scale mountain building. Some changes in sea-level may be related to the size of ice accumulations at the poles.

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Geology and Exploration of Three Greater Bass Strait Basins, Australia

Three major Mesozoic-Tertiary basins lie in succession along the eastern one-third of the south coast of Australia within a distance of about 700 miles. The total area embraced is approximately 100,000 square miles, and it includes parts of three of Australia's six states. Fully three-fourths of the area is classified as an offshore shelf.

The general east-west alignment of the basins resulted from sharp taphrogenic breakdown across the generally north-south Paleozoic orogenic trend of eastern Australia and Tasmania. The main faults and many of the basin features have northeasterly or northwesterly trends, suggesting that rotational or transcurrent stresses and subsidence were involved in the breakup.

Sedimentation began at least as early as Late Jurassic. The succeeding Mesozoic development lacks uniformity over the area, but the Tertiary is more uniformly developed throughout. Several unconformities are recognized. Though not all sediments carry marine fossils, the contained waters are saline beyond the limits of the fresh water flushing onshore.

The Gippsland or eastern basin covers about 22,000 square miles. More than 12,000 feet of rapidly deposited Jurassic-Cretaceous clastic rocks fills a downfaulted central trough and overlaps the basin shelves on the north and south. About 10,000 feet of more widely extending Tertiary sandstone, shale, marl, limestone, and some coal, completes the basin fill.

The deeply silled Bass basin, which separates the island State of Tasmania from the mainland, covers about 35,000 square miles. The section is composed of 12,000 feet or more of sandstone, shale, marl, limestone, and some coal. Deposition began in the central part of the basin, probably as early as Late Cretaceous time, and continued through the Tertiary, progressively overlapping radially in all directions.

The western or Otway basin covers more than 40,000 square miles. The Mesozoic consists of sandstone, shale, siltstone, and mudstone. Deposition began during Late Jurassic time and continued, with laterally differing breaks in deposition, into the Paleocene; a maximum thickness of more than 15,000 feet was deposited. Approximately 8,000 feet of overlapping Tertiary sandstone, shale, marl, and limestone completes the basin fill.

Potential traps for petroleum accumulation of the following types occur: tectonic folds; fault or fault-block structures; massive, elongate sandstone bodies associated with pronounced transgressive overlap and compaction drape; porosity abutment both above and below extensive low-angle unconformities; unconformable overlap of basin-sink sediments over broad bottom highs and against and over major fault scarps; structural noses; extensive progressive flank overlap around a deeply silled basin by a section composed of sandstone, shale, marl, and carbonate rocks; and porosity pinchouts.

Approximately 30 exploratory wells drilled onshore in the extensively fresh-water-flushed basin flank, found numerous non-commercial oil and gas shows. The first offshore well drilled in the Gippsland basin 20 miles from the coast (the first offshore well in Australia) resulted, early in 1965, in a major wet gas discovery in thick, very porous Tertiary sandstone.

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Petrographic and Chemical Study of Yucatán Carbonates

Carbonate rocks of Eocene(?) to Recent age crop out in northern Yucatán. Subsurface data from a few widely scattered wells indicate these Tertiary and Recent rocks range in thickness from 3,000 to 5,000 feet. Cretaceous (Comanchean and Gulfian) carbonates, evaporites, and volcanics underlie the Tertiary carbonate rocks.

Samples from all outcropping stratigraphic units in northern Yucatán have been collected. These samples have been studied in the following ways: (1) in hand specimen and by etching, (2) by preparation of acetate peels, (3) by staining (silver nitrate-potassium chromate) for calcite-dolomite content and by preparation of stained peels, (4) in thin section, and (5) by "wet" chemical analysis. Samples are presently being analyzed for $CaCO_3/MgCO_3$ content by EDTA (ethylenediaminetetraacetic acid) titration.

Virtually all carbonate rock types are present, but deposits of foraminiferal microcrystalline carbonates predominate. Reefoid carbonates are present in only minor quantities. Dolomitization and silicification are encountered in many samples. Silicification is most intense in reefoid deposits and negligible in all other rock types. Preliminary results of analyses for calcite-dolomite content in the rocks disclose no apparent correlation of dolomitization with individual rock types. There is, however, an apparent increase in dolomite content with the age of the rocks; this aspect is being investigated more thoroughly.

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Stratigraphy and Structure of Parras Basin and Adjacent Areas of Northeastern Mexico

The Parras basin, in southern Coahuila and western Nuevo León, contains 15,000–20,000 feet of Upper Cretaceous and lower Tertiary terrigenous clastic sediments. From 5,000–7,000 feet of Lower Cretaceous carbonate rocks and 6,000–10,000 feet of Triassic and (or) Jurassic evaporites, carbonate, and terrigenous clastic rocks flank parts of the basin and underlie large areas within the basin. The Triassic and (or) Jurassic sedimentary rocks exhibit complex facies relations. Lower Cretaceous carbonate rocks are remarkably uniform over large areas of northeastern Mexico. Most of the Upper Cretaceous and lower Tertiary calcareous-arenaceous-argillaceous sediments were deposited in a boot-shaped, shallow, subsiding basin between the present-day Sierra Madre Oriental and the Coahuila Platform.

