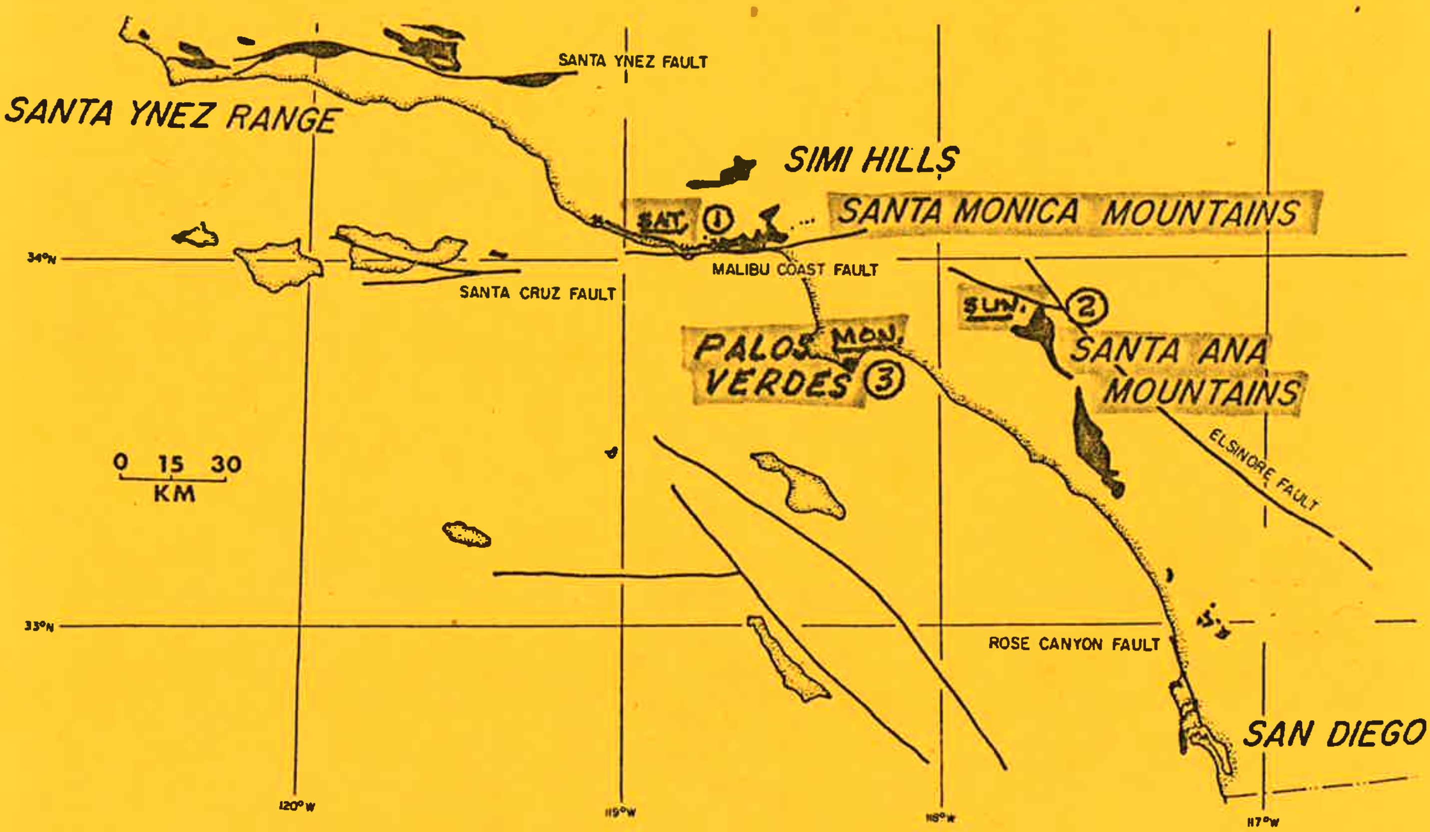
Spring 86

Los Angeles Basin ~ California



THE LOS ANGELES BASIN

A BRIEF INTRODUCTION TO THE GEOLOGY OF THE LOS ANGELES BASIN — UPPER CRETACEOUS - TERTIARY - QUATERNARY ROCKS — THE MALIBU COAST FAULT - THE NEWPORT INGLEWOOD FAULT ZONE — SOME PROBLEMS (THE BIG ROCK LANDSLIDE, THE POINT FERMIN AND PORTUGUESE BEND LANDSLIDES, BEACH EROSION, FLOODING, EARTHQUAKE RISK)

MAJOR STOPS:

1/15 - SATURDAY — (CSUN - 8 AM) THE SANTA MONICA MOUNTAINS - THE OLIGOCENE - MIOCENE CYCLE - SPECTACULAR PILLOW BASALTS - THE PT MUGU FAN ETC - THE MALIBU COAST FAULT

CAMP - SYCAMORE CANYON

1/16 - SUNDAY — THE SANTA ANA MOUNTAINS - A LATE CRETACEOUS CYCLE THE BAKER CANYON - HOLZ SHALE -

CAMP - SILVERADO CANYON

1/17 MONDAY — PALOS VERDES PENINSULA - A MONTEREY SUBMARINE FAN, COASTAL LANDSLIDES, SECOND STREET - 'CRITTERS' (if time)

CSUN - BY ABOUT 6 PM -

LED BY: FISCHER, CHERVEN, FRITSCHE AND PERRY RUSSELL

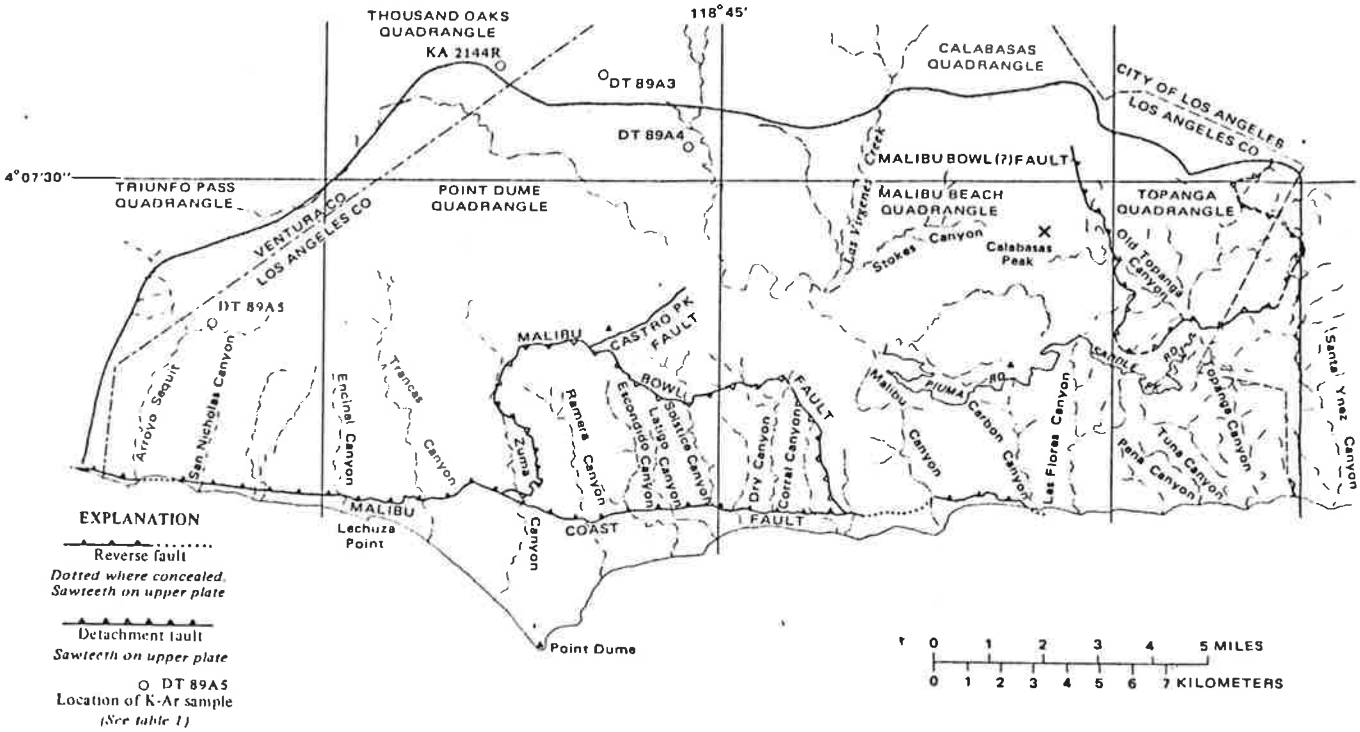


FIGURE 1.10 Map of central Santa Monica Mountains showing area mapped in detail (shaded boundary) and 7½-minute quadrangles.

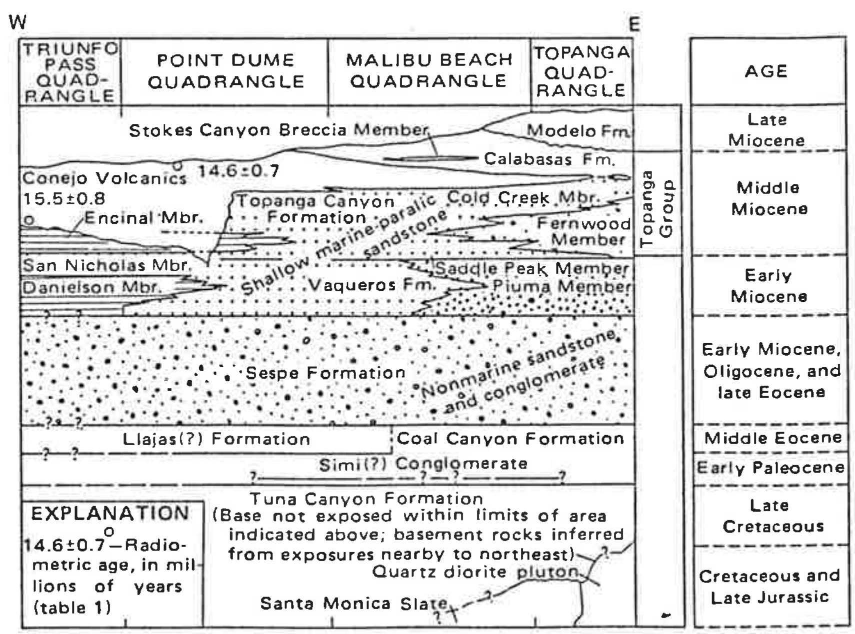


FIGURE 1.11 Correlation diagram of units north of the Malibu Coast fault (except for those restricted to the upper plate of the Malibu Bowl fault).

