domes (which are probably deep-seated salt domes); anticlinal closures associated with regional syn-depositional faults; fault closures; and stratigraphic traps on the flanks of structural noses or closures where no hydrocarbons are trapped on the apex of the structure.

The total estimated ultimate recovery of 691 fields in the area is 9,057,003,000 barrels of oil, 2,223,215,000 barrels of condensate, and 85,688,836,000,000 cubic feet of gas. Using an economic value of one barrel of oil equals 15,000 cubic feet of gas, the total ultimate recovery of hydrocarbons is equivalent to 16,959,196,000 barrels of oil.

Salt domes account for 17.9% of the number of producing fields, 61.09% of the ultimate oil, 18.48% of the ultimate condensate, and 19.48% of the ultimate gas recovery. *Circular* or *elongate domes* account for 20.98% of the producing fields, 18.96% of the ultimate oil, 47.94% of the ultimate condensate, and 47.15% of the ultimate gas recovery. *Anticlinal closures associated with regional syndepositional faults* account for 20.41% of the producing fields, 12.63% of the ultimate oil, 21.88% of the ultimate condensate, and 22.09% of the ultimate gas recovery. *Fault closures* account for 31.74% of the producing fields, 6.43% of the ultimate oil, 9.61% of the ultimate condensate, and 9.04% of the ultimate gas recovery. *Closures on regional noses* account for 3.91% of the producing fields, .56% of the ultimate oil, 1.13% of the ultimate condensate, and 1.29% of the ultimate gas recovery. *Stratigraphic traps* on flanks of structural noses or closures account for 5.06% of the producing fields, .36% of the ultimate oil, .86% of the ultimate condensate, and .95% of the ultimate gas recovery.

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Locating the Source of Sands in Flysch Troughs

Field characteristics of sand units are stressed in most flysch studies. Megascopic properties of lithology, stratification, and sedimentary structures are essential for interpretation of depositional environments and directions of sediment transport within mobile belts. Problems related to the *source* of sands, however, cannot be solved by field work alone.

In certain studies, two of the most important questions concerning source remain unanswered:

(a) What was the nature of the parent-rocks exposed in the source area?
(b) Where was the source area with respect to the site of flysch accumulation?

Petrographic examination of sands on a regional scale is required to help solve these fundamental problems. Heavy mineral studies are particularly useful in providing paleogeographic information. Heavy mineral assemblages display a lack of diversity (small number of mineral species) in almost all flysch formations where they have been examined. These assemblages are invariably mature to supermature (high percentages of resistant minerals). Sands containing assemblages of this type were probably derived from terrains already lacking a diversity of minerals. Thus, sands in many flysch troughs were largely derived from older clastic formations (re-sedimentation or "cannibalization" process) exposed within or adjacent to the mobile belt.

Furthermore, the distribution patterns of light and heavy mineral fractions vary laterally in these formations indicating the presence of local sediment sources along mobile belts. Petrography serves as a check on the relative importance of lateral versus longitudinal transportation of sands in flysch troughs.

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Direction of Crustal Movements Indicated by Earthquake Data

Two factors make desirable a re-evaluation of the inferences, drawn from seismic data, concerning the direction of crustal movements: 1) the revision of published fault plane solutions, occasioned by questions of the reliability of the solutions and by the recognition of bias in favor of strike-slip faulting; 2) the development of other methods, including the use of S waves and the application of surface waves in determining the directivity, dimensions, and initial phase of the source.

The most extensive seismic data pertinent to crustal movements are associated with the borders of the northern Pacific Ocean. Data from the smaller earthquakes (magnitude $6\frac{3}{4}$–$7\frac{1}{4}$) indicate predominantly reverse or thrust faulting along fractures parallel to (e.g. Kamchatka-Kurile Island arc) or oblique to (e.g. Aleutian Islands) the trend of the tectonic features, with a lesser transcurrent component of motion. The principal compressive stress is nearly horizontal and is directed normal to the trend of the arc. The major earthquakes, on the other hand, especially as inferred from the data of surface waves, are predominantly strike slip. Fracturing extends for hundreds of kilometers and parallels oceanic deeps.

Examination of other regions, especially South America and regions of the southwest Pacific, permit inferences related directly to the underlying causes of crustal movement.

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Local Variations in Earth Tides

Observations in various parts of the world show marked inconsistencies in the apparent deformations produced by earth-tides; such variations may in large part result from errors of measurement. However, horizontal variations in crustal composition must produce effects of this kind, and accordingly an attempt has been made to estimate the order of magnitude of such anomalies. The very complicated elastic problem could be solved numerically if we had any idea of the changes of composition involved. In default of such information, a two-dimensional model has been investigated, using a method of successive approximation. Two cases are of special interest—(1) where changes of elastic constants are appreciable within a small fraction of the circumference of the Earth, and (2) where the wave-length is one-half of the Earth's circumference.

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Age of Some California Coast Range Lower Tertiary Marine Red Beds

Microfossils, including benthonic and planktonic foraminifera as well as coccolithophorids and related nannoplankton, are abundant in the marine red beds of the California Coast Ranges. These have usually been assigned a middle Eocene age. Comparative studies of the foraminifera and nannoplankton in these red beds have revealed two of these microfossil assemblages (from San Miguel Island, Santa Barbara, and the Oakland hills) to be of Campanian, Upper Cretaceous age; two others (from the lower red bed, type Anite Shale