aerated squeezed waters indicate that CO_2 pressures in the sediment may be an order of magnitude higher than that in equilibrium with the atmosphere, an effect probably related to the bacterial decomposition of organic matter.

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SIGNIFICANT 1961 EXPLORATION DEVELOPMENTS EXCLUSIVE OF NORTH AMERICA

Oil discoveries were recorded in 1961 in Colombia, Libya, the Sahara, Turkey, Iran, Gabon, Australia, India, and the Philippines. A significant gas discovery was reported from New Zealand. Exploration was underway in Peru, Ireland, England, the Spanish Sahara, Greece, Somalia, Australia, Southwest Africa, Bechuanaland, South Africa, Ivory Coast, Mauritania, Sardinia, Sudan, Tunisia, Niger Republic, Yeman, Portuguese Timor, and many of the Middle East countries. Argentina was the scene of both exploration and development drilling on a large scale. A significant development was the first export of oil from Libya, where exploration concessions were first granted in 1955. Various concession areas were surrendered after substantial exploration expenditure in the Gulf of Paria, Nigeria, Jordan, Lebanon, Dhofar, and Portuguese Guinea. Individual operators withdrew from Turkey and Argentina. Exploration operations ceased outside the producing areas in Iraq. Offshore acreage acquisitions or applications were announced in Turkey, Nigeria, France, Israel, Tunisia, Libya, Burma, Honduras, and Trinidad. First marine offshore drilling on the African continental slope was underway off Gabon; offshore drilling occurred also off the southern Netherlands, in the Persian Gulf, and Sicily. Many new American operators were either active in foreign areas or had applied for concessions. Russian, French, Italian, and Rumanian technicians appeared for the first time in several new areas. Up until November 1, when summarized, the really outstanding exploration development of 1961 was that it became more truly world-wide than ever before.

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TERTIARY GEOLOGIC HISTORY OF WESTERN OREGON AND WASHINGTON

The region of western Oregon and Washington at the beginning of the Tertiary was the site of a north-trending eugeosyncline that is inferred to have occupied the site of the present Coast Range-Olympic Mountains uplift and the Puget-Willamette trough. The distribution of marine and continental facies suggests that the eastern margin of the eugeosyncline extended under the Tertiary volcanic rocks of the Cascade Range. Analysis of the distribution, thickness, facies changes, and sedimentary structures of a thick Eocene turbidite sequence indicates that the western margin of the eugeosyncline lay west of the present coast line.

Tholeiitic pillow lavas and breccias, as much as 20,000 feet thick, were erupted in places into the subsiding geosyncline during early to middle Eocene time and interfingered complexly with marine tuffaceous siltstone and sandstone. Uplift south of the geosyncline during middle Eocene time resulted in an influx of great quantities of arkosic sands which were swept generally northward along the axial part of the trough by turbidity currents. Concurrently, northeast of the geosyncline, a plutonic and metamorphic terrane supplied large quantities of arkosic detritus that accumulated on a broad coastal plain and intertongued westward with marine beds.

In post-middle Eocene time broad uplifts and thick volcanic accumulations divided the geosyncline into several separate basins. These basins were the sites of deposition of as much as 15,000 feet of upper Eocene to Pliocene marine sandstone and siltstone and associated pyroclastic and epiclastic volcanic debris. Upper Eocene and middle Miocene basalt flows from local centers interfinger in places with this sequence.

In western Oregon these Tertiary strata have been folded and faulted into structures that trend predominantly northeastward, parallel with the structure of the pre-Tertiary rocks of the Klamath Mountains. North of the Columbia River, the principal structures trend northwestward, approximately parallel with the structural grain of the pre-Tertiary rocks in northern Washington. This trend is interrupted by the more complex Olympic Mountains uplift.

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SAND-GRAIN ORIENTATION AND IMBRICATION IN TURBIDITY-CURRENT SANDSTONES

Orientation studies of thirty-five sandstone samples of turbidity-current origin show statistically significant preferred grain orientation. There is a consistent angular divergence between sand-grain orientation and the linear sole features such as groove casts and flute casts associated with individual sandstone beds. This relationship persists throughout the 80-foot stratigraphic section studied. Sole features show divergences of 40°–60° (47° average) from preferred grain orientation in the overlying sandstone. Differences in lineation of the two types of features are due to differences in direction of erosional and depositional currents, even though the currents may not be separated greatly in time.

Imbrication studies throughout the section show consistent southeast inclination of elongate grains with respect to the bedding. Flute casts, small-scale crossbedding and regional paleogeography indicate a southeastward sediment source; thus the imbrication data are in agreement with the theory of up-current imbrication. Three-dimensional orientation analysis indicates that grains are oriented parallel with the depositing current. This suggests that sand grains were oriented parallel with the current through original deposition from suspension, or if some grains rolled along the bottom, they were re-oriented before reaching a final position of rest.

Grain orientation can provide general information on source direction for turbidity-current deposits; imbrication indicates the sense of current movement along that direction. Limited paleogeographic inferences can be drawn from local studies of the relationship between grain orientation and erosional sole features.

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MIDDLE TERTIARY VERTEBRATE FAUNA FROM AUSTRALIA

A middle Tertiary vertebrate fauna has been discovered in the Great Artesian Basin east of Lake Eyre, South Australia. The fossils occur in the Etadunna Formation and have been called the Ngapakaldi fauna. The Etadunna Formation (? Oligocene), consists of more than 100 feet of green lacustrine claystone, sand-

stone, calcareous mudstone, and dolomitic limestone. In the basin there is a thick subsurface section of earlier Tertiary sedimentary rock, whereas in the surface exposures the Etadunna is dissected in places by the fossiliferous Mampuwordu Sands (? Pliocene), which in turn are truncated by the unfossiliferous red beds of the Tirari Formation. Cutting deeply into the Tirari are the fluviatile fossiliferous Katipiri Sands (Pleistocene).

