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Geology and Exploration History of South Marsh Island Block 9 Field, Offshore, Louisiana

South Marsh Island Block 9 field, a piercement salt dome, is one of the older oil and gas fields in the Gulf of Mexico, yet significant exploration continues in the field to the present day. Through acquisition of new geological data and use of advanced geophysical techniques, recent exploration of this dome has more than doubled field reserves since 1980.

The field is located 20 mi offshore in 60 ft of water. Domal growth occurred from Miocene through Pleistocene time; the salt plug truncates objective Pliocene and Miocene deltaic sands from 9,000 to 18,000 ft.

Early exploration beginning in 1962 found limited reserves but established the presence of thick prospective sand-shale sequences. The dome was believed to be overhung, making definition of the salt-sediment interface difficult when using conventional seismic techniques.

Through custom geophysical data acquisition and processing, Chevron was able to improve definition of the salt profile. Subsequent drilling discovered significant accumulations of hydrocarbons and led to successful second-generation drilling on previously tested and abandoned domal flanks. These new wells have resulted in the discovery of over 400 ft of hydrocarbons per well in multiple pay sands updip from previously drilled dry holes. This success, occurring 18 yr after initial testing of the dome, illustrates that significant new reserves may be found in old salt dome fields through the use of modern exploratory methods.

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Andean Structures Along West Flank of Neuquen Basin, Argentina

During the Mesozoic, a series of back-arc basins formed along much of western South America. The Neuquen basin, an important petroliferous basin in west-central Argentina, is a roughly triangular remnant of this back-arc basin system preserved along the east side of the Andean Cordillera from about 34° to 40°S. The west flank of the Neuquen basin is formed by the Late Cretaceous-Tertiary foreland fold and thrust belt of the eastern Andean foothills that trends approximately north-south and crosscuts extensional trends that were active during formation of the Triassic-Early Cretaceous Neuquen basin.

Field studies have shown that the style of surface structures varies along the west flank of the Neuquen basin, largely as a result of the changing stratigraphic section in which the structures are developed. In thick sediments of the deeply subsided basin, low-angle thrusting is important, with major decollement in evaporitic and shale intervals. These thrusts show a characteristic ramp and flat geometry. Where the fold and thrust belt crosses a block-faulted Jurassic basin margin, a complex zone of imbricate thrust structures is developed. This structural style is suggested to be due to thrust ramping at the eastern pinch-out of major decollement zones. Where the foothills cross a portion of the eastern platform, the structural style is strongly controlled by sub-Jurassic igneous and metamorphic basement, including compressional reactivation of normal faults formed during Triassic-Jurassic extension. A series of length balanced cross sections shows this variation in structural style.

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Breaking Walther's Law

Walther's law of facies cannot be meaningfully applied to explain major facies transitions in the Helderberg Group of New York. Correct application of the law requires that superimposed facies accumulated conformably, that is "only those facies and facies areas can be superimposed primarily which can be observed beside each other at the present time." Application of the law to the Helderberg Group fails on the conformable constraint. The Helderberg Group consists entirely of punctuated aggradational cycles (PACs), shallowing-upward cycles (1-5 m thick) separated by isochronous surfaces of marked facies discontinuity. The facies changes across these surfaces indicate that they were produced by abrupt relative sea level rises. Analysis of facies within any pair of successive PACs indicates that each sea level rise disrupted the environmental spectrum associated with the deposition of the underlying PAC and established a disconnected new environmental pattern in which deposition of the overlying PAC was initiated. Therefore, facies changes analogous to those occurring across PAC boundaries cannot be found in contiguous modern environments. It is possible to meet Walther's strict criterion of conformity, and thus correctly apply his law, only for vertical facies transitions within PACs. The law cannot be applied to thicker rock sequences such as the Helderberg Group, represented by several formations and major facies, because they consist entirely of PACs and thus contain many paleo-environmental discontinuities. We conclude that stratigraphers, as a consequence of assuming the paradigm of stratigraphic gradualism, have failed to recognize the significance of these discontinuities and therefore have been breaking Walther's law. One of the consequences of adopting a new paradigm of episodic accumulation may be that stratigraphers will apply Walther's law in the manner that Walther apparently intended, as an actualistic rule for interpreting conformable vertical sequences.

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Influence of Depositional Facies on Hydrocarbon Production in Pennsylvanian Tensleep Sandstone, Big Horn and Wind River Basins, Wyoming

Primary patterns of reservoir-rock porosity and permeability characteristics in the Pennsylvanian Tensleep Sandstone are the effects of grain-packing fabrics and early-diagenetic cements that are controlled by the environments in which the formation was deposited. These environments are a regressive sequence of shoreface to eolian and sabkha interbedded sandstones and dolomites. The formation has laterally correlatable tabular layers with strongly directional permeability in the eolian section.

Tensleep reservoir characteristics can be interpreted from resistivity density and sonic log responses once calibrated to porosity, permeability, saturation, and grain-density analyses from a local full-section core. Directional permeability can be interpreted from dip logs.

Because the controls on deposition are systematic, primary reservoir characteristics are predictable. These characteristics may be summarized as follows: lower Tensleep is moderately permeable shoreface sands interbedded with nonreservoir, relatively brittle dolostones; upper Tensleep is significantly more permeable cross-stratified eolian sands with approximately 10:1 ratio of along-bedding-plane vs. through-bedding-plane permeability, appearing cyclically in composite sets of strata, which have interdune sabkha, nonreservoir, horizontal to wavy-bedded, dolomitic sands at their bases.

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Depositional Patterns of Kerogen, Atlantic Margin, North America

Geochemical and biostratigraphic data from offshore wells along the Atlantic margin of North America define a depositional history dominated by coastal-plain and shallow-shelf facies containing degraded and residual continent-derived kerogen. Exceptions to this generalization are 4 depositional facies containing hydrogen-rich amorphous kerogen assemblages.

The rocks containing hydrogen-rich amorphous kerogen assemblages are: (1) Upper Jurassic inner-shelf facies probably deposited in algal-rich lagoonlike environments, (2) Lower Cretaceous nonmarine coaly facies, probably deposited in algal-rich swamplike environments, (3) middle Cretaceous abyssal-plain facies probably deposited by turbidity currents that originated on an algal-rich slope, and (4) Miocene outer-shelf to upper-slope facies probably deposited under algal-rich upwelling systems.

Correlation of these facies to seismic packages allows for extrapolation of probable organic facies distribution throughout the continental margin. Such modeling of organic facies distributions in conjunction with plate-tectonic and ocean-circulation models permits refinement of strategies for hydrocarbon exploration.