the rocks; and development of environmental information by the study of the character of preservation, presence of reworked fossils, relative percentages of other organisms, and characteristics of sediments themselves.

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RECENT ESTUARIAN AND MARINE SEDIMENTS, COOS BAY AREA, OREGON

Coos Bay, the estuary of Coos River, is located on the southern coast of Oregon. Although Coos River is one of the smaller rivers draining the Oregon Coast Range, its estuary is one of the largest along the Oregon Coast. The estuary occupies a structural depression and has been formed by drowning of the river mouth following rise of sea-level in late Pleistocene time. The outer part of the bay has been developed by the southward prolongation of North Spit by longshore drift. This estuary opens onto a narrow continental shelf, which, in this vicinity, ranges in width between 10 and 15 miles.

Texture and mineralogy of sediment samples taken along the 12-mile length of Coos Bay suggest derivation of the estuarian sediments from two sources: (1) sediment in the inner bay is chiefly fine sand and is similar to the detritus carried by Coos River; (2) sediment in the outer bay is mostly medium-grained sand, with an increase in grain size toward the bay mouth. This sand is most closely related mineralogically to sands along the coast north of Coos Bay. Thus, it appears that although sediment in the inner bay has been brought to it by Coos River, sediment in the outer bay has been derived chiefly from the influx of beach and dune sands carried over North Spit by the prevailing westerly winds and into the mouth of the estuary by tidal currents.

Sediment samples from the continental shelf adjacent to Coos Bay, between the mouths of the Umpqua and Coquille Rivers, range in median diameter from medium sand to silt, and from very well sorted to moderately sorted. They display a general decrease in grain size and degree of sorting in a seaward direction. However, a band of fine, well sorted, glauconitic sand lies along the outer margin of the continental shelf. The location and mineralogy of this sand suggest that it is relict sediment (Emery, 1952) related to a lower sea-level during Pleistocene time that has not yet been covered by modern sediment.

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MARINE SEDIMENTATION OF CLASTIC VOLCANIC STRATA

Many sequences of geosynclinal strata are composed of pyroclastic ejecta and detritus eroded from contemporaneous volcanic accumulations. Their lithologic successions are governed largely by secular variations in the type and intensity of the contributory volcanism and their facies patterns, by the spatial distribution of eruptive centers. The linkage between volcanism and sedimentation can be as direct as, for example, when showers of airborne ash rain into the final site of deposition, or the linkage can be as indirect as the subtle influences caused by changes in submarine topography with the construction of volcanic piles within a basin of deposition. To reconstruct the depositional histories of the clastic volcanic sequences, the role of volcanism in controlling environments of deposition, determining the dispersal agents of sediment, and creating transitory sources of sediment must be correctly evaluated.

The following genetic assemblages of clastic volcanic strata can be recognized in Paleozoic and Mesozoic marine sequences of western North America.

1. Volcanic center assemblages include (a) pillow lavas, pillow breccias, and palagonitic tuffs from submarine eruptions; and (b) lavas, flow-breccias, and pyroclastic breccias from subaerial eruptions.
2. Volcanic shelf assemblages were deposited on (a) narrow shelves flanking volcanic piles and (b) broad platforms of tectonic origin. The rocks of the assemblages are composed of vitroclastic ash and abraded grains in varying proportions, and are commonly fossiliferous.
3. Volcanic slope assemblages were deposited on subaerial or submarine slopes forming the sides of (a) elevated tracts built up by volcanic outpourings and (b) tectonic ridges capped by volcanos. The sedimentary structures of the assemblages include erosive scour, sole markings, cross-bedding, and graded bedding.
4. Volcanic basinal assemblages were deposited in (a) low tracts lying between volcanic piles and (b) tectonic depressions lying within the dispersal radius of volcanic sources. The rocks of the assemblages include vitroclastic tuffs deposited by showers of airborne ash and rocks formed by the settling of suspended sediment.

These assemblages have counterparts in other regions where similar rocks are exposed. Modern analogues are present in Recent sediments of the Caribbean and Indonesian regions.

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FUTURE OF OIL EXPLORATION ABROAD

In any consideration of the status of exploration of the oil industry today we are bound to look to history. The industry has always been pursued by the ghost of scarcity one day and the specter of overwhelming surplus the next. Part of this has been due to the sudden opening of new areas for exploration and part of it to the introduction of new methods of exploration, all of which has made available new supplies. Politics also affected the supply of crude.

Today we face surpluses in most areas of the world and the problem of these surpluses has afflicted us with a pessimism that has reached into our training schools for geologists and petroleum engineers. Such a mood makes it imperative that we glance at the future.

First we must remember that present world proved reserves of oil, producible at present costs, run in the neighborhood of 275 billion barrels, and that there is probably in sight 500 billion barrels. This is in contrast to Pratt's estimate of $77\frac{1}{2}$ billion barrels made 10 years ago. Present world demand is close to 7 billion barrels per annum and is doubling every 11 years. This means that we have proved more than 20 years of supply. These figures would look very different, however, if it were not for the restriction of automotive use in the Communist countries. If all the world consumed oil at the same per capita rate as the United States, the demand would be 50 billion barrels a year and we would have about 5 years of supply in sight. We should, therefore, in our long-run interest, keep on looking. This raises the question of how well we have explored the world.