(Yerkes & Campbell '79)

SANTA MONICA MTS.

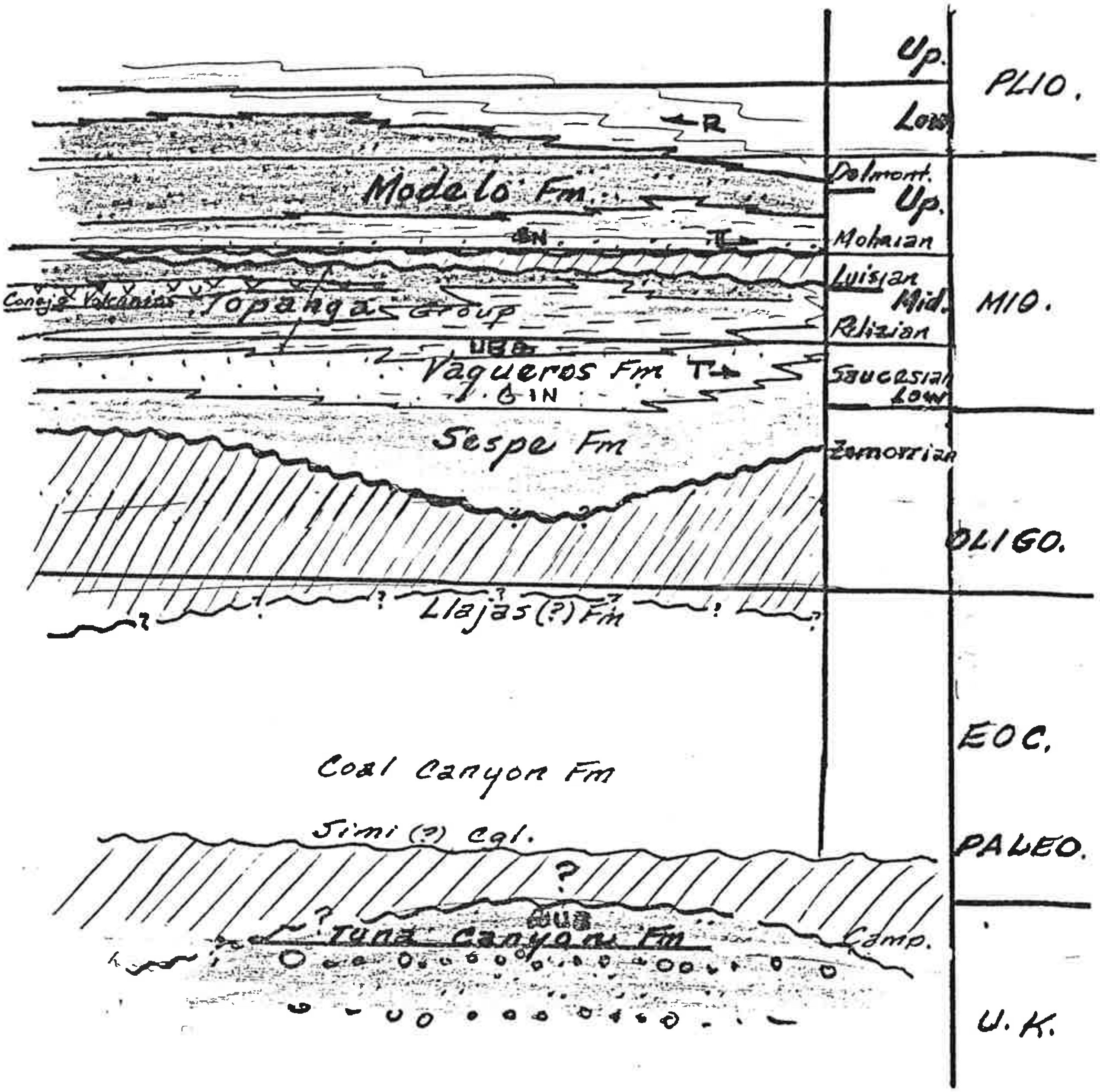


Figure 1.12 'Cycle' chart Santa Monica Mtns (north of Malibu Coast fault). J '70

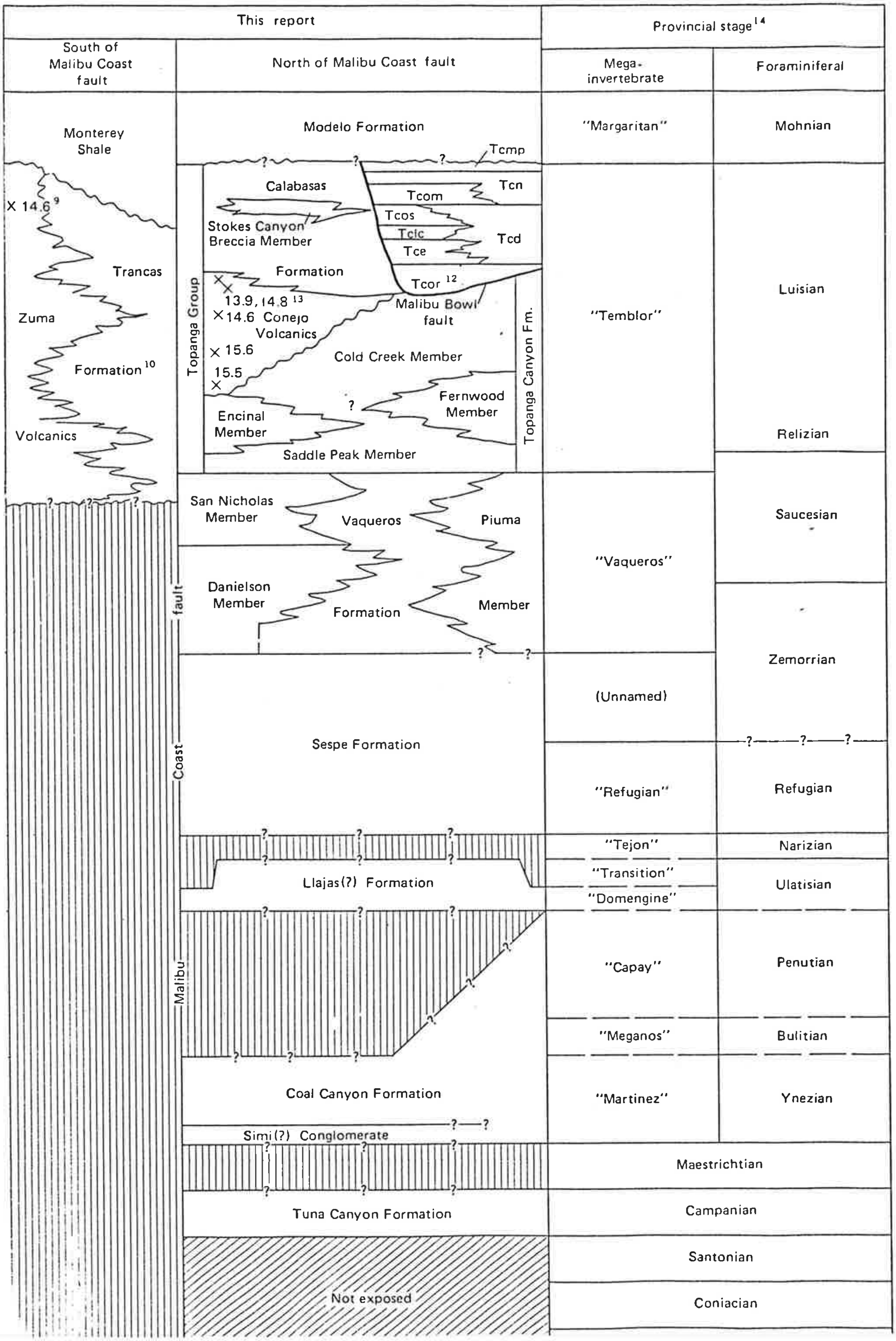


Figure 1.13 Stratigraphy of the Santa Monica Mtns (Yerkes & Campbell

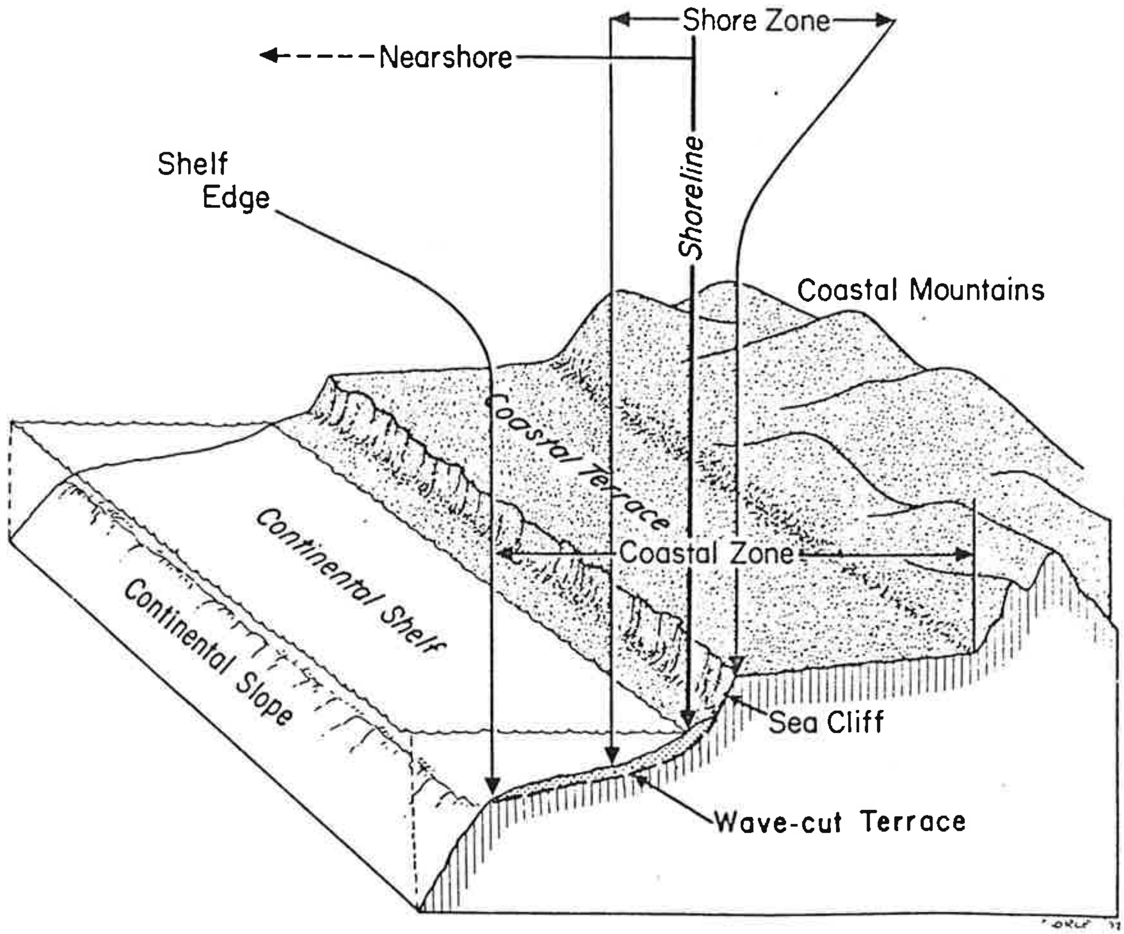


