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NEW CLASSIFICATION OF WATER-LAID CLASTIC SEDIMENTS

Because of their economic importance as petroleum reservoirs, water-laid clastic sediments may be classified usefully according to their mode of deposition, including transport, which determines to a great extent their lithologic composition. Although an infinite number of variables can affect deposition and composition, there are four principal processes of aqueous sedimentation which produce characteristic deposits herein designated as tractionites, gravitites, turbidites, and hemipelagites.

A *tractionite* is a bed of clean, winnowed sand or coarse clastics deposited by moving water which sorts the particles as it sweeps or drags them along the bottom. Tractionites are prevalent in river beds, beaches, offshore-marine areas where bottom currents are strong enough to move coarse sediments. Ripple marks and other current-produced features are common. These beds contain little if any fine-particle matrix.

A *gravitite* is a bed of poorly sorted clastics, ranging in size from clay to boulders, deposited by a sedimentary flow in which the motivating force is gravity that causes the sediment to move as a unit down a slope with sufficient gradient at speeds ranging from very slow creep to those of considerable momentum. Bedding features are poor because the particles are not in suspension and, therefore, are not able to respond hydrodynamically. Fossils, if present, are randomly oriented and scattered through the heterogeneous mass. If the velocity of movement becomes great enough, the sediments may be stirred sufficiently with water to form a suspension mixture capable of generating a turbidity current.

A *turbidite* is a well-graded sedimentary unit deposited rapidly from the suspended load of a turbidity current and includes all of the intervals, grading upward from coarse sand to silt and clay, resulting from a single flow. Because the prime motivating power of a turbidity current is the density differential between the turbid water with its suspended load and the clear water which it encounters, a turbidity current once generated can move along a flat bottom. Turbidites are well graded because particles in a suspension flow are able to respond hydrodynamically. If the suspended load includes a wide range of particle sizes, a "complete" turbidite is formed with at least three distinct divisions, the graded sand interval at the base overlain by the current-bedded interval and the pelitic interval. A turbidite is characterized by features indicating suspension flow, such as preferentially oriented megafossils, hydrodynamically sorted microfossils, and a high (10–30 per cent) silt-clay matrix in the graded sand interval. Turbidite contains only reworked faunas if faunas are present.

A *hemipelagite* is a layer of marine debris formed by the slow accumulation on the séa floor of organisms and fine terrigenous particles. Though a hemipelagic deposit generally caps a turbidite, the hemipelagite is not part of the turbidite but is indicative of an interval of quiet between turbidity-current flows. Its thickness is related to the time during which this type of sedimentation takes place without interruption. Hemipelagite contains the only indigenous fauna in the turbidite sequence.

Examples of the preceding sedimentary processes and deposits are discussed with the aid of slides and motion pictures.

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APPLICATION OF UTILITY THEORY TO PETROLEUM DECISION-MAKING

The application of logic to the exploration for minerals may be divided into two discrete phases—preparation and analysis of the raw data, and the decision-making process based on such analyses. Both involve non-random characteristics that are not entirely encompassed by the procedures of classical probability and statistics methods, which are based largely on the supposition of random systems.

This paper is a report on a study in depth of the decision-making process in several petroleum companies, one of which is a "major." The purpose of the study is to define better what role "utility theory" might play (if any) by establishing whether or not characterization of individuals and groups is feasible. This necessarily involves the establishment of criteria for such characterization so that the degree of the non-random factors may be better understood.

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EXPLOITATION OF CALIFORNIA OFFSHORE FIELD, PARCELS 14 AND 20A, HUNTINGTON BEACH, CALIFORNIA

Union was awarded Parcel 14 by the State of California in 1962 for a bonus of $6,110,000. In 1964 Union bought the southern part of the adjoining Parcel 20A from the Signal Oil Company. Development of both parcels is complete and resulted in a westward extension of the offshore Huntington Beach oil field.

Parcels 14 and 20A are located on the west-plunging nose of a large east-west-trending asymmetrical anticline. Oil is produced from upper Miocene division "C" sandstones, defined as the Upper Main (UM) and Main No. 1 (M-1) zones. Both of these productive sandstone zones thin and grade laterally into shale in an easterly direction, up the plunge of the anticline, forming a stratigraphic trap. Maximum net oil-bearing sandstone penetrated in wells is 512 feet.

Asymmetry of the structure is formed by a steep-dipping south flank, with a known maximum dip of 65°, and a shallow-dipping north flank averaging approximately 10°. The axis hades toward the north at approximately 70°.

Faulting on Parcels 14 and 20A is minor; two 50-foot normal faults have been mapped.

Thirty-eight wells have been drilled directionally and completed from Union's Platform *Eva* on 10-acre spacing. These wells are positioned on a five-spot water-flood pattern for future secondary operations.

An estimated 40 million barrels of 22° oil ultimately will be recovered from Parcels 14 and 20A by both primary and secondary recovery methods of depletion.

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STATISTICAL PROPERTIES OF DUNES GENERATED BY UNIDIRECTIONAL WATER CURRENTS

Field and laboratory studies of ripples and dunes formed in sand by unidirectional water currents show for coarse and very fine sand that the ripple index is related to median particle size and to flow intensity as measured by a dimensionless shear stress parameter. However, for medium-grained sand (0.25–0.50 mm.)