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Paleogene benthic foraminifers from the Loma Prieta Quadrangle, California

by

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ABSTRACT

Paleogene benthic foraminifers were identified from five formations (units) within the Loma Prieta 7 1/2 Minute Quadrangle. Southwest of the San Andreas Fault the Butano Sandstone contains a poorly preserved arenaceous fauna which is Eocene in age whereas foraminiferal faunas from the San Lorenzo Formation are more diverse and range from late Eocene to Oligocene in age. Foraminiferal faunas from the Butano Formation suggest deposition occurred at lower bathyal depths. Deposition of the San Lorenzo Formation occurred at shallower depths: lower middle bathyal depths during the Narizian and upper bathyal depths during the Refugian. Faunas from these formations are most similar to faunas from the Butano and San Lorenzo Formations in the Santa Cruz Mountains to the west. Late Eocene faunas in Washington, Oregon, and in the southern San Joaquin Valley of California contain some species in common with the San Lorenzo faunas. Northeast of the San Andreas Fault the "mottled mudstone of Mt Chual" (Te_1), "marine sandstone and shale" (Te_2), and the basal part of the "marine shale and sandstone of Highland Way" (Tme) are early Eocene in age and assigned to the Penutian

benthic foraminiferal stage as modified by McDougall (1988). The upper part of "marine shale and sandstone of Highland Way" (Tme) is Oligocene to early Miocene in age and assigned to the Zemorrian benthic foraminiferal stage. The early Eocene faunas indicate deposition occurred at lower bathyal to abyssal depths. Similar faunas are found in the Woodside and Tres Pinos sections of California. Coeval but shallower water faunas are found in the Pacheco Syncline, New Idria, Lodo Gulch, Devils Den, and Media Agua Creek sections of California.

INTRODUCTION

The Loma Prieta 7 1/2 Minute Quadrangle is located in Northern California, south of San Jose in the San Jose 2° sheet (fig. 1). The Loma Prieta Quadrangle is cut by the San Andreas Fault and numerous other faults which generally run NW-SE across the area (figs. 1-2). Southwest of the San Andreas Fault, Paleogene formations include marine sandstone, shale and siltstone assigned to the Butano Sandstone (Tbs), and marine mudstone and sandstone assigned to the San Lorenzo Formation (Tsl). Northeast of the San Andreas Fault, Paleogene formations include the "mottled mudstone of Mt Chual" (Te_1), "marine sandstone and shale" (Te_2), and "marine shale and sandstone of Highland Way" (Tme). All five formations were sampled for microfossils. The purpose of this paper is to document the Paleogene benthic foraminiferal faunas which occur in the Loma Prieta Quadrangle, California, and indicate the age and paleoecology as well as probable correlation with other faunas in California.

Benthic foraminiferal data in the Loma Prieta Quadrangle comes from newly collected samples, and samples on file with the Paleontology and Stratigraphy Branch. Age interpretations are based on the modified benthic foraminiferal zonations of Almgren and others (1988) and McDougall (1988) which were integrated with planktic microfossil zonations. Environmental interpretations are based on an overview of California benthic foraminifers by Ingle (1980), a study of Atlantic Paleogene benthic foraminifers by Tjalsma and Lohmann (1983), and a study of cosmopolitan deep-water benthic foraminifers by van Morkhoven and others (1986). Only general environmental interpretations are given because 1) paleoecological controls of Paleogene benthic foraminifers are not well known and 2) statistical data is not available for most of the Loma Prieta samples. Correlations to coeval formations in California are only briefly discussed as much of this work is still in progress.

Methods

Samples studied were collected as part of the U.S. Geological Survey National Mapping Program's San Jose 2° Sheet Project currently in progress and an earlier study by R.L. Pierce (unpublished reports from 1967 through 1970). The sample locations are shown on figure 2 and given in Table 9, Appendix I. Foraminiferal slides and residues are on file with the Branch of

Paleonotogy and Stratigraphy, U.S. Geological Survey, Menlo Park, California.

Samples collected as part of the National Mapping Project were disaggregated with solvent (kerosene) and washed in water through a 63 micron screen. Benthic foraminifers from the abundantly fossiliferous samples were counted for statistical analysis. The majority of the samples were, however, sparsely fossiliferous or barren. For these samples the entire residue was examined and, if fossiliferous, representative numbers of specimens were picked. Foraminiferal species identified from these assemblages are given in Tables 1-8.

Material from the earlier studies consisted of picked slides or representative amounts of residue preserved on a foraminiferal slide. Processing techniques are not known. This material was re-examined to revise the age and environmental interpretations as well as the taxonomic nomenclature. Benthic foraminiferal species identified from these assemblages are given in Tables 1-8.

Biostratigraphic Framework

Biostratigraphic zonations developed by Laiming (1939) and Mallory (1959) are the primary means of dating and correlating Paleogene strata in California. Planktic microfossil workers have, however, demonstrated that the benthic foraminiferal stages and zones are time transgressive (figs. 3-4) (Schmidt, 1975; Steineck and Gibson, 1971; Gibson, 1976; Bukry and others, 1977;

Warren, 1980, 1983; Poore, 1976, 1980). Recently several studies reduced the problem through a multidisciplinary approach which integrates benthic foraminiferal zonations with planktic chronologies (Almgren and others, 1988; McDougall, 1988).

The benthic foraminiferal zonation proposed by Almgren and others (1988) calibrates the existing benthic foraminiferal zonations (Laiming, 1939; Mallory, 1959) with the calcareous nannofossil zonation of Okada and Bukry (1980). After a review of the problems encountered with Mallory's zonation, Almgren and others, (1988) suggest abandoning Mallory's zonation, even the modified version they present, in favor of an emended Laiming zonation. The emended Laiming zonation which includes eleven zones identified by key benthic foraminiferal species, is correlated to the calcareous nannofossil zones of Okada and Bukry (1980) (fig. 5). As noted by Almgren and others (1988), the time transgressive nature of the benthic foraminiferal zones although not completely eliminated by the emended zonation, is reduced. Problems with the emended Laiming zones of Almgren and others (1988) include a significant chronologic overlap of the zones and a strong environmental connotation to each of the zones (i.e. Zone C and pseudo-C are deep water whereas the coeval B zones are shallow water). The zones are, however, more accurately calibrated to time than the original zones proposed by Laiming (1939).

A preliminary study of the Penutian Stage by McDougall (1988) also integrates planktic chronologies with benthic foraminiferal zonations. In this study, the type area of the Penutian Stage (Media Agua Creek) was re-examined and cosmopolitan deep-water benthic foraminiferal species whose ranges have been calibrated with planktic chronologies worldwide (van Morkhoven and others, 1986) and computer analysis of faunal similarities were used to recognize faunal groups in the section (fig. 6). Four faunal groups recognized in the Media Agua Creek section corresponded only roughly to the four stages recognized by Mallory (1959, 1970). The faunal groups more closely approximated the planktic microfossil zones and suggested unconformities in the section as previously noted in the planktic studies (Poore, 1976). These faunal groups were recognized in other California sections. Since each group continued to occur with the same planktic zones, Mallory's stage names were applied: the Ynezian Stage correlates to P4 (CP4 through lower CP8), the Bulitian Stage correlates to P6b through P7 (upper CP8 through CP9), the Penutian Stage correlates to P8 through P9 (upper CP9 through CP11), and the Ulatisian Stage correlates to P10 through at least P12 (CP12 through CP13) (fig. 7). Benthic foraminiferal assemblages younger than P10 and older than P4 have not been examined yet. The upper boundary of the Ulatisian Stage and the lower boundary of the Ynezian Stage have, therefore, not been accurately dated. The strata correlative to P5 and P6a (upper CP8) is missing from most sections examined in this study. Although this late Paleocene interval is abritarily assigned to the Ynezian Stage, it may subsequently be assigned to the

Bulitian Stage, as many Eocene species have their first appearance in this interval.

The ranges of cosmopolitan deep-water species useful in recognition of these stages are given in figure 8. The ranges of California species useful in recognition of these stages are given in figure 9. The ranges of the California species may not represent total ranges yet as only a small number of sections have been examined. Both cosmopolitan and California species are discussed in Appendix II.

The placement of stage boundaries by McDougall (1988) correlates closely with major changes in sea level (Haq and others, 1987) but differs from the placement of stage and zone boundaries as recognized by Almgren and others (1988) (fig. 10). The primary difference between Almgren and others (1988) and McDougall (1988) is the placement of the Penutian Stage or Zone C. McDougall (1988) considers the Penutian Stage coeval with nannofossil zones CP10 and most of CP11; Almgren and others (1988) restrict Zone C (Penutian Stage) to CP9 and CP10, and recognize a pseudo C zone which extends from CP10 through CP12. These differences are in part due to recognition of shallow water biofacies as separate chronostratigraphic zones, failure to recognize total ranges of deep water species by Almgren and others (1988) (fig. 5), and the near absence of diagnostic shallow water species in the zonation by McDougall (1988) (figures 8 and 9). Despite these problems, both zonations reduce but do not eliminate the time transgressive nature of the benthic foraminiferal stages and zones.

