associated with thin cratonic sediments contain 80% illite in the mixed-layered species, and these rocks were probably never heated over 60°C. In addition, many shales and limestones of Devonian age and older contain almost pure illite despite histories of only moderate burial depths.

Studies of shales near contacts with basaltic dikes show that compositions near 80% illite are associated with peak temperatures (calculated) of approximately 300°C, though the duration of the heating event was short ($\approx$ 1,000 yr).

A synthesis of available information suggests that the smectite to illite transformation is kinetically controlled, and that a high-order rate law is required, despite laboratory synthesis results which fit a first-order kinetic scheme. These conclusions are not accepted by all investigators, and the details of the reaction stoichiometry, kinetic mechanisms, and the possible occurrence of equilibrium intermediate compositions have yet to be convincingly demonstrated.

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Character and Origin of Natural Gases from Wattenberg Area, Denver Basin, Colorado

Hydrocarbons are being produced at depths ranging from 4,000 to 8,500 ft along the axis of the Denver basin. On the basis of chemical and isotopic composition, gases from the three main reservoirs of Cretaceous age are interpreted to be of thermogenic origin. Gases from the Terry and Hygiene Sandstone Members of the Pierre Shale, the youngest reservoir, are the isotopically lightest ($\delta^{13}C_1$ values range from -55.7 to -49.2 ‰) and chemically wettest (C_1/C_{1-5} values range from 0.67 to 0.83), and are associated. Gases from the Codell Sandstone Member of the Carlile Shale generally become isotopically heavier ($\delta^{13}C_1$ values range from -47.8 to -43.9 ‰) as they become chemically drier (C_1/C_{1-5} values range from 0.76 to 0.8). During the main part of mature stage, oil and associated gas (isotopically lightest and chemically wettest) were generated from type II kerogen. During the hotter, later part of the stage, wet gas (isotopically heaviest and chemically driest) and condensate were generated from residual kerogen and from heavier hydrocarbons previously generated. Variations in character of the gases from the "J" sandstone, the oldest reservoir, are similar to those of the Codell; they become isotopically heavier ($\delta^{13}C_1$ values range from -47.9 to -43.1 ‰) as they become chemically drier (C_1/C_{1-5} values range from 0.84 to 0.87). Gases from "J" are interpreted to have been generated at similar levels of maturity as those of the Codell, but from type III kerogen. These gases are nonassociated and are isotopically heavier and chemically drier at similar levels of maturity than are those generated from type II kerogen.

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Recognition of Anhydrite Dissolution—A Cause of Secondary Porosity in Two Petroleum Reservoirs

Rectangular and "stair-step" pore reentrants in carbonate mudstones have been recognized previously as indirect evidence for anhydrite dissolution. In this study, direct evidence for dissolution of interstitial anhydrite in subsurface rocks includes: (1) cleavage-related dissolution fringe on anhydrite crystal surfaces and (2) isolated remnants of optically continuous (formerly poikilotopic) anhydrite. Influenced by the prominent cleavages, the dissolution fringe on the surfaces of the anhydrite crystals consists of a series of sharp, right-angled projections and reentrants. Experimentally etched anhydrite surfaces exhibit features that directly compare to the dissolution fringe, whereas experimentally grown anhydrite does not.

Anhydrite in both the dolomite grainstones of the Permian San Andres Limestone in the Vacuum field, Lea County, New Mexico, and the sandstones of the upper (Permian) part of the Minnelusa Formation in the West Mellot Ranch field, Crook County, Wyoming, exhibited these direct evidences, demonstrating the presence of secondary porosity after anhydrite.

We deduced the following sequence of anhydrite dissolution within these rocks. Slow incipient dissolution began along the boundaries between anhydrite and adjacent minerals. From these intercrystalline boundaries, solutions penetrated anhydrite cleavages, leading to more rapid preferential dissolution perpendicular to the more prominent cleavage planes. The widened cleavage planes, together with intercrystalline boundaries, acted as conduits for removal of dissolved ions. In the final stage, as dissolving anhydrite borders retreated toward pore throats, dissolution slowed and was, again, restricted to intercrystalline boundaries. This process was repeated in adjacent interstices.

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Mixed Siliciclastic and Carbonate Sedimentation Within Spar Mountain Member of Ste. Genevieve Limestone, Hamilton County, Illinois

The Spar Mountain Member of the Ste. Genevieve Limestone (middle Mississippian) in Hamilton County, Illinois, consists of 40-60 ft (12-18 m) of interbedded limestones, shales, and sandstones. Five cores and 1,400 electric logs were used to delineate two shallowing-upward carbonate cycles and 2 major clastic pulses within the Spar Mountain. Eight lithofacies representing 6 depositional environments were identified. They are: (A) echinoderm-brachiopod dolomicstone to packstone (outer ramp), (B) ooid-peloidal grainstone (intermediate ramp), (C) skeletal grainstone (intermediate ramp), (D) ooid-molluscan-intraclastic wackestone to grainstone (inner ramp), (E) pelletal-skeletal wackestone (inner ramp), (F) quartzarenite (channelized nearshore), (G) quartz-sublithic arenite to wacke (delta platform), and (H) quartz mudstone (prodelta, delta platform).

Deposition occurred on a southwest-dipping carbonate ramp, with siliciclastic sediments originating from the northeast. The sequence of facies and their inferred depositional environments record 2 major progradational episodes. Oolitic facies are interpreted to be of tidal-bar belt origin and quartzarenite facies are interpreted to be of delta–distributary channel origin. Their distribution is partially controlled by antecedent and syndepositional topography. Many of these paleotopographic highs are positive features today and yield pinch-out stratigraphic relationships. Paleogeographic reconstructions demonstrate that the primary control on facies distribution was the position of the delta proper along strike. However, depositional topography also influenced sedimentation, particularly in the sand-sized fraction. Using this concept, better prediction of underlying porous buildups (ooid shoals) is possible if thickness of the overlying siliciclastic is known. Within buildups, a complex diagenetic history complicates the distribution of porosity.

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Trenton Formation in New York, a Computer-Aided Study

The Trenton Formation is an Upper Ordovician sequence of interbedded limestones and limy shales that extends from the Hudson River valley in the east throughout the western part of New York state. It was one of the first gas-producing reservoirs in the area with most of the more than 300 test wells producing or indicating natural gas.

Subsurface information on the Trenton includes century-old reports, operators tops, sample logs, and geophysical logs. The logs, run over more than a 40-yr span, vary widely in type, lithology response, and depth scale. To aid interpretation, all available data were added to the New York state computer data base for map processing, and the geophysical logs were digitized for uniform evaluation and presentation. Individual log curves were corrected to a standard lithology response, combined, and played out as a series of standard control cross sections. Computer posted and contoured maps were constructed and compared to log sections for correction of errors. Finally, geologic interpretation was added to the maps and cross sections to produce a new evaluation of the Trenton Formation.

The Trenton in the subsurface can be divided into three distinct members with a disconformity between the lower two. Depositional centers shifted from central New York for the lower member to the northern part of the state for the upper member. The formation is a fractured porosity reservoir with the main fracture zones located along basement-controlled tectonic structures. The main features trend northeast-southwest in the northern part of the state, whereas orthogonal, northwest-southeast trends dominate in the south.