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DISTRIBUTION OF PALEOZOIC ROCKS BENEATH GREAT ARTESIAN BASIN, QUEENSLAND

The Jurassic-Cretaceous Great Artesian basin occupies most of the interior of eastern Australia. The subsurface geology of this area before 1960 was virtually unknown. Extensive geophysical surveys and wildcat drilling have been undertaken during the past few years, mainly in Queensland and northeastern South Australia. The results of this work, made public under provisions of the Petroleum Search Subsidy Acts of the Commonwealth of Australia, have delineated three new petroliferous provinces: the Surat basin (Permo-Triassic) of southeastern Queensland, Adavale basin (Devonian-Carboniferous) of south-central Queensland, and Cooper Creek basin (Cambrian-Permian) of northeastern South Australia and southwestern Queensland. The subsurface extent of the Drummond basin (Devonian-Carboniferous) and the Lake Galilee basin (Permian) of north-central Queensland has not been delineated fully.

Oil and gas are produced from Permian, Triassic, and Jurassic reservoirs in the Surat basin, and gas has been found in the Middle Devonian of the Adavale basin and in the Permian of the Cooper Creek basin. A fair oil show was found in the Permian(?) of the Lake Galilee basin.

A regular progression in time and space is noted with respect to regional metamorphism across the Great Artesian basin, suggesting eastward shift of the Tasman geosynclinal complex form Proterozoic to Permian time.

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WALL STRUCTURES, CLASSIFICATION, AND EVOLUTION IN PLANKTONIC FORAMINIFERA

Previous classifications and generic determinations of planktonic Foraminifera have been based variously on features of gross test morphology, including chamber shape and arrangement; test shape and ornamentation; and apertural number, form, and position. Certain of these features appear to be convergent adaptations for a planktonic existence, and hence are unreliable for determining natural relations.

Skeletal, chemical, and mineralogical composition, microcrystalline structure, and septal lamellar characters appear not to be environmentally affected, and hence probably best reflect relationships. Planktonic Foraminifera, superfamily Globigerinacea, have perforate tests constructed of radially built calcite crystals, with *c*-axes perpendicular to the test surface. Although the surface texture may be modified by secondarily deposited material (crusts, pustules, and rugosities), the primary texture is determined by three different types of radial microstructure. These characteristic wall features of the enrolled planktonic Foraminifera provide a useful basis for family delineation.

A wall constructed of closely packed identical crystals, resulting in a predominantly smooth surface, is found in the Cretaceous families Planomalinidae, Schackoinidae, Rotaliporidae, and Globotruncanidae, and also is characteristic of the Cenozoic Globorotaliidae and Hantkeninidae. The Cenozoic family Catapsydracidae differs in having thicker rod-like crystals surrounded by finer ones between which occur the test perforations. In the Globigerinidae, thicker crystals are greatly elongated as spines extending far beyond the general test surface, and very thin crystals surround the crystal spine bases. This characteristic wall structure, distinguishable even where elongate spines are broken, is the latest to appear in the geologic record.

The Globorotaliidae and Catapsydracidae appear to have descended directly from Cretaceous stocks and the Hantkeninidae from the Globorotaliidae in the Eocene. Cenozoic Globigerinidae are not closely related to the morphologically similar Cretaceous hedbergellids, but were derived from the Catapsydracidae during Eocene time.

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ERA BOUNDARIES RECONSIDERED

During the long history of the evolution of life on earth, boundaries between geologic eras represent time of transition, when character and composition of the biosphere changed more rapidly and markedly than at intersystemic boundaries within eras. Although many causes have been suggested to explain these changes, most workers have attempted to find one common cause for all. More detailed analysis of the nature of the biologic changes that occur at era boundaries, however, support the conclusion that a common cause does not exist.

At the transition from the Precambrian to the Paleozoic Era, life changed from a little-known state in the Precambrian to a state that at least in part resembled life as we know it now. The emergence of Paleozoic life took place during Cambrian and Early Ordovician time, a span of 100 million years. At the Paleozoic-Mesozoic boundary, mass extinctions were common among benthonic marine life. Life on land, both plant and animal, was not so affected. After the mass extinctions it took 20–30 million years until a well-balanced and diversified benthonic fauna was reestablished in the seas.

At the Mesozoic-Cenozoic boundary, mass extinctions were widespread among terrestrial animals, especially reptiles, but not among plants. In the sea spectacular extinctions occurred among planktonic organisms such as foraminifers and coccoliths, but not nearly to the same extent among benthonic organisms, including benthonic foraminifers. On the land it took many millions of years to fill the ecologic niches left vacant by the disappearance of the reptiles. In the sea replacement of the extinct forms of planktonic organisms by other types was almost instantaneous.

It seems that the biologic changes that took place at and around the three era boundaries were so different in kind that no single cause can be invoked to explain them all.

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CLAY-MINERAL DISTRIBUTION IN RECENT SEDIMENTS FROM NORTHERN PACIFIC COAST OF MEXICO

The clay-mineral composition of 86 samples from the Northern Pacific coast of Mexico was identified and the relative abundance of each clay mineral was obtained. The known minus 2μ fraction was analyzed in oriented aggregates using X-ray diffraction. Prior to X-ray, the samples were freed of carbonates, organic matter, iron oxides, and colloidal silica and alumina.

