Foraminifera from the trawls and the smaller Foraminifera from the cores. Maximum size of the larger Foraminifera usually is between 1–10 mm. The zonation is:

TRAWLS

Meters	
179	*Valvulineria inflata* Group
878	*Cibicides wuellerstorfi* and *Reophax scorpiurus* Groups
1,171	*Cyclammina canellata* Group
1,863	*Alveolophragmium subglobosum* and *Reophax nodulosus* Groups
2,489	*Hormosina ovicula* Group
3,149	*Planispirinoides bucculenta* Group
3,404	*Recurvoides turbinatus-Bathysiphon* Group

CORES

Meters	
796	*Epistominella pacifica smithi* Group
1,171	*Bulimina rostrata* Group
1,932	*Eponides tumidulus* Group
2,498	*Nonion pompilioides* Group
3,257	*Stilostomella antillea* Group

Estimates of the total volumes of material caught by each trawl range from 2 to about 43 kg., dry weight.

FREDERICK A. F. BERRY, University of California, Berkeley, California

Origin of Nitrogen-Methane Gas and Anomalously High Fluid Pressures, Sacramento Valley, California

Nitrogen gas is commonly found in natural gas accumulations within Cretaceous and younger rocks in selected areas of the Sacramento Valley. Considerations of a variety of data and concepts suggest that the nitrogen originates independently from and earlier than the methane with which the nitrogen is now commingled and that it does not originate within the sediments in which the natural gas accumulations are found today. The proposed answer is that the Sacramento Valley nitrogen originates from low-grade metamorphism of sedimentary rocks containing organic matter. By elimination, the enigmatic Franciscan rocks of the Coast Range province appear to be the most probable source of this nitrogen. Abnormally high fluid pressures also exist within the Cretaceous sediments of the Sacramento Valley and may play a critical role in the origin of the methane within this dry-gas province. The existing fluid-potential distribution strongly suggests that the abnormally high-fluid potentials are the result of tectonic compaction—stemming from continuous uplift of the Coast Ranges at least from late Tertiary into Recent time.

The general fluid-potential distribution within the Sacramento Valley is such that vertically upward flow is commonly present. Water flowing upward through shales serving as methane sources would contain in solution different quantities of methane per unit volume of water depending upon the fluid pressures. The high solubilities of simple paraffin hydrocarbons in water as opposed to those of more complicated hydrocarbons and the exponential variation of these solubilities with pressure provide a mechanism for selectively transporting in aqueous solution essentially only simple paraffins—particularly methane—from a shale source at high pressure and discharging them as free gas at lower pressures in a reservoir rock. The operation of such a mechanism would be dependent upon significant vertical fluid-potential differences and would be independent of the age and degree of compaction of the shale. The methane for the Sacramento Valley dry-gas province thus may have evolved and accumulated fairly recently—subsequent to the presumed initiation of the regional high fluid potentials in late Tertiary time.

DONALD M. BLUE, Western Geophysical Company of America, Los Angeles, California

Reflection Techniques Suggest Nature of Deep-Ocean Sediments

Conventional reflection profiling reveals a deep-ocean sedimentary column up to 3,500 m. thick. Sedimentary layers are grouped into an upper acoustically transparent zone, 20–510 m. thick, and a lower acoustically responsive zone up to 3,000 m. thick. The former, exhibiting a minimum of internal structure, has an average $V_i = 1.70$ km./sec. determined from X^2, T^2 analyses, an average thickness of 200–250 m., and is interpreted as unconsolidated, water-saturated red clay or pelagic ooze. The responsive zone is strongly layered, has an average $V_i = 3.0$ km./sec., and is interpreted to be semi-consolidated to consolidated mixed red clay and ooze, turbidites, or volcanic products. Low-velocity sediments blanket ocean-bottom topography and exhibit relief (up to 100 m.) largely at the water-sediment interface suggesting bottom scour and transport. Higher-velocity, stratified sediments lie on an irregular basement with pronounced discordance; thickness is dependent on basement topography and suggests differing depositional processes and rates of diagenesis. The uniform, plane surface interface between the two sedimentary units and extraordinary smoothness of layers within the stratified zone may be explained by the leveling effect of turbidity currents in rapidly filling sediment basins.

EARL E. BRABB, U. S. Geological Survey, Menlo Park, California

Stratigraphy and Oil Possibilities of Mesozoic Rocks in Kandik Basin, East-Central Alaska

Mesozoic sedimentary rocks in the Kandik basin are subdivided provisionally into four units. The oldest, unit A, rests unconformably on the Tahkandit Limestone of Permian age. It consists mainly of carbonaceous argillite but includes some limestone, oil shale, and quartz arenite. This unit is about 5,000 ft. thick and ranges in age from Middle Triassic (Ladinian) at its base to Early Cretaceous (Valanginian) at its top. Conformably overlying unit A is unit B, a massive quartz arenite with minor interbeds of argillite and chert-pebble conglomerate. Unit B is less than 100 ft. thick south of the Yukon River but northward it thickens to about 1,000 ft. or more in the headwaters of the Black River. Pelecypods of Valanginian age have been found in the quartz arenite at several widely spaced localities. Unit B grades conformably upward into unit C, a rhythmically bedded quartz arenite and argillite, at least 5,000 ft. thick, that forms a substantial part of the Kandik Formation (Lower Cretaceous) at its type locality. Pelecypods of Valanginian age occur in the lower part of unit C. Unit D consists of chert-pebble conglomerate, sandstone, siltstone, and argillite, all of the graywacke type. It rests conformably on unit C in the vicinity of the Yukon

River, but apparently rests unconformably on units B and A and on rocks of Paleozoic age near Indian Grave Creek. Unit D is several thousand feet thick and is provisionally correlated with non-marine clastic rocks of Early Cretaceous (Albian) age near Eagle, Alaska.

