The Otway basin has a classic "pull-apart" structural style with a series of normal faults parallel with the spreading axis. The Gippsland and Bass basins are similar but their complete pull-apart was prevented by the influence of the Tasmanian continental block (subplate). The separation of New Zealand from Australia had only a minor effect on the structural framework of the Gippsland basin in the shallow-slope areas.

Following the continental breakup and margin collapse, the Otway basin remained structurally quiescent but the Bass and Gippsland basins continued to subside and accumulate thick Tertiary sections. However, during the late Eocene and Miocene all basins were subjected to an east-west right-lateral-shear deformation. In Gippsland, the shear generated large en echelon anticlines and rejuvenated some of the old tensional faults. Hydrocarbons accumulated in these anticlines or their eroded remnants. In Bass and Otway the shear was less severe and confined to the northern margins. The deformation in these basins was correspondingly less intense.

However, structural styles in each basin are similar enough that their varying intensity does not explain fully the lack of success in the areas explored in Bass and Otway. Other factors such as the presence or absence of organic matter, maturation, and migration must have influenced hydrocarbon distribution.

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EVOLUTION OF PORPHYRY COPPER PROVINCE OF NORTHERN CORDILLERAN OROGEN

In the area from the Columbia Plateau to the Wrangel Mountains of Alaska, porphyry copper deposits formed as adjuncts to differing magmatic and tectonic environments. The most important early event related to development of porphyry copper appears to have been the rifting of the Alexander terrain in Alaska away from the North American craton beginning in the late Paleozoic and continuing into the Jurassic. Introduced during this period of distensional tectonism were the "diorite" porphyry copper deposits and the composite zoned batholiths carrying porphyry copper deposits (the granitic-pluton type). Most deposits of these types are Triassic in age. Porphyry copper deposits are not present in the Upper Jurassic and Lower and middle Cretaceous rocks. The Late Jurassic and Early and middle Cretaceous appear to have contained periods of rapid sea-floor spreading and strong compression, as well as periods of intrusion of the large batholiths. This implies that magmas associated with porphyry copper deposits do not necessarily have an origin similar to that postulated for Sierra Nevada type batholiths.

Porphyry copper deposits also have been dated as Late Cretaceous and Tertiary. These deposits differ from their Triassic predecessors in that they tend to be smaller stocks or bosses, have some of the features of diapir or piercement, and mineralization associated with them tends to be associated with a quartz monzonite magma.

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NICKEL- AND COPPER-RICH NODULES OF EQUATORIAL NORTH PACIFIC

The authors compiled a map of all available data on the distribution and metal content of ferromanganese deposits throughout the oceans which revealed only one geographic area where nodules were abundant and consistently rich in copper and nickel. It was an east-west band in the equatorial North Pacific between coordinates 8°00'N to 10°00'N and 125°00'W to 154° 00'W. Nodular deposits were most abundant at the eastern and western ends of this rectangular province. Inspection of analytical data reveals that they are at least twice as rich in copper and nickel than the world average for nodules. Moreover, metal values suggest east-west axes of maximum values of both copper and nickel (2.5 to 3.0% dry weight of the nodules) at the northern and southern limits of the province.

In order to explain this unusually rich province, the east-west trends of maximum metal values, and variations in abundance of the nodules, a comprehensive study is underway. In order to quantify the data, many sea-floor parameters were established and each inserted as a viable controlling influence on the distribution and metal content of the deposits. They include gradient of sea-floor, water depth, submarine physiography, topographic grain of seabed, distribution of seamounts, distance from major fracture zones, substrate type, porosity and moisture content of substrate, and age of surficial sediment. Characteristics of the nodules, including average and range of size, percent of sea-floor covered and their concentration, were combined with the preceding measures.

Our study has led to the following conclusions: (1) the geographic limits of nodules rich in copper and nickel reflect the distribution of exposures of Tertiary sediments on the ocean floor. (2) The east-west trend of the province is a function of exposures of Miocene, Oligocene, and Eocene strata. (3) Copper and nickel content of nodules appear to increase with increasing age of substrate, *i.e.*, Eocene strata, and presumably "Eocene" nodules, are characterized by maximum values of these metals (3%). Miocene strata and associated nodules have lower copper and nickel values (2.5%), but contain greater amounts of these metals than other nodular deposits. (4) The regional patterns of major nodule fields are directly related to locations of seamounts and fracture zones. Presumably subsea weathering and explosive submarine volcanism release and disperse seed grains of basalt. Nodules are most abundant in the eastern and western thirds of the enriched zone where submarine volcanoes are common, and along a narrow band which follows the Clarion fracture zone. The central section has appreciably fewer nodules because of a limited number of volcanoes and the Clipperton fracture is a site of rapid sedimentation. (5) "Eocene" nodules represent potential mineable deposits. (6) Further evaluation of this resource should be directed toward definition of Eocene, Oligocene, and Miocene exposures close to sources of basaltic seed grains. (7) Porosity and moisture content of radiolarian deposits are higher than any other ocean sediment and may play a role in upward diffusion of metals within the substrate and into nodules. (8) Differential erosion and deposition within the area of Tertiary exposures during the past 55 m.y. may have imposed a secondary pattern of nodular concentration over crests of abyssal hills and dilution by burial in adjacent valleys.