For this paper, benthic foraminferal ranges are given in terms of the planktic foraminiferal zones of Blow (1969) and Berggren (1972) or calcaresous nannofossil zones of Okada and Bukry (1980). Stage names are used and based on the modifications as proposed by McDougall (1988) for the early to middle Eocene. For the late Eocene and Oligocene assemblages, the zonations of McDougall (1980) and Kleinpell (1938) are used.

PALEOGENE FORMATIONS SOUTHWEST OF THE SAN ANDREAS FAULT

Butano Sandstone (Tbs)

Four samples were collected from the Butano Sandstone for foraminiferal analysis. One sample, Mf7436, near the primary trace of the San Andreas Fault is barren of foraminifers. The remaining three samples (Mf4498, Mf4499, and Mf7443) contain common arenaceous specimens, foraminiferal fragments, and rare calcareous specimens (Table 1). These assemblages are Cenozoic and probably Eocene in age.

The cosmopolitan species *Silicosigmoilina californica* and *Globocassidulina globosa* occur in Mf4498 and suggest late Paleocene to middle Eocene age. The former species ranges from Cretaceous to middle Eocene (last appears in planktic foraminiferal zone P9) with rare or questionable occurrences in the late Eocene (through zone P14). The latter species first appears in the late Paleocene (rare in zone P4) and becomes more common in the Eocene sediments. The common occurrence of both species favors an age of early to middle Eocene. A more restricted age interpretation is not possible as age diagnostic species are lacking.

Samples Mf4499 and Mf7443 contain fewer species that are not diagnostic of age. The preservation of Mf4499 and Mf7443 is similar to Mf4498.

The faunas from the Butano samples suggest that deposition occurred on the lower slope. Arenaceous species present have upper depth limits in the lower middle bathyal and lower bathyal biofacies indicating deposition occurred at depths of 1500 m or greater. Most of the calcareous specimens were probably removed by diagenesis. Chilostomella oolina, and Allomorphina cf. A. macrostoma which are frequently associated with low oxygen conditions in Eocene assemblages (McDougall, 1980, Ingle, 1980) indicate transport from the upper slope.

San Lorenzo Formation (Tsl)

Benthic foraminiferal samples were collected primarily from two sections: Buzzard Lagoon Road and Aptos Creek. Only one (Mf1582) of the six samples collected along Buzzard Lagoon Road contained common benthic foraminifers (Table 2); the remaining samples were either barren of foraminifers (Mf7441, Mf7442 and Mf1580) or contained arenaceous fragments which could not be identified. The single fossiliferous sample from Buzzard Lagoon

Road is late Eocene (Narizian) in age. The six samples collected along Aptos Creek (Mf1583 through Mf1588) contain sparse to moderately abundant benthic foraminifers (Table 2) and range from late Eocene (Narizian) to early Miocene (Zemorrian) in age.

Sample Mf1582 from the San Lorenzo Formation along Buzzard Lagoon Road contains a relatively diverse assemblage. Age diagnostic species are not common. Eggerella elongata, Plectina garzaensis, and Spiroplectammina tejonensis first appear in the upper Ulatisian and Eggerella subconica first appears in the lower Narizian (Appendix II). Most of these species last appear in the upper Narizian along with Spiroplectammina directa which also occurs in this sample. The age of this sample is restricted to the late Eocene, Narizian Stage.

Foraminiferal assemblages along Aptos Creek contain species diagnostic of the late Eocene, Narizian Stage, the late Eocene to early Oligocene, Refugian Stage, and the Oligocene to early Miocene, Zemorrian Stage. Sample Mf1588 contains Eggerella subconica which first appears in the lower Narizian and Eggerella elongata which appear in Ulatisian assemblages (middle Eocene) but is usually restricted to the Narizian (Mallory, 1959; McDougall, 1980, 1983). This sample is thus considered late Eocene in age and diagnostic of the Narizian Stage. Sample Mf1587 is probably also Narizian. The only age diagnostic species present is Quinqueloculina minuta which is restricted to the Narizian.

The next stratigraphically higher sample Mf1586 contains Plectofrondicularia packardi and P. vokesi which first appear in the upper Narizian but are most common in the Refugian, and Cibicides elmaensis, Cibicides haydoni, and Uvigerina atwilli which first appear in the lower Refugian and are restricted to the Refugian (C. haydoni and U. atwilli) or range no higher than the Zemorrian (C. elmaensis); thus, this assemblage is considered Refugian, late Eocene to early Oligocene in age. Sample Mf1585, which is stratigraphically higher in the section, does not contain age diagnostic species.

The youngest part of the San Lorenzo Formation sampled along Aptos Creek is represented by Mf1584 and Mf1583. Age diagnostic species are present primarily in Mf1583 and include Bolivina marginata, Bulimina carnerosensis and Plectofrondicularia cf. P. miocenica. Bolivina marginata first appears in the Refugian whereas the other two species first appear in the Zemorrian. Bolivina carnerosensis is restricted to the Zemorrian Stage. Plectofrondicularia packardi continues to appear in Mf1583 suggesting this assemblage was deposited early in the Zemorrian.

Environmental conditions during deposition of the San Lorenzo Formation vary from upper middle bathyal (500-1500 m) in the Narizian assemblages to upper bathyal (150-500 m) for the Refugian assemblages to upper middle bathyal depths (500-1500 m) for the Zemorrian assemblages. The diverse assemblage in Mf1582 contains Eggerella elongata, Eggerella subconica, Martinotiella cf. M. eocenica, and Rhabdammina eocenica as well as several species of *Spiroplectammina* which suggest upper middle bathyal depths. Also present in this assemblage are *Globobulimina pacifica* and *Chilostomella oolina* which indicate transport from upper bathyal depths. The less diverse Narzian assemblage in Mf1588 contains both species of *Eggerella* which indicated deposition at upper middle bathyal depths. The presence of several species with upper depth limits on the shelf (*Boldia hodgei*, *Cibicides elmaensis*, *Cibicides haydoni*, and *Uvigerina atwilli*) coupled with the absence of any species with upper depth limits in deeper water indicates that deposition during the Refugian occurred on the outer shelf (50-150 m) or upper slope (150-500 m). The various species of *Cibicidoides* and *Uvigerina* common in these Refugian assemblages are most abundant in the upper bathyal biofacies (McDougall, 1980) so deposition at upper bathyal depths is the preferred interpretation. The shallowing observed in the lower part of the San Lorenzo Formation has been noted elsewhere (McDougall, 1983) and correlates with the worldwide lowering of sea level which occurs between 40 and 36 Ma (Haq and others, 1987). The Zemorrian assemblages which contain *Bulimina carnerosensis* and *Plectofrondicularia* cf. *P. miocenica* indicate a return to upper middle bathyal depths.

PALEOGENE FORMATIONS NORTHEAST OF THE SAN ANDREAS FAULT

"Cretaceous Shale" (Ku_1)

Four samples were taken along Loma Prieta road southwest of Mt. Chual. These samples were taken in hard, black shales believed to be Cretaceous in age. Analysis of the benthic foraminifers suggest that this outcrop may be one of the younger Tertiary units rather than the "Cretaceous shale" unit. Samples Mf7451 and Mf7452 are barren of foraminifers; samples Mf1586A and Mf1587A contain low diversity arenaceous fauna which is Eocene in age (Table 3). Most of the species present are long-ranging species which first appear in the late Cretaceous or Paleocene and continue into the middle or late Eocene. Spiroplectammina directa which first appears in the early Eocene (CP11, Appendix II) suggests the lower age limit for this fauna whereas Dorothia bulletta, Marssonella oxycona, and Silicosigmoilina californica, indicate a late Eocene, upper age limit for this fauna.

Species present in samples Mf1586A and Mf1587A also occur in the "mottled mudstone of Mt. Chual" (Te_1) , the "marine sandstone and shale" (Te_2), and the "sandstone of Highland Way" (Tme) units. Similar faunas have not been recovered from other samples in the "Cretaceous shale " unit; these samples may be mislocated or they may be from a small outcrop of the "mottled mudstone" (Te_1) or "marine sandstone and shale" (Te_2) units (McLaughlin, personnal communication, 1989).

The dominance of arenaceous species which use a siliceous cement in the sparsely fossiliferous samples Mf1586A and Mf1587A suggests that diagenesis has removed the nonsiliceous material or that deposition occurred at lower bathyal to abyssal depths. Both conditions are believed to have affected these assemblages.