Figure 1.1. Definition sketch of coastal zone nomenclature for coasts similar to the California coast (from Inman and Brush, 1973).

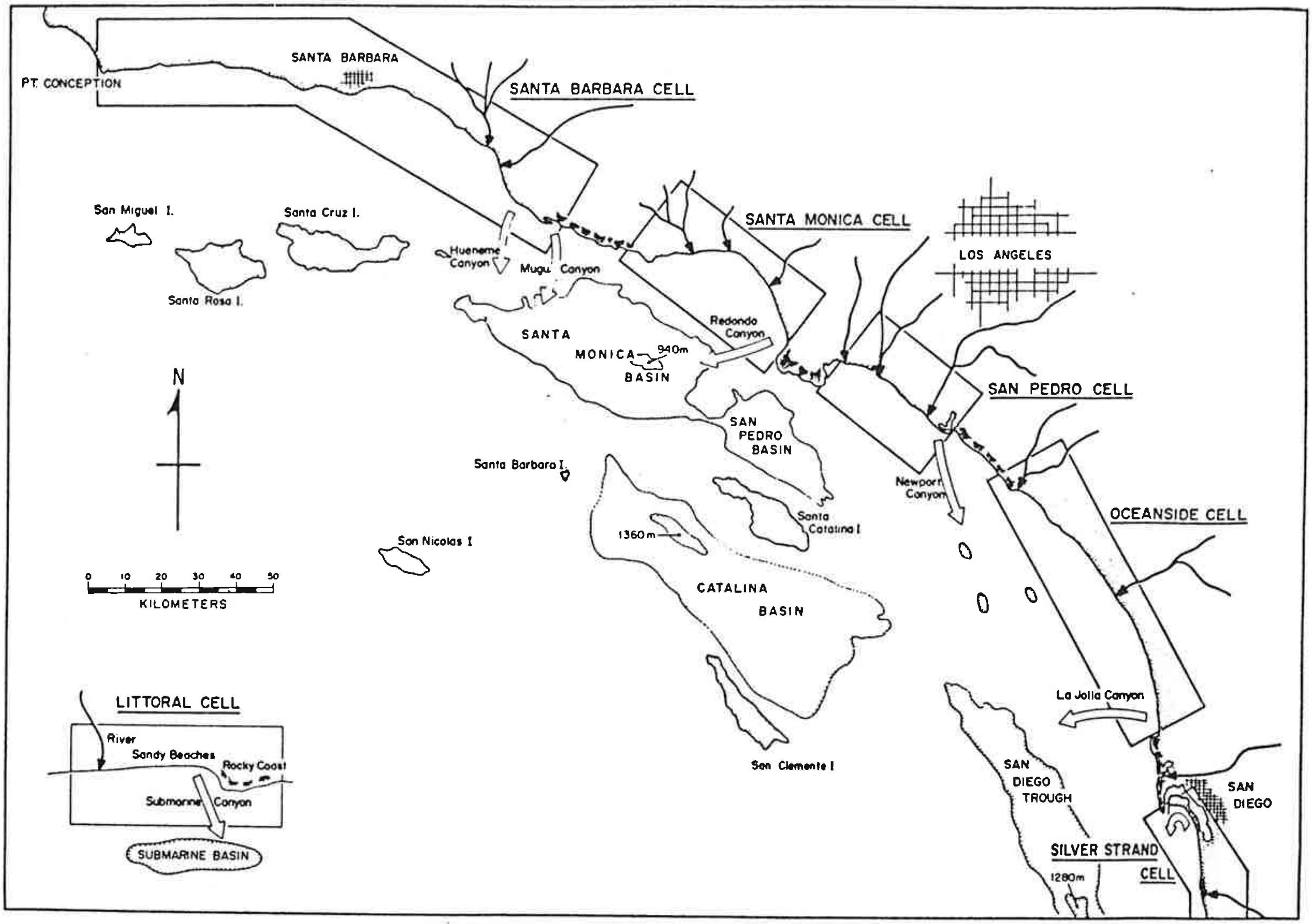
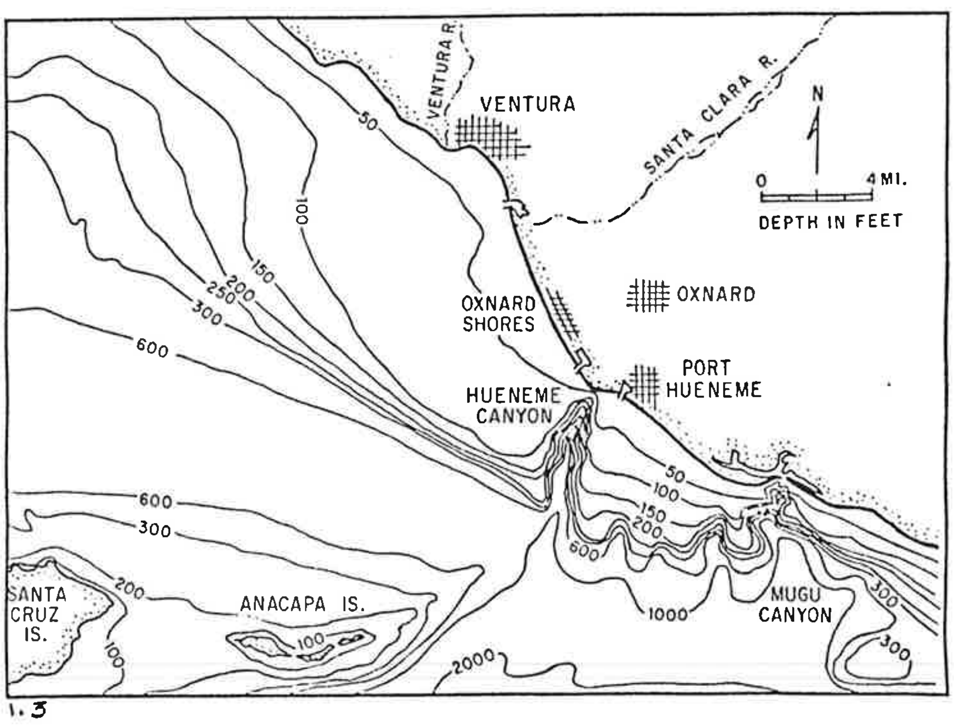


Figure 1.2. Southern California littoral cells, showing cell limits, major streams supplying sediment and sinks. (Inman'76)



