aspects of the dynamics and characteristics of these processes with ground-water flow theory and by scaled sandbox experiments. Reflux is not restricted to hypersaline brines, but can occur with bankwaters of only slightly elevated salinity such as those found on the Bahama Banks today (42 ‰). The lack of evaporites in a stratigraphic section, therefore, does not rule out the possibility that reflux may have operated. Flows associated with freshwater lenses include flow in the lens, in the mixing zone, and in the seawater beneath and offshore of the lens. Upward transfer of seawater through the platform margins occurs when surrounding cold ocean water migrates into the platform and is heated. This type of thermal convection ("Kohout convection") has been studied by Francis Kohout in south Florida. The ranges of mass flux of magnesium in these processes are all comparable and are all sufficient to account for young dolomites beneath modern platforms. Each process yields dolomitized zones of characteristic shape and location and perhaps may be distinguishable in ancient rocks. The concepts presented here may have application to exploration for dolomite reservoirs in the Gulf Coast and elsewhere.

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Deposition, Compaction, and Mineralogic Alteration of Miocene Sandstones, South Louisiana

Miocene sandstones of Iberia and St. Mary Parishes, Louisiana, cored at depths of 12,000-16,000 ft (3,600-4,800 m), were deposited in fluviodeltaic and shallow marine environments. The reservoir quality of these sandstones is not only dependent on the environment of deposition, but also on the diagenetic history of these rocks.

Pore volume reduction due to mechanical compaction (ΔV_{mc}) was determined petrographically for the three sandstones by assuming $\Delta V_{mc} = 40 - (C + P)$, where 40 is the original porosity, C the amount of cement, and P the amount of pore space (all in percents). Of the three sandstones studied, the "S" sand has experienced the least mechanical compaction and the *Planulina* 6 sand the most. The difference in mechanical compaction between these sandstones is due to the depth at which calcite cementation effectively stopped compaction.

During early (shallow) stages of diagenesis, chlorite rims and quartz overgrowths precipitated in the pore spaces of the sands. As silica cementation proceeded, calcite cementation began. Mechanical compaction occurred contemporaneously with these cementation events but was hindered by the calcite cement when it developed in abundance. Mechanical compaction and calcite cementation was completed at a burial depth of 6,300 ft (1,920 m) for the "S" sand. Fluids from nearby shales that had undergone smectite-to-illite conversion and organic maturation caused partial to complete dissolution of this calcite cement when a burial depth greater than 10,000 ft (3,050 m) was reached. Dissolution created the present secondary porosity. Kaolinite precipitated in the sands during cement dissolution. As the pH of the pore fluids in the sand increased, late mixed-layer illite/smectite and chlorite precipitated.

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Validity of Use of Spontaneous Potential Curve Shape in Interpretation of Sandstone Depositional Environments

The shape of spontaneous potential curves is frequently used in the interpretation of sandstone depositional environments. The "cylinder-," "funnel-," and "bell-shaped" SP profiles are among the most frequently employed. However, the validity of this commonplace practice has never been thoroughly established.

Theoretical and experimental work and actual field examples suggest that the trend of the SP deflection does not display a direct relationship with the trend of variables known to be controlled by the sandstone paleoenvironment. The trend of quartz grain size shows a low linear correlation with the trend of SP deflection. The trend of clay content shows a higher correlation, but changes in clay type and cation exchange capacity can have more impact on the SP than the simple volume of clay.

Field examples from the Upper Cretaceous and Tertiary of the Gulf Coast show that hydrocarbons, local variations in the mud filtrate salinity, and regional differences in formation water salinity can greatly alter the shape of the SP curve. This can result in erroneous interpretations of sandstone origin.

Curve shapes derived from the microresistivity measurements of the dipmeter tool are an alternative to those of SP curves. The greater sensitivity of the the dipmeter tool, its immunity to the problems of hydrocarbons and Rmf/Rw contrasts, and the relationship of microresistivity to primary rock properties are factors favoring the use of microresistivity curve shapes for the interpretation of sandstone depositional environments from subsurface data.

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Smackover and Haynesville Facies Relationships in North-Central East Texas

The Smackover Formation was deposited as a coarsening-upward carbonate unit that developed first with the deposition of transgressive laminated silty limestones in deep anoxic waters. Mudstones and wackestones were deposited during a slow rise in sea level as the carbonate system became established. Packstones and grainstones were deposited at the Smackover shelf margin in thick coarsening-upward sequences. Local lenses of anhydrite and dolomitic mud developed on the shoreward side of the shelf break. Pelleted sands also developed in the low-energy Smackover lagoon. Ultimately, a thin blanket of ooid sands covered the shelf.

During Haynesville deposition, a carbonate barrier at the shelf margin created an evaporative lagoon in which Buckner anhydrite and halite precipitated. As sea level rose, limestones and dolomites were deposited along the downdip margin of the Buckner lagoon. Terrigenous clastics began to prograde into the updip areas. Continued sea level rise flooded the shelf, and Gilmer limestones were deposited as far updip as the present Mexia-Talco fault zone. At the end of Haynesville deposition, limestones and shales were deposited on either side of the Gilmer shelf margin as quartzose clastics continued to prograde into updip areas.

