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.

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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.

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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 ~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.

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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.

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

Rocks of the Stuart Fork Formation, previously considered part of the central metamorphic belt of the Klamath Mountains, California, are correlative with unnamed rocks of the adjacent western Paleozoic and Triassic belt. Originally designated by Hershey in 1901 as the Abrams Formation of Precambrian (?) age, the type Stuart Fork rocks in the Minersville Quadrangle represent western Paleozoic and Triassic belt rocks exposed in a large window through an overlying thrust plate of central metamorphic belt units (Salmon and Grouse Ridge Formations). The Stuart Fork window or fenster, which occupies the core of a major north-south antiformal fold nearly 20 mi. long, lies 7–10 mi. east of the western belt.

Correlation of Stuart Fork rocks with those of the western belt is based on lithologic similarities (rhythmically bedded metacherts, slates and phyllites, basic metavolcanic rocks, and marbles, in decreasing order of abundance), mutual tectonic separation from overlying Salmon hornblende schists of higher metamorphic grade, and similar metamorphic and structural histories. It is probable that additional mapping of Stuart Fork rocks in the northern Cecilville and Coffee Creek Quadrangles will show them to be continuous with the western Paleozoic and Triassic terrane. Fossils collected in the western belt from limestones southeast of Cecilville have not yet been identified, but limestones in the same belt to the south have yielded Pennsylvanian (?) to Triassic faunas. The age of Salmon and Grouse Ridge rocks, also considered to be Precambrian (?) by Hershey, which structurally overlie Stuart Fork—western belt rocks, is still unknown.

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(Movie Film)

"RIVERS-OF-SAND" AND OTHER EROSIONAL PROCESSES IN SUBMARINE CANYONS

Observations of the sediment and micro-relief found in submarine canyons from the *Trieste I* and *II*, Cousteau's diving saucer, and by SCUBA diving indicate that submarine erosional processes are actively modifying the shape of many canyons. Sediment that is trapped in the bowl-shaped heads of nearshore canyons has been shown by marker stakes and other objects embedded in this fill, to creep slowly or slump intermittently downslope. This slow movement erodes the bottom and the sides of the lower part of the canyon by corrosion. The concentration of erosive forces at the base of the canyon walls commonly results in large overhangs and a cross-axial profile that has an hour-glass shape.

In areas where storm-induced bottom currents rapidly introduce sand-size non-cohesive sediments on slopes that exceed the angle of repose, spectacular quasi-liquid sand flows develop that erode both the existing sediment fill and the rock walls of the canyon. In Baja California, Mexico, sand flows have been observed that can be truly called "rivers of sand."

The motion pictures presented at this convention were collected over the past 5 years in La Jolla and Scripps Canyons off southern California, canyons that are cut in sedimentary rocks, and in San Lucas and Los Frailes Canyons on the eastern side of the southern tip of Baja California, Mexico, canyons that are cut in granite. The film depicts the sedimentary and erosional processes active in these canyons.

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UPPER CRETACEOUS PLANKTONIC FORAMINIFERA FROM YOLO AND COLUSA COUNTIES, CALIFORNIA

Samples containing pelagic Foraminifera were examined from five-widely spaced localities in the Upper Cretaceous Venado, Yolo, and Sites Formations on the western side of the Sacramento Valley, California.

The basal formation, the Venado, overlies the late Cenomanian "Antelope Shale," and is predominantly a sandstone unit with discontinuous beds of conglomerate and thin, dark-colored carbonaceous siltstone. Along Putah Creek, Yolo County, the Venado contains *Globotruncana* and *Hedbergella*, which suggest a Turonian age.

The overlying Yolo Formation is a dark-colored siltstone with some sandstone and shale beds. The siltstone and shale contain an abundant, well-preserved foraminiferal fauna, including *Clavihedbergella*, *Globigerinelloides*, and *Heterohelix*.

The Sites Formation is composed of thin, rhythmic sequences of siltstone and sandstone interbedded with thick sandstone beds. The finer clastics, in many places with a high mica and carbonaceous content, yielded the largest and most diversified planktonic assemblage. The genera *Globotruncana*, *Rugoglobigerina*, *Hedbergella*, and *Schackoina* are present.

The pelagic microfossils appear to correlate with the microfaunas from the Turonian of Europe and the Austin Group of the Gulf Coast. The Venado and Yolo Formations are correlated with Popenoe's Members II and III, and the Sites with Member IV of the Cretaceous strata in the Redding area, California. The planktonic assemblages fall within Goudkoff's H and G-2 zones.

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EFFECTS OF WATER TABLE AND TIDE CYCLE ON SWASH-BACKWASH SEDIMENT DISTRIBUTION AND BEACH PROFILE DEVELOPMENT

A study of deposition in the swash-backwash zone along a sandy beach indicates that fluctuations in sea-level relative to beach water-table level, resulting from the semi-diurnal tide cycle, show appreciable effects on sediment distribution. In the swash-backwash zone, sediment distribution is dependent on the interaction of swash deposition, swash erosion, backwash deposition and backwash erosion. When the tide level is high and the beach water-table is low, swash deposition and swash erosion predominate; this results in the formation of a thick lens of sediment on the shoreward side of the swash-backwash zone and a scoured area on the surf side of the zone. In contrast, a relatively high water-table results in maximum back-wash erosion and backwash deposition; thick lenses of sediment form near the surf boundary. Therefore, as sea-level fluctuates above and below the general water-table level with the tide, the zone of deposition correspondingly shifts its position within the swash-backwash zone and either increases or decreases the gradient of the beach slope. As the tide rises, sediments deposited by previous swashes are redistributed by the encroaching surf. Above the limit of surf encroachment and in the highest swash-mark area, a berm forms, which displays an onlap-offlap series of