A system of large to small northwesterly flowing braided streams, fed from the quartz-rich southern source, deposited clean, laterally persistent, reservoir sands (braided fluvial and delta front facies) and impervious sealing shales (prodelta slope and prodelta shelf facies) across the slowly subsiding Saharan Platform. These deposits can be traced northward in the subsurface, across the entirety of western Libya, into the outcrop in the Jebel Nefusa, the northern limit of onshore control. Deposition ultimately extended northward into the more rapidly subsiding, organic rich, Gabes-Sabratha basin.

Simultaneously, the locally sourced reservoir facies were deposited, north-northwesterly, from the region of the Garian basement high. Coarse conglomerate quartz sands (braided fan delta plain facies) were transported a short distance to the Jebel Nefusa and northward, forming a wedge of clean, reservoir quality sands (braided fluvial and delta front facies) and sealing shales (prodelta slope and prodelta shelf facies) lying below well control in the Gabes-Sabratha basin area immediately adjacent to the Libyan coast due west of Tripoli.

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Lithofacies and Paleontology of Late Paleozoic Allochthonous Deep-Water Carbonates: Example from West Texas Subsurface

Twenty-one lithologies have been identified in cores of lowermost Wolfcampian limestone and shale in six wells in Reagan and Crockett Counties in the general area of World field, Midland basin. These lithologies are summarized into four major lithofacies: (1) floatstone and variably compacted rudstone containing angular, lithologically diverse, platform-derived lithoclasts and bioclasts in a clayey or marly matrix; lithoclasts are a product of disintegration of lithified platform facies, probably Wolfcampian; (2) interbedded shale and thin, horizontal, and in places ripple-laminated, carbonate sands mainly of allochthonous bioclasts; (3) micritic rudstone and wackestone containing platform-derived micritic intraclasts and bioclasts; this facies is variably porous with intergranular, moldic, solution-enlarged moldic, intragranular, and fracture porosity; (4) argillaceous packstone and wackestone with allochthonous bioclasts and intraclasts and semi-intraclasts of off-platform origin; this facies displays a variety of soft sediment deformation features.

Facies components probably were supplied and emplaced episodically by a variety of shelf edge and slope processes during a time of faulting in the area. Syndepositional faulting is interpreted from thickening of strata on downthrown sides of faults. Rudite-size clasts were transported 15 mi (24 km) or more from the Central Basin platform to the west. Finer detritus swept basinward for much greater distances. Limited comparison is made with carbonate sediments of Exuma Sound, Bahamas.

Off-platform Wolfcamp facies abruptly overlie and contrast strongly with a variety of Des Moines (Strawn) shallow subtidal platform facies displayed in three cores. The contact, present in one core, is interpreted primarily as a nondepositional disconformity.

Age and facies determinations from the cores significantly alter correlations and interpretations made with wireline logs alone, resulting in improved exploration play concepts. Allochthonous carbonate complexes may well provide new, potentially important reservoirs in this region.

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Holocene Gypsum Types and Formative Processes in Tidal Flat Settings, Carnarvon Basin, Western Australia

Study of gypsum presently forming in terrigenous and carbonate tidal flats along the semiarid coastline of Western Australia indicates that gypsum crystal habits, textures, structures, and fabrics developed on or within host sediments can be correlated with the physical, chemical, and hydrologic conditions of formation. By treating the study of gypsum from a sedimentologic approach, a classification of gypsum types is developed which allows comparative analysis and appears to be applicable to the interpretation of ancient evaporitic sequences.

Gypsum precipitated on a substrate from a free-standing body of water crystallizes in a habit dominated by the prism (110) and displays variations in texture, fabric, and structure that are related to the maintenance or progressive change in environmental conditions within the brine body. The action of physical and organic agencies is important in the genesis of the fabrics and structures displayed and in their destruction to form clastic gypseous sediments.

Gypsum precipitated within a host sediment crystallizes in a habit dominated by the hemi pyramid (111) and displays textures, fabrics, and structures that are related to host sediment properties, brine chemistry, ground-water hydrology, and the mechanisms for maintenance of such environmental conditions. Gypsum emplacement acts to disrupt and modify sedimentary features within the host and to form new textures, fabrics, and structures which are related to, and overpoint, their precursors.

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Sunnyside Petroleum-Impregnated Sandstone Deposit, Uinta Basin, Utah

The Sunnyside oil-impregnated sandstone deposit is a giant, exhumed oil field which occurs in the Green River Formation (Eocene), southwestern Uinta basin, Utah. The updip limit of the deposit has been eroded; thus, the precise mechanism of entrapment cannot be determined.

The deposit occurs within a transgressive continental and lacustrine sequence. The alluvial Colton Formation (early Eocene) underlies the deposit and grades into marginal lacustrine strata of the overlying Green River Formation. The lower part of the marginal lacustrine sequence is predominantly deltaic, but the upper third is interbedded with open lacustrine facies. The uppermost part of the Green River Formation in the area is eroded.

Petroleum-impregnated sandstone beds occur throughout the approximately 1,370 ft (418 m) of exposed marginal lacustrine facies. However, the main part of the deposit has a gross oil column of at least 860 ft (270 m) of which 640 ft (195 m) are petroleum-saturated siliciclastic rocks.

The deposit is exposed only on the southwest side and at the northwest corner. Only 12 significant wells were drilled in an area of 20 sq mi (52 sq km) prior to 1979. Thus, the limits of the deposit and the contained petroleum resource are difficult to assess. The delineated part of the deposit contains about 2.2 billion bbl of petroleum in place. The downdip limit of the deposit has not been defined.