Evidence in east Texas suggests that the depositional model for the Smackover followed a shelf margin rather than the generally accepted ramp model. The shelf margin is clearly identified as a carbonate barrier during Haynesville deposition, outlining a Buckner lagoon as the depocenter that continued to subside at least through the end of Haynesville deposition.

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Petrology of Lower and Middle Eocene Carbonate Rocks, Floridan Aquifer, Central Florida

Study of cores from a U. S. Geological Survey test well near Polk City, Florida, indicates that the Avon Park-Lake City (Claibornian) and Oldsmar (Sabinian) Limestones, which comprise most of the Floridan aquifer in central Florida, can be divided into six microfacies: foraminiferal mudstone, foraminiferal wackestone-packstone, foraminiferal grainstone, nodular anhydrite, laminated dolomicrite, and replacement dolomite. Dolomite containing variable amounts of nodular anhydrite forms more than 90% of the Avon Park-Lake City interval, whereas the Oldsmar is chiefly limestone. The depositional model inferred for these units is a broad, shallow-water marine platform with environments ranging from supratidal-sabkha to shallow water shelf.

Diagenetic pathways vary with rock type, but generally include: (1) marine phreatic—grain micritization and radially fibrous cementation within foraminiferal tests, (2) meteoric vadose—minor leaching of aragonitic grains, and (3) meteoric phreatic—neomorphism of unstable grains, dissolution of aragonitic allochems, formation of isopachous equant calcite cement and coarse spar in grainstones, and syntaxial calcite overgrowths on echinoderms.

Several episodes of dolomite formation are recognized. Laminated dolomicrite formed syngenetically in a supratidal-sabkha environment. Crystalline dolomite with nodular anhydrite formed early by replacement of limestone through reflux of dense, magnesium-rich brines. Replacement dolomite not associated with evaporites and containing "limpid" crystals probably formed later by a mixed-water process in the subsurface environment. Late diagenetic processes affecting crystalline dolomites include hydration of anhydrite to gypsum, partial dissolution of gypsum, minor alteration of gypsum to calcite, and dissolution of calcian dolomite cores in stoichiometric crystals.

Crystalline dolomite and grainstone are the only rock types that have high enough porosities and permeabilities to provide significant yields of water. Medium and finely crystalline dolomites show best values of porosity and permeability because they have high percentages of intercrystal and moldic pores that are well connected. Filling of pores by anhydrite or gypsum can significantly reduce porosity and permeability.

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Metallic Sulfide Deposits in Winnfield Salt Dome, Louisiana: Evidence for Episodic Introduction of Metalliferous Brines During Cap Rock Formation

. Winnfield dome is a shallow piercement salt structure that penetrates Late Jurassic through early Tertiary siliciclastic and carbonate strata of the North Louisiana basin. Quarrying operations in the calcite and anhydrite portions of the cap rock have exposed zones of metallic sulfides and barite. Within the anhydrite portion of the cap rock, sulfides form laminar zones parallel to the tightly intergrown layered anhydrite; sulfides occur either as cement between anhydrite grains or as coarse euhedral crystals in open space. The sulfide layers are up to several centimeters thick and extend for tens of meters. These layers locally thicken into laminated, flat-bottomed, concave-downward, massive sulfide mounds. Monoclinic pyrrhotite is the dominant sulfide; sphalerite, galena, or barite may also be present. In weathered samples hydrating to gypsum, marcasite is common and appears to be an alteration product of pyrrhotite.

A roughly laminated massive sulfide lens is exposed at the calcite to anhydrite transition zone. This sulfide body has a maximum thickness of about 5 m (16 ft) and extends for about 45 m (150 ft). The edges of the lens taper to a layer about 30 cm (1 ft) thick that separates the overlying calcite from the anhydrite. The massive sulfide lens is comprised of marcasite and pyrite complexly intergrown with calcite, gypsum, and anhydrite. Colloform sphalerite, galena, marcasite, pyrite, and barite line the vugs and fractures; pyrrhotite is found locally within the sulfide lens. Examination of rotary drill samples suggests that massive sulfide concentrations, similar to the exposed example, are common along the calcite to anhydrite transition zone.

These sulfide concentrations are believed to have originated from the interaction of metalliferous basinal brines with reduced sulfur trapped within the cap rock. Textural relationships and variations in chemical compositions between the sulfide layers in the anhydrite portion of the cap rock suggest that distinct pulses of metalliferous brines were responsible for the sulfide concentrations. Anhydrite grains that are completely surrounded by sulfides are euhedral and undeformed, similar to the anhydrite disseminated throughout the salt mass. Anhydrite grains outside the mineralized areas are deformed and tightly intergrown. These textures suggest that mineralizing fluids were introduced episodically along the salt and anhydrite interface at the zone of salt dissolution before that portion of the anhydrite zone was compressed and accreted to overlying anhydrite cap rock. Therefore, the earliest formed sulfides originating by this mechanism occur at the top of the anhydrite cap rock zone, whereas the last sulfides to form are found at the base. Extensive sulfide concentrations along the anhydrite-calcite contact suggest that this contact also acted as a permeable zone allowing metalliferous brines into the cap rock. Textural and compositional relationships suggest that sulfides that formed along the anhydrite-calcite contact are locally superimposed on sulfides that formed at the salt-anhydrite contact.