1.3

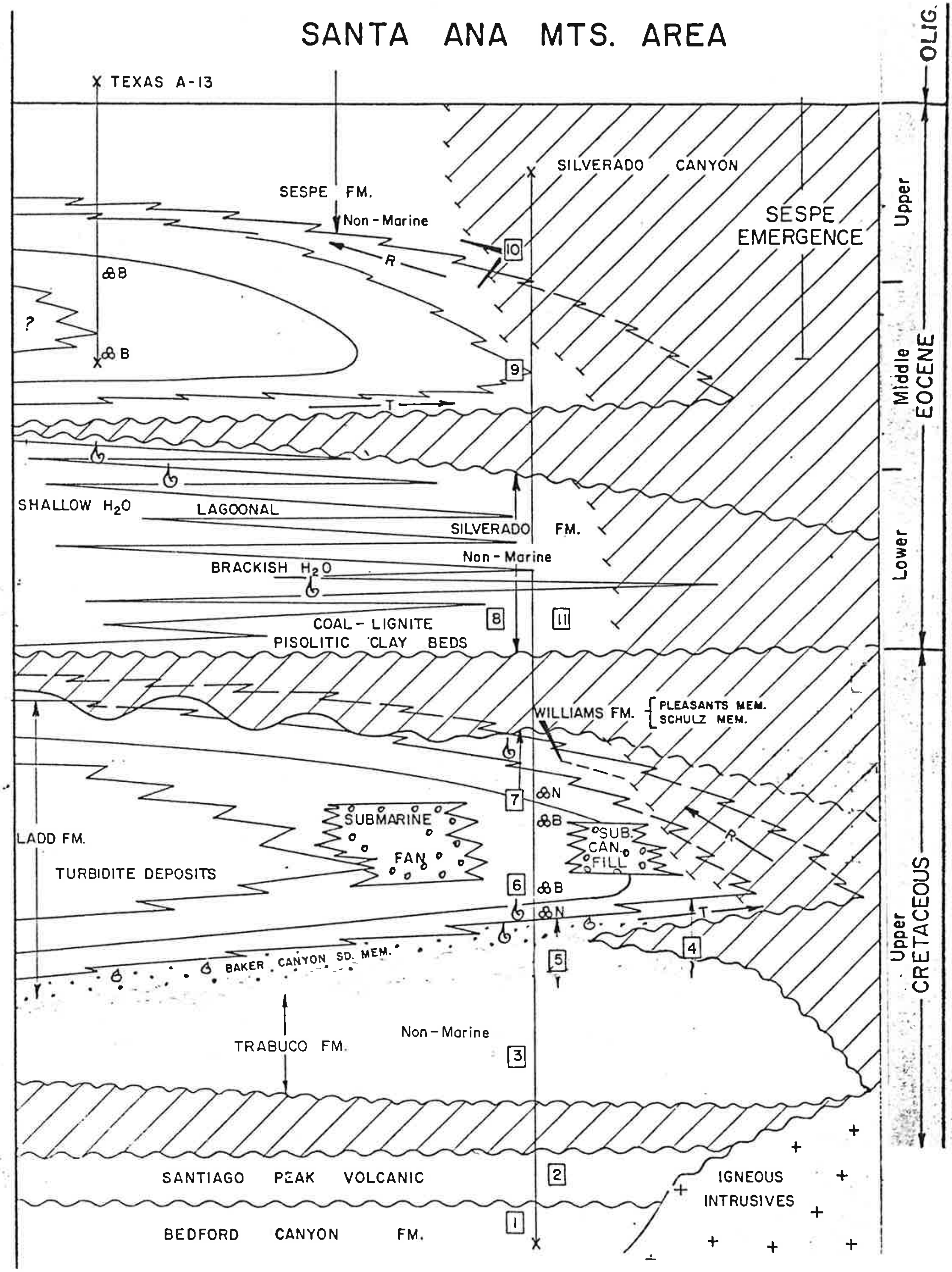


Figure 2.0 "Cycle" chart - Santa Ana Cretaceous - Paleogene

LATE CRETACEOUS DEPOSITIONAL ENVIRONMENTS AND PALEOGEOGRAPHY, SANTA ANA MOUNTAINS, SOUTHERN CALIFORNIA

David J. Bottjer
Department of Geological Sciences
University of Southern California
Los Angeles, California 90007

Ivan P. Colburn
Department of Geology
Calif. State Univ., Los Angeles
Los Angeles, California 90032

John D. Cooper
Department of Earth Science
Calif. State Univ., Fullerton
Fullerton, California 92634

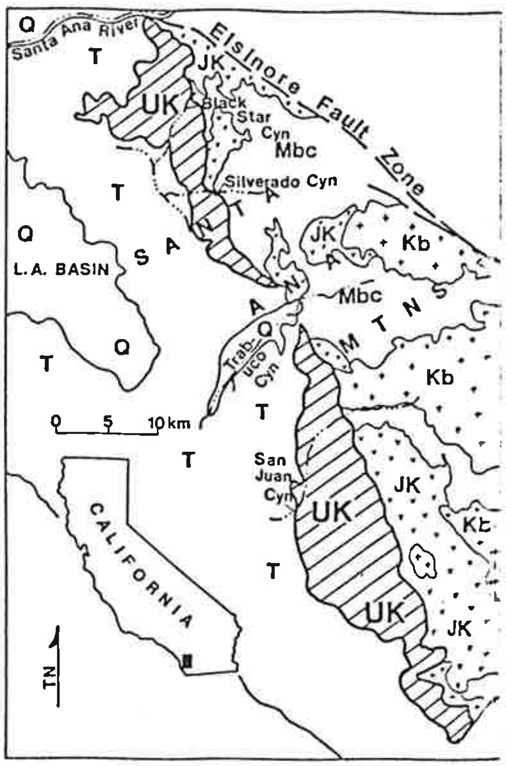


Figure 2.1 Generalized geologic map of northern Santa Ana Mountains showing outcrop belt of Upper Cretaceous sedimentary rocks (UK). Other rock units shown include the Triassic (?) - Jurassic Bedford Canyon Formation (Mbc), the Jurassic - Cretaceous Santiago Peak Volcanics (JK), and granitoid rocks of the Southern California Batholith (Kb), which collectively make up the basement complex. Tertiary (T) and Quaternary (Q) sediments of the southeastern margin of the Los Angeles Basin are also indicated. (After Rogers, 1965)

GEOLOGIC SETTING

The Santa Ana Mountains are in the northern part of the Peninsular Range Province and border the southeastern margin of the Los Angeles Basin (Fig. 5). The Upper Cretaceous rocks in the Santa Ana Mountains comprise a thick (500 to 1500 m) succession of predominantly marine terrigenous clastics sandwiched unconformably between rock assemblages of Jurassic-Early Cretaceous and Paleogene ages.

The oldest rocks in the northern Santa Ana Mountains are the Bedford Canyon Formation, a thick (greater than 5000 m) Triassic (?), Jurassic (Imlay, 1963, 1964; Silberling et al., 1961; Criscione et al., 1978) succession developed mainly as flysch (Moscoso, 1967) deposits of a forearc basin (Buckley et al., 1975) and exposed in the overturned limb of a large nappe (Moscoso, 1967). Bedford Canyon rocks locally are cut by shallow intrusives and overlain unconformably by extrusive andesitic rocks of the Santiago Peak Volcanics of Late Jurassic to Early Cretaceous age (Fife et al., 1967; Colburn, 1973). Intrusive rocks of the Southern California batholith (Larsen, 1948; Woyski, 1972) of Early to Middle Cretaceous age (Evernden and Kistler, 1970; Krummenacher et al., 1975) are exposed several km south of the trip route (Fig. 5).

The intensely deformed Bedford Canyon flysch, the andesitic Santiago Peak Volcanics, and the magmatic arc rocks of the Southern California batholith comprise the ancestral Santa Ana Mountains assemblage and reflect an orogenic history related to Late Mesozoic subduction (Hill, 1971; Yeats, 1974; Gastil, 1975). The overlying post-orogenic Upper Cretaceous rocks, which comprise the lower part of a pre-Middle Miocene, pre-inception of Los Angeles Basin (Yerkes et al., 1965; Yeats, 1968) coastal clastic wedge, are the subject of this field trip.

UPPER CRETACEOUS STRATIGRAPHY

The Upper Cretaceous sedimentary rocks of the northern Santa Ana Mountains crop-out as a northwest-striking homocline that dips west to southwest at 15 to 40 degrees (Schoellhamer et al., 1954). The succession is subdivided into the following units, in ascending order: Trabuco Formation, Ladd Formation (including the Baker Canyon and Holz Shale Members), and Williams Formation (including the Schulz, Pleasants, and Starr Members). This sequence provides an instructive example of a non-marine to shallow marine to equivocal deep marine transition, as well as exemplifying facies products of alluvial fan, fan-delta, fan-delta fringe, shallow marine shelf, and equivocal bay, outer shelf, upper slope, and submarine channel depositional systems. These strata record a major marine transgression as well as several major progradational events during Late Cretaceous time in the Santa Ana Mountains district.

Macrofaunal (Popenoe, 1942, 1973) and microfaunal (Almgren, 1973; Lang, 1976) successions indicate an age of Turonian through Campanian. The Turonian age of the unfossiliferous Trabuco Formation is based on the gradational relationship with the overlying fossiliferous Baker Canyon Member of the Ladd Formation; however, the Trabuco could be as old as Cenomanian (Lang, 1976). Fossils of possible Maastrichtian age have been reported from the upper part of the Williams Formation in the southern part of the outcrop belt (Morton, 1972).

Some questions have arisen regarding the internal conformity within the Cretaceous section. Although Yerkes et al. (1965) reported a Santonian and Coniacian age for the lower part of the section, the basis for this age assignment was not discussed. Almgren (1973; this volume) and Saul (this volume) find little evidence for the existence of Santonian and Coniacian strata in the succession.

* Bottjer, D.J., Colburn, I.P., and Cooper, J.D., eds., 1982, Late Cretaceous Depositional Environments and Paleogeography, Santa Ana Mountains, Southern California, Pacific Section, SEPM, Field Trip Volume and Guidebook, pg. 3-10.

