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

laminae; also, portions of it are cross-laminated. This berm and its internal structure are a result of sedimentation during the flood- to ebb-tide period.

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COILING DIRECTION RATIOS OF FORAMINIFERA *Globigerina pachyderma* (EHRENBERG) IN NORTHEASTERN PACIFIC SURFACE SEDIMENTS

Coiling direction ratios of *Globigerina pachyderma* (Ehrenberg) plotted for sediment surface samples from the northeastern Pacific north of 40°N. did not show the consistent relationship which would recommend them as reliable guides for deep-sea core analysis in this region. A generally increasing tendency for sinistral coiling toward the north was noted, from 13 per cent left reported by Parker (1962) from a nearshore sample (40°N.) to a consistent 95–100 per cent left in the northern Gulf of Alaska. Great irregularity in coiling ratios in seaward (east-west) traverses may be related to a nearshore area of warm-water intrusion (Fleming, 1958) affecting the type of plankton supplied to the substrate. Variations from 20–96 per cent left coiling were observed in these traverses. Dextral coiling percentage usually was higher in samples containing many species and few individuals. The "recency" of the surface sample also affected the coiling ratios. The problem of distinguishing small *Globoquadrina dutertrei* (d'Orbigny)—predominantly right coiling—from *Globigerina pachyderma* (coiling in question) may qualify coiling ratios reported by various authors. Plankton tow samples off Oregon, Washington, and the Aleutian Islands had smaller percentages of *G. pachyderma* and higher dextral ratios than samples from the underlying sediment surface.

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ARCHEOPYLE IN FOSSIL DINOFLAGELLATES

Fossil dinoflagellates, the most important marine component of many Mesozoic-Tertiary palynological preparations, are remains of chiefly planktonic organisms. Commonly abundant and well preserved, they can be highly useful in problems of local, regional, and interregional dating and correlation. They have been used less than their potential warrants, at least partly because the unalerted eye, bewildered by the variety of their more spectacular structures, readily overlooks others of greater diagnostic value. This paper draws attention to one morphological feature of fossil dinoflagellates, the archeopyle, a distinctive opening in the test which is usually easy to see and is a significant aid in distinguishing among stratigraphically important genera and species.

The archeopyle is formed through release of an *operculum* along the *primary archeopyle suture*. The operculum is *simple* when it consists of a single piece and *compound* when it is divided into two or more parts by *secondary archeopyle sutures;* it is *free* when the primary archeopyle suture completely surrounds it and *attached* when that suture does not close on itself. Archeopyle shape and position relate to the basic pattern of plate arrangement, or tabulation, which is one of the striking features of dinoflagellates. Accordingly, an archeopyle may be *apical, intercalary, precingular*, or *epithecal*, depending upon the part of the test involved in its formation. In all, about 10 distinctive archeopyle types have been recognized. Some fossil dinoflagellates lack an archeopyle entirely and a few have openings of combined types or of types that do not fit readily into a simple classification.

Careful observation of the archeopyle is prerequisite for precise and consistent identification of fossil dinoflagellates. Besides being a character of taxonomic value in its own right, the archeopyle often helps when attempting to determine specimen orientation, girdle and sulcus location, and tabulation. It is especially useful in studying those dinoflagellates with spherical bodies, long processes, and obscure tabulation, called hystrichospheres.

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PALYNOLOGICAL SURVEY OF CERTAIN MESOZOIC-TERTIARY STRATA IN CALIFORNIA

NSF Grant GP-473 supported a 1-year preliminary palynological study of selected Mesozoic and Tertiary rocks in portions of the Central Valley and Coast Ranges in northern California to determine: (1) where and how palynology can contribute to solving geological problems in the area, and (2) what stratigraphic sequences contain organic microfossils suitable for fundamental paleontological study.

After establishing a laboratory for processing samples, slides from about 800 samples were prepared and examined. These samples were, in part, matrix from specimens in Stanford collections, in part, provided by other agencies and individuals, and, in part, newly collected. Most of the samples are from outcrops. Principal conclusions are:

1. Problems of Franciscan geology are not likely to be solved quickly by use of palynology although contained microfossils permit dating of occasional samples.
2. Two areas of particular promise for future work are: (a) the uppermost Jurassic-Lower Cretaceous sequence north and south of Paskenta west of the Sacramento Valley, and (b) the Upper Cretaceous-lower Tertiary sequence in the belt south of Tracy west of the San Joaquin Valley.
3. Cretaceous-Miocene clastics in the Santa Cruz Mountains generally contain abundant organic matter but only poorly preserved pollen and spores.
4. From lithology or appearance in hand specimens it is not possible to predict with satisfactory consistency how fossiliferous a sample may be or how well preserved its fossils.
5. In many of the better samples dinoflagellates are better preserved and seem to show more striking stratigraphic changes than spores and pollen in the same samples.

As a follow-up of this survey, both taxonomic and stratigraphic studies of dinoflagellates in the areas mentioned in item 2 are now under way. At the same time sampling to delineate additional areas and topics for future research continues.

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RECENT OIL AND GAS EXPLORATION ACTIVITIES IN WASHINGTON