



with "chemical" rocks as limiting members, represents a cross section of a Pennsylvanian cycle extending from seaward to landward (left to right) extremities. Examples show that this simple model is modified by local as well as regional conditions.

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RECENT CARBONATES OF ISLA MUJERES? QUINTANA ROO

Isla Mujeres, off the northeast tip of Yucatan, consists of oölitic dunerock. The Caribbean coast is subjected to heavy waves, and the sediments are coarse, well sorted, highly polished and rounded; coralline algae, carbonate rock fragments, *Halimeda* and coral are abundant. The lee (western) beach is protected; sands are finer, well sorted, dull, and angular with *Halimeda* greatly predominant. Straits separating Isla Mujeres from Yucatan are swept by strong northerly currents; sediments are poorly sorted, negative-skewed, and consist of a bimodal mixture of (1) dominant small, polished oölitic, and (2) subordinate coarse oölitic rock fragments with some skeletal grains.

Sorting of beach sediments is a sinusoidal function of mean grain size; best sorting is at 2ϕ , -3ϕ , and -8ϕ . Sorting values (σ) of 0.3-0.6 ϕ are characteristic of all beaches regardless of grain size, from fine sand to coral boulders, regardless of composition and regardless of wave energy of the coast. Protected bay sediments are muddy and poorly sorted (immature); sediments from current-swept straits are winnowed, but poorly sorted (submature); sediments of lee beaches are well sorted but dull and angular (mature); and sediments of beaches exposed to high waves are well sorted, rounded and highly polished (super-mature).

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RESEARCH AND THE PETROLEUM INDUSTRY

If research were to be considered as an industry in itself, it would rank among the largest in the United States. Ever since the beginning of World War II, the amount of money invested in research and development has been increasing much more rapidly than the Gross National Product (GNP); growing from a few tenths of a per cent of GNP in 1939 to about 3 per cent of GNP in 1961. Although research by and for the U. S. Government is now more than half of the total, the expansion of research in the petroleum industry has been almost entirely financed by that industry. Research in the earth sciences has become a large part of the petroleum industry effort. It is, however, different in many ways from research on processes and products. For many years, a lack of appreciation of the true nature and role of geological and geophysical research inhibited effective

integration of the results of research into the operations of the industry. By now, research is widely recognized as an important and valuable ally of the exploration geologist and geophysicist.

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DETAILED STRATIGRAPHIC CONTROL THROUGH DIP COMPUTATIONS

Recent dip interpretation techniques utilize high-density computations to define depositional and structural features. The definition of stratigraphic patterns is accomplished in both shallow and deep horizons. The method is of increased importance in the deeper provinces, where seismographic techniques lack resolution.

Faults may be recognized and defined, both as to direction of dip and to strike. Characteristic dip patterns delineate channels, bars, and unconformities. Definition of complex channeling has provided the necessary control for more efficient development of some deep South Louisiana fields. Patterns of deltaic depositions, with definition of foreset beds, are also apparent from dip computation results.

Reef structures can be located and defined by interpretation of dips resulting from deposition on the irregular reef surface, from talus slopes, and from differentially compacted formations.

In several instances, the presence of shale diapirs has been confirmed.

Machine computations of Dipmeter surveys, with dips computed as frequently as one per foot of hole, are particularly suited to these problems.

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ANALYSIS TECHNIQUES AND SIGNAL ENHANCEMENT METHODS APPLIED TO THE BELLSHILL LAKE STRATIGRAPHIC TRAP PROGRAM

A test program was conducted in the Bellshill Lake field to investigate the application of seismic techniques to finding the stratigraphic trap formed by the irregular sand bar type build-up within the Basal Quartz section controlling production in the field.

The seismic interpretative criteria were postulated from synthetic seismograms.

Controlled field tests were conducted to find the factors which influenced record quality, to examine the effect of each factor on the signal-to-noise ratio, and to evaluate the field techniques developed from the test results. Critical field techniques were the selection of charge sizes and hole depths yielding both suitable shot wave forms and a means for attacking the ghost reflection problem, the attenuation of shot generated boundary waves through wave length filtering with arrays of multiple seismometers, and the preservation of true amplitude information in the recording procedure. Special data processing techniques included the application of a velocity filter, the "pie slice" process to improve the signal-to-noise ratio without signal distortion, and the stacking of vertically distributed charges with a process designed to eliminate the ghost over a broad frequency range without signal distortion.

The emphasis in the experimental survey was in the methods of investigation and the particular balance in techniques which must be struck to solve an explora-

tion problem rather than in a demonstration of techniques as such.

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GEOLOGICAL SIGNIFICANCE OF THE MOONIE OIL FIELD DISCOVERY, QUEENSLAND, AUSTRALIA

The discovery of the first commercial oil field on the Continent of Australia has caused a reappraisal of the petroleum prospecting potential of all its sedimentary basins. The Moonie discovery marks the beginning of an oil-producing industry and has caused many preconceived ideas to be discarded. Geologically, Moonie is most significant for its contribution to the understanding of the structural and sedimentary history of the Surat Basin as related to the accumulation of petroleum.

