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Sublacustrine Fan Reservoirs of Riacho da Barra Field, Reconcavo Rift Basin, Brazil

The producing sandstone of Riacho da Barra field represents the middle and distal portions of uplap sublacustrine gravitational fans, deposited in a northeast-southwest elongate graben developed during the Early Cretaceous on the northeastern part of the Reconcavo rift basin, Brazil.

Since the earliest stages of exploitation of the field, geologists and engineers have worked together to describe the reservoirs. A geologic and hydrologic model for the Riacho da Barra field was proposed, with emphasis on the lateral continuity of the reservoirs, which was mainly controlled by pressure-gradient correlations. This model was created to guide not only the development of the field, but also to define the possible use of waterflooding as a secondary recovery method.

Two main reservoir sets were identified. The first group corresponds to medium-grained, well-sorted, massive sandstones, with centimetric conglomerate levels, deposited in channels in the middle of gravitational fans. This group represents the best reservoirs, with an average porosity of 16% and average permeability of 100 md, but restricted lateral continuity. Major trends of channel deposits are the most favorable directions for waterflooding.

The second group includes a cyclic sequence of coarse-grained massive sandstones and medium-grained parallel-stratified sandstones, deposited as lobes of middle and distal fans. These sandstones have a wider distribution and contain 85% of the original oil in place of the field (50 million stock tank bbl). However, they have poorer reservoir quality, with average porosity of 12% and average permeability of 20 md. These characteristics are due to the significantly large thickness of poorly sorted parallel-stratified sandstones and also to the thin sandstone beds interlayered with shales, which show high contents of calcite cement.

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Freshwater-Phreatic Calcite Cementation, Schooner Cays, Bahamas

Freshwater-phreatic calcite cementation is an active process on 700 and 2,700 yr-old ooid-sand islands in the Schooner Cays, Bahamas. Cement fabrics and textures indicate a general, four-stage model of pore infilling. (1) The precipitation of isolated, decimicron-sized, rhombohedrons of calcite on grain surfaces forms an incipient circumgranular cement. (2) Continued precipitation enlarges crystal sizes and forms new rhombohedral crystals, resulting in a continuous circumgranular rim of cement. (3) Additional cementation quickly masks the circumgranular fabric, producing a partial pore-filling mosaic. (4) The remaining pore space is occluded with a mosaic of calcite cement. Petrographic evidence for the earlier circumgranular rim of cement is not necessarily apparent after the last stage of cementation.

Empty pores and all four stages of phreatic-zone cementation were observed in the diagenetically immature 700 yr-old rocks, but only stages 2 through 4 were observed in the diagenetically more mature 2,700 yr-old phreatic-zone samples. Cements are distributed homogeneously within each pore at every stage, yet because each pore may proceed through the four stages at different rates, each pore can be at a different stage of infilling. This results in an inhomogeneous distribution of cement between pores during the initial stages of cementation.

Recognition of a cement stratigraphy similar to that described here should aid in the identification of freshwater-phreatic diagenesis in ancient carbonate rock sequences. Variability in the amount of freshwater-phreatic cement between pores should be expected and not interpreted as the product of different paragenetic sequences.

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Distribution of Oceanic Versus Transitional Crust in Deep Gulf of Mexico Basin—Implications for Early History

Regional studies of seismic reflection and refraction data in the deep Gulf of Mexico basin outline in considerable detail the distribution of oceanic vs. transitional crust. Oceanic crust forms a narrow east-west belt up to 300 km wide across the deep Gulf. Most current models for early Gulf evolution suggest the belt was emplaced in the Late Jurassic following widespread deposition of salt on rifted and attenuated continental crust (transitional crust). The southern boundary is defined by a zone of prominent salt structures along the northern margin of the Sigsbee salt basin. The northern boundary is obscured below the Texas-Louisiana slope, but is inferred from the distribution of large vertical salt structures. The eastern boundary is clearly marked by onlap and pinch-out of thick Jurassic sedimentary sequences. This distribution is corroborated by regional magnetic and gravity data and total tectonic subsidence analysis, and provides constraints for early Gulf basin reconstructions.

An appropriate reconstruction must account for plate motion accommodated by ocean crust formation and extension of continental crust. The data seem most consistent with a model in which the Yucatan block moved generally south and rotated somewhat counterclockwise. This reconstruction implies very little lateral displacement along transform faults between Yucatan and Florida during early basin history. This is supported by seismic stratigraphic studies and DSDP drilling in the southeastern Gulf.

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Plate Tectonic History of the Arctic

The Arctic Ocean represents the last great challenge in establishing the broad outlines of the histories of the present oceans of the earth. The rotation of the Lomonosov Ridge away from the Barents Shelf during the Cenozoic is well established, and a unique present relationship has been demonstrated between the Gakkel Ridge and the Poloussnoye graben system. Earlier history of the Arctic is poorly known, but a possible and testable scenario involves rifting of the North Slope Alaska–Chukotsk block (NSAC) from the Canadian Arctic Islands during the Early Cretaceous and rifting of the New Siberian block (NSB) along strike on the same margin a little later. Both NSAC and NSB were involved, after rapid rotation, in the assembly of northeastern Asia with such other blocks as "Greater Japan" (much of Kyushu, Honshu, Hokkaido, Sakhalin, Sikhote Alin, Kamchatka, and Koryak) and Omolon. During earlier Mesozoic, Permian, and Carboniferous times, NSB and NSAC occupied one Atlantic-type margin of the triangular Boreal embayment of the Pacific, while the Verkhoyansk Atlantic-type margin of Siberia (with the prominent Vilyuy rift embayment) occupied the other. These 2 rifted margins, which are now caught up respectively in the Brooks Range–South Anyui–Sviatory Nos suture zone and the Sette Daban–Chirskiy suture zone, had formed during the Late Devonian close to the site of and shortly after the Innuitian suturing event between Siberia and North America.

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Paleo-temperatures from Fluid Inclusions—Advances in Theory and Technique

Recent studies of fluid inclusions in diagenetic cements have attempted to determine paleosubsurface temperatures. Three sets of observations are necessary to make accurate interpretations: (1) detailed petrography to establish the relative time of formation of the inclusions, (2) careful analysis of the burial and tectonic history of the host rocks to relate the diagenetic paragenesis to the geologic history of the basin, and finally, (3) analysis of individual inclusions for homogenization and final melting temperatures, and for chemical composition to define the PVT properties of the trapped fluids.

Once these observations are complete, 2 major limitations on the temperature interpretation remain. First is the assumption that the inclusions have not altered in composition or volume since entrapment. Recently published work shows that inclusions can re-equilibrate, but the extent that this affects most observations in sediments is unknown. Second, we must independently determine a "paleopressure" during inclusion formation, and we must know whether this pressure was hydrostatic or approached lithostatic. Data from both hydrocarbon and aqueous fluid inclusions in core samples from the Mission Canyon formation, Williston basin, North Dakota, illustrate a method for independently determining both paleotemperature and paleopressure from a single set of fluid inclusion measurements. The technique requires petrographic evidence for