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-