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Criteria for Recognition of Diverse Dolostone Types from Host Rocks for Mississippi Valley-Type Ore Deposits

Dolostones are the favored host rocks for low-temperature lead and zinc ore deposits, probably because these dolostones formed in evaporitic environments. Sulfate concentration, providing a local sulfur source, probably enhanced the chances of ore formation. Reduction of sulfate by organic reducing agents, commonly gas or oil, is the most likely intermediate step. If this is so, the presence of the sulfide ores in apparently sulfate-free dolostones may indicate a former sulfate abundance. Orebodies are commonly associated with solution-collapse breccias, many of which are attributed to evaporite solution. The nearly complete, subsequent removal of the evaporites renders proof of the supposition difficult. In the big southeast Missouri breccia-hosted ore deposits, evidence in favor of former evaporitic conditions is conclusive.

Most randomly selected dolostones have minute solid inclusions of gypsum or anhydrite that can be released by solution of the enclosing carbonate. Greatly enlarged and readily recognizable crystal aggregates can be cultured from the insoluble residues. In the Lockport Dolostone of southern Ontario, gypsiferous vugs are common. Chloride ions are so abundant in the Lockport that serious corrosion problems arise when structural steel is encased in concrete using crushed-stone aggregate derived from this source. Fluid inclusions within sphalerite in Mississippi Valley-type ore deposits typically indicate ore precipitation from strongly hypersaline and even saturated brines. Geologic evidence supports the growth of white sparry dolomite gangue contemporaneously with such sphalerite.

We conclude that most ancient dolostones are formed in association with evaporitic facies and/or hypersaline brines.

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Modern Exploration Strategy in Frontier Areas, Case History from Upper Egypt

Exploration of a frontier area in southern Egypt was begun in November 1976. Using current technology, including detailed ERTS photography, aeromagnetics, and geologic field studies, two basins later known as the Eastern Nile basin and the Western Dakhla basin were delineated. Preliminary stratigraphic studies suggested the presence of Late Cretaceous and early Tertiary marine rocks in these basins.

Acquisition of reconnaissance seismic data began in February 1977. This effort confirmed basin configuration and depth and defined areas of greatest potential. Concurrently, additional surface work described Jurassic rocks and suggested the presence of previously hidden Paleozoic sediments in the western basin. A synthesis of geochemical data indicated that petroleum source rocks were available for hydrocarbon generation.

The first well will be spudded in early 1979.

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Secondary Carbonate Porosity, Zelten Field, Libya

Zelten field is located in the center of the Sirte basin, Libya. Hydrocarbon production at depths of 5,000 to 5,300 ft (1,500 to 1,600 m) below sea level is from the Zelten Member of the Ruaga Limestone of Paleocene and early Eocene age. Fifteen carbonate facies are easily recognized from this producing unit, but most of the production is from two highly porous facies: (1) *Discocyclina* foraminiferal grainstone and packstone and (2) coralgal wackestone. Core porosity ranges as high as 40%.

Primary interparticle and intraparticle and secondary leached matrix and moldic porosity occur in the Zelten reservoir. High primary porosity was preserved in the grainstones by slight amounts of early cement which prevented compaction. In the packstones and wackestones porosity was preserved by the presence of porous carbonate mud which inhibited cementation. This primary porosity was enhanced by extensive secondary porosity formed by subsequent freshwater leaching during a period when most of the carbonate bank was subaerially exposed.

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Lower Cretaceous Shelf-Margin Carbonate Facies, Northwestern Gulf of Mexico

Lower Cretaceous carbonate sediments accumulated on a broad shallow-water shelf which completely encircled the Gulf of Mexico. Along the edge of this shelf, biogenic growth climaxed with a complex of rudist reefs, banks, bars, and islands. The shelf-margin trend has been recognized offshore north of Yucatan; along the east coast of Mexico in the Golden Lane and Poza Rica trend in the subsurface, and outcrops in the Sierra Madre Oriental; through Texas and Louisiana parallel with and approximately 100 mi inland from the present coastline; and offshore of Florida along the west Florida Escarpment. These shelf-margin deposits are best known from the subsurface Golden Lane and Poza Rica trend, the outcrop in the Sierra Madre Oriental, and the subsurface of south Texas, where it is commonly referred to as the Stuart City trend.

Five major depositional environments have been recognized from the carbonate rocks of the south Texas Stuart City trend: shelf lagoon, shelf margin, upper shelf slope, lower shelf slope, and open marine. The shelf-lagoon facies include miliolid wackestone, mollusk wackestone, toucasid wackestone, and mollusk-miliolid grainstone. These facies accumulated under generally low-energy conditions in water depths from 0 to 20 ft (0 to 6 m). In contrast, the narrow band of shelf-margin carbonate beds is made up of algae-encrusted miliolid-coral-caprinid packstone, coral-caprinid boundstone, requienid boundstone, and rudist grainstone, all of which accumulated in moderate-energy to high-energy waters less than 15 ft (5 m) deep. Seaward of the shelf margin, the upper shelf-slope environment comprises the caprinid-coral wackestone and coral-stromatoporoid boundstone facies, and the lower shelf slope comprises the intraclast grainstone, echinoid packstone, and echinoid-mollusk wackestone facies. Farther seaward, in water depths greater than 60 ft (18 m), the open-marine environment is represented by the planktonic foram wackestone.

