features can be detected with conventional maximum temperature readings from well logs despite the considerable error in such values. Well-log temperature data are much more readily available than accurate subsurface pressure data. Thus, practical exploration for these elusive gas accumulations is facilitated greatly through mapping the subsurface temperature regimes.

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Petroleum Geology of Arabian Peninsula

Petroleum activities in the Arabian Peninsula show new trends in the 80s. Petroleum exploration is intensified and huge discoveries are anticipated. A giant Jurassic gas field along the coast of the Arabian Gulf discovered recently tops 150 tcf, the largest single reserve ever. Other giant oil fields in the area are undergoing expansion in development and productivity. Today, the peninsula, with a total area that surpasses one million sq mi (2,590,000 sq km), produces and exports more oil and gas and has greater reserves than any other area in the world. The excellent reservoir rocks are located in the Jurassic and Cretaceous formations between the Arabian shield and the Tethyan seaway. They represent porous and permeable marine cyclical beds sealed by impervious shales and anhydrites. Reservoir sedimentology was affected by two orogenies during Late Cretaceous and Pliocene time portrayed by the cratonic area to the southwest and the orthogeosynclinal area to the northeast. The eastern part was little deformed by these movements.

Land satellite images and remote sensing data are salient features of the modernized exploration technology of Arabia in addition to seismic and gamma ray-neutron surveys. The crude oils encountered have high gravity (30 to 40° API) and their sulfur content ranges from 2 to 8%. Shut-in pressures are abnormally high and may range to 9,000 psi (62,000 kPa). All producing wells in the region are flowing wells and none of them require pumping.

Despite temporarily imposed production ceiling to 13 million bbl/day by OPEC, oil discovery rate is growing, and production may soon increase to help alleviate worldwide energy shortages.

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Early Cretaceous Sedimentation and Tectonics in Southeastern Arizona

Sedimentary strata of Aptian to Albian age are widespread in southeastern Arizona, southwestern New Mexico, and northern Mexico. These rocks comprise a transgressive/regressive marine/nonmarine basinal sequence, locally over 3,000 m thick, of sandstone, shale, limestone, and conglomerate mapped as the Bisbee Group. In general, the nonmarine lower third of the sequence is composed of coarse clastic alluvial fan and basin-fill deposits of local origin and rests unconformably on rocks of Jurassic to Precambrian age. These syntectonic sediments were deposited during regional southwest-northeast extension where local fault-block uplifts bounded by northwest-trending normal faults created a basin-and-range paleogeography with isolated clastic-filled basins and mountain ranges rimmed by alluvial fans.

The marine and marginal-marine shales and limestones of the middle third are restricted to the southeastern part of the region and represent the northwestern end of a shallow marine sea (Bisbee Sea) which advanced northwestward across northeast Mexico from the Jurassic rift basins of the Gulf of Mexico. Shallow-water platform carbonates were deposited over a wide area, with coral-algal-rudist patch reefs localized over paleostructural highs. The upper part of the Bisbee Group is the regressive facies of this sea and is composed primarily of nonmarine deltaic (fan delta), lacustrine and fluvial sandstones, and siltstones.

This facies reconstruction suggests that differential vertical displacements along northwest-trending normal faults controlled the regional variations in thickness, lithology, and grain size in the Bisbee Group.

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Formation of Secondary Porosity in Sandstones: How Important is It and What are Controlling Factors?

Secondary porosity in sandstones may form by chemical dissolution of grains or cements. Care must be taken to distinguish between local dissolution and reprecipitation which do not increase the net porosity, and leaching which produces a net increase in the porosity, requiring a throughflow of large volumes of undersaturated pore water to remove the reaction products in solution. Such undersaturated pore water may be derived from: (1) meteoric water driven by a hydrostatic head; (2) subsurface pore water made acid by the release of CO_2 from maturing kerogen; and (3) clay mineral reactions involving transformation of kaolinite and smectite to illite and dissolution of feldspar and carbonate—($Al_2Si_2O_5(OH)_4 + KAlSi_3O_8 = KAl_3Si_3O_{10}(OH)_2 + 2SiO_2 + H_2O$).

In the Jurassic sandstones of the North Sea (Statfjord field), secondary porosity is formed during early diagenesis from meteoric water dissolving feldspar. However, the kaolinite formed as a product of the leaching may form aggregates of pore-filling cement, reducing porosity and especially permeability. Petrographic examination and microprobe analyses show that clastic feldspar is rimmed by authigenic feldspar indicating that leaching was not important in creating secondary porosity