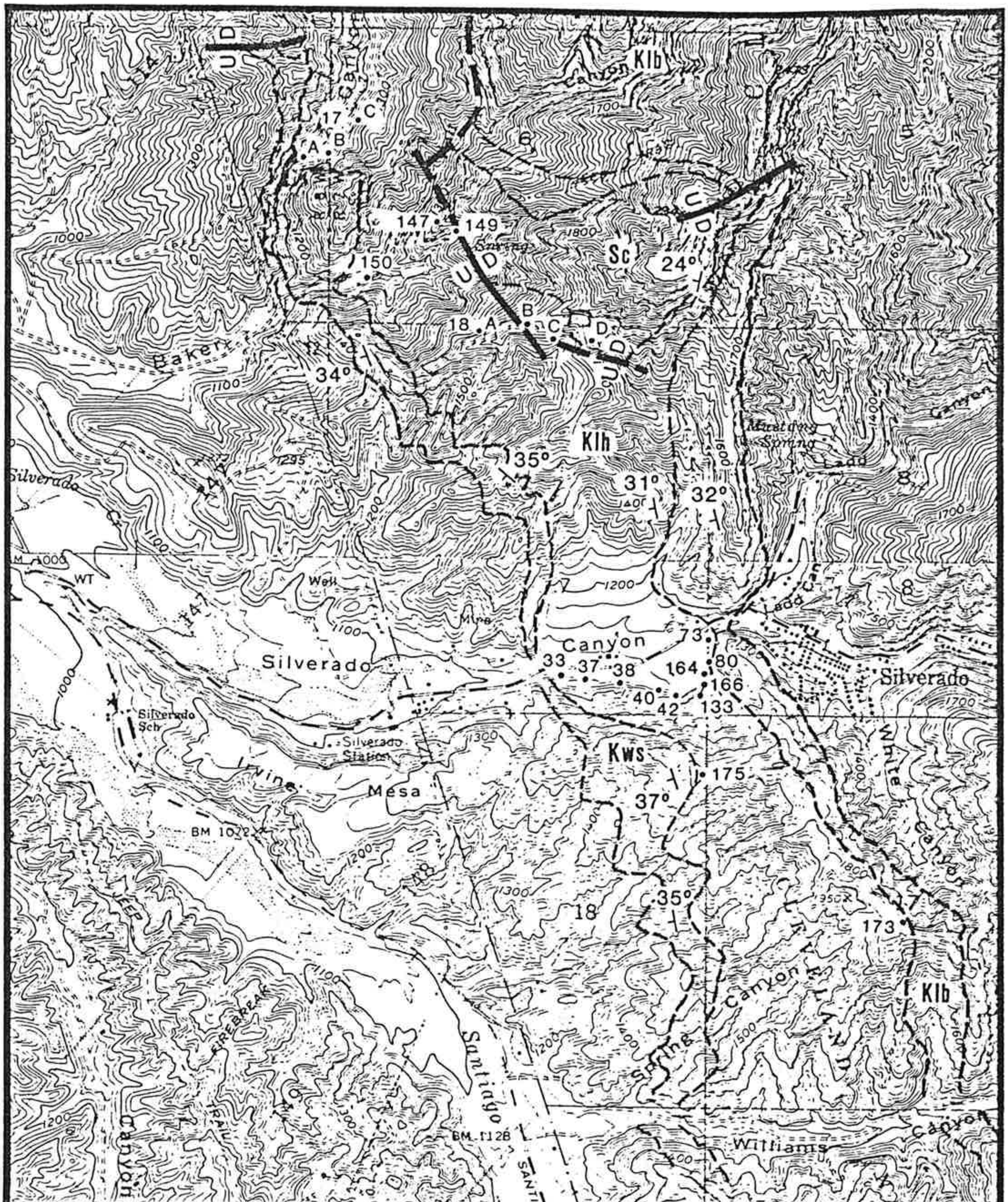


Figure 2.2 Map showing locations of foraminiferal samples from Silverado Canyon and Baker Canyon-Mustang Spring area. Stratigraphic positions of these samples are shown in Fig. 3, and foraminifera present are shown in Table I and Table II. Formation boundaries are those of Schoellhammer, et al., 1954. Formation designations are as follows: KlB=Baker Canyon Member; Klh=Holz Shale Member of the Ladd Formation; Sc= Mustang Spring Conglomerate Member of the Holz Shale; Kws=Schulz Member of the Williams Formation.

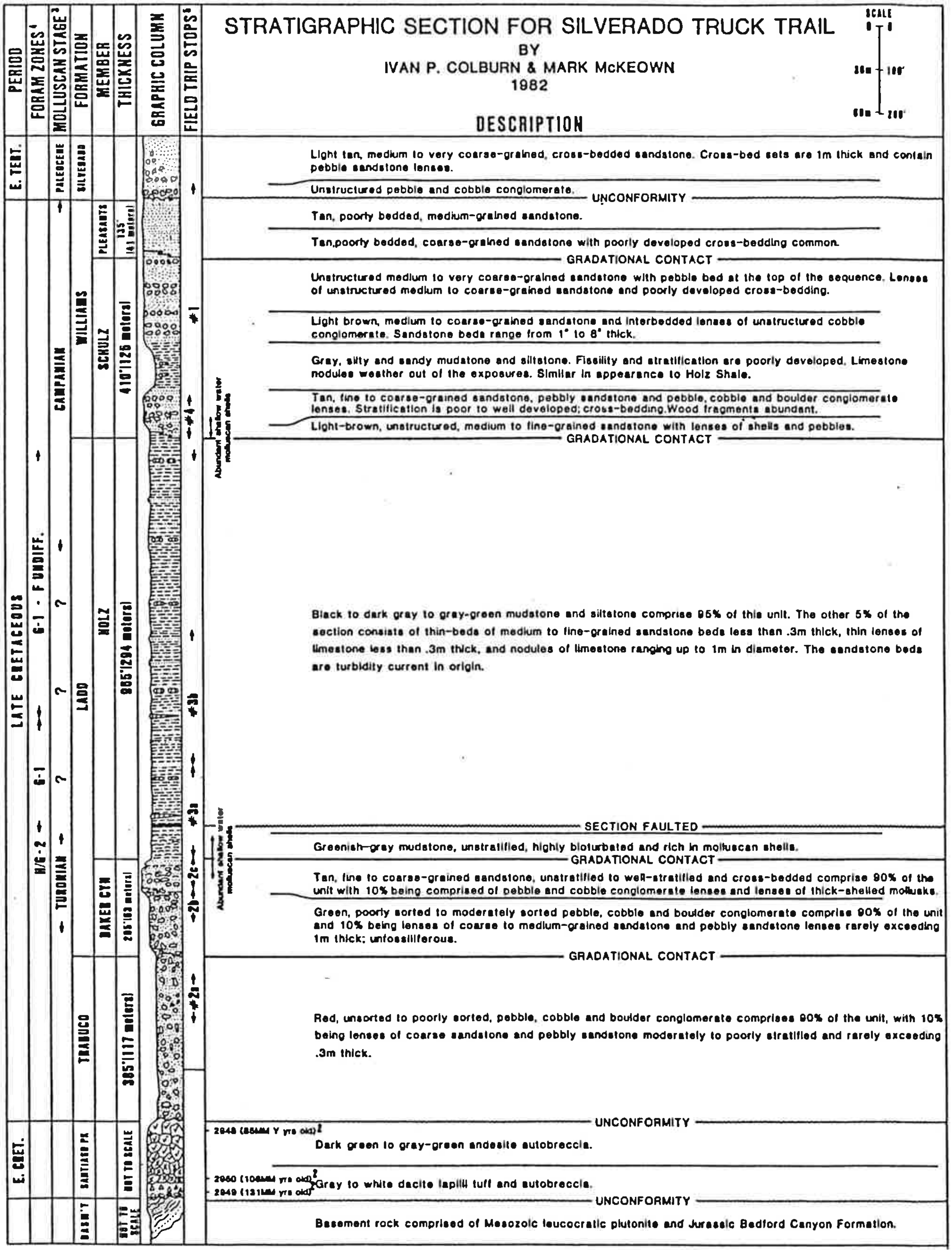


Figure23. Silverado truck trail stratigraphic section.

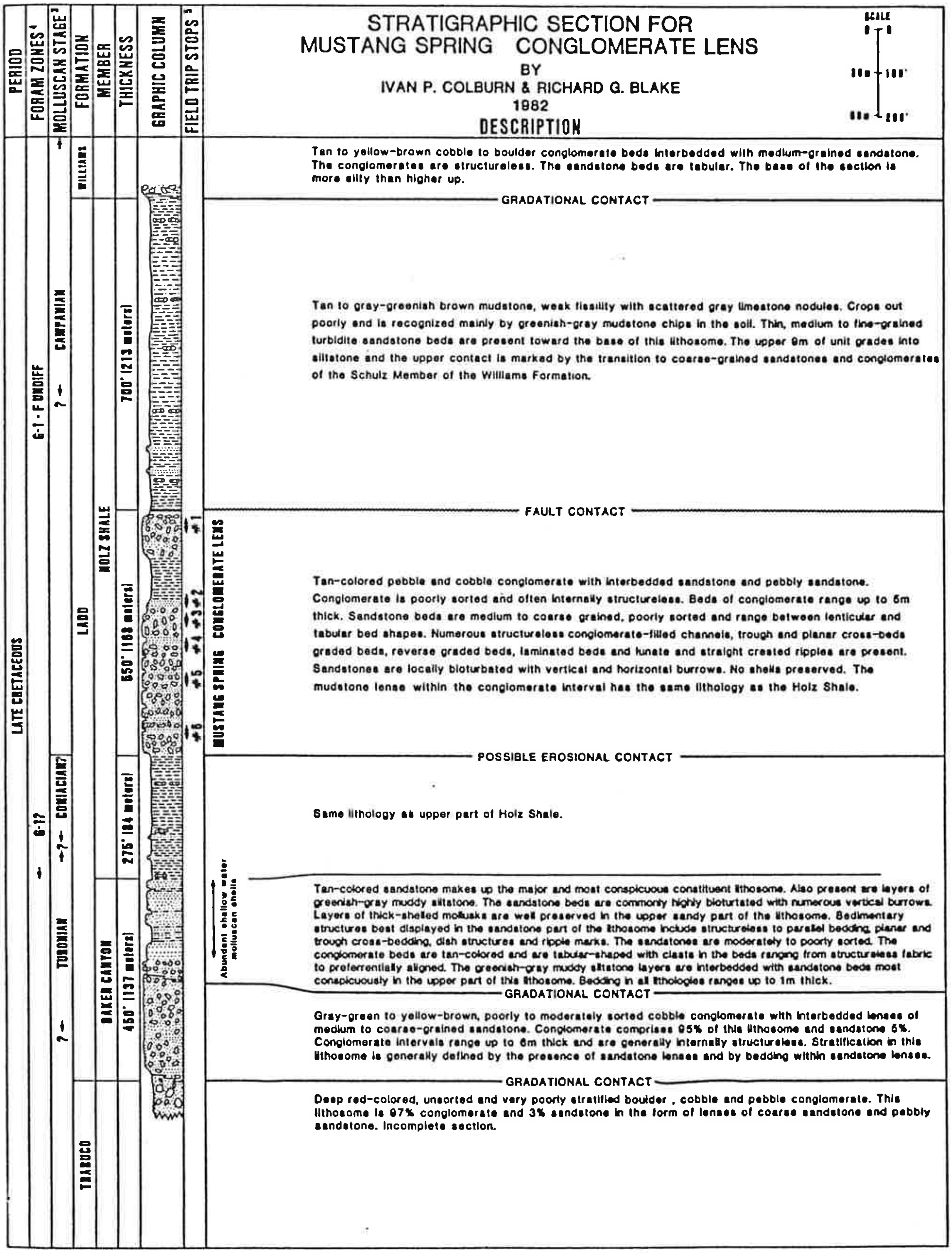


Figure 24. Mustang Spring conglomerate lens stratigraphic section.