Intraparticle, interparticle, and fracture porosity are present in the thick limestone section along the Stuart City shelf margin. Intraparticle porosity, in places reaching 20%, is common, although permeability in facies with intraparticle porosity is low. Facies with interparticle porosity greater than 5% have good permeability up to 10 md. Permeability in any facies may be enhanced by the presence of thin fractures which were common in several cores. Only four facies, however, have greater than 5% porosity and 5 md permeability—the algae-encrusted miliolid-coral-caprinid packstone, mollusk grainstone, rudist grainstone, and coral-stromatoporoid boundstone. Rudist grainstone is potentially the most consistent in terms of porosity and permeability, thickness, and lateral extent.

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Potential for Production of Geopressured Geothermal Energy, Texas Gulf Coast

Tertiary strata of the Texas Gulf Coast include several terrigenous depositional wedges, some of which thicken abruptly at their downdip ends as a result of contemporaneous movement of growth faults and underlying salt. The Frio Formation is one of these wedges.

Broad regional studies, followed by detailed local investigations, were pursued in order to delineate prospective areas for production of geopressured geothermal energy. A prospective area must meet the following minimum requirements: reservoir volume of 3 cu mi (12.5 cu km), minimum permeability of 20 md, and fluid temperatures of 300°F (149°C). Several geothermal fairways were identified as a result of the Frio study. Only the Brazoria fairway, however, meets all of the specifications for a geothermal prospect.

In the Brazoria fairway, located in Brazoria and Galveston Counties, Texas, several hundred feet of deltaic sandstones have fluid temperatures greater than 300°F (149°C). Permeabilities within these reservoirs are greater than 20 md; this high permeability is related to secondary leached porosity, which developed in the moderate to deep subsurface.

The geothermal-test-well site is located within the Austin Bayou prospect, Brazoria fairway. The reservoir will consist of 250 to 300 ft (75 to 90 m) of sandstone with core permeabilities between 40 and 60 md and fluid temperatures from 300 to 350°F (149 to 177°C). The sandstone-shale section within the Austin Bayou area is represented by seven progradational depositional sequences. Each sequence is composed of a gradational vertical succession characterized by low-porosity prodelta and distal delta-front shale and sandstone at the base grading to porous distributary-mouth-bar and delta-plain sandstone and shale at the top. The older depositional sequences represent the distal half of a lobate delta, and the later events represent the entire deltaic complex.

More than 10 billion bbl of water are in place in these sandstone reservoirs of the Austin Bayou prospect; there should be approximately 400 Bcf of methane in solution in this water. Only 10% of the water and methane (1 billion bbl of water and 40 Bcf of methane) will be produced without reinjection of the waste water into the producing formation. Reservoir-simulation studies indicate that more than 50% of the methane can be produced with reinjection.

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World's First Geopressured Geothermal Test Well, Brazoria County, Texas

In July 1978, the General Crude Oil and Department of Energy 1 Pleasant Bayou geopressured geothermal test well was spudded near the Chocolate Bayou field, Brazoria County, Texas, on a site identified through regional and detailed geologic, engineering, and environmental studies. The well was expected to find thick, permeable, deltaic sandstone units from the Frio Formation between 13,500 and 16,500 ft (4,050 and 4,950 m) below sea level. Temperature of the gas-saturated brine was predicted to be higher than 300°F (149°C), and formation pressure to range between 10, 000 and 13,000 psi (68,950 and 89,635 kPa). The well has been completed and initial testing has begun.

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Hydrocarbon Potential of Central Gulf of Alaska

The geologic evolution of the Gulf of Alaska sedimentary province includes active trench deposition during Mesozoic–early Tertiary time and prograding shelf and glacial sedimentation during the remainder of the Cenozoic. Through interaction between bounding oceanic- and continental-plate movements, these beds have been deformed by repeated high-angle reverse and transcurrent faulting and folding. The stratigraphic succession within the province includes uppermost Mesozoic and a composite total of 40,000 ft (12,000 m) of Tertiary rocks. Major rock types are clastic sedimentary and volcanic rocks.

Compressional forces and wrench-faulting tectonics have generated sharp, elongate, structural folding of the Tertiary sediments in the Yakataga area (Kayak Island to Icy Bay). These structures generally trend either northeast-southwest or east-west and are bounded on the southeast or south by high-angle reverse faulting. Three apparent ages have been observed in these structures: early Miocene (post-Poul Creek–pre-lower Yakataga), late Miocene (middle Yakataga) and early Pliocene.

Post-Paleocene sediments in the Gulf of Alaska were derived from a Mesozoic arc complex and are generally poor in quartz and rich in feldspars and rock fragments. The sandstones are texturally immature and mineralogically unstable. Diagenetic alterations of framework grains resulted in the formation of (1) early calcite or zeolite cement, (2) clay rims and coats, (3) zeolite and