the present with non-dated intervals being virtually non-existent. One of the most interesting sets of facts to emerge has been the relative refinement of correlation attainable with different paleontological disciplines. A complete time scale based on mammalian correlations is presented. Special emphasis is placed on dating of rocks in the time-range 50,000–2 m. y. B.P., and thus on the time scale of human evolution.

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COMPARISON OF MARINE-BAR WITH VALLEY-FILL STRATIGRAPHIC TRAPS, WESTERN NEBRASKA

Marine-bar and valley-fill stratigraphic traps in the Cretaceous "J" sandstone in Cheyenne and Banner Counties, Nebraska, illustrate control of reservoir shape, size, and characteristics by depositional environment.

Reservoirs deposited as shallow-marine bars are elliptical lenses 2–5 miles long, 0.5–1 mile wide, and less than 25 feet thick. Sandstone grades laterally into marine mudrock. There are two generations of bars in this area, closely spaced stratigraphically, but with different directions of elongation. These lenses presently are tilted with a regional southwest dip. Entrapment is independent of structural closure. Most bar bodies are entirely oil-filled.

Reservoirs deposited as a valley-fill occur within a prism of sandstone more than 20 miles long, 2,000 feet wide, and 50–80 feet thick. The boundaries of this body are erosional. Oil is trapped only where the valley-fill trend crosses plunging anticlines. The valley-fill interconnects all pools as a single aquifer system.

Exploration and production efforts are guided by the following. Position of marine-bar reservoirs can be predicted by techniques which map gradients in sandstone-shale proportions, such as those based on mechanical logs. Bars in this area are scattered and not in chains; orientation is varied. Structure is unimportant. In contrast, valley-fill reservoirs are separated by erosional boundaries from enclosing rocks; hence, they can not be detected by examination of the enclosing facies. Where located, however, the valley-fill has great continuity and persistence of trend. Structure is vital. Valley-fill reservoirs have water drives and high primary recoveries, whereas marine-bar reservoirs have only solution-gas energy.

Environmental interpretation of these reservoirs is based on fossils, sedimentary structures, textures, facies relations, and geometry. A single core commonly allows correct interpretation. Exploration and production programs are guided profitably using environmental concepts at an early stage.

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MARINE GEOLOGY OF SANTA CRUZ SUBMARINE CANYON, CALIFORNIA

The beaches and shallow offshore areas of Santa Cruz and Santa Rosa, the two major northern channel islands off the California coast, are the sole source areas for sediment that ultimately is deposited in the Santa Cruz basin. The intermediate position in this three-stage sediment-transfer system is occupied by the Santa Cruz submarine canyon. Through a network of tributaries at its head the canyon receives material from the islands. The material is moved down the canyon axis and dispersed across the basin as a submarine fan. A main channel, with natural levees, persists across the fan and a series of distributary channels develop from it.

Cores recovered from the canyon axis and fan contained graded layers of sand and gravel, including one such unit 116 centimeters long .The gradation in this last unit is somewhat unusual, in that it differs greatly from the "fine-at-the-top, coarse-at-the-bottom" conceptual model of graded bedding. Instead, there is a constant compositional population with a modal class at $+2\phi$, which decreases in over-all percentage as the bottom of the unit is approached. A second, coarser-grained population appears midway in the unit, with a modal class at $+0.75\phi$. This second population increases in over-all percentage and shifts its modal class gradually to -4.25ϕ toward the bottom of the unit.

The coarsest particles in all the graded beds are disseminated in a narrow zone *above* the base of the bed. Thus the bottom of each graded bed is a zone of reverse graded bedding.

All graded sand and gravel layers are extremely clean, usually containing less than 1 per cent silt and clay. Contacts with overlying mud are sharp and distinct. Lower contacts, where visible, commonly are gradational. Detailed pipette analyses show that overlying "pelagic" mud in many places is graded (in the usual sense). Electron micrographs show a decrease of organic remains (diatoms, coccoliths, *etc.*) toward the base of the graded beds, with a marked, increase *at* the base. Maximum organic remains are in mud surrounding the sand layers.

The writer postulates the existence of an originally clean sand and gravel body that was able to move down the canyon or across the fan, *maintaining its internal integrity*. Such a body would exhibit properties described above. It may act as a triggering mechanism; itself setting off "true" turbidity currents.

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ATHABASCA OIL-SAND EVALUATION USING COMPUTER AND DATA-PROCESSING METHODS

A 4,000-acre oil-sand mining operation in northeastern Alberta is being conducted by Great Canadian Oil Sands, Ltd. The sandstones contain as much as 18 per cent by weight of low-gravity oil or tar, they are lenticular and interbedded with barren shale and siltstone. In order to determine in-place oil content and other ore-body characteristics, an extensive coring and well-logging program was conducted during the winters of 1963–64 and 1964–65. Using a comprehensive well-log-analysis computer program, core-analysis data, and a geological data-processing system, the average grade, in-place oil reserves, and other characteristics of the mining lease were determined. Of all logging devices tested, the formation density-laterolog 3 combination provided the best borehole measurements of porosity and water saturation. Numerous comparisons of core *versus* log analysis results indicate that accurate oil content can be ascertained in the oil-sands using conventional log-analysis methods. Core and log information was combined to produce continuous oil saturation, water saturation, porosity, and bulk-density profiles for each test hole. Stratigraphic correlations and oil-grade cutoff tops and bases also were included for each test hole. From this information numerous maps and cross sections for use in defining the ore body and in mine planning were produced, using the computer-plotting combination