"Mottled mudstone of Mt. Chual" (Te_1)

The mottled mudstone unit (Te_1) is described by McLaughlin and others (1988) as composed of a basal conglomerate (up to 8 m thick) or glauconitic sandstone (up to 2 m thick), overlain by a red and geen mottled mudstone (up to 210 m thick). The mottled mudstone outcrops in several bands north of the San Andreas Fault (fig. 2). Sixteen grab samples were analyzed for foraminifers from this unit. The highest concentration of samples (10) is in the Mt. Chual area where benthic foraminiferal faunas are abundant and diverse (Table 4). Another group of samples were taken from a band of mottled mudstone in fault contact with the Te_2 unit just north of the San Andreas fault. Five samples were taken from three locations within this unit (fig. 2). Foraminiferal faunas in these samples are similar to those near Mt Chual but less diverse (Table 5). An additional sample was taken from an outcrop of Te_1 near the eastern boundary of the quadrangle between the Sargent and Berrocal Fault zones. Foraminifers are present but not diverse in this sample (Mf1604, Table 5).

Benthic foraminiferal assemblages from the mottled mudstone are similar. The primary difference is in diversity which is dependant on preservation. Samples Mf1585A and Mf7453 from the Mt Chual area contain a low diversity foraminiferal assemblage, 7 and 5 species, respectively. Arenaceous species present in these samples used a siliceous cement or resistant calcareous cement.

Arenaceous species also dominate the low diversity samples Mf1591 (4 species) and Mf1604 (8 species) in the band north of the San Andreas Fault. Some calcareous species are present in these samples. Moderately diverse assemblages (15-33 species) contain both the resistant arenaceous species and calcareous species. The diverse assemblages contain 40 or more species and include many rare species represented by 1 specimen.

The foraminiferal assemblages from the mottled mudstone near Mt. Chual (Table 4) suggest assignment to the Penutian Stage as modified by McDougall (1988) and thus are equivalent to Early Eocene planktic foraminiferal zones P8 to P9. Present in these assemblages are many species which first appear in the late Cretaceous, Paleocene or early Eocene (P6b), range throughout the Eocene and into younger strata. The age of the assemblages is restricted to planktic zones P9 through P10 by the cosmopolitan deep-water species *Bulimina callahani* (P6a-P10), *Bulimina macilenta* (P7-P15), *Cibicidoides subspiralis* P9-P13), *Cibicidoides grimsdalei* (P8-N4), *Pullenia eocenica* (P9-P17 with questionable occurrences in P6a-P8), and *Silicosigmoilina californica* (Cretaceous-P9 with questionable occurrences in P10-P13) (Appendix II). Except for *Bulimina callahani* and *Cibicidoides grimsdalei*, these species are common in the Mt. Chual samples. Additional age data is provided by California species *Anomalina regina* (P6b-P10) which is common in these samples, *Nodosarella advena* (first appears in P8) is rare, and *Vaginulinopsis asperuliformis* (P8-P14?) which is also rare

(Appendix II). Together these species suggest that the Mt. Chual samples are age equivalent to planktic foraminiferal zone P9. This interpretation is supported by nannofossil assemblages in samples Mf7471 and Mf7473 which are questionably assigned to the early Eocene nannofossil zone CP11 (Bukry, unpublished data, 1988).

Benthic foraminiferal assemblages from the band of mottled mudstone just north of the San Andreas Fault include the same age diagnostic species observed in the Mt. Chual area. Also present in these samples are rare occurrences of the cosmopolitan deep-water species Plectofrondicularia paucicostata (P12-P20 with questionable occurrences in P8-P11) and the California species Bulimina excavata (P8-P10) and Uvigerina lodoensis miriamae (late P8-P10) (Appendix II) which support an early Eocene age, equivalent to planktic zone P9. Lenticulina ulatisensis which occurs in Mf1052A is usually found in association with nannofossils assigned to zone CP12 (equivalent to planktic zones late P9-P10) it does however occur rarely in strata assigned to zone CP11 (P8). Nannofossils in Mf7475 are questionably assigned to nannofossil zone CP11 (Bukry, unpublished data, 1988) and thus support an early Eocene age.

All benthic foraminiferal assemblages in the mottled mudstone unit are dominated by species which have upper depth limits in the upper middle bathyal or deeper biofacies. Although many of these species may first appear at bathyal depths, greatest abundances of these species usually occurs at abyssal depths. Species indicative of abyssal depths include Anomalinoides capitatus, Chrysalagonium, Cibicidoides, Pleurostomella, and Nuttalides truempyi (Ingle, 1980; van Morkhoven and others, 1986; Appendix II). The rare specimens of Discorbis and few to common lenticulinids which are usually broken and worn, suggest some transport from outer shelf depths.

"Marine sandstone and shale" (Te_2)

The marine sandstone and shale unit (Te_2) is described by McLaughlin and others (1988) as composed of a basal sandstone (up to 3 m thick) overlain by sandstone rhythmically interbedded with mudstone (no thickness given). This unit is usually in fault contact with the mottled mudstone unit. Seven samples were taken from this unit (fig. 2). Five of these samples were barren of foraminifers. The remaining two samples, Mf1582A and Mf1590, contain a low diversity, primarily arenaceous fauna (Table 6).

Species present in samples Mf1582A and Mf1590 are primarily long-ranging. The occurrence of Silicosigmoilina californica suggests that the assemblage is Eocene or older whereas Lenticulina laimingi suggests an Eocene or younger age. Species present in Mf1582A and Mf1590 are also found in faunas of the mottled mudstone unit and the samples near Mt Chual which were originally assumed to be Cretaceous. No stratigraphic or chronologic correlations can made. Deposition of this unit probably occurred at lower bathyal to abyssal depths based on the dominance of arenaceous species which use siliceous cement.

"Marine shale and sandstone of Highland Way" (Tme)

The marine shale and sandstone of Highland Way is exposed in a band running NW-SE just north of the San Andreas Fault (fig. 2). This fault bounded unit is composed of an unknown thickness of shale with minor sandstone. Twenty-four samples were analyzed for foraminifers: eight samples (Mf7483, Mf7484, Mf7491, Mf7498, Mf7606, Mf7607, Mf7608, and Mf7609) are barren of foraminifers, four samples (Mf7488, Mf7492, Mf7494, and Mf7496) contain arenaceous fragments which could not be identified, one sample (Mf7469) contained molds which may have been fragments of planktic foraminifers, and eleven samples contained benthic foraminifers (Table 7and Appendix I). The foraminiferal assemblages suggest that the lower part of the unit is early Eocene in age and the upper part is Miocene. The faunal transition from early Eocene to Miocene assemblages is not well documented because of numerous barren or poorly preserved samples and the concentration of samples in the lower part of the unit. Samples Mf7481, Mf7486, Mf7487, Mf7489, Mf7493, and Mf7497 contain low diversity assemblages which are not diagnostic of age. Eocene assemblages were identified in samples Mf1053, Mf7482, Mf7485 and Mf7490, and an assemblage which is probably early Miocene in age was recovered from sample Mf7495.

Samples Mf7482 and Mf7485 are from near the base of the unit on the western side of the quadrangle. Although the foraminiferal assemblages are only moderately diverse, age diagnostic species suggest an early Eocene age correlative with planktic foraminiferal zones P7 to P10. Species which restrict the age of the assemblage include the cosmopolitan deep-water species Aragonia aragonensis (P5-P14), Bulimina macilenta (P7-P15), and Pullenia eocenica (P9-P17 with questionable occurrences in P6a-P8; P9-P18), and the California species Anomalina regina (P6b-P10). The similarity of these faunas to those observed in the mottled mudstone unit suggests that the "marine shale and sandstone unit of Highland Way" is Penutian which is correlative with planktic foraminiferal zones P8-P9. Nannofossil assemblages in these samples are assigned to zone CP11 (Bukry, unpublished data, 1988) which supports the narrower age range.

Samples Mf1053 and Mf7490 are from the center of the quadrangle. Based on the strike, Mf1053 appears to be stratigraphically lower in the section than MF7490. The low diversity assemblage in Mf1053 contains long-ranging species. The narrowest age constraints are imposed by the cosmopolitan species Cibicidoides eocaenus and C. praemundulus which range from planktic zone P6b through P22 and the California species Spiroplectammina directa which last occurs in the late Eocene. The moderately diverse assemblage in MF7490 includes the cosmopolitan deep-water species Cibicidoides subspiralis (P9-P13), Pullenia eocenica (P9-P17 with questionable occurrences in

P6a-P8), and _Silicosigmoilina_ _californicus_ (Cretaceous through P9 with questionable occurrences in P10-P13), and California species _Anomalina_ _regina_ (P6b-P10). These species restrict this assemblage to planktic zones P9-P10. Planktic microfossils were not examined from this sample but the benthic foraminiferal fauna is very similar to the fauna observed in the mottled mudstone unit and samples Mf7482 and Mf7485 where nannofossils suggested an early Eocene age (CP11). Sample Mf7490 is therefore assigned to the Penutian Stage as modified by McDougall (1988) and correlated with planktic zone P9.