Montmorillonite, illite, and chlorite were found to be the most abundant clay minerals. Kaolinite and vermiculite were present in some samples, usually in minor amounts.

The distribution patterns of clay minerals in the lower Gulf of California are determined by the source areas and strong diagenetic effects ensuing on contact with sea water.

The clay-mineral distribution shows a sharp contrast in clay-mineral assemblages between the marine and non-marine sediments. The montmorillonite, illite, and chlorite content of the normal marine samples is very uniform. In the warmer hypersaline environment of the swamps, formed in the depressions between cheniers, the clay-mineral assemblages have greater proportions of chlorite, indicating that intense chemical conditions behind cheniers are particularly effective in modifying the composition and structure of the clays entering the sea from rivers.

The clay mineralogy of the terrestrial samples is controlled by the source material and the weathering conditions of the area.

In both terrestrial and marine environments, anomalous clay-mineral assemblages reflect small-scale or local geographic conditions (provenance).

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ASPECTS OF WALL ULTRASTRUCTURE IN SOME HYALINE FORAMINIFERA

Electron-microscopic examination of interior wall structure in some of the hyaline Foraminifera discloses that a variety of microcrystalline arrangements exists. In many instances the term "radial wall" is a misnomer. Some radial forms (*Ammonia beccarii*) are completely lacking in fibrous or prismatic crystals, displaying instead a very finely layered array composed of many plate-like crystals. In such cases, the appearance in polarized light is caused by the statistical, preferred orientation of *c*-axes giving rise to a more or less uniform extinction. The "prismatic" appearance is derived from the effect produced by the superimposition of "chitinous"-lined pore canals, even within the thickness of a thin section. An indistinctly radial form (*Cibicides refulgens*) has an identical microcrystalline arrangement except that the statistical *c*-axis uniformity is poorer, some areas being relatively well oriented with respect to the test surface and others not. True prismatic morphologic types do occur (*Lenticulina calcar*) as do walls composed of uniformly oriented microrhombs. The wall of the "granular" form *Nonion labradoricum* is constructed of lamellae, each lamella being composed of tabular granules sutured together. Each granule is a single crystal of calcite.

The lamellar character of the walls of many of the hyaline Foraminifera is not in agreement with the models suggested for this group. Indeed, some forms are non-lamellar. The concept that each chamber overlaps all previous chambers is not supported in every case by the data.

These observations clearly support earlier suggestions that any rational classification of the Foraminifera will have to consider the detailed structure and architecture of the walls. The fact that radial wall structure (in the petrographic sense) can be represented by several different microcrystalline morphologic types is as important as the difference recognized between radial and granular forms.

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ONLAP, KEY TO WORLDWIDE UNCONFORMITIES AND DEPOSITIONAL CYCLES

Subsurface studies in many sedimentary basins around the world reveal that widespread onlap has occurred several times since the Precambrian. The existence of onlap indicates deposition on an unconformity surface that had topographic relief. There are several worldwide onlap unconformities. These began to form during (1) early Oligocene, (2) early Paleocene, (3) Late Jurassic (pre-Portlandian-Purbeckian), (4) latest Triassic (pre-Rhaetian), (5) Permian (pre-Leonardian), (6) latest Mississippian (post-type-Chesterian), (7) Early Devonian, and (8) Middle Ordovician times. In addition, several less important, but worldwide, periods of onlap, restricted largely to basin margins or actively rising areas, have been observed. These occurred during (1) late Miocene, (2) early Miocene, (3) early Eocene, (4) Early Cretaceous (pre-Cenomanian), (5) Middle Jurassic (pre-Dogger), (6) Early Triassic, (7) Pennsylvanian (pre-Desmoinesian), (8) Late Devonian, and (9) Early Silurian times.

Earlier workers recognized many of these unconformities in the United States and Canada on the bases of truncation (overstep) and onlap. In this paper onlap is emphasized as the better indicator of unconformities, because onlap is much more widely prevalent than truncation. Unconformities identified only by truncation usually occur in regions which have undergone a local period of uplift.

Several factors may obscure the presence of major unconformities. If the underlying sediments were relatively flat at the time of onlap or if the basin was subsiding differentially, yet rapidly, at the depositional site, detailed correlations across large areas usually are required to reveal the presence of an onlap unconformity. The unconformity may be missing in basin centers because of continuous deposition. In such a situation, the strata which were deposited while an unconformity developed toward the basin margin may be identifiable because of a change in depositional rate within the time-equivalent sediments of the basin center. Highly mobile belts commonly have many unconformities; only a few of these may be worldwide. In addition, continental sediments deposited above sea-level also may contain unconformities that formed entirely as a result of local factors.

Characteristically, the sediments of an onlap cycle are deposited relatively rapidly at the beginning of the cycle, and are deposited less rapidly later in the cycle. At the conclusion of the cycle, onlap at the basin margins is scarcely noticeable. During the next succeeding cycle, onlap commonly is relatively rapid again, but the area of onlap is nearer to the depositional basin center. This shift of onlap cycles through time from basin margin to basin center is believed to represent a fairly rapid drop in sea-level. The initiation of onlap is then interpreted to be the result of a gradual rise in sea-level, and local basin subsidence and sedimentation play the dominant roles in determining the positions and amounts of onlap and sedimentary thickening.

Although the basic causes of changes in sea-level are not well known, they may be related to changes in the configuration of ocean basins resulting from large-