important in recognizing individual environments of deposition; equally important is the association of the environments to one another. This relationship must be understood for correct paleogeographic reconstruction of ancient deltaic deposits. The manner in which a sequence of marine and deltaic deposits might accumulate in a segment of a basin with resulting stratigraphic relationships of associated environmentally determined facies, is illustrated.

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ORIGIN AND VARIATION OF FESTOON OR TROUGH CROSS-STRATIFICATION WITH PARTICULAR REFERENCE TO SEDIMENTS OF THE SYDNEY BASIN, AUSTRALIA

Recent papers on the origin and classification of cross-stratification by Allen have revived and stimulated interest in the use of cross-stratification as a tool for the interpretation of paleocurrents and environment of deposition. Cross-stratification has been described throughout the geological literature in numerous articles. Relationships between individual sets of large-scale cross-strata of relatively small size (5–30 cms. thick) have been frequently observed in outcrops that are sufficiently well preserved to allow a reconstruction of the pattern of the sets in three dimensions. However, descriptions of the stratification patterns of large (1–3 m. thick) cross-stratified units are rare. This is understandable since such units outcrop over large areas, and the outcrops required for the measurement of these units occur very infrequently.

Large cross-stratified units are well preserved along the coastline of eastern New South Wales in the vicinity of Sydney where sandstones of Triassic age, forming part of the Triassic-Permian Sydney basin, outcrop in horizontal or nearly horizontal attitudes along the rocky cliffs and headlands. At many localities it is possible to measure the areal extent of individual sets of cross-strata, enabling the construction of diagrams showing the cross-stratification pattern in three dimensions. Large individual sets of cross-strata commonly appear to be planar in random sections or in surfaces of small areal extent, but where they can be seen preserved over large areas, they are generally trough-shaped. The shape and distribution of the troughs may lend support to the theory that they have been formed due to migration of very large-scale linguoid or lunate asymmetrical ripples as suggested by Allen.

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RESIDUAL GRAVITY ANALYSIS OF THE MID-CONTINENT GRAVITY HIGH

The high speed computer has many uses in the geophysical industry. Early techniques of analysis of data which required much of the time of the geologist and geophysicist are now routinely done by the computer. New techniques which were impossible by desk calculator are now possible through the speed of these machines.

Important advances have been made possible by the computer in the analysis of gravity data. A new technique of gravity analysis involving the fitting of non-orthogonal polynomial surfaces to a collection of gravity data by the principle of Least Squares has been developed. This was suggested by Simpson (1954), Grant (1957), and others using surfaces of 2nd, 3rd, and 4th order to fit the gravity data. For small areas and small amounts of data these low-order surfaces were sufficient. More recent work by Haubrich (1960) developed the technique to the 7th order on the IBM 650. In modern usage, for large areas and several thousand data, high-order surfaces up to the 15th order are used. The use of these larger areas, and high-order surfaces, allows better geologic interpretation of an area as a whole rather than trying to fit together several small pieces. And, in fact, through the use of several polynomial surfaces of varying order, the small geologic or structural features may be separated from the large so-called regional features.

As an example of the use of this technique, we may examine the Mid-Continent gravity high in Iowa, Nebraska, and Kansas. The polynomial analysis shows a detailed correlation of the gravity residuals with both basement geology and Paleozoic structure. This area is an example of Precambrian structure controlling Paleozoic deformation. Features such as the Abilene anticline in Kansas, the Thurman Redfield structural zone in Iowa and other Paleozoic structures are directly tied to Precambrian fault zones along which later adjustment has taken place. Paleozoic synclines and basins reflect Precambrian structural lows. It is apparent in this area as in many others that this relationship of old zones of weakness to younger movement is the norm rather than the exception.

Unfortunately, the lack of drill holes makes study of the basement geology difficult. This leaves the task to geophysical methods. The use of the computer and new techniques of analysis improves our efforts but it is only through a combination of the geophysical methods, computers, and all available geologic information that we can get the most nearly accurate answer.

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DEEP-WATER SEDIMENTARY STRUCTURES, PLIOCENE PICO FORMATION, SANTA PAULA CREEK, VENTURA BASIN, CALIFORNIA

The Pliocene Pico Formation, according to paleogeographic and paleoecologic interpretations, was deposited in marine waters at least 300 m. deep. Sedimentation of mud, sand, and some gravel was largely the result of bottom-following underflows generally traveling west. Resulting sedimentary structures—some viewed in stilled-stages of development—are: stratification with eroded and deformed contacts, internal stratification, graded bedding, small-scale cross-stratification, disturbed bedding, fossils with preferred orientation, imbricated clasts and shells, ripple marks, flame structures, pull-aparts, load pockets, load waves, and many others.

Ideal graded bedding is generally rare, but most sandstones display grading superposed on other structures such as internal lamination. Thin but persistent strata with signature sedimentary structures imply infilling on a nearly horizontal sea floor by bottom-contact currents tending to level the accretional surface. Eroded and deformed contacts at the base of beds imply vigorous current impact and drag. Larger disruptions such as deformed or disturbed zones, several beds thick, may result from current drag rather than from gravity-induced downslope slumping. Accordingly, some penecontemporaneous folds are less reliable indicators of paleoslopes than current-induced structures such as cross-stratification.