The oil shale within unit A is a potential source bed for petroleum, but none of the Mesozoic rocks cropping out in the Kandik basin seem to have enough porosity to make them potential reservoirs. Although the oil possibilities of the Mesozoic rocks are not encouraging, some of the Paleozoic rocks contain oil and therefore deserve further investigation.

JOHN V. BYRNE AND NEIL J. MALONEY, Department of Oceanography, Oregon State University, Corvallis, Oregon

OFFSHORE OREGON: OBSERVATIONS ON REGIONAL GEOLOGY

The continental margin west of Oregon consists of a generally convex-upward surface 35 to 60 mi. (nautical) wide. The continental shelf, which forms the upper part of the surface, slopes seaward at less than 1° and ranges irregularly in width from 9 to 35 mi. Several elongate hills or banks rise above the general shelf level. The lower portion of the continental margin (continental slope) increases in average declivity from about 1°–10°, and is modified by numerous ridges, hills, benches, and submarine canyons.

Off the central part of the Oregon coast the shelf widens from 13 mi. at 45°00′N. to 35 mi. at 43°58′N., and then narrows abruptly to 16 mi. at 43°55′N. Two essentially north-trending shoals, Stonewall Bank and Heceta Bank, dominate the topography of the shelf in this area.

The apparent offlap relationship of late Eocene to middle Miocene marine sedimentary rocks along the shore and the occurrence of Pliocene marine sedimentary rocks on the two banks suggest that one or more Tertiary sedimentary basins exist beneath the continental shelf and slope. Gravity measurements indicate that thick sections of sedimentary rocks may be present. From echo soundings, Stonewall and Heceta Banks are interpreted to be the surface expressions of structures associated with the Tertiary basins.

Fine to very fine detrital sands and glauconite-rich silts and clays cover the shelf in areas between the gravel and rock outcrops common on and in the vicinity of the shoals.

S. E. CALVERT, University of California, Scripps Institution of Oceanography, La Jolla, California

ACCUMULATION OF DIATOMACEOUS SILICA IN SEDIMENTS OF GULF OF CALIFORNIA

Sediments of the deep basins of the central and southern Gulf of California contain high concentrations of diatom and radiolarian tests. Determinations of the amounts of opal in the sediments, by X-ray diffraction, show that the diatoms contribute the greater proportion of biogenous SiO_2 to the sediments. An opal-rich area is confined to the central Gulf, which is also the site of most intense phytoplankton production. Over an area of approximately 2,500 km.^{2}, sediments containing 50 per cent by weight opal are accumulating at a rate of $\sim$3 mm./yr. Within this region, the ratio of the rate of accumulation of opal to that of terrigenous material is highest for the whole Gulf.

The Gulf is in open communication with the Pacific Ocean, and the annual exchange of water through the mouth is estimated to be $\sim 5 \times 10^{16}$ liters. With northerly winds, the surface waters, depleted of plant nutrients, are driven out of the Gulf, to be replaced by upwelled nutrient-rich waters flowing into the Gulf at depth from the Pacific. In this way, sufficient silica is supplied to the euphotic zone, where it is utilized by diatoms, to account for all the silica known to be accumulating on the floor of the Gulf. River supplies are 100 times less than the ocean supply. In view of numerous observations of a so-called genetic association between diatomaceous sediments and volcanism, the mechanism operating in the Gulf of California should be considered as a means of concentrating dissolved silica, at concentrations of 1–2 ppm, as siliceous sediments. Sufficient silica is present in sea water, in the form specifically utilized by diatoms, to form deposits of purity comparable with the Monterey diatomites of California.

B. F. D'ANGLEJAN, University of California, Scripps Institution of Oceanography, La Jolla, California

STUDIES OF SOME MARINE PHOSPHORITES FROM BAJA CALIFORNIA

Along the western coast of Baja California, between approximately 24.5° and 27° N. lat., extensive fine-grained phosphate deposits occur on a 100-km.-wide continental shelf. They are found from a depth of 100 m. to the shore where carbonate apatite makes up to 25 per cent by weight of present and more ancient barriers built up in front of coastal lagoons. Their similarity with ancient phosphorites, believed to have developed on large shallow submarine platforms, prompted a study of these sediments. Intense seasonal upwelling of deep nutrient-rich waters from the California Current controls the hydrography of the whole shelf, and shallow ridges form an effective sill restricting circulation over it. A reducing environment has developed and iron sulfides are present nearly everywhere. Locally produced organic matter is being supplied continuously to the bottom through the oxygen-deficient waters, this at a fairly high rate because of shallow depths. Conditions favorable to the preservation of large quantities of non-oxidized inorganic phosphate in the sediments are in this way maintained. Whether or not this situation results in the present formation of calcium phosphate minerals cannot be ascertained. Apatite could be measured quantitatively by X-ray diffraction down to very low levels. This shows the persistence of a rich zone over 20–30 km. along the coast between depths of 60–100 m. From several evidences these deposits represent ancient barriers reworked during the last transgression. Onshore similar phosphatic sands over 50 ft. thick are known to exist in the vicinity of the lagoons. From geological considerations and geochemical arguments the average age of these deposits is Pliocene to Pleistocene. They could be as old as Miocene. They appear in equilibrium with their modern environment and, if so, could continue to develop, but unambiguous evidences concerning their present growth have been difficult to obtain.

GREGORY A. DAVIS, University of Southern California, Los Angeles, California

CORRELATION OF STUART FORK FORMATION WITH ROCKS OF WESTERN PALEOZOIC AND TRIASSIC BELT, KLAMATH MOUNTAINS, CALIFORNIA