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PATTERNS OF CALCIFICATION IN NACREOUS LAYER OF PELECYPODS AND GASTROPODS

The aragonitic nacreous layer (mother-of-pearl) of Holocene pelecypods and gastropods has been studied by scanning electron microscopy of inner shell-growth surfaces. Three distinct patterns of crystal formation and growth have been distinguished which are taxonomically significant.

The pattern developed in the nacre of the Atlantic pearl oyster, *Pinctada radiata* Leach, is characteristic of pelecypods. Thin broad mineral laminae overlap at the growth surface giving it the appearance of a series of long, parallel steps. Growth occurs along the free margins of individual laminae through the deposition of discrete, tabular crystals which, by lateral expansion, coalesce and merge evenly with the laminae.

In the family Pinnidae, crystals are deposited in long, parallel rows spaced 15–20 μ apart. Euhedral crystals observed in *Pinna carnea* Gmelin are commonly eight sided; their long dimensions parallel the rows. With lateral expansion, the crystals merge end-to-end to form strips over which new crystals are deposited. At depth, adjacent strips merge to form the broad laminae which characterize the nacre.

In the gastropods *Cittarium pica* (Linné) and *Astraea caelata* (Gmelin), no stepped patterns or crystal rows are observed. Instead, crystals are deposited in tall vertical stacks spaced 5–10 μ apart. Crystal anlages deposited at the tops of the stacks expand laterally as deposition continues and eventually merge at depth with crystals of adjacent stacks to form continuous laminae. In *A. caelata* crystals are euhedral and commonly six sided. Crystal orientation is constant within stacks, but not between stacks.

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GEOLOGICAL-ENGINEERING STUDY OF CATO (SAN ANDRES, PERMIAN) FIELD, CHAVES COUNTY, NEW MEXICO

Cato field in Chaves County, New Mexico, produces 25° gravity oil from two Permian San Andres dolomite reservoirs which are separated by 20 ft of impermeable anhydrite. Average depth to pay is 3,500 ft and each zone is about 50 ft thick. Although the average porosity of the upper zone generally is less than that of the lower zone, 70% of the field reserves are in the upper zone.

Dolomite beds of the upper zone (main pay) differ from those of the lower zone in that they are darker, more coarsely crystalline, have larger connective pores, a much lower water saturation, and although generally less porous, have much better permeability. The environment of deposition apparently was one in which shoal oölite was deposited with laterally equivalent lagoonal carbonate mud and open-marine fossiliferous mud. The net pay of this zone has large intergranular pores, coarse intercrystalline pores, and cavernous dolomite with solution channels and large vugs.

Dolomite beds of the lower zone are believed to be an evaporitic lagoonal deposit. They are apparently of primary and early diagenetic origin. Generally, they are light-colored, very finely crystalline, anhydritic dolomite. Very fine intercrystalline pores and fine moldic pores are prevalent with lesser amounts of interparticle pores. Mercury-injection capillary-pressure data, porosity-permeability plots, and thin-section studies were analyzed together with reservoir performance. Results indicate that the pay of this facies has a much higher porosity cut off than the upper zone (main pay) because of extremely fine pore connections.

Detailed core studies of fracture intensity were compared with performance data and indicate that the San Andres of Cato field is not a "fracture reservoir." Joint type fractures are typically only a few inches in length and do not form a self-connecting, petroleum-permeable system. They do serve as connective links between zones of matrix permeability. Lithologic studies, production interference test studies, and laboratory analyses indicate that well spacing greater than 40 acres would make this type reservoir more attractive economically. Cores and good samples along with a good logging program are a necessity in San Andres Formation evaluation.

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DEEP GAS TREND IN WEST TEXAS—GEOLOGY AND RESERVES

The deep gas trend in west Texas includes an area of 9,000 sq mi underlain by favorable reservoir rock in the Delaware and Val Verde basins. Approximately an eighth of the favorable area has been explored. In addition, only Wolfcampian and older formations are considered. This trend should develop into the largest gas-producing area in the world. Expensive drilling costs, carbon dioxide gas distribution, the uncertainty of future gas prices, lack of deep subsurface data, and difficulty with seismic interpretations have caused an erratic development.

The first giant gas field was discovered in 1952. Subsequent discoveries have established the deepest gas production in the world, some fields having as much as 3,500 ft of gas column above the gas-water contact. On the basis of reserve prediction methods developed by Hendricks, huge volumes of gas in place remain to be discovered.