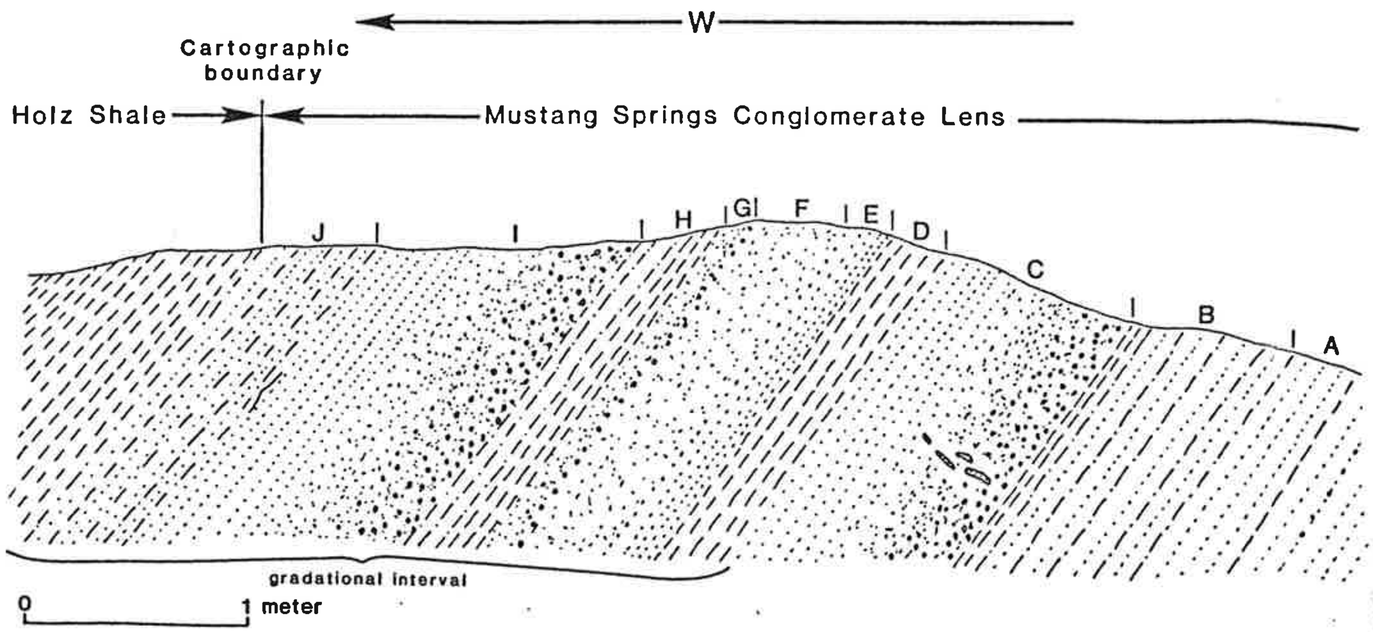


Figure 2.5 Stop 2 illustrates the lithologic characteristics of the stratigraphic upper units of the Mustang Spring Conglomerate Lens and its contact with the overlying Holz Shale. It can be seen at this stop that the upper part of the lens has a number of beds exhibiting partial Bouma bed form sequences thereby establishing that turbidity currents were depositionally active in the later phase of the lens development. Beds at this stop are finer grained and thinner bedded relative to beds stratigraphically lower in the lens (see Fig. 12). This relationship indicates an overall fining and thinning upward transition beginning in about the stratigraphic middle of the lens. (Blake & Colburne '82)

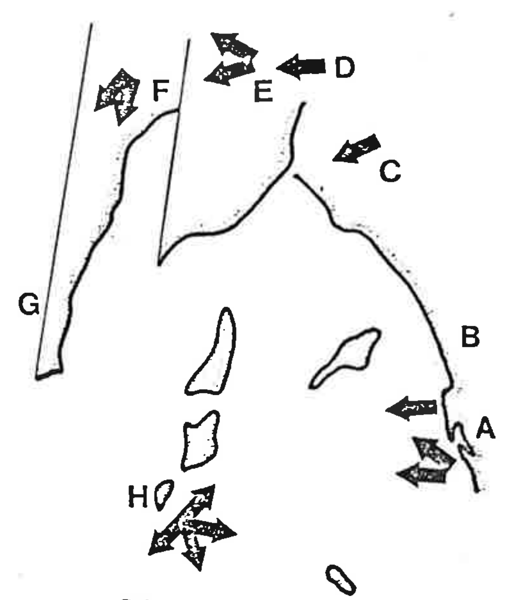


Figure 2.6 Pre-Neogene palinspastic reconstruction of Southern California showing location of areas of outcrop of Cretaceous strata, and paleocurrent directions. A = San Diego; B = Carlsbad-Rancho Santa Fe; C = Santa Ana Mountains; D = Santa Monica Mountains; E = Simi Hills; F = Wheeler Gorge; G = Santa Ynez Range; H = San Miguel Island.

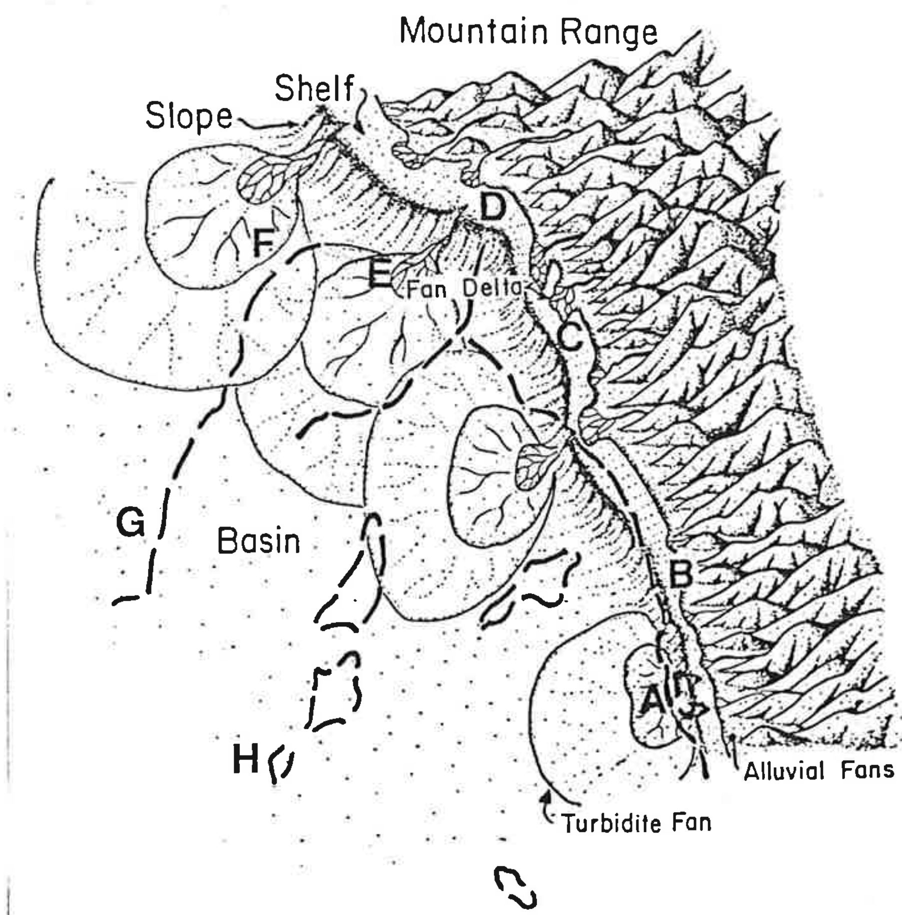


Figure 2.7 Paleogeographic reconstruction of Southern California during the Late Cretaceous (Campanian). Dashed lines represent the pre-Neogene geographic locations of the present-day coastline. Letters indicate pre-Neogene locations of present-day outcrop areas of Cretaceous strata (see Fig. 2.6 for explanation). (SUNDBERG + COOPER 82)

POINT FERMIN SUBMARINE FAN
PALOS VERDES, CALIFORNIA

Regional Setting

The Point Fermin submarine fan is within the Monterey Formation of the Palos Verdes Peninsula, California (Fig. 1). The Palos Verdes Peninsula contains rocks of a portion of an extensive, predominantly submarine terrane of the inner California Continental Borderland where middle Miocene and younger strata rest unconformably on a tectonically disrupted basement of Mesozoic Catalina Schist (Platt, 1975; Howell and Vedder, 1981). The Monterey Formation of the Palos Verdes Peninsula, which contains remarkably abrupt changes in lithofacies in the time interval from 16 Ma to 4 Ma (middle Miocene to early Pliocene) (Rowell, 1982) and has been divided by Woodring and others (1946), into three members (in ascending order): the Altamira Shale (300 m), Valmonte Diatomite (125 m), and Malaga Mudstone (125 m). They further subdivided the Altamira Shale into (in ascending order): tuffaceous lithofacies, cherty lithofacies, and phosphatic lithofacies (Fig. 2).

Subdivision	Dominant Lithology	Thickness in type area in meters	Age Range in million years	Duration in million years
Malaga Mudstone	radiolarian mudstone	125	6.9 to 3.5	3.4
Valmonte Diatomite	diatomite and phosphatic diatomaceous shale	125	13.0 to 6.9	6.0
Point Fermin sandstone lithofacies	sandstone derived from a Catalina Schist source	30	14.5 to 10.0	4.5
Phosphatic lithofacies	phosphatic diatomaceous shale and phosphatic mudstone	25	14.2 to 13.0	1.2
Cherty lithofacies	porcelanite and chert	16	14.5 to 14.2	0.3
Tuffaceous lithofacies	porcelanite, silty and sandy shale, basalt and tuff	275	15.5 to 14.5	1.0

Figure 2. Subdivisions and selected features of the Monterey Formation of the Palos Verdes Peninsula. Chronostratigraphy by Rowell (1982) (Conrad and Ehlig, 1983).