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DEVONIAN GAS FIELDS IN BRITISH COLUMBIA: A PROBLEM IN CARBONATE PETROLOGY

Major gas fields in northeastern British Columbia occur in several types of carbonate porosity traps of Middle Devonian age. These traps consist of lenses or "patch reefs" in a shelf environment, barrier reef ridges at the shelf edge, and apparently of isolated bioherms in the adjacent basin. The reef limestones are primarily stromatoporoid rubble. These rocks apparently had high original porosity but, except where dolomitized, are now tightly cemented by calcite. As a result, production is now found only in the dolomitized rocks.

The process of dolomitization is controlled in part by original depositional environment, but is partly independent of original lithology. Exploration for these reservoirs, therefore, requires a study of both depositional environment and the cementation and dolomitization processes.

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ARAGONITE FORMATION BY MARINE BACTERIA

Investigations of the calcium and magnesium metabolism of marine deaminating bacteria have revealed that these organisms are capable of binding alkaline-earth elements on or in the cell wall-cell membrane complex. In actively metabolizing cells, both calcium and magnesium are taken up as a complex with amino acids and peptone. Accumulation of these elements during this phase, however, is low as compared with senescent cells. In the latter case, the accumulation of calcium is such that a given volume of cells will concentrate up to 100X the concentration in an equivalent volume of sea water. Magnesium concentration is considerably less and the element appears to be preferentially exchanged for calcium at this stage.

The nature of the binding force is under investigation but appears to be a type of weak adsorption or ion exchange. The bound calcium may be eluted from cells by washing with any isotonic fluid at pH's varying between 5 and 9.

Unwashed cells may be considered as small concentrated sources of calcium. When carbonate concentration becomes sufficiently high (from respired CO₂) and pH is at a minimum of 7.8 (from excretion of NH₃), calcium carbonate precipitation occurs as aragonite crystals with bacteria occupying the center of the crystal. It is surmised that bacteria may act as nuclei for precipitation in nature since the environ-

ment produced in static culture in the laboratory is similar to that produced in interstitial spaces of the upper sediments—only on a smaller scale. Examination of fine sediment particles from Florida Bay have revealed them to be largely calcified bacteria.

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DEVELOPMENT OF CLAY MINERAL ZONES DURING DELTAIC MIGRATION—SUBSURFACE RECENT SEDIMENTS OF THE EASTERN MISSISSIPPI DELTA AREA

Three clay mineral zones have been recognized in cores from Recent sediments of the eastern Mississippi Delta area. The clay mineral suite in each of these zones is apparently related to the position of the active Mississippi Delta as follows: (1) during the regressive St. Bernard subdelta phase, when the active delta was near the cored locations, the clay suite deposited there was richly montmorillonitic, reflecting the type of clay being carried by the ancestral Mississippi River; (2) when the site of active deltaic deposition shifted to the west of the cored locations (in this case down-current), local transgressive conditions developed in the eastern Delta area, and the clay included in the sediments deposited there was influenced more by local weathering conditions and by longshore drifting of clay from the more kaolinitic eastern Gulf province. These two factors probably combined to form the slightly more kaolinitic clay mineral suite which characterizes the two transgressive phases above and below the sediments of the St. Bernard subdelta.

Comparison of St. Bernard subdelta clays with modern Mississippi River clays indicates that the clay mineral suite carried by the river has become less montmorillonitic within the past few thousand years. The possibility exists, therefore, that the various ancient Mississippi River subdeltas may be characterized by distinctive clay mineral suites.

The highly montmorillonitic clay carried by the St. Bernard phase of the Mississippi River affected, to a limited degree, an area to the east outside of the actual subdelta. This wider distribution, which was probably brought about by oceanic, wind, and tidal currents, extends across some environmental boundaries and has allowed the Recent section of the Mississippi Sound to be subdivided and correlated chronologically with the St. Bernard subdelta section approximately 40 miles away.

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GEOLOGY AND PETROLEUM EXPLORATION, WESTERN ARCTIC ISLANDS

The Queen Elizabeth Islands of the Canadian Arctic Archipelago are considered most favorable for petroleum exploration. The main structural feature is the Parry Island fold belt extending from west-central Melville Island east across Bathurst and Cornwallis Islands and thence northeasterly. The strata within the fold belt are a conformable sequence of Ordovician to Upper Devonian beds. The age of folding is placed as Hercynian. South of the Parry Island fold belt, the Ordovician—Upper Devonian succession is essentially a gentle north-dipping homocline broken by the north-south-trending Boothia Arch on which movement occurred in late Silurian or early Devonian time (Caledonian). North of the fold belt, the Sverdrup Basin is a conformable sequence of Pennsylvanian to Tertiary strata. The sedimentary axis of the basin