The dominance of species with upper depth limits in the middle bathyal to abyssal depths in the more diverse early Eocene faunas (Mf1053, Mf7482, Mf7485, and Mf7490), and the common occurrences of _Cibicidoides_ and _Nuttalides_ _truempyi_ along with rare occurrences of _Pleurostomella_ indicates deposition occurred at abyssal depths. Species with upper depth limits on the shelf and upper slope are not common in these assemblages indicating little transport from shallower depths. The low diversity assemblages (samples Mf7481, Mf7486, Mf7487, Mf7489, Mf7493, and Mf7497) which contain primarily arenaceous species were probably also deposited at abyssal depths.

Sample Mf7495 from the eastern side of the quadrangle contains a poorly preserved fauna composed of three species: _Buliminella_ _subfusiformis_, _Fursenkoina_ _californiensis_, and _Pseudonodosaria_ _inflata_. These species suggest a late Oligocene to early Miocene age and upper bathyal depths. Sample RMH-55-71 which was examined by Pierce (unpublished data, 1971; Table 8) contains a more diverse fauna than Mf7495. Pierce interpreted the age as Saucesian or Zemorrian, possibly late Zemorrian (late Oligocene) based on benthic foraminifers and fish scales. The benthic foraminiferal assemblage suggests water depths were lower bathyal or greater and that some specimens were transported from upper bathyal depths.

SUMMARY AND CORRELATIONS

Benthic foraminiferal assemblages in the Butano Sandstone and San Lorenzo Formation, southwest of the San Andreas Fault range from Eocene to Oligocene in age. The Butano Sanstone contains long-ranging benthic foraminiferal species which suggest an Eocene age. Deposition of the Butano Sanstone occurred on the lower slope in the lower bathyal biofacies, (1500-2000 m). Benthic foraminiferal assemblages from the San Lorenzo Formation range from late Eocene to Oligocene in age and are assigned to the Narizian, Refugian and Zemorrian stages. Deposition of the San Lorenzo Formation occurred at upper middle bathyal depths during the Narizian and Zemorrian stages and upper bathyal depths during the Refugian Stage. Sampling was not extensive enough to determine whether these formations represent continuous deposition or whether unconformities are present.

Similar though more diverse benthic foaminiferal faunas are observed in the Butano and San Lorenzo formations in the Santa Cruz Mountains to the west (Fairchild, Wesendunk, and Weaver, 1969; Berggren and Aubert, 1983; McDougall, 1983). There, the Butano Sandstone was questionably assigned to planktic foraminiferal zone P8 (Berggren and Aubert, 1983). Faunas were considered characteristic of deposition on the distal part of a turbidite fan at depths of 1000-2000 m. The San Lorenzo Formation in the Santa Cruz Mountains ranges from middle Eocene through Oligocene in age and was assigned to the Narizian through Zemorrian benthic foraminiferal stages, planktic foraminiferal zones P14 through P20, and calcareous nannofossil zones CP14 through CP19a (McDougall, 1983; Poore and Bukry, 1983). An unconformity was noted between the Narizian and Refugian stages.

Similar faunas are also found in Washington and Oregon (McDougall, 1980), in Southern California near Santa Barbara (Kleinpell and Weaver, 1963), and in the southern San Joaquin Valley in the Tejon and San Emigdio Formations (Delise, 1967; Tipton, Kleinpell and Weaver, 1973). These formations contain a more diverse calcareous fauna so comparisions with the Butano or San Lorenzo Formation in the Loma Prieta Quadrangle are difficult. Faunas from the Tejon and San Emigdio Formations generally indicate deposition occurred at slightly shallower depths than those observed in the Santa Cruz Mountains or Loma Prieta Quadrangle.

Benthic foraminiferal assemblages from northeast of the San Andreas Fault in the Loma Prieta Quadrangle, are from the "Cretaceous shale" (Ku_1), "mottled mudstone of Mt Chual" (Te_1), "marine sandstone and shale" (Te_2), and "marine shale and sandstone of Highland Way" (Tme). The mottled mudstone unit and the basal part of the marine shale and sandstone of Highland Way contain early Eocene benthic foraminifers which are diagnostic of the Penutian Stage as modified by McDougall (1988) and thus coeval with planktic foraminiferal zones P8 through P9 and clacareous nannofossil zones CP10 through CP12. Nannofossil age interpretations suggest that the benthic foraminiferal faunas correlate with zone CP11 (late P8-P9). Benthic foraminiferal assemblages from the assumed Cretaceous shale, and the marine sandstone and shale unit (Te_2) are poorly preserved and composed primarily of long-ranging arenaceous species. Although the arenaceous species only restrict the age to Eocene, these assemblages are probably coeval with those found in the mottled mudstone unit and therefore early Eocene in age. Benthic foraminifers from the top of the marine shale and sandstone of Highland Way are Oligocene to early Miocene in age. These assemblages are assigned to the Zemorrian Stage of Kleinpell (1938) and suggest deposition occurred at lower bathyal to abyssal depths ($\geq$2000 m) with some transport from the outer shelf and upper slope biofacies. Samples from the middle of the formation are barren of foraminifers.

Early Eocene faunas are common throughout California (fig. 11). Faunas diagnostic of the early Eocene Penutian Stage equivalent to plantkic foraminiferal zones P8-P9 and nannofossil zones CP10-CP11 occur in the Pacheco Syncline (Smith, 1957; McDougall, 1988, and unpublished data, 1988), Woodside (Graham and Classen, 1955), Tres Pinos (Kaar, 1962), New Idria (Woodside, 1957), Lodo Gulch (Martin, 1943; Israelsky, 1951, 1955; Mallory, 1959, Bramlette and Sullivan, 1961; Schmidt, 1970; Poore, 1976; Berggren and Aubert, 1983), Devils Den (Mallory, 1959; Berggren and Aubert, 1983; Warren, 1983; McDougall, unpublished data, 1988), and Media Agua Creek (Mallory, 1959, 1970; McDougall, 1988, and unpublished data, 1988). Strata in the Salinian and Nacemento blocks and southern California such as the Lucia Shale, Sierra Blanca Limestone, and Santa Susana Formation, have not been examined yet and may prove to be age equivalent.

The Woodside, Tres Pinos and New Idria sections contain many benthic foraminiferal species common to the Loma Prieta assemblages. Benthic foraminifers suggest deposition in the Woodside and Tres Pinos areas was at lower bathyal to abyssal depths and thus the faunas are similar to those in the Loma Prieta Quadrangle. Early Eocene faunas in the New Idria section contain more shallow water species which are absent from the Loma Prieta Quadrangle, Tres Pinos, and Woodside assemblages. These sections are currently under further study.

Benthic foraminiferal faunas from the other early Eocene sections in the San Joaquin Valley are characteristic of upper bathyal to outer neritic biofacies (Lodo Gulch) and middle to upper bathyal biofacies (Devils Den) (fig. 12). The Loma Prieta assemblages contain species in common with these sections but because deposition occurred at greater depths and further from the shelf edge the Loma Prieta assemblages include fewer shelf and upper slope species.

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APPENDIX I
TABLE
SAMPLE LOCALITIES
LOMA PRIETA 7 1/2 MIN. QUADRANGLE

Mf Number	Field Number	Latitude Longitude	Comments
Mf1052	EB621A	37° 04'55" N 121° 49'00" W	Te_1 Sample from a greenish shale unit stratigraphically above a boulder conglomerate that may represent the base of the Tertiary sequence in NW1/4, sec. 12, T10S, R1E Collector: Brabb, 1967. Slide with residue only.
Mf1052A	EB621B	37° 04'55" N 121° 49'00" W	Te_1 Sample above 50 feet stratigraphically above Mf1051. Collector: Brabb, 1968. Slide with residue only.
Mf1053	EB673	37° 03'53" N 121o 48'55" W	Tme Sample taken within a rhythmically bedded sandstone and shale unit. Stratigraphic relation with Mf1052 and 1052A uncertain. NW 1/4, sec. 13, T10S, R1E. Collector: Brabb, 1967. Slide with residue only.
Mf1580	EB618	37° 02'35' N 121° 50'25" W	Tsl Sample from east side of Buzzard Lagoon Road. Collector: Brabb, 1968. Slide with residue only. Barren of foraminifers.
Mf1581	EB618A	37° 02'35" N 121° 50'25" W	Tsl Same locality as Mf1580. Collector: Brabb, 1968. Slide with residue only. Sample contained several specimens of <u>Haplopragmoides</u> spp.
Mf1582	EB619	37° 03'00" N 121° 50'20" W	Tsl Sample from southeast side of Buzzard Lagoon Road. Collector: Brabb, 1968. Slide with residue only.