Underflows, acquiring energy through flow down the trough margin, probably debouched from submarine canyons; many flows were ephemeral but others deposited relatively continuously for longer periods. Most underflows possessed sufficient energy to move a tractional load, and the stronger ones vigorously eroded and disturbed the sea floor. Complexity in form and genesis of the sedimentary structures dictates a comparable complexity in the depositing current.

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UNDERWATER STUDY OF RIPPLES IN EASTERN LAKE MICHIGAN

Underwater study of oscillation ripples in nearshore sediments of Lake Michigan indicates grain size and subaqueous topography to be dominant controlling factors in ripple magnitude and development. Depth of water is not a primary factor in the formation of ripples in this environment.

With the use of self-contained underwater breathing apparatus (SCUBA), ripples were measured at 389 stations in eastern and southeastern Lake Michigan. Measurements of water depth, distance from shore, and of amplitude, wave length, and orientation of the ripples were made at each station. The ripples range in size from 2.5 to 38 inches from crest to crest. Those larger than 9 inches are found only in very coarse sand in the topographic lows. The smaller ripples are always present on highs and may also be found in deeper water.

Although only the nearshore shallow environment (up to 20 feet of water) was investigated, ripples are present in 36 feet of water more than one mile from the shore.

Ripple crests are normal to the general wind direction, although variation of as much as 60° in wind direction does not have noticeable effect on their trend. Great change in wind direction causes formation of interference ripples and subsequent change in ripple orientation. The trend of ripple crests approaches that of the shoreline as the strand line is approached.

Heavy-mineral concentrations are common on ripple crests, generally on the landward side of the crests.

Flat-topped ripples, heretofore described as being formed by planing off during falling tides or water level, are present in 8.6 feet of water. Incomplete ripples are common where till crops out on the lake bottom. Secondary ripples are common in many ripple troughs, particularly in the large ripples.

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PEACE RIVER ARCH OF WESTERN CANADA

The Peace River arch is a pre-Devonian structure 250 miles long which was modified by post-Devonian tectonic events. It is situated in the west-central part of the Alberta basin in Western Canada.

The structure consists of Precambrian and Cambrian rocks which were tectonically elevated and formed an island in the Devonian seas. The island was enveloped in sedimentary rock by the close of Devonian time or very soon thereafter.

The arched area became slightly negative during Mississippian time and failure in the crestal part resulted in a horst and graben complex. The configurations oi deeply buried horizons were altered by these tectonic movements which depressed the pre-Devonian surface· A very moderate negative condition prevailed fn the area of the arch until about Middle Cretaceous time, after which the rate of subsidence was common to most of the Alberta basin.

The Laramide orogeny resulted in uplift and differential warping. The Alberta basin tilted westward and the arch formed a westward-plunging nose on the basement surface.

The present westward dip results in a number of large stratigraphic and structural traps along the east (updip) side of the arch. Major hydrocarbon accumulations were anticipated but only small pools have been found despite intensive search. The lack of major accumulations may be due to one of three factors or combinations of them: (1) a lack of source rocks surrounding the most important reservoir systems; (2) a loss of hydrocarbons up the slope of the island during a lengthy period of nondeposition, and (3) a lateral and vertical dispersal of hydrocarbons into numerous small pools in many reservoir systems and structural complexes.

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ELECTRONIC STORAGE, RETRIEVAL, AND PROCESSING OF WELL DATA

The storage, retrieval, and processing of geologic and engineering data by modern electronic computers present the geologist with a powerful tool in the solving of technical problems, but at the same time imposes upon him a requirement that he better organize his thoughts concerning the method of problem solution.

A major factor in the economics of processing data by computer is the cost of transcribing the basic information into a machinable form. In order to reduce this cost factor, an increasing number of oil and gas companies are entering into agreements with service agencies who transcribe the information from well bores onto punch cards or magnetic tape. The machinable data prepared by any one of these groups is generally referred to as a "well-data system." The various "well-data systems" which have begun in the past several years may by the end of this decade incorporate much of the drilling information from wells in the United States and Canada.

Proper use of a machinable well-data file can reduce the time and (or) cost of a particular study. The improper use of such a file, however, can have the opposite effect. Several uses of a machinable file are presented to illustrate the merits of the machine handling of data in different types of geologic and statistical studies.

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RELATIONSHIP OF MINERALIZATION TO PRECAMBRIAN STRATIGRAPHY IN THE NORANDA-MATTAGAMI LAKE-VAL D'OR DISTRICTS, QUEBEC

Most of the rocks are of Archean age and consist of volcanic-sedimentary complexes containing abundant intrusive rocks of ultrabasic to acidic types. Almost all rock types contain some economic or potentially economic mineral deposits.

Base metal deposits, mainly massive sulphides, generally occur at contacts within a particular group of lavas. The rocks beneath the sulphide deposits are rhyolite breccia in most areas and are overlain by andesite or porphyritic rhyodacite. The sulphides and the enclosing rocks appear to exhibit a close relationship in time and space.

Ore bodies containing gold are related to dioritic and granitic intrusive rocks. The loci of deposition tend to be near the contacts of major groups of sedimentary and