The Upper Cretaceous-lower Tertiary Difunta Group displays intertonguing relations between two distinct lithic types; red, non-marine, arenaceous-argillaceous strata alternate with gray to black, brackish, calcareous-arenaceous-argillaceous strata. The red formations pinch out or change facies toward the north and east in the basin. Marine deposition was continuous from Late Cretaceous to early Tertiary in the eastern part of the basin. A few redbeds grade down depositional dip into gray, marine strata. Red strata have been discovered in the Upper Cretaceous Parras Shale, which normally is a gray to black, calcareous shale, 4,000-5,000 feet thick.

During Paleocene or Eocene time, the sediments of the Parras basin were deformed contemporaneously with the adjacent Sierra Madre Oriental. Deformational intensity in the Lower Cretaceous carbonate rocks of the Sierra Madre appears related to the distribution and thickness of the Minas Viejas (Jurassic?) evaporites. The type and degree of deformation in the Upper Cretaceous Parras basin is not uniform as indicated by the following: (1) overturned folds and imbricate thrusts, which probably do not extend below the Parras Shale, characterize the constricted western part of the basin; (2)broad, elongate, open folds in the southeastern part extend downward to folds in Lower Cretaceous strata; and (3)broad, open, domal folds in the northeast are related to Lower Cretaceous uplifts on the surface and at depth.

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SYSTEMATIC INTERPRETATION OF UNCONFORMITIES

The term unconformity is applied to first-order discontinuities which bound major continental framework sequences. Regional and interregional identity and continuity of most unconformities have remained unappreciated because: (1) they normally are erased in many areas by later degradation; (2) empirical criteria are inconsistently developed and commonly obscure the unconformities; (3) most empirical criteria do not make it possible to distinguish between unconformities and countless small-magnitude discontinuities; (4) conventional stratigraphy is depositionally, but not degradationally, oriented; (5) unconformably separated sequences commonly are erroneously equated and thus mistakenly interpreted as facies; (6) miscomprehension of the base-level concept has resulted in failure to relate episodically contemporaneous marine, non-marine, and volcanic successions; (7) individual unconformities are too commonly conceived to be of a single type rather than to represent several or all types; (8) diagnostic faunas commonly are absent from critical strata; and (9) many biostratigraphic standards are inadequate to define unconformities.

Failure to recognize these obstacles has led in many cases to the fallacious expedient of interpreting events directly from the unconformity-riddled and thus degradationally fragmented stratal record. As a result, the occurrence of alternating interregional depositional and degradational episodes generally has remained unappreciated, and many conventional interpretations are erroneous.

Because all unconformities have certain phenomena in common, particularly in regard to their manner of development, and because the beds above and below an unconformity repeatedly have certain relations to one another and to the unconformity separating them, certain axioms and corollaries can be stated that apply specifically to unconformities. It is believed that analytical procedures devised and carried out in the light of these axioms and corollaries provide a systematic basis for the interpretation of unconformities and for their distinction from the myriads of minor breaks.

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QUANTITATIVE APPROACH TO NATURE AND AREAL VARIABILITY OF FOLD GEOMETRY

For describing variations of fold style, orientation, and location, quantitative scalar variables are preferred to quantitative vectoral or qualitative attributes. T. V. Loudon showed that useful quantitative data are obtained if fold profiles are subdivided into one-wavelength units, and if the inclinations (Θ), from the principal axes, or normals to the folded surfaces are measured; the orthogonal principal axes are defined first by factor analysis. The first four statistical moments of these cos Θ values provide scalar descriptors of mean slope, tightness, asymmetry, and shape, respectively. Additional scalars include direction cosines of the principal axes, kurtosis and skewness of the cos Θ values, and the ratio of profile length to wave length.

Vectoral fold attributes plotted on Schmidt equal-area projections necessarily divorce measurements from geographical locations. Scallars facilitate the drawing of contour maps of the areal variability of fold geometry. Surface-trend analyses, widely used in stratigraphic and petrographic research, are used to illustrate regional changes in fold terranes.

Scalar descriptors are useful also in sequential, multivariate regression analyses to search for those geologic factors that controlled the nature and regional variability of folds. Such methods have potential in analyzing subsurface folds for water or petroleum-resource studies. Examples are based on correlations of regional fold patterns with (a) variations of member thickness, lithology, cementation, stratigraphy, *etc.* and (b) proximity to major tectonic features. Such methods are valuable for prediction and permit quantitative testing of hypotheses, *e.g.*, that fold styles in an area (a) change progressively with metamorphic grade or (b) are dissimilar in sandstone and limestone.

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PROBLEMS IN BIOSTRATIGRAPHY AND TAXONOMY OF MIDDLE LIASSIC AMMONITES OF ALPINE-MEDITERRANEAN PROVINCE

The zonation of the Lias (Lower Jurassic) of the Northwest European ammonite province has been worked out in great detail and is based on very careful collecting from representative sections. It recently has been summarized thoroughly by Dean, Donavon, and Howarth (1961). In contrast, the zonation of the Pliensbachian Stage in the Alpine-Mediterranean province still is inadequate, despite extensive descriptive literature. There are several reasons for this.

1. Authors of ammonite monographs usually do not take into account the distinctive character of this faunal province, which requires zonation of its own, based on indigenous index forms. Efforts to correlate these assemblages with the classic zones established in Germany and England have led mostly to confusion.

2. During the Early Jurassic, most of the Alpine-Mediterranean province was undergoing a rapid and complex change of paleogeographic pattern, reflected in extreme heteropic differentiation. This process,