It is probably a maxim that every generation believes it knows the limit of world resources. This is largely self-delusion. The next barrel of oil (or ton of copper, if you prefer) is always the hardest to find. But ingenious minds develop new methods which are successful, or bold spirits invade new areas. We drill deeper holes, we refine our means of gathering data. We venture to sea and we today have no idea of the limit to which those explorations will carry us. Three maps are presented showing prospective areas of the world: first one, dated 1944, was prepared by the foreign division of P.A.W.; second one is from "Geography of Petroleum," 1950, by Wallace Pratt and Dorothy Good; third one is speaker's own interpretation of the data available today.

The first conclusion from all this is that the exploration of the world has just begun. The second conclusion is that instead of slackening our geological, geophysical, and engineering programs, we shall be wise to increase them and to develop wider and better training programs with particular emphasis on technical excellence.

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Late Mesozoic Sedimentation and Orogenesis Along Southwestern Oregon Coast

Mapping, petrology, and paleocurrent investigations by the speaker and students provide new evidence of sedimentation in a continuously active orogenic belt in southwestern Oregon. Formational units have been traced into California, demonstrating that at least the northern part of the "Franciscan terrane" is divisible. Intensely sheared, northerly trending zones up to 3 miles wide have been traced from California for 100 miles north along the Oregon coast. They pass offshore beneath the seismically active northeast Pacific Basin. Paleogeology shows that these were superimposed upon arcuate Klamath Province fold trends from late Mesozoic to the present.

Extrusion of Jurassic rhyolitic to basaltic marine pillow lava and pyroclastics accompanied deposition of graded and non-graded arkosic wacke, mudstone and bedded chert (Dothan and Rogue? Formations). Associated local conglomerates contain granitic boulders, evidencing hitherto unrecognized "pre-Nevadan" granites. Laminated quartz arenite and argillite intruded by diorite contain Late Jurassic? *Foraminifera* (Galice Formation). Over large areas these units all have been metamorphosed to form the Colebrook Schist. Thus Late Jurassic orogeny is recorded by deformation, metamorphism, and ultramafic and dioritic plutons. Latest Jurassic and Early Cretaceous rocks contain excellently graded volcanic wackes, mudstone, and thick chert-volcanic conglomerates (Myrtle Group). Diorite, serpentine and schist clasts together with overlap relationships provide sensitive indicators of diastrophic pulses. Volcanism ceased during Cretaceous.

Later orogeny is recorded by severe deformation (but lack of metamorphism) of the Myrtle Group, emplacement of batholiths inland in the eastern Klamath Province, and unconformable overlap by shallow marine Late Cretaceous (Campanian) quartz arenites, quartz wackes, and mudstone. Major shear zones were developed at least by mid-Cretaceous and have been reactivated intermittently since. Post-Cretaceous warping and erosion recurred prior to widespread Eocene transgression, renewed volcanism, and deposition of graded volcanic wackes, cross-stratified volcanic arenites, and coal. Regression commenced in Late Eocene. Later Cenozoic movements along the major faults apparently formed the north-trending Coos synclinorium and were related to formation of north-trending Cascade volcanoes and plutons and to widespread faulting in eastern Oregon and Nevada.

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Paleoecology of Pamlico Formation (Late Pleistocene), Horry County, South Carolina

Depositional environments and paleogeography of the Late Pleistocene Pamlico Formation in Horry County, South Carolina, indicate that the formation was deposited near shore under non-marine, restricted marine, and shallow, open ocean conditions. Slight fluctuations of sea-level and other factors, such as shifting currents and migration of barriers produced sharp vertical and lateral facies.

From the observed distribution of macrofauna and microfauna, four marine environments are recognized: (1) inside intertidal, (2) shallow shelf, (3) lower bay (inlet influenced), and (4) upper bay (semi-restricted).

Paleoecologic, stratigraphic, lithologic, and paleogeographic observations provide evidence that the Pamlico deposits are related to a low stand of the sea, higher than 10 feet and less than 40 feet above present sea-level. Thus it is suggested that the Pamlico Formation be correlated with the making of the Pamlico shoreline (25–30 feet above present sea-level), which on paleogeographic and subsurface evidence was never located more than 5–7 miles inland from the present shoreline in Horry County.

During deposition of the Pamlico Formation, water depth was probably not more than 40 feet and generally much less; temperature of the water was probably slightly higher than that in the same latitude today; the water was usually slightly turbid and well oxygenated; and the salinity was variable. Inland from the bay and lagoon shores cypress swamps developed so that today non-marine clays and peat beds interfinger with brackish-water deposits.

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Automatic Acquisition, Processing, and Interpretation of Geologic Data

The study of the abundance and distribution of minerals is in an explosive phase. In the few years that have elapsed since the first interpretations of X-ray analyses of rock composition were made thousands of determinations have been reported in hundreds of published papers. The precision of stratigraphic interpretation, correlation, and determination of environment is improved by using mineral composition but the cost has been high. Utilization of automatic equipment and data processing methods makes it feasible to obtain economically a wide variety of geological information.

Ditch, air-drilled, core, and outcrop samples are ground mechanically and sieved through a 450-mesh screen as the grinding proceeds. After homogenizing, the powder samples are prepared on microscope slides for X-ray analysis. A magazine-type automatic sample-changer holding 60 samples feeds the slides in turn into the X-ray diffractometer for analysis. The resulting data are punched automatically onto IBM cards using electrical control circuits to coordinate the many sequential operations. The suitably coded IBM cards containing digital diffraction intensities taken at each 1/10 degree of scan are processed in the IBM 704 computer using a dictionary-type program to produce a summary card showing the minerals present in a sample and their abundance. The summary cards containing control information and mineralogical composition are