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Controls on Reservoir Quality of Sandstones, Cotton Valley Group (Upper Jurassic), East Texas Basin, Texas

Sandstones in the Cotton Valley Group are poor-quality gas reservoirs that require massive hydraulic fracturing for economic production. Burial diagenesis of these rocks has resulted in extensive cementation and grain replacement that, with few exceptions, has reduced porosity to less than 10% and permeability to less than 0.1 md. Major diagenetic minerals are quartz and carbonates (calcite, ankerite-dolomite) with clay minerals, albite, and anhydrite present in subordinate amounts. The abundance of cement is related in part to initial sandstone composition. Cotton Valley sandstones are very fine to fine-grained, moderately to well-sorted quartzarenites and subarkoses. In quartzose sandstones, pore-filling cements average between 15 and 20% of the rock volume, whereas in feldspathic sandstones cements usually comprise over 20% of the rock volume. These cements eliminate most of the primary intergranular porosity leaving a series of nearly isolated voids connected by submicron-size pore throats. Although blockage of pore throats by authigenic clay minerals locally contributes to low permeability, quartz and carbonate cements usually line pores and appear to more effectively block pore throats.

Porosity preserved in the Cotton Valley consists of primary intergranular and secondary dissolution voids. Most secondary porosity results from dissolution of feldspar and chert; a sparse amount of secondary voids originate from dissolution of shell fragments and possibly calcite cement. Dissolution porosity is locally the most abundant type of porosity, particularly in feldspathic sandstones, but is usually associated with inadequate permeability to improve reservoir quality. Secondary voids are not interconnected because their distribution depends on the presence of soluble grains, which are dispersed in the sandstones. Highest permeability is present where primary intergranular porosity forms over 50% of the total porosity.

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Computer-Aided Offshore Reservoir Delineation

Delineation of discrete reservoirs is essential in the development of a petroleum field. This may be especially complex in offshore situations where numerous wells deviate from one or more platforms. An offshore field in southern California is an example where reservoir delineation was needed prior to designing a secondary flooding program.

A data base, containing directional survey data and measured depths of stratigraphic horizons, was used to generate structural cross sections at user-defined planes. These cross sections aided in the structural interpretation by outlining the plunging anticline, identifying faults, and revealing the variability in zone thicknesses.

Digital well-log data were used by the Stacked Curves System to assist in the stratigraphic interpretation. Color stratigraphic cross sections were generated on a zone-by-zone basis to compensate for the changing locations of the deviated boreholes. Lithology and porosity variations were easily determined from the color cross sections.

Merging the information obtained from structural and stratigraphic cross sections provided a detailed geologic picture of the field allowing the strategic location for injection wells.

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Sedimentology and Petroleum Geology, Spirit River Formation (Lower Cretaceous), Deep Basin, Alberta

The Spirit River Formation is subdivided into three members in northwest Alberta. The basal Wilrich Member consists of two 50 to 100-m thick upward-coarsening cycles of marine shales, siltstones, and sandstones. The Falher Member consists of nonmarine clastics and coals in the southern part of the area. Around the Elmworth gas fields, it is composed of five transgressive and regressive cycles in which marine and nonmarine conditions alternated. Each cycle can be traced northward into a laterally extensive upward-coarsening marine cycle.

The gas reservoirs are complexly interbedded fine conglomerates and sandstones. Conglomerates interpreted as fluvial deposits have sharp bases, moderate to poor sorting, some cross-bedding, and variable amounts of sandy matrix. Those interpreted as beach deposits are moderate to well-sorted, horizontally bedded, and may lack matrix entirely. A complete gradation exists between the types, which are closely interbedded. Shoreface and beach sandstones are fine grained, well sorted, burrowed, and have near horizontal laminations and truncation surfaces. On a large scale, this shore-zone complex is best considered a wave-dominated delta. The Notikewin Member is the final seaward progradation of this system.

Most sandstones in the Falher have less than 6% porosity and 1 md permeability whereas the reservoirs may have 20% porosity, much of which is secondary, and several darcys permeability. Early cementation, then formation of secondary porosity in the delta complex followed by deep gas generation have created a combined stratigraphic-diagenetic trap.

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Depositional Environments in Lower Cretaceous Gates Member, Northeastern British Columbia

The Lower Cretaceous Gates Member, which outcrops in the Rocky Mountain Foothills of northeastern British Columbia, consists of approximately 300 m of marine and nonmarine clastic sediments. The lower unit consists of several coarsening-upward marine cycles, which thicken and increase to the north. Thin coal seams at the top of some of these cycles thicken to the south and pinch out northward. Sediments in the middle unit of the Gates were deposited in a nonmarine environment and include several thick coal seams which are economically important. Fluvial sandstones and conglomerates in this interval were deposited in rivers which flowed in general to the north, subparallel to the tectonic strike and into a paleocoastline which was trending approximately east-west. Three major fluvial conglomerates are recognized and are interpreted as indicating three pulses of tectonic activity in the source area to the southwest. During the deposition of the upper unit of the Gates, a marine transgression occurred which reworked part of the underlying section and deposited locally a thin marine lag conglomerate. The overlying marine sandstones were deposited in a marine shelf and tidally influenced coastal environment. Coastal sand bodies include fining-up subaqueous channel deposits which grade laterally into coarsening-up sandstone units interpreted as marine shoals. The orientation of these sand bodies is at right angles to the paleocoastline.

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Depositional Environments of Ratcliffe Interval, Mississippian Madison Group, Williston Basin, North Dakota