

Caprock seal capacity is a function of pore size, rock integrity, regional continuity, and thickness. Calculations of the oil or gas the pore system of a rock can seal can be made by Smith's 1966 formula:

$$H = \frac{PdB - PdR}{(pw-ph) \times 0.433}$$

Data necessary to make these calculations are: pore size, oil and water density, oil-water interfacial tension, and wettability.

Rock integrity, or lack of open fractures, controls whether or not the pore system of the rock will be dominant in controlling seal capacity or of minor importance. Rock integrity is a function of mechanical properties, structural stress and fluid pressures in the subsurface. Mechanical properties can be measured in the laboratory and qualitatively used to estimate rock integrity when incorporated with subsurface stress conditions.

Samples from seals for 27 reservoirs were collected and analyzed for detailed lithology, pore size, and rock mechanical properties. On the basis of this sampling, all major rock types can act as local caprock seals for hydrocarbons. Evaporites and ductile clay shales are the most likely rock types to act as regional caprock seals because of their small pore size and ductile mechanical properties. Limestones, dolomites, siltstones, and sandstones can act as local caprock seals based on this sampling.

SCHOWALTER, TIM T., Mosbacher and Pruet Oil Producers, Denver, CO

Prediction of Lateral Seal Capacity from Core Data

Mystery Reef field produces oil from a porous stromatoporoid, limestone reef buildup. Only a small part of the total reef porosity is filled with oil. The maximum oil column in the field is 120 ft (37 m). The upper half of the column is sealed by marine shales that filled in depositional topography. The lower half of the oil column is sealed by the reservoir-equivalent fore-reef facies.

Lateral seal capacity, in terms of vertical oil column, were calculated from capillary pressure curves for five wells updip from the field. The seal capacity for the lowest displacement pressure rock in each well ranged from 10 to 150 ft (3 to 46 m). This spread of values for the updip reservoir equivalent facies at Mystery Reef field suggests that the prediction of lateral seals from core samples can provide only a very rough approximation of seal capacity in heterogenous carbonate rocks.

Two of the five wells studied updip from the field were oil stained in the reservoir equivalent horizon. Calculations of the minimum oil column necessary to explain the oil shows in these rocks range from 10 to 84 ft (3 to 26 m). Seal capacity of the higher displacement pressure oil stained rocks ranges from 60 to 84 ft (18 to 26 m). These values are similar to the oil column known to be trapped by the sampled fore-reef facies. Estimates of lateral seal capacity from core data should put the greatest emphasis on the oil stained samples with the highest seal capacity.

SCHRANK, JOSEPH A., and ERCILL HUNT, Schlumberger-Doll Research, Ridgefield, CT

Core and Log Analysis for Subtle Trap: Cotton Valley Tight Gas Sand

Several Cotton Valley zones that appear wet from standard log calculations have proven to be gas productive in recent

months. In an attempt to understand this phenomenon, a case study was performed in conjunction with Champlin Petroleum Co. on cores from the Carthage field, east Texas. The zone studied was of low resistivity (less than 2Ωm) which, when combined with porosity (16%), calculates very high water saturation (>60%) using the standard Archie equation and $m=n=2$.

Geologic studies indicate the low resistivity zone was deposited as a middle to upper bar sequence exhibiting massive and laminated bedding while a normal resistivity zone (~8Ωm) immediately below exhibits both a dense characterless section and a lower bioturbated facies with marine trace fossils.

Examination of the pore system using an SEM shows authigenic illite (identified by XRD) lining the pores and pore throats in both zones. Authigenic clay precipitation was subsequent to the development of quartz overgrowths and prevented complete occlusion of the pore system by the quartz. Secondary intergranular porosity is developed where feldspar grains have undergone dissolution.

The total porosity of the low resistivity interval (16%) is twice that of the normal resistivity zone (8%). Permeability is low throughout the interval (< 20 md), but somewhat higher in the low resistivity zone. Cation exchange and surface area measurements indicate that the authigenic clay is of equal volume in each zone. However, electrical measurements suggest greater rock conductivity and lower m and n Archie parameters in the low resistivity zone. The petrophysical and geologic data collected on the Cotton Valley provided more realistic petrophysical parameters for water saturation calculations, and led to a better understanding of the pore network and origin of the low resistivity interval.

SCHREIBER, B. CHARLOTTE, Queens College (CUNY) Flushing, NY, and Lamont-Doherty Geol. Observatory, Palisades, NY, JUDITH A. MCKENZIE, Geology Inst., Swiss Federal Inst. Technology, Zurich, Switzerland, and ARVEDO DECIMA, Ente Minerario Siciliano, Palermo, Italy

Evaporitive Limestone: Its Generation and Diagenesis

The Calcare-di-base is the only significant carbonate facies of the upper Miocene evaporites of Sicily. It was deposited within an exceedingly saline but marine water body adjacent to older, exposed carbonate terranes which surround the depositional basin. This somewhat dolomitic limestone is commonly cavernous or brecciated at outcrop and contains numerous zones of evident halite dissolution. It also interfingers with thin gypsum stringers in many areas and overlies diatomites of variable thickness. Based on petrographic and isotopic studies, it appears that this limestone was produced by diagenetic processes from an original aragonitic mud containing displacive halite hopper and massive halite zones. Regional variation in carbon-13 ($\delta^{13}C$ from 0 to 49 ppt PDB) and oxygen-18 ($\delta^{18}O$ from +6 to -5 ppt PDB) can be tied to variations in the mineral content of the original sediment and to later diagenetic waters and their organic content. The very negative carbon-13 values and the presence of native sulfur are indicative of the calcitization of gypsum, the by-product of the life processes of sulfate-reducing bacteria. These bacteria utilize part of the available and commonly copious organic matter associated with both the carbonate and with the diatomite. Inversion of the original aragonite to calcite has resulted in expulsion of strontium from the carbonate crystal lattice and the formation of celestite ($SrSO_4$) which now fills the voids left by the dissolution of halite, and the associated pore spaces.

SCHWARTZ, DANIEL E., WILLIAM E. HOTTMAN, and STEPHEN O. SEARS, Shell Development Co., Houston, TX