Mf1582A	TS-61	37° 06.40' N 121° 49.75' W	Te_2 Sample taken 2,350 feet N, 2,450 feet W from the SW corner of sec. 35, T9S, R1E. Collector: Brabb, 1970. Slide with residue only.
Mf1583	EB625	37° 04'10" N 121° 51'14" W	Tsl Sample taken along Aptos Creek. Collector: Brabb, 1968. Slide with residue only.
Mf1583A	TS 273	37° 07.12' N 121° 49.90' W	Te_1 Sample taken 2,350 feet N, 2,450 feet W, from SW corner of sec. 35, T9S, R1E, Mt. Chual area. Collector: Brabb, 1970. Slide with residue only.
Mf1584	EB626	37° 03'47" N 121° 51'27" W	Tsl Sample taken along Aptos Creek. Collector: Brabb, 1968. Slide with residue only.
Mf1584A	LP-273A	37° 07.12' N 121° 49.90' W	Te_1 Sample taken from same locality as Mf 1583A. Collector: Brabb, 1970. Slide with residue only.
Mf1585	EB627	37° 03'45" N 121° 51'26" W	Tsl Sample taken along Aptos Creek. Collector: Brabb, 1968. Slide with residue only.
Mf1585A	LP-275	37° 07.15' N 121° 49.90' W	Te_1 Sample taken 2,275 feet S, 1,675 feet E of NW corner of sec. 26, T9S, R1E, Mt. Chual area. Collector: Brabb, 1970. Slide with residue only.
Mf1586	EB628A	37o 03'44" N 121° 51'27" W	Tsl Sample taken along Aptos Creek. Collector: Brabb, 1968. Slide with residue only.
Mf1586A	LP-295	37° 06.90' N 121° 50.00' W	?Ku_1 Sample taken 3,200 feet S, 1,300 feet E from NW corner of sec. 26, T9S, R1E, Mt. Chual area. Collector: Brabb, 1970. Slide with residue only.
Mf1587	EB629	37° 03'40" N 121° 51'30" W	Tsl Sample taken along Aptos Creek. Collector: Brabb, 1968. Slide with residue only.

Mf1587A	TS-295	37° 06.90' N 121° 50.00' W	?Ku1 Sample taken from same locality as Mf1586A. Collector: Brabb, 1970. Slide with residue only.
Mf1588	EB630	37° 03'28" N 121° 51'28" W	Tsl Sample taken along Aptos Creek. Collector: Brabb, 1968. Slide with residue only.
Mf1588A	TS-315	37° 07.00' N 121° 49.25' W	Te1 Sample taken 3,025 feet S, 100 feet W of NE corner of sec. 26, T9S, R1E, Mt. Chual area. Collector: Brabb, 1970. Slide with residue only.
Mf1589	TS-315A	37° 07.00' N 121° 49.25' W	Te1 Sample taken from the same locality as Mf1588A. Collector: Brabb, 1970. Slide with residue only.
Mf1590	EO 6-4	37° 04.90' N 121° 47.60' W	Te2 Sample taken 3,250 feet S, 2,600 feet E of NW corner of sec. 7, T10S, R2E. Collector: Brabb, 1970. Slide with residue only.
Mf1591	EO 7-1	37° 04.3' N 121° 47.6' W	Te1 Sample taken 2,100 feet S, 1,700 feet E of NW corner of sec. 7, T10S, R2E. Collector: Brabb, 1970. Slide with residue only.
Mf1604	70CB871	37° 04.0' N 121° 45.12' W	Te1 Sample taken 325 feet S, 3,700 feet E of NW corner of sec. 16, T10S, R2E. Collector: Brabb, 1970. Slide only.
Mf2648	RMH-15	37° 06.80' N 121° 48.40' W	Te1 Slide with planktic foraminifers picked by R.S. Poore on file. Benthic foraminifers examined by W.W. Rau; slide and residue not available.
Mf2649	RMH-60-71	37° 02.30' N 121° 47.10' W	Te1 Slide with planktic foraminifers picked by R.Z. Poore on file. Benthic foraminifers examined by W.W. Rau; slide and residue not available.

Mf4498	77CB1762	37° 03.25' N 121° 49.25' W	Tbs Collector: Brabb, 1977.
Mf4499	77CB1762A	37° 03.25' N 121° 49.25' W	Tbs Collector: Brabb, 1977.
Mf4500	77CB1765	37° 02.4' N 121° 48.3' W	?Tsl Collector: Brabb, 1977. Barren of foraminifers.
Mf4501	77CB1771	37° 02.2' N 121° 49.1' W	Tvq Collector: Brabb, 1977.
Mf4502	77CB1773	37° 02.15' N 121° 49.1' W	Tvq Collector: Brabb, 1977.
Mf7436	88CB2542	37° 05'13" N 121° 52'17" W	Tbs Sample is from laminated shale exposed along southside of jeep trail, elevation 1880 feet. Barren of foraminifers. Collector: Brabb, 1988.
Mf7440	88CB2551	37° 02'46" N 121° 50'30" W	Tsl Sample taken from west side of Buzzard Lagoon Road in a well-bedded sandstone and mudstone. Collector: Brabb, 1988. Sample contains abundant fragments of areanaceous foraminifers. One specimen of Cyclammina pacifica Beck can be identified.
Mf7441	88CB2552A	37° 03'03" N 121° 50'15" W	Tsl Sample taken on west side of Buzzard Lagoon road from a unit that may be in fault zone. Collector: Brabb, 1988. Barren of foraminifers.
Mf7442	88CB2552B	37° 03'03" N 121° 50'15" W	Tsl Same locality as Mf7441. Collector: Brabb, 1988. Sample contains only crushed and poorly preserved foraminiferal fragments; only Bolivina and Fursenkoina can be identified to genus.
Mf7443	88CB2561	37° 03'11" N 121° 50'10" W	Tbs Sample taken from east side of Buzzard Lagoon Road in sandstone and mudstone. Collector: Brabb, 1988. Sample contains abundant fragments of arenaceous

			foraminifers. One specimen of Cyclammina pacifica Beck can be identified.
Mf7444	88CB2562	37° 03'50" N 121° 50'18" W	Tsl Sample taken from west side of Buzzard Lagoon Road in laminated dark brown shale. Collector: Brabb, 1988. Sample contains abundant fragments of arenaceous foraminifers. Bathysiphon, Eggerella, and Dorothia are recognizable to genus.
Mf7450	88KM-6	37° 07'05" N 121o 51'31" W	Te_2 Sample was taken from a roadside outcrop of sandstone, 0.7 miles west ofsharp curve and firebreak along "Sierra Azul" Road. Collector: McDougall, 1980. Barren of foraminifers.
Mf7451	88KM-7	37° 06'51" N 121° 50'05" W	Ku_1 Samples were taken along a dirt road just west of Crystal Peak, near township marker between sections 35 and 26. Collector: McDougall, 1988. Barren of foraminifers.
Mf7452	88KM-8	37° 06'51" N 121o 50'05" W	Ku_1 Same locality as Mf7451. Collector: McDougall, 1988. Barren of foraminifers.
Mf7453	88KM-9	37° 07'05" N 121° 50'07" W	Te_1 Sample taken from red lithology exposed in road cut on south side of Mt. Chual. Collector: McDougall, 1988.
Mf7454	88KM-10	37o 07'05" N 121° 50'07" W	Te_1 Sample from same locality as Mf7453 in green lithology. Collector: McDougall, 1988.
Mf7469	MSJ-13-88	37° 03'59" N 121° 49'43" W	Tme Sample taken from road cut. Collector: McLaughlin, 1988. Sample contained rare pyrite molds of planktic foraminifers; no benthic foraminifers
Mf7470	MSJ-68-88	37° 06'06" N 121° 47'54" W	Te_2 Sample taken from road cut. Collector: McLaughlin, 1988. Barren of foraminifers

Mf7471	MSJ-36-88	37° 07'02" N 121° 49'14" w	Te_1 Sample taken from stream bed. Collector: McLaughlin, 1988.
Mf7472	MSJ-53-88	37° 06'23" N 121° 48'27" W	Te_2 Sample taken from road cut. Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7473	MSJ-59-88	37° 06'35" N 121° 48'20" W	Te_1 Sample taken from road cut. Collector: McLaughlin, 1988.
Mf7474	MSJ-66-88	37° 06'33" N 121° 48'52" W	Te_1 sample taken from stream cut. Collector: McLaughlin, 1988.
Mf7475	MSJ-122-88	37° 03'12" N 121° 45'10" W	Te_1 Sample taken from road cut. Collector: McLaughlin, 1988.
Mf7479	MSJ-124-88	37° 03'40" N 121° 45'10" W	Te_2 Sample taken from a road cut. Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7480	MSJ-121-88	37° 03'10" N 121° 45'05" W	Te_1 Sample taken from road cut. Collector: McLaughlin, 1988.
Mf7481	MSJ-150-88	37° 05'30" N 121° 52'21" W	Tme Collector: McLaughlin, 1988.
Mf7482	MSJ-152-88	37° 05'26" N 121° 51'54" W	Tme Collector: McLaughlin, 1988.
Mf7483	MSJ-159-88	37° 03'54" N 121° 48'55" W	Tme Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7484	MSJ-156A-22	37° 04'02" N 121° 49'34" W	Tme Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7485	MSJ-147-88	37° 05'15" N 121° 51'36" W	Tme Collector: McLaughlin, 1988.
Mf7486	MSJ-144-88	37° 05'07" N 121° 51'12" W	Tme Collector: McLaughlin, 1988.
Mf7487	MSJ-146-88	37° 05'03" N 121o 51'12" W	Tme Collector: McLaughlin, 1988.
Mf7488	MSJ-143-88	37° 04'59" N	Tme Collector: McLaughlin,

