ity of the patterns from such diverse areas and sediment types suggests that the distribution of dolomite in these sediments is not due to random groupings and may be a consequence of a common global cause.

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Fibrous Calcium Sulfate in Veins

In an extensional vein, fibrous anhydrite is reported for the first time. It resembles satinspar and is termed "satinspar-A." Satinspar-A contains most features typical for satinspar (subhorizontal attitude of the veins, vertical fibers, a parting separating a lower from an upper seam, incorporated wall-rock fragments), but several observations are new, such as the stacked nature of the fibers, tapering of wall-rock fragments, pressure shadows next to the wall-rock fragments, and parabolic alignment of the fragments.

Previous interpretations of satinspar veins are unsatisfactory and partly contradictory. The combination of the foregoing features leads to a generally applicable interpretation of the mode of infilling of veins of this type. In this process, the veins are opened owing to vertically tensile stress. The vein-filling crystals grow centrifugally outward from the initial plane of rupture (which now forms the parting) keeping pace with the dilation. The mode of incorporation of wall-rock fragments in the fibers requires repeated differential opening of the fissure. Thereby, the wall-rock and fiber interfaces rupture in a statistically alternating fashion.

The source of the calcium sulfate may be adjacent evaporite beds but, at least, in the case of satinspar-A, an external source is indicated by trace-element data and the absence of evaporite deposits in the area. In contrast to previous interpretations, the hydration of anhydrite to gypsum in the host rock is not a prerequisite for the formation of satinspar veins.

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Geology of Fulmar Oil Field, United Kingdom Sector, Central North Sea

The Fulmar field is situated within the United Kingdom sector of the central North Sea, 170 mi (270 km) southeast of Aberdeen, in water depths averaging 265 ft (81 m). The field was discovered in 1975 when Shell/Esso well 30/16-6 established the presence of an important oil play within shallow-marine sands of Late Jurassic age in the southwest Central graben of the North Sea basin. The well encountered an oil column of 668 ft (204 m) within apparently homogeneous sandstones displaying excellent reservoir properties. Commercial production was confirmed by an appraisal well, and 4 development wells were pre-drilled from a subsea template prior to platform production, which commenced in February 1982. The reservoir geology was consequently found to be more complicated than originally thought and has led to a diversity of depositional and structural models. To date, 23 development wells have been drilled. Current recoverable oil reserves are estimated at 427 million bbl with an oil gravity of 40° API.

Fulmar field is operated by Shell U.K. Ltd. on behalf of the Shell/Esso North Sea Venture and the Fulmar Unit.

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Fracture Permeability and High Initial Water Cut in a Carbonate Gas Reservoir

Waveland field in Hancock County, Mississippi, produces gas and condensate from the Lower Cretaceous Mooringsport Formation at approximately 13,400 ft. Total gas reserves have been estimated at 256 bcf. The reservoir is a fractured lime packstone, containing milliolid and orbitolinid foraminifers, mollusk fragments, and echinoderms. Core plug permeability is low, commonly below 1 md, yet productive wells flow at rates of as much as 8,000 MCFGD. Thus, fracture permeability is an important reservoir property. Short-term flow tests can be misleading, as productive wells may initially produce an uneconomically high water cut for several days.

The trap is a south-southwest-plunging anticline with no apparent structural closure to the north. A map of averaged, thickness-weighted porosity values for productive stratigraphic intervals indicates that porosity does not decrease across the northern limit of production. In order to compare the productivity potential of zones with varying porosity and water saturation, Buckles Numbers (product of porosity and water saturation) were mapped for zones within the productive stratigraphic interval. Averaged, thickness-weighted Buckles Numbers indicate that productivity potential does not decline across the northern limit of the field. Thus, it is concluded that the northern (updip) extent of effective fracture permeability controls the northern limit of production at Waveland field.

High initial water cut indicates that water is in the fractures and gas and water are in the matrix. The presence of water in fractures adjacent to rock with much narrower effective pore-throat radii is a normally unstable situation, as capillary pressure would be expected to result in the matrix imbibing water and releasing gas to the fractures. It is proposed that fracturing occurred after hydrocarbon migration and that there is little or no fluid exchange between fractures and matrix prior to wellbore drawdown.

Waveland is an example of a field where limits of productivity are controlled by permeability rather than by porosity, hydrocarbon saturation, or trap geometry. Buckles Numbers maps are a useful tool for describing productivity potential of similar fields.

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Valencia Fan (Northwestern Mediterranean): Channelized Distal Deposition Fan Variant

The Valencia Fan, a large deep-sea depositional system in the western Mediterranean Sea, developed in the structural depression between the Valencia Trough and the Balearic Basin Plain. Six main lithoseismic units are identified from 6,000 km of sparker profiles. Channelized and irregularly stratified units predominate. It is inferred that the sedimentary processes controlling the development of these units include channelized sediment flows that evolve downfan into sheet flows. Three fan depositional provinces are differentiated on the basis of the relative proportions of lithoseismic units and the inferred sedimentary processes.

Regularly stratified seismic units predominate in the non-fan environments. These units are dominated by fine-grained deposits resulting from hemipelagic settling and overbank flows from turbidity currents. Distal flows from the continental slopes of the Iberian Peninsula and Balearic Islands also contribute sediment for the development of these environments. The wavy units flanking the upper fan probably resulted from migrating sediment waves, whereas transparent units are attributed to extensive mass flow. The Valencia Valley is largely an erosional feature across which sediments from several source areas bypassed to the distal, deep-sea depositional system of the Valencia Fan. Deposition begins at the mouth of the valley where it is constricted by a volcano and beyond which there is a break in slope.

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Upper Jurassic Norphlet Eolian Dune, Wadi, and Marine Petroleum Reservoirs, Central and Eastern Gulf of Mexico Regions

The Norphlet Formation (Upper Jurassic) of the central and eastern Gulf of Mexico regions accumulated under arid climatic conditions. Norphlet paleogeography in southwestern and offshore Alabama and the Florida Panhandle was dominated by a broad desert plain rimmed to the north and east by the Appalachian Mountains and to the south by a developing shallow sea. The desert plain extended westward into eastern and central Mississippi. Quartzose sandstones were deposited as dune and interdune sediments. The source of the sand was adjacent and updip alluvial-fan, plain, and wadi deposits. Wadi and playa-lake sediments also accumulated in the interdune areas. A marine transgression was initiated during upper Norphlet deposition resulting in the reworking of previously deposited sediments.

Petroleum reservoir rocks consist primarily of quartzose sandstones that are eolian dune, wadi, and marine in origin. The high-angle (up to 30°) cross-bedded eolian sandstones are moderately well-sorted to well-