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Early Opening of Initially Closed Gulf of Mexico and Central North Atlantic Ocean

Regional structures beneath the northern Gulf of Mexico coastal plain clearly reveal the fit of the American continents following the late Paleozoic Appalachian-Ouachita orogeny. Most diagnostic is a wrench fault zone within the former Gondwana megacontinent, recognizable from the Florida Panhandle to western Mississippi, along which future South America moved northwest against the southern edge of North America to form the Ouachita foldbelt, while future Africa was already subducting that continent along the Appalachian belt. Extending west from this fault zone is the Wiggins arch, underlain by "granite" and phyllite of Late Pennsylvanian to Early Permian age, apparently part of a volcanic arc. Along its north side and that of its counterparts farther west are shallow marine strata of similar age. These strata appear to occupy the area of a remnant ocean on North American oceanic crust that was uncoupled by the close approach of future South America and subducted briefly beneath North America, while the sediments on it were peeled off and thrust onto the continent. The inferred volcanic arc and remnant ocean, and a Late Triassic rift system that separates them from the Ouachita foldbelt, terminate abruptly in east Texas against a wrench fault that transferred this rifting south-southwest to the Rio Grande Embayment area.

If the Pickens-Quitman-Gilbertown-Pollard and the Mexia-Talco fault zones, which mark the approximate updip limit of appreciable Louann Salt, represent the northward-converging wrench faults, then northern continental South America (i.e., the Guyana shield) fits precisely against them, with some overlap onto the Wiggins and Sabine uplifts. With Africa conventionally joined to South America, this continental fit also places west Africa's two prominent capes opposite the pronounced salients of the southern and central Appalachian foldbelt, while Capes Cod and Hatteras face the principal west African basins, which occupy salients in the equivalent African foldbelt. Also, pre-Mesozoic Florida lies in the reentrant between the southern continents, seemingly separated from each by an arm of a triple rift system whose third arm passes between them.

From this tightly closed condition, the Gulf of Mexico opened by right-lateral translation of eastern North America (south of Newfoundland) against the bulge of northwestern Africa—actually a rotation about a pole near the central southern edge of the Sahara. The Interior rift system formed by the sialic block that includes the Wiggins and Sabine uplifts, remaining briefly with South America as North America moved north-northeast along the east Texas transform and a parallel one at the east end of the Wiggins arch. The rifting jumped south of these uplifts after extension of perhaps 50 mi (80 km) to open the present Gulf basin. Almost 200 mi (322 km) of such translation brought Cape Hatteras solidly against Africa's Cap Blanc, ending this movement in earliest Jurassic time.

Magnetic anomaly lineaments off the southeastern states, used as crude isochrons, show that opening of the central North Atlantic Ocean (CNAO) began by southern North America swinging westward to disengage the obstructing capes. The Blake Plateau basin and Carolina trough opened first, then the spreading jumped east of the latter and propagated northward along the entire CNAO, followed by a second jump marked by development of the Blake Spur magnetic anomaly lineament. Changes in North America's movement direction throughout this period were recorded by the Great Abaco fracture zone (as reinterpreted), a leaky transform along which the early CNAO terminated against the Florida-Bahama platform. Right-lateral offsets of this fracture zone, totaling about 65 mi (100 km), are associated with the two spreading-center jumps.

The Late Triassic intercontinental transform continued across northwestern Morocco into the Tethyan sea, which then extended west into what is now the northern CNAO. As the CNAO opened to its full length, it appropriated this tip of Tethys and left the intervening Moroccan Meseta with Africa. Tethys' venture into the future CNAO followed the earliest Mesozoic rifting in eastern North America, which may also have formed an inferred series of grabens responsible for the Brunswick magnetic anomaly lineament in the southeastern states and offshore.

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Sedimentology of Upper Cretaceous Coffee Sands in North-Central Mississippi

The Upper Cretaceous Coffee Group within the Desha basin of Mississippi is composed of two major lithologies, a light to dark marlstone and a series of white, fine to medium-grained siltstones and sandstones. The two source areas for the sands are the Sharkey platform to the south and the southern Appalachians. The presence of hydrocarbons has been described at the outcrop and in subsurface cuttings and cores. Depositional environments in the shallow shelf consist of lagoons, barrier island bars, offshore bars, and surge channel deposits. Southwest regional dip of approximately 40 ft/mi (8 m/km) is reflected on all Upper Cretaceous horizons.