naissance area, delineating areas of clay- and silt-rich soils suitable for irrigation and crop yield, denoting locations free from encroaching sand seas, and providing transportation and accessibility estimates.

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Subsurface Geology of Honor Rancho Area, Ventura County, California

Surface and subsurface data determine the San Gabriel fault geometry and history of faulting in the Honor Rancho area. The northwest-trending, east-dipping San Gabriel fault consists of two strands: an older, concave-upward strand, which becomes low angle at depth, and a younger, high-angle, planar strand. The two strands merge to form one high-angle fault southeast of the Wayside Honor Rancho oil field. West of the San Gabriel fault zone the Modelo Formation (lower and upper Mohnian) overlies granitic basement. West of the fault, the Modelo and Towsley (Delmontian) Formations are in fault contact with the Castaic Formation present only east of the older San Gabriel fault strand. The marine Castaic Formation (lower and upper Mohnian) unconformably overlies the nonmarine Mint Canyon Formation of middle to late Miocene age. The Pico Formation (Pliocene) unconformably overlies older strata on both sides of the fault. Despite lithologic similarities of the Pico on both sides of the fault, markers within the formation cannot be correlated across the fault. The Saugus Formation (Pleistocene) unconformably overlies the Pico Formation and correlates well across and within the fault zone. Ease of correlation suggests that most of the right slip along the San Gabriel fault occurred prior to late Pliocene time. There appears to have been no lateral offset during Pleistocene and Holocene times, but primarily vertical displacement has occurred since the deposition of the Saugus Formation. However, seismic studies infer that right-slip activity is still present at depth along the San Gabriel fault.

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Dual Origin of Natural Gases in Subalpine Tertiary Basins

Many young sedimentary basins produce a great variety of natural gases ranging from deep wet gases to shallow dry gases. It is of considerable interest to find evidence for the origin of these gases, especially with regard to deep exploration.

In the Tertiary subalpine Molasse basin of south Germany, dry gases occur in shallow Oligocene to Miocene reservoirs ($\delta^{13}C_1 \sim -70$ to -60 parts per thousand), low C_{2+} gases in upper Eocene reservoirs ($\delta^{13}C_1 \sim -60$ to -50 parts per thousand), and wet gases in other Eocene reservoirs ($\delta^{13}C_1 \sim -50$ to 62 parts per thousand; the wet gases being partly associated with crude oils). Two alternatives for the origin of the gases should be considered: (1) the dry gases may be migrated wet gases which have been stripped of their C_{2+} components and have been enriched in carbon 12 isotopes; and (2) the dry gases are of biogenic origin.

Carbon and hydrogen isotope analyses on gases in the Molasse basin have brought direct evidence for the dual origin of these gases. The shallow dry gases are of biogenic origin, as shown by the direct relation between the deuterium isotope ratios of the methane and their associated waters. The wet gases are of thermogenic origin. The scatter in the carbon isotopic composition and the C_{2+} concentration in this particular basin is due to downmixing of the bacterial gases to deeper strata owing to an underlying underpressured zone. C and H isotope analyses on gases from two other Tertiary subalpine basins (Austria and northern Italy) have shown the dual-origin concept to be generally applicable to these basins. In particular the D/H and $^{13}C/^{12}C$ patterns of the gases reflect mixing processes and thus give information on the general hydrodynamic situation of the basins.

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Porosity Relations in Chalk Reservoirs

Oil and gas reservoirs in chalks of the Gulf Coast, Denver basin, and North Sea show similar porosity relations. Most of the storage capacity in the three areas comes from the preservation of primary porosity. Normally, the high initial porosity (60 to 75%) of chalks is progressively lost during burial owing to mechanical and chemical compaction effects. Thus, in many areas of the Gulf Coast and the Western Interior, paleoburial depths of about 1,000 to 1,500 m (3,300 to 5,000 ft) form an economic lower limit for exploration because primary porosity has been drastically reduced at greater depths.

Three factors can strongly influence this relation of porosity and burial depth. First, fracturing can greatly improve the effective permeabilities of chalk reservoirs. Fracturing related to gentle flexuring, salt-dome tectonics, or fault zones has a major influence on the reservoir characteristics of North Sea and Gulf Coast fields and may be involved in Western Interior fields as well. Second, abnormally high pore-fluid pressures (geopressures) reduce or completely halt mechanical and chemical compaction and thus aid in the preservation of primary porosity. In the North Sea and offshore Louisiana, geopressuring has allowed preservation of as much as 40% porosity at depths of greater than 3,000 m (10,000 ft). Finally, early formation of biogenic methane (from bacterial decomposition of organic matter contained within the chalks) or early introduction of migrated hydrocarbons to the point of virtual oil or gas saturation (as in some North Sea chalks) may also be instrumental in porosity preservation during burial.

The porosity relations in chalks, although fairly complex, are far simpler than those typically seen in shallow-water limestones. Thus, based on relatively sparse data, reservoir properties and petroleum potential of chalks can be reliably predicted throughout large areas.

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