Ngapakaldi fauna. MOLLUSCA: gastropods. ANTHROPODA: ostracodes. OSTEICHTHYES: lung fish, teleosts. REPTILIA: chelonians—including a ? meiolanid, crocodileans, varanid lizards. AVES: pelicans, flamingos, ducks, cranes, thick-knees, and a gull or tern. MARSUPIALIA: two dasyurids, *Perikoala*, rat-kangaroo, a primitive kangaroo, thylacoleo-like animal and a primitive diprotodontid.

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COMPARISON OF THREE CRETACEOUS SPORE-POLLEN ASSEMBLAGES FROM MARYLAND AND ENGLAND

Comparative studies of dispersed spores and pollen from the Upper Cretaceous Magothy Formation and the Lower Cretaceous Arundel Formation, both in Maryland, and the Lower Cretaceous Wealdian sequence in southern England reveal striking similarities and differences among the dominant species. The two Lower Cretaceous assemblages consist almost exclusively of fern spores and gymnosperm pollen. Of the thirteen most abundantly occurring fern spore species in the Arundel association, ten are conspecific with species in the Wealdian one. In spite of the wide geographic separation of the two assemblages, only four of the dominant species reported from the Wealdian were not observed in the Arundel microflora.

A much greater difference is evidenced in comparing the Upper and Lower Cretaceous assemblages from Maryland, each of which contains a distinctive and diagnostic microflora. Of the twenty-five most abundant fern spore and angiosperm pollen species (thirteen from the Arundel, twelve from the Magothy), only one is common to both. An even more obvious difference is the fact that no angiosperm pollen were observed in the Arundel. However, in the Magothy angiosperm pollen constitute approximately forty per cent of the dominant species. Furthermore, the Magothy assemblage, in general, is characterized by species whose morphology is more complex and more advanced than that shown by the forms in the Arundel.

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DOLOMITE IN MODERN CARBONATE SEDIMENTS, SOUTHERN FLORIDA

The western margin of Florida Bay contains extensive shallow-water banks of unconsolidated, fine carbonate mud. The banks are separated by narrow tide channels and rest on hard Pleistocene bedrock. The banks attain a maximum thickness of about 4½ feet. Radiocarbon dates show that they have been formed in the past 4,000 years. The carbonate mud is composed principally of aragonite, with lesser proportions of dolomite and both high- and low-magnesium calcite. The proportion of dolomite varies, ranging up to about 5 per cent by weight of the total carbonate. Other constituents are quartz and opaline sponge spicules, but these rarely form more than 1 or 2 per cent.

Dolomite crystals are euhedral rhombohedrons varying in size from less than 1 micron to approximately 60 microns. They commonly have dark internal rhombohedrons that appear to be intergrowths of dolomite and organic materials. Complex clusters of interpenetrating rhombohedrons are present, but are rare.

The occurrence of interpenetrating rhombohedrons and intergrowths of organic and carbonate material suggests that dolomite has been formed *in situ* in Florida Bay; however, radiocarbon dating shows that the dolomite is older than 35,000 years and must be detrital.

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SEDIMENTARY BASINS AND OIL DEVELOPMENTS IN INDONESIA

In spite of retarded developments of the oil potentials in Indonesia since World War II, the Indonesian Archipelago ranks as ninth in the list of world crude production. Aside from the known oil fields in Borneo (Kalimantan), Sumatra, Java, and West-Irian (New Guinea), great possibilities exist to further develop the oil potentials of the sedimentary basins of Indonesia provided that the Indonesian Government grants liberal terms and attractive conditions for existing and new concessions to private oil companies.

This summary of the stratigraphy, structure, and oil potentials of the Tertiary basins of Indonesia is based mainly on available literature (E. W. Beltz, H. M. Schuppli, G. F. Kaufmann, J. Weeda, J. H. L. Wennekers, and others) and to a smaller degree on personal experience.

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SACRAMENTO AND NORTHERN SAN JOAQUIN VALLEY GAS AREAS

The Sacramento and Northern San Joaquin Valleys are now a major dry gas province, there being about 65 dry gas fields from Fresno on the south to Redding in the north, a distance of approximately 300 miles. The Sacramento and Northern San Joaquin Valleys are a southeasterly plunging synclinorium bounded on the east by the Sierra Nevada and on the west by the Coast Ranges. This sedimentary trough is asymmetrical, the west flank steeper than the east. The stratigraphic section from Cretaceous through Recent represents a composite thickness of approximately 50,000 feet. Because of tilting and subsequent truncation, the stratigraphic section of the Sacramento Valley becomes successively younger in a southerly direction. Stratigraphic traps formed by the truncation of the southerly plunging section are economically significant. The configuration of the resultant edge lines takes parabolic form with its apex at the north. Three unique detritus-filled erosional gorges transect the Sacramento Valley within the subsurface.

The synclinorium is broken by several northeasterly trending subsurface anomalies: the Red Bluff arch, the Marysville-Colusa arch, the Sacramento hinge-line, and the Stockton fault which structurally separates the Sacramento Valley from the San Joaquin Valley. The Marysville Buttes, Dunningan Hills, Kirby, and Potrero Hills are several prominent topographic features closely associated with gas accumulation.

In general, the Sacramento Valley gas production is separated on the basis of stratigraphy into two parts by the Sacramento hinge-line. The Rio Vista basin,