Local Setting

In the Point Fermin area, a portion of a submarine fan system occupies the stratigraphic position of the cherty and phosphatic lithofacies and the lower part of the Valmonte Diatomite (Fig. 3). Beds consisting predominantly of blue-schist-bearing sandstone and breccia, intraformational breccia, and interbedded silty and phosphatic shale occur within a channel system which has scoured into the upper tuffaceous lithofacies. Paleocurrent, grain orientation, and imbrication studies indicate a southeastward sediment source

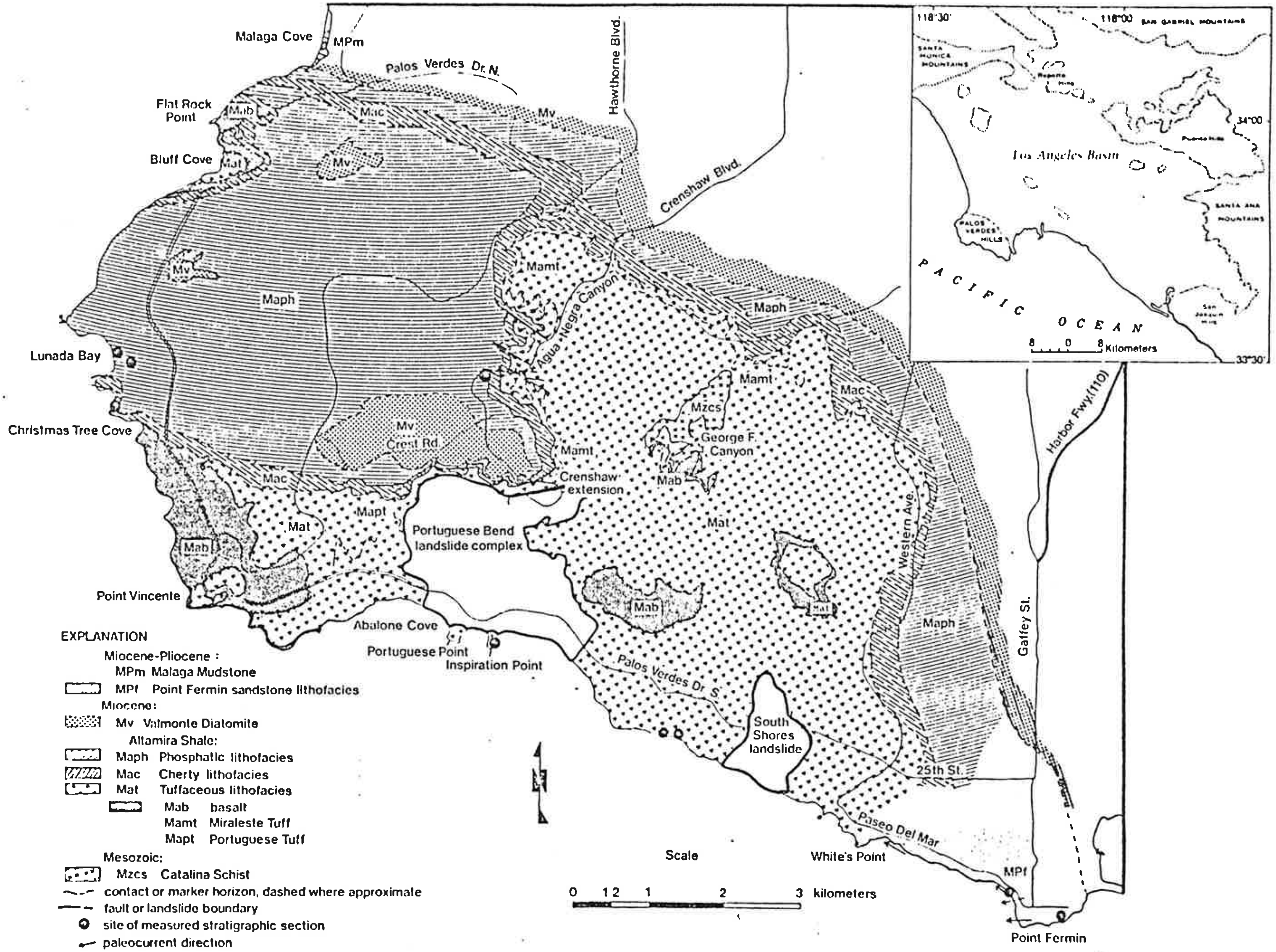


Figure 1. Bedrock distribution of the lithofacies of the Monterey Formation of the Palos Verdes Peninsula (Conrad and Ehlig, 1983).

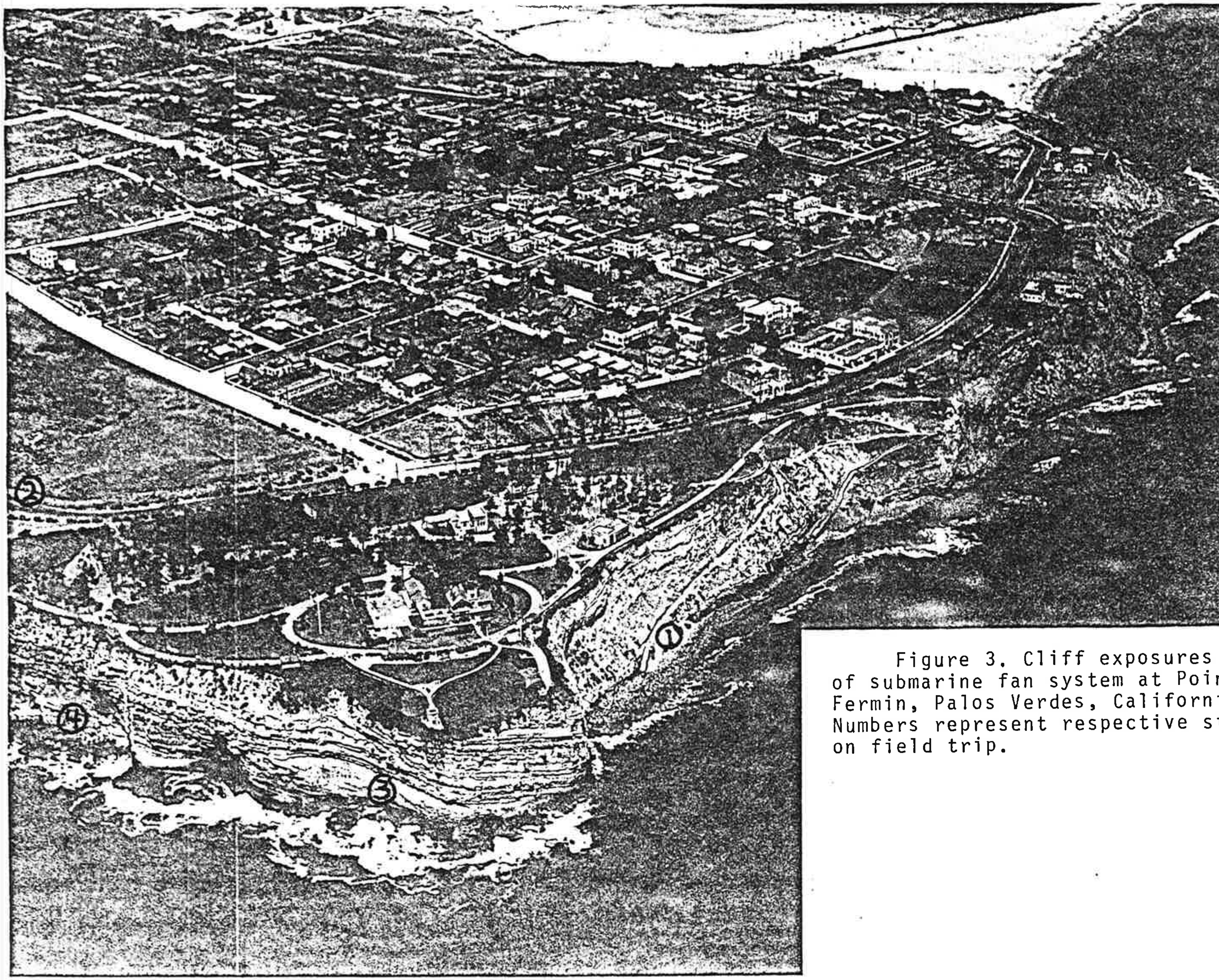


Figure 3. Cliff exposures of submarine fan system at Point Fermin, Palos Verdes, California. Numbers represent respective stops on field trip.

(Spotts, 1964; Conrad and Ehlig, 1983). Previous reports (Woodring and others, 1946; unpublished report by Biostratigraphics, 1981) indicate that the fan developed within the time interval between about 15.0 and 10.0 Ma. The total thickness is difficult to estimate, but is at least 300 ft (Woodring and others, 1946).

Stop 1

On the east side of Point Fermin, the above strata consist of two sandstone units and a shale unit. The upper sandstone unit forms a 100-foot sheer cliff and grades easterly down into the shale unit. The lower sandstone unit forms the base of the beach cliff and fines upward into the shale unit. The two sand units merge at the base of the sheer cliff. This is interpreted to be the amalgamation of two channel systems. Thinning and fining upward is characteristic of channel deposits (Fig. 4). Large rip-up clasts can be seen in some sand beds (Fig. 5).

Stop 2

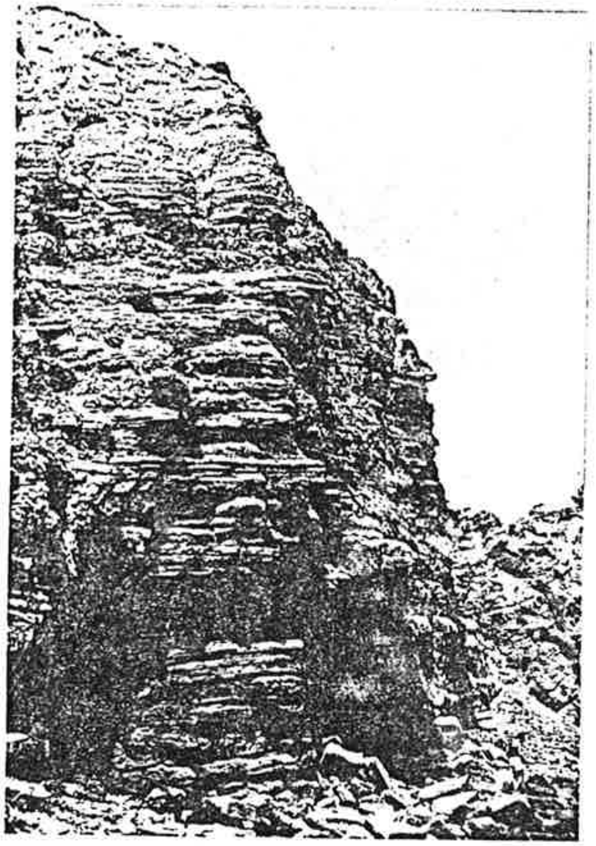
The roadcut on the northwest side of Point Fermin displays characteristic channeling features such as lenticularity, erosive scour, rip-up clasts, and amalgamated beds. Layers of shale can be traced into breccia composed of shale fragments of identical composition and embedded in a sandstone matrix like that interbedded with the shale. The channel margin can be seen in the western portion of the outcrop.