		121° 51'02" N	1988. Unidentifiable fragments of arenaceous foraminifers present.
Mf7489	MSJ-155B-88	37° 24'06" N 121° 49'54" W	Tme Collector: McLaughlin, 1988.
Mf7490	MSJ-155A-88	37° 04'06" N 121° 49'54" W	Tme Collector: McLaughlin, 1988.
Mf7491	MSJ-156B-88	37° 04'02" N 121° 49'34" W	Tme Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7492	MSJ-183-88	37° 02'15" N 121° 45'59" W	Tme Sample from hillside north of Eureka Canyon Road. Collector: McLaughlin, 1988. Sample contains questionable arenaceous foraminifers.
Mf7493	MSJ-184-88	37° 02'11" N 121° 46'10" W	Tme Sample is from hillside north of Eureka Canyon Road. Collector: McLaughlin, 1988.
Mf7494	MSJ-188-88	37° 01'54" N 121° 45'55" W	Tme Sample is from hillside north of Eureka Canyon Road. Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7495	MSJ-189-88	37° 01'50" N 121° 46' 00" W	Tme Sample is from hillside northwest of Gamecock Canyon. Collector: McLaughlin, 1988.
Mf7496	MSJ-200-88	37° 03'34" N 121° 48'32" W	Tme Sample is from hillside northwest of Gamecock Canyon. Collector: McLaughlin, 1988. Sample contains questionable arenaceous foraminifers.
Mf7497	MSJ-202-88	37° 03'34" N 121° 48'30" W	Tme Sample is from hillside northwest of Gamecock Canyon. Collector: McLaughlin, 1988.
Mf7498	MSJ-204-88	37° 03'30" N 121° 48'32" W	Tme Sample is from hillside northwest of Gamecock Canyon. Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7606	MSJ-227-88		Tme Sample from a hard carbonaceous, siliceous, locally laminated shale which forms the ridge west of Diablo Gulch and north of Highland

		Way. Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7607	MSJ-228-88	Tme Sample from a hard carbonaceous, siliceous, locally laminated shale which forms the ridge west of Diablo Gulch and north of Highland Way. Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7608	MSJ-229-88	Tme Sample from a hard carbonaceous, siliceous, locally laminated shale which forms the ridge west of Diablo Gulch and north of Highland Way. Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7609	MSJ-230-88	Tme Sample from a hard carbonaceous, siliceous, locally laminated shale which forms the ridge west of Diablo Gulch and north of Highland Way. Collector: McLaughlin, 1988. Barren of foraminifers.
Mf7610	MSJ-226-88	Te_2 Sample is from a concretion in a brown silty mudstone near the crest of Loma Chiquita and close to the center of SW1/4, sec. 3, T9S, R2E. Collector: McLaughlin, 1988. Barren of foraminifers.
	RMH-55-71	Sample taken 4,400 feet E, 3,000 feet north of the SW corner sec. 29, T10S, R2E. Collector: McLaughlin, 1971. Report prepared by R.L. Pierce, August 9, 1971. No material available for re-examination.

APPENDIX II

TAXONOMIC NOTES

This appendix represents an attempt to bring California benthic foraminiferal taxonomic nomenclature into conformity with nomenclature used worldwide. This section is, therefore, a summary of work in progress and subject to further changes and additions. Data on age and environmental constraints will be continuously refined as more information becomes available. Current sources of environmental data on Paleogene benthic foraminifers are Ingle (1980), Tjalsma and Lohmann (1983), and van Morkhoven and others (1986). Stratigraphic ranges of benthic foraminiferal species given by Mallory (1959) are included in this summary; they may not be accurate and should be used with caution.

Alabamina wilcoxensis Toulmin

Alabamina wilcoxensis Toulmin, 1941, p. 603, pl. 81, figs. 10-14.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 187, pl. 28, fig. 8.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 227, pl. 19, fig. 10.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 13.

Eponides beisseli (White) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 182, pl. 27, fig. 7.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 237.

RANGE: Mallory (1959) gives range as lower Bulitian to upper Penutian.

OCCURRENCE: Loma Prieta Quad. (Tme); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Alhambra)

Allomorphina conica Cushman and Todd

Allomorphina conica Cushman and Todd, 1949, Cushman Lab. Foram. Res., Contr., v. 25, p. 62, pl. 11, fig. 8a-c.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 244, pl. 33, fig. 15a-b, pl. 37, fig. 14a-b.

RANGE: Mallory (1959) gives range as lower Ynezian to lower Ulatisian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Allomorphina macrostoma Karrer

Allomorphina macrostoma Karrer, 1862, K. Akad. Wiss. Wien., Math.-Naturw. Cl., Sitzber., Osterreich, Bd. 44, Abth. 1, p. 448, pl. 2, fig. 4a-d.

ECOLOGY: *Allomorphina macrostoma* has an upper depth limit on the outer shelf biofacies, 50-150 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Tbs)

Allomorphina paleocenica Cushman

Allomorphina paleocenica Cushman, 1948, Cushman Lab. Foram. Res., Contr., v. 24, p. 45, pl. 8, fig. 10.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 245, pl. 22, fig. 4.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 140.

RANGE: Mallory (1959) gives range as lower Penutian and Lower Ulatisian.
ECOLOGY: *Allomorphina paleocenica* has an upper depth limit on the outer shelf biofacies, 50-150 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1)

Allomorphina trigonia Reuss

Allomorphina trigonia Reuss, 1850, p. 380. pl. 480, fig. 14.
- - McDougall, 1980, SEPM Paleontological Monograph, no. 2, p. 33.

OCCURRENCE: Loma Prieta Quad. (Tsl)

Ammobaculites cubensis Cushman and Bermudez

Ammobaculites cubensis Cushman and Bermudez, 1937, Cushman LAb. Foram. Res., Contr., v. 13, pp. 106-107, pl. 16, figs. 4, 16-18.
- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 8.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Ammobaculites sp. of Smith (1957)

Ammobaculites sp. of Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 150, pl. 17, fig. 12a-b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 114, pl. 2, fig. 13a-b; pl. 36, fig. 1a-b.

OCCURRENCE: Loma Prieta Quad. (Tsl)

Ammodiscoides turbinatus Cushman

Ammodiscoides turbinatus Cushman, 1909, U.S. Nat. Mus. Proc., v. 36, p. 423, pl. 33, figs. 1-6.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 108, pl. 1, fig. 15a-b.

Ammodiscoides sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 149, pl. 17, fig. 6a-c.

RANGE: Mallory (1959) gives range as Ynezian through lower Bulitian.
OCCURRENCE: Loma Prieta Quad. (Te_1)

Ammodiscus incertus (d'Orbigny)

Operculina incerta d'Orbigny, 1839, in Ramon de la Sagra, 1839, p. 49, pl. 6, figs. 16-17.
Cornuspira incerta (d'Orbigny) emend. Loeblich and Tappan, 1954, p. 308, tf. 1.
Ammodiscus cf. A. incertus (d'Orbigny) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 108, pl. 1, figs. 11-12; pl. 39, fig. 2.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 27.
- - Smith, 1971, Univ. Calif. Publ. Geol. Sci., v. 91, p. 24.
Ammodiscus incertus (d'Orbigny) - - McDougall, 1980, SEPM Paleo. Monograph, no. 2, pl. 1, figs. 2-5.
Ammodiscus glabratus Cushman and Jarvis - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 6.
COMMENTS: The test is discoidal with an initial globular proloculus surrounded by a planispiral coil. The wall is composed of fine-grained arenaceous material and cement, which does not react with dilute hydrochloric acid.
RANGE: Mallory (1959) gives range as Ynezian through Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1, Te_2, Tme)

Amphimorphina ignota Cushman and Siegfus

Amphimorphina ignota Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 11, p. 27, pl. 6, figs. 10-13.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 216, pl. 18, fig. 7; pl. 33, fig. 9.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 100.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 22, pl. 14, fig. 18.
Amphimorphina (?) sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 172, pl. 24, fig. 1.
RANGE: Mallory (1959) gives range as upper Ynezian to lower Narizian. Tjalsma and Lohmann (1983) find this species occurring sporadically throughout the Eocene (P6b-P18).
OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Las Juntas, Alhambra)

Anomalina garzaensis Cushman and Siegfus

Anomalina garzaensis Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 11, p. 32, pl. 7, fig 3a-c.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 259, pl. 31, fig. 1a-c.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 152.

