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 during deeper burial. Calculations of the total amounts of CO_2 released by kerogen in sedimentary basins suggest that secondary porosity is favored by high contents of humic kerogen, but that the CO_2 produced and/or pore-water flow in many types of basins are too small to create significant amounts of secondary porosity. Reactions with clay minerals may, however, provide additional sources of acid.

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Three-Dimensional Seismic Interpretation of a Piercement Salt Dome

Eugene Island Block 77 field is a shallow (1,100 ft, 335 m) piercement salt dome with a low relief overhang which is productive from upper Miocene sands at depths between 13,300 and 15,800 ft (4,054 and 4,816 m, or between 3.260 and 3.690 sec). These hydrocarbon accumulations are trapped in steeply dipping beds (10 to 40° by dipmeter) between the salt mass and the rim syncline. Small radial faults (50 ft, 15.2 m, of throw) also affect reservoir limits, as is evidenced by varied gas/water contacts and reservoir production performance.

This combination of factors (piercement dome, salt overhang, deep objective, steeply dipping beds, tight rim syncline, small faults) makes Block 77 field difficult to map accurately with 2-D seismic. Unmigrated lines do not show the dip between the salt mass and rim syncline; migrated lines contain migration artifacts, making a salt interface interpretation ambiguous and recognition of small faults impossible. To overcome the problems inherent to the 2-D seismic method, a dense grid of data (trace spacing of 110 ft, 33.5 m, in both X and Y directions) was collected over this field and migrated in three dimensions. This placed events in their proper spatial relationship, thus enhancing both fault delineation and salt face interpretation. In previous interpretations (based on 2-D data), only one fault was mapped—a large down-to-the-north fault extending eastward from the northeast quadrant of the dome. The 3-D data show a more complicated combination of fault systems including other large parallel faults, some with compensating faults; buried down-to-the-south faults; and an extensive system of small radial faults.

Salt-face maps based on 2-D data were very inaccurate. Due to sideswipe problems, only lines shot radially across the dome were interpretable. This created large areas of no control. Using a 3-D grid eliminated the sideswipe problem and increased the amount of control on which to base the interpretation. The salt face, as seen on the seismic was tied to existing well control to make an accurate salt-face interpretation.

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Fan-Delta and Lacustrine Margin Sedimentation, Chinle Formation (Upper Triassic), Canyonlands National Park, Utah

Cyclic fluvial, fan-delta, and lacustrine margin depositional systems dominate the lower part of the Chinle Formation, Canyonlands area, southeastern Utah. Detailed facies analysis of the Moss Back Member and related strata document two alternating fluvial-lacustrine sequences. (1) During high fluvial output, coarse-grained meander belts built fan-deltas into shallow lakes. (2) During low fluvial output, braided streams waned before reaching the lakes, and algal and evaporatic mud flats formed on broad lacustrine perimeters.

The high fluvial output phase comprises three depositional systems. (1) The coarse-grained meander belt system consists of point-bar and channel deposits. Abundant carbonate grains were cannibalized from upland caliche soils and lowland oncolite-bearing carbonate mud flats. (2) The fan-delta system contains sandstone and mudstone delta foresets that coarsen upward into delta-distributary deposits. (3) Blue-green, bentonitic, limy mudstone was deposited in the shallow lacustrine system.

The low fluvial output phase comprises three depositional systems. (1) Braided stream deposits contain trough and planar cross-stratified calcarenite, calcirudite, and quartzarenite. (2) Micritic limestone, algal mats, and oncolites formed on swampy lake margins. (3) Shallow, warm, clear-water, lacustrine deposits are represented by continuous micritic limestone beds and bioturbated limy mudstone and sandstone.

Three external controls produced the cycles. Tectonics associated with the adjacent salt anticline region affected source terrane (intrabasinal carbonate output) and fluvial discharge. Regional humid-arid cycles affected fluvial discharge and lake levels. Volcanic eruptions to the southwest produced periodic influx of volcanic debris that caused increased turbidity and sedimentation rates and decreased carbonate production.

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Sedimentology and Provenance of Miocene Intraclastic Chalks, Blake-Bahama Basin

Leg 76 of the Deep Sea Drilling Project cored 165 m of a 500-m thick Miocene intraclastic chalk formation in the Blake-Bahama Basin. The carbonate material was derived mainly from the Blake Plateau and slopes of Little Bahama Bank with less amounts coming from the shallow platform of Little Bahama Bank. The sediment was transported 150 to 200 mi (240 to 320 km) into the Blake-Bahama Basin via Great Abaco Canyon and Eleuthera Ridge (a Miocene submarine canyon).

Deposition close to the sources was primarily by mass flow or debris flow mechanisms (medium to coarse grains of both shallow- and deeper-water origin float chaotically in a matrix of carbonate mud), whereas turbidite deposition (finely laminated to massive silt and clay-size carbonate) dominates throughout most of the basin. Turbidite sedimentary structures also dominate over debris flow structures in the various facies of this formation.

Upon entering the basin, these chalk turbidites descended below the carbonate compensation depth and eroded and incorporated clasts of partly consolidated siliceous mudstone (the background hemipelagic sedimentation). These clasts of mudstone, as well as clasts of limestone and previously cemented chalk, produce the distinctive appearance so characteristic of this formation.

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U.S. Geological Survey Activities in Oil Shale

Since the early 20th century, the U.S. Geological Survey has been concerned with oil shale; the extent of Survey activity has fluctuated widely during these decades as functions of changing national energy needs and economic outlook for competitive production. Recent international events, namely the rapid price escalation of crude oil imposed by OPEC and the ever-lingering concern over further import constraints, have again made oil shale a potentially attractive energy source. Although organic-rich shales occur in several formations in the United States, the rich deposits of the Green River Formation in Colorado, Utah,