Stop 3

The channel axis is generally evident at the southern end of the Point. Lenticularity of bedding is readily apparent. It is in this region of the outcrop that the most diverse and well-displayed sedimentary structures can be found. These include flame structures and convoluted bedding (Fig. 6), ripple bedding (Fig 7), contorted rip-up clasts (Fig. 8), and cut-and-fill structures (Fig 9).

Stop 4

A channel margin is evident on the west side of Point Fermin. An irregular, scoured base can be seen where coarse-grained sandstone and pebble conglomerate rest unconformably on interbedded shale and sandstone (Fig. 10). These interbedded shale and sandstone beds represent levee deposits. Slump folds, typical of levee deposits, can be seen just below the irregular sandstone contact (Fig. 11).



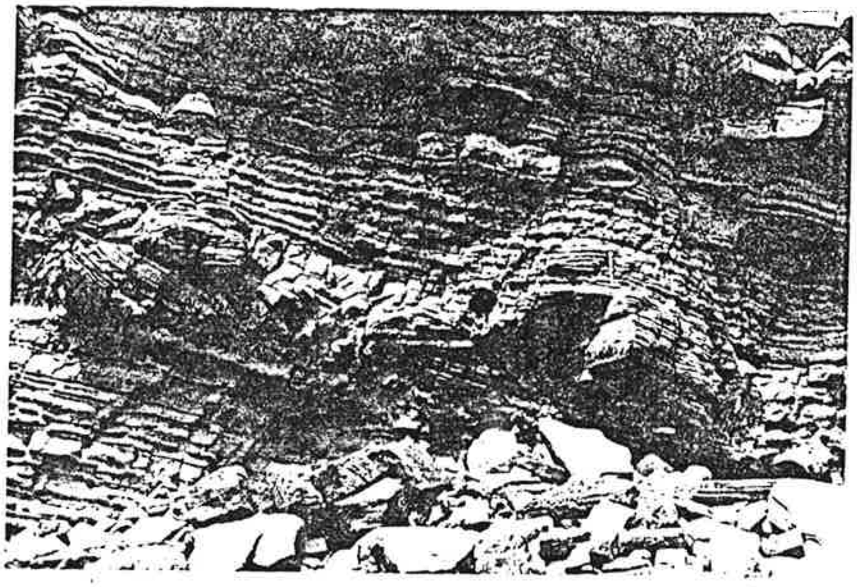


Figure 5. Large shale rip-up clasts in channel deposits.

Figure 4. Thinning and fining upward of channel deposits.

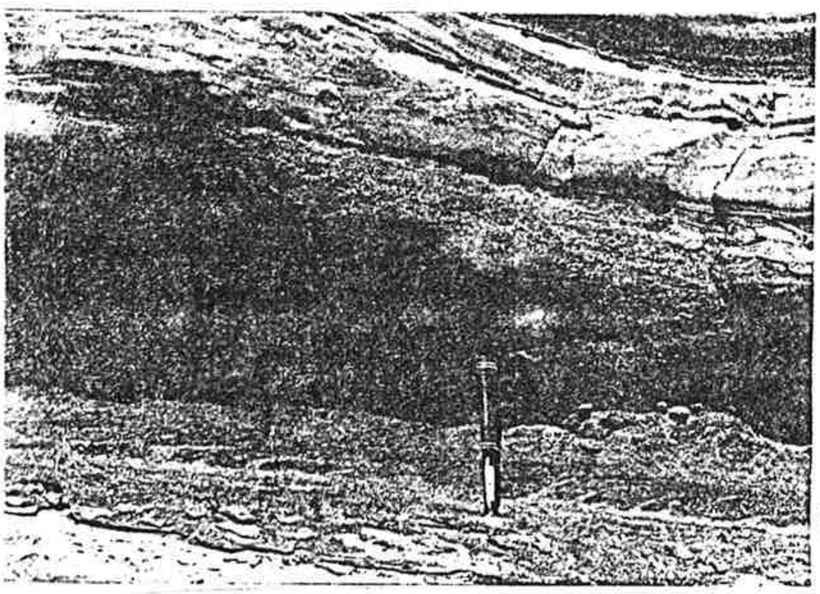


Figure 6. Flame structures and convoluted bedding in channel deposits.

Figure 7. Climbing ripples in channel deposits.

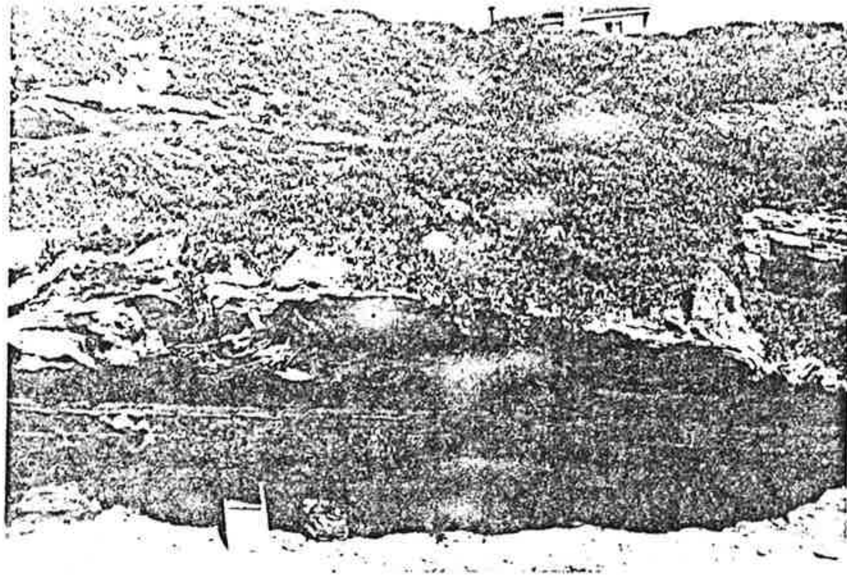


Figure 8. Contorted shale rip-up clasts.

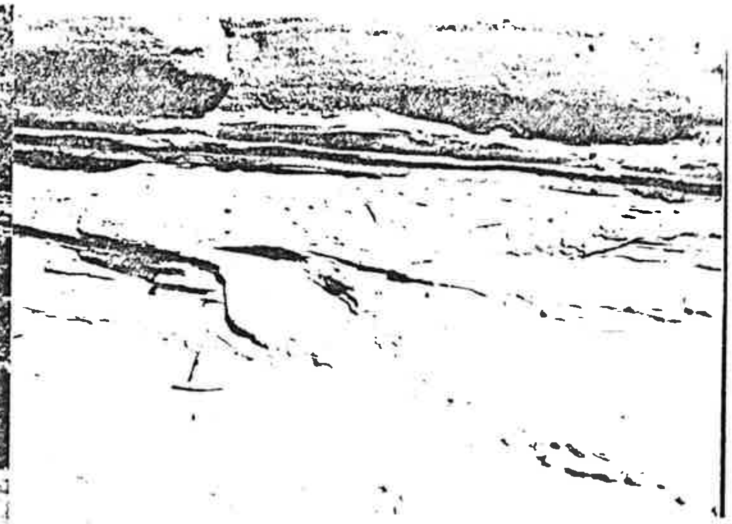


Figure 9. Cut-and-fill channel structure.

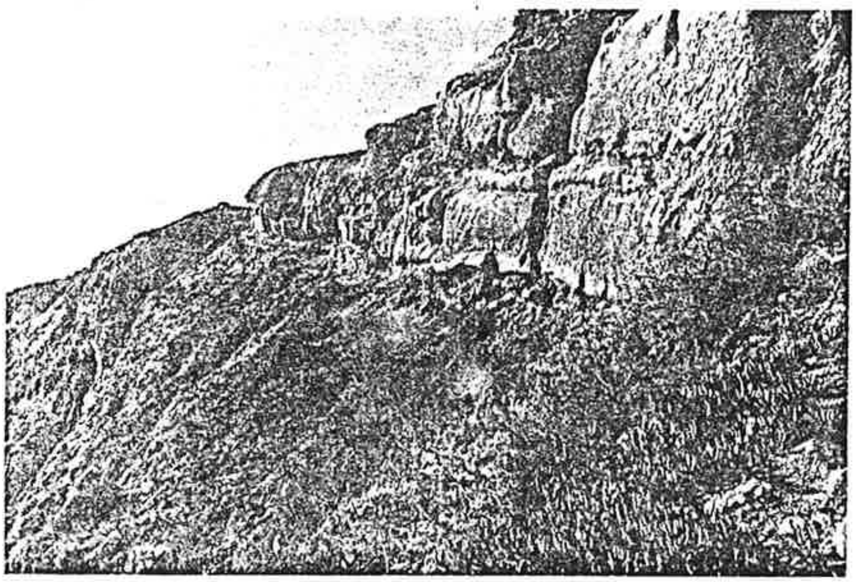


Figure 10. Irregular, scoured base of channel margin.

Figure 11. Slump fold in levee deposits.

REFERENCES CITED

Conrad, C. L., and Ehlig, P. L., 1983, The Monterey Formation of the Palos Verdes Peninsula, California - an example of sedimentation in a tectonically active basin within the California Contnental Borderland, in Larue, D. K., and Steel, R. J., eds., Cenozoic marine sedimentation, Pacific Margin, U.S.A.: Society of Economic Paleontologists and Mineralogists, Pacific Section.

Howell, D. G., and Vedder, J., 1981, Structural implications of stratigraphic discontinuities across the southern California Borderland, in Ernst, W. G., ed., The geotectonic development of California. Rubey Volume 1: Englewood Cliffs, New Jersey, Prentice-Hall, p. 535-582.

Platt, J. P., 1975, Metamorphism and deformational processes in the Franciscan Complex, California: Some insights from the Catalina Schist terrane: Geological Socity of America Bulletin, v. 86, p. 1337-1347.

Rowell, H. C., 1982, Chronostratigraphy of the Monterey Formation of the Palos Verdes Hills, in Landslides and landslide abatement, Palos Verdes Peninsula, southern California: Association of Engineering Geologists, Southern California Section, p. 7-13.

Spotts, J. H., 1964, Grain orientation and imbrication in Miocene turbidity current sandstones, California: Journal of Sedimentary Petrology, v. 34, p. 229-253.

Woodring, W. P., Bramlette, M. N., and Kew. W. S., 1946, Geology and paleontology of Palos Verdes Hills, California: U.S. Geological Survey Professional Paper 207, p. 145.