RANGE: Mallory (1959) gives range as lower Penutian to upper Narizian.

ECOLOGY: Anomalina garzaensis has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Anomalina regina Martin

Anomalina regina Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 28, pl. 19, fig. 3a-c.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 191, pl. 29, fig. 8.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 154, pl. 9, fig.3a-c.

Anomalina cf. A. regina Martin - - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 154, pl. 14, fig. 5.

Anomalina regina minor Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 192, pl. 29, figs. 2 and 4.

Anomalinoides welleri (Plummer) - - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p. 16.

COMMENTS: Smith (1957) descibed the varity minor to include specimens with 9 rather than 12 chambers and a smaller size. Specimens of A. regina and A. regina minor figured by Smith (1957) all contain 9 chambers. There is a slight size difference which is probably due to environmental conditions.

Anomalina regina probably referred to Anomalinoides welleri by Berggren and Aubert (1983); also Berggren and Aubert (1975, p. 151, pl. 5, fig. 3).

Anomalina regina differs from A. garzaensis because A. regina is smaller, has fewer chambers (12 or less rather than $\geq$ 14), smaller pores and sutures, and an umbo ring which is not as limbate or heavy.

RANGE: Mallory (1959) gives range as lower Bulitian to upper Penutian.

ECOLOGY: Anomalina regina has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Melonis regina, Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas, Alhambra)

Anomalinoides acutus (Plummer)

Anomalina ammonoides acuta Plummer, 1926, Univ. Texas Bull. 2644, p. 149, pl. 10, fig. 2.

Anomalina acuta Plummer - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 258.

Anomalinoides acuta (Plummer) - - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p. 11, pl. 5, figs. 1-3.
Cibicides alazaensis (Nuttall) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 195, pl. 29, fig. 10.
Cibicidoides midwayensis (Plummer) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 196, pl. 30, fig. 4.
RANGE: Mallory (1959) gives range of A. acuta as lower Ulatisian; and of C. susanaensis as lower Ynesian to lower Bulitian.
ECOLOGY: Anomalinoides acutus has an upper depth limit in the outer shelf biofacies, 50-150 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1, questionable occurrence); Pacheco Syncline (Vine Hill Sandstone, Las Juntas)

Anomalinoides capitatus (Gumbel)

Rotalia capitata Gumbel, 1868, K. Bayer. Akad. Wiss., Math.-Physik Cl., Abh., Bd. 10, p. 653, pl. 2, fig. 92.
Anomalinoides capitatus (Gumbel) - - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p.
- - van Morkhoven and others, 1986, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 276-278, pl. 92, figs. 1-2.
Gavelinella capitata (Gumbel) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 31, pl. 16, figs. 4-5.
Anomalina dorri Cole, 1928, Bull. American Paleo., v. 14, p. 218, pl. 34, figs. 1-2.
Anomalina dorri aragonensis Nuttall, 1930, Jour. of Paleo., v. 4, p. 291, pl. 24, fig. 18; pl. 25, fig. 25.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 191, pl. 31, figs. 1-2.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 259, pl. 35, fig. 5.
- - Almgren and others, 1988, fig. 5 (list).
Anomalina (?) sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 192, pl. 29, fig. 7.
Gavelinella rubiginosus - - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p.
COMMENTS: Anomalinoides dorri and A. dorri aragonensis are distinquished on the basis of sutural differences. Tjalsma and Lohmann (1983), and van Morkhoven and others (1986) found too many transitional forms to justify the separation at species level. Van Morkhoven and others (1986) also felt that A. dorri and A. aragonensis were junior synonyms of A. capitatus.
RANGE: A late Paleocene (P6a) through early Oligocene (P18) range with doubtful occurrences in early Oligocene Zones P19 and P20 is given by van Morkhoven and others (1986). Forms transitional between A. rubiginosus (range K-P5) and A. capitatus have been observed in the middle Paleocene (P4) and early Eocene (P6b-P11) (van Morkhoven and others, 1986). In California, Berggren and Aubert (1983) found A. aragonensis in association with the early Eocene Lodo (P6-

P9) and Kreyenhagen (P8-P9) Formations. Almgren and others (1988) give the range of Anomalinoides dorri aragonensis as zones E and pseudo C which correspond to nannofossil zones CP5 through CP11 (planktic foraminiferal zones P4 through P9). The older occurrences noted by Almgren and others (1988) hav not been exammined yet and may be the transitional forms noted by van Morkhoven and others (1986).

ECOLOGY: Anomalinoides capitatus was primarily a bathyal species but ranged to abyssal depths (van Morkhoven and others, 1985). Ingle (1980) considers this species to have and upper depth limit in the lower bathyal biofacies, $\geq$ 2000 m.

OCCURRENCE: Loma Prieta Quad. (Te1); Pacheco Syncline (Vine Hill Sandstone, Las Juntas)

Aragonia aragonensis (Nuttall)

Textularia aragonensis Nuttall, 1930, Jour. Paleo., v. 4, p. 280, pl. 23, fig. 6.

Bolivina aragonensis (Nuttall) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 199-200, pl. 28, fig. 19a-b.

Aragonia aragonensis (Nuttall) - - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, pl. 2, figs. 15-17.

- - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 308-314, pl. 101a, figs. 1-3; pl. 101B, figs. 1-4; pl. 101C, figs. 1-3.

Bolivina capdevilensis Cushman and Bermudez, 1937, Contr. Cushman Lab. Foram. Res., v. 13, p. 14, pl. 1, figs. 49, 50.

- - Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 9 (list).

RANGE: Mallory (1959) gives range as upper Ynezian to lower Narizian. Van Morkhoven and others (1986) give range as late Paleocene (P5) through latest middle Eocene (P14).

ECOLOGY: Aragonia aragonensis has an upper depth limit in the upper bathyal, 150-500 m (Ingle, 1980) but is considered primarily a lower bathyal and abyssal form (von Morkhoven and others, 1986).

OCCURRENCE: Loma Prieta Quad. (Te1, Tme)

Astacolus sp. of Graham and Classen

Astacolus sp. of Graham and Classen, 1955, Cushman Found. Foram. Res., v. 6, p. 10, pl. 2, fig. 1.

OCCURRENCE: Loma Prieta Quad. (Te1)

Bathysiphon eocenicus Cushman and Hanna

Bathysiphon eocenicus Cushman and Hanna, 1927, Calif. Acad. Sci., Proc., 4th Ser., v. 16, p. 270, pl. 13, figs. 2-3.

Bathysiphon eocenica Cushman and Hanna - - Graham and Classen, 1955, Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 1.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 148, pl. 17, fig. 1.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 105, pl. 1, fig. 4.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 25.
ECOLOGY: *Bathysiphon* spp. such as *B. eocenicus* have upper depth limits in the lower bathyal biofacies, $\geq$ 2000 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1, Te_2, Tme, Tbs, Tsl); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir, Alhambra)

Bathysiphon santecruis Cushman and Kleinpell

Bathysiphon santecruis Cushman and Kleinpell, 1934, Cushman Lab. Foram. Res., Contr., v. 10, p. 1, pl. 1, figs. 1-2.
- - Smith, 1971, Univ. Calif. Publ. Geol. Sci., v. 91, p. 23, pl. 1, fig. 1.
Rhabdammina eocenica - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 148, pl. 17, fig. 4.
COMMENTS: *Bathysiphon santecruis* is usually smaller than *B. eocenicus*. The cement is siliceous with little arenaceous material.
ECOLOGY: *Bathysiphon* spp. such as *B. santecruis* have upper depth limits in the lower bathyal biofacies, $\geq$ 2000 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (?Ku_1, Te_1, Te_2); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir)

Bathysiphon sp. (coarse)

?*Bathysiphon* sp. Graham and Classen, 1955, Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 3.
COMMENTS: Small compressed fragments composed of sand grains which give a coarse appearance to test.
OCCURRENCE: Loma Prieta Quad. (Te_1, Tbs)

Bifarina eleganta (Plummer)

Bifarina eleganta (Plummer) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 204, pl. 17, fig. 2.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 114.
RANGE: Mallory (1959) gives range as lower Penutian to upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1)

Boldia hodgei (Cushman and Schenck)

Cibicides hodgei Cushman and Schenck, 1928, Univ. Calif. Pub. Geol. Sci., v. 17, p. 315, pl. 45, figs. 3-5.

Boldia hodgei (Cushman and Schenck) - - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 33.
ECOLOGY: Boldia hodgei is considered to have an upper depth limit in the inner shelf biofacies, 0-50 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Tsl)

Bolivina marginata Cushman

Bolivina marginata Cushman, 1918, U.S.G. S. Bull., v. 676, p. 48, pl. 10, fig. 1.
- - Kleinpell, 1938, Miocene Stratigraphy of California, AAPG, p. 275-276, pl. 9, fig. 2; pl. 12, fig. 7.
- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 34.

RANGE: This species first appears in the Refugian and continues to the Recent (Kleinpell, 1938; McDougall, 1980)
ECOLOGY: Bolivina marginata has an upper depth limit in the upper bathyal biofacies, 150-500 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Tsl)

Budashevaella multicamerata Volshinova

Circus multicameratus Volshinova in Volshinova and Budasheva, 1961, p. 301, pl. 7, fig. 6a-c.; pl. 8, fig. 1a-c.
Budashavaella multicamerata Voloshinova - - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 34.
OCCURRENCE: Loma Prieta Quad. (Tsl)

Bulimina carnerosensis Cushman and Kleinpell

Bulimina carnerosensis Cushman and Kleinpell, 1934, Cushman Laboratory for Foraminiferal Research, Contributions, v. 10, p. 5, pl. 1, figs. 12a-b.
- - Kleinpell, 1938, Miocene Statigraphy of California, AAPG, p. 252

RANGE: Kleinpell (1938) gives range as Zemorrian (early Oligocene to early Miocene).
ECOLOGY: Bulimina carnerosnsis has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980)
OCCURRENCE: Loma Prieta Quad. (Tsl)

Bulimina callahani Galloway and Morrey

Bulimina callahani Galloway and Morrey, 1931, Bull. American Paleo., v. 15, p. 350, pl. 40, figs. 6.
- - Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 9 (list).
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 87-88, pl. 20, figs. 20, 23.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 188, pl. 16, fig. 10.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p.

- - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p.
- - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 322-327, pl. 105A, figs. 1-3; pl. 105B, figs. 1-4.

RANGE: Mallory (1959) gives range as upper Ynezian through lower Ulatisian. Van Morkhoven and others (1986) give range as Late Paleocene (P6a) through middle Eocene (P10).

ECOLOGY: Bulimina callahani is a middle and lower bathyal and abyssal species (van Morkhoven and other, 1986). Its upper depth limit is estimated as 600 m along the Pacific Margin (Berggren and Aubert, 1983). Ingle (1980) places the an upper depth limit of this species in upper middle bathyal biofacies, 500-1500 m.

OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Las Juntas)

Bulimina corrugata Cushman and Siegfus

Bulimina corrugata Cushman and Siegfus, 1935, Cushman Lab. Foram. Res., Contr., v. 11, p. 92, pl. 14, fig. 7a-b.
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 93, pl. 22, fig. 2.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 189, pl. 28, fig. 13a-b.
- - Almgren and others, 1988, Paleogene Stratgraphy of the West Coast, SEPM Pacific Section, fig. 5 (list).

Bulimina whitei Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 20, pl. 6, fig. 5a-b.
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 97, pl. 30, fig. 11.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 198, pl. 28, fig. 18a-c; pl. 36, fig. 19a-c.

COMMENTS: The difference between Bulimina whitei and B. corrugata are the fewer and lower costae which continue to the last chamber and the distinctly visible early chambers (Martin, 1943). These differences are not consistant and gradations between the two morphologies are frequently found. Bulimina corrugata is the senior synonym.

RANGE: Mallory (1959) gives range as lower Ulatisian through upper Narizian for B. corrugata and lower Bulitian through lower Narizian for B. whitei Martin. Almgren and others (1988) give range of B. corrugata as pseudo C through A-2 zones which are equivalent to nannofossil zones CP11 through CP14b (planktic foraminiferal zones late P8-P14).

ECOLOGY: Bulimina corrugata and Bulimina whitei have upper depth limits in the lower middle bathyal biofacies, 500-1500 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas)

Bulimina excavata Cushman and Parker

Bulimina excavata Cushman and Parker, 1936, U.S.G.S., Prof. Paper 210-D, p. 41, pl. 7, fig. 4a-c.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 190, pl. 16, fig. 13.
- - Almgren and others, 1988, Paleogene Stratgraphy of the West Coast, SEPM Pacific Section, fig. 5 (list).

RANGE: Mallory (1959) gives range as upper Ynezian through lower Bulitian. Almgren and others (1988) restrict this species to their C zone or modified Penutian Stage which is equivalent to nannofossil zones CP9-CP10 (planktic foraminiferal zones P7-P8).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Bulimina macilenta Cushman and Parker

Bulimina macilenta Cushman and Parker, 1936, Cushman Lab. Foram. Res., Contr., v. 11, p. 47, pl. 7, figs. 7-8.
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 98-99, pl. 23, figs. 2-3.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 193-194, pl. 28, fig. 15a-c.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 108.
- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, pl. 15, figs. 3, 4.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 25, pl. 14, fig. 3.

Bulimina pachecoensis Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 175, pl. 24, fig. 14.

RANGE: *Bulimina macilenta* occurs rare to frequently in zones P7 to P15 (Tjalsma and Lohman, 1983). Mallory (1959) gives range as upper Ynezian through lower Narizian.

ECOLOGY: *Bulimina macilenta* has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Vine Hill Sandstone, Las Juntas Formation)

Bulimina semicostata Nuttall

Bulimina semicostata Nuttall 1930, Jour. Paleo., v. 4, p. 274, pl. 23, figs. 15, 16.
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 93, pl. 21, figs. 28, 29.
- - van Markhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 279-281, pl. 93, figs. 1-5.

Bulimina semicostata lacrima Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 196, pl. 16, fig. 8a-c.

RANGE: An early Eocene (P6b) through early Oligocene (P18) range is given by van Morkhoven and others (1986). Mallory (1959) gives range as lower Ulatisian through lower Narizian.
ECOLOGY: Although Bulimina semicostata is primarily a lower bathyal and abyssal species, it has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980; van Morkhoven and others, 1986).
OCCURRENCE: Loma Prieta Quad. (Te₁, Tme)

Bulimina trintatensis Cushman and Jarvis

Bulimina trinatensis Cushman and Jarvis, 1928, Cushman Lab. Foram. Res., Contr., V. 4, p. 102, pl. 14, fig. 12.
- - Cushman and Parker, 1946, U.S.G.S. Prof. Paper 210-D, p. 86, pl. 20, figs. 16, 17.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p.
- - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213.
- - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 299-303, pl. 98a, figs. 1-2; pl. 98B, figs. 1-4.

RANGE: A range of early Paleocene (P1) through late Eocene (P16) is given by van Morkhoven and others (1986).
ECOLOGY: Bulimina trintatensis was primarily a bathyal to abyssal species (van Morkhoven and others, 1986). During the Eocene the upper depth limit may have been as shallow as 500-600 m (Barr and Berggren, 1981; Tjalsma and Lohmann, 1983; van Morkhoven and others, 1986).
OCCURRENCE: Loma Prieta Quad. (Te₁, Tme); Pacheco Syncline (Las Juntas)

Bulimina tuxapamensis Cole

Bulimina tuxapamensis Cole, 1928, Bull American Paleo., v. 14, p. 212, pl. 32, fig. 23.
- - Cushman and Parker, 1946, U.S.G.S. Prof. Paper 210-D, p. 101, pl. 24, fig. 6.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 26, pl. 12, figs. 3-4.
- - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 155-158, pl. 51A, figs. 1-4; pl. 51B, figs. 1-2.

Buliminella bradbury (Martin) - - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p. 16, pl. 2, fig. 13.
Uvigerina cf. lodoensis (Martin) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 178, pl. 25, fig. 7.
COMMENTS: Test stout, tapering, very regular in outline, broadest near the apertural end, very finely perforate; chambers slightly inflated; sutures in most specimens relatively wide, limbate; aperture loop-like or comma shaped, aperture terminal. Bulimina tuxapamensis is relatively featureless, however illustrated specimens appear

to have irregular sutures: line of suture is indented as if retral process were present. This species is often included with B. bradbury to which it is closely related. Bulimina bradbury has a more slender test, somewhat more inflated chambers, and is smaller in size (Tjalsma and Lohmann, 1983).

The specimen of Uvigerina cf. U. lodoensis (Martin) illustrated by Smith (1957, pl. 25, fig. 7) closely resembles Bulimina tuxapamensis. Sutures are crenulated and aperature is broken on illustrated specimen. Mallory (1959) named this species Uvigerina lodoensis miriamae for specimens found in Media Agua Creek and Devils Den sections. U. lodoensis miriamae and Buliminella bradbury are reported by Berggren and Aubert (1983) from Devils Den section. The latter is probably Bulimina tuxapamensis and occurs in association with P8 planktics.

RANGE: A range of late Paleocene (P6a) through early middle Miocene (N9) with doubtful occurrences in middle Miocene Zones N10-N13 is given by van Morkhoven and others (1986).

ECOLOGY: Bulimina tuxapamensis is a bathyal to abyssal species which occurs commonly in the upper bathyal biofacies (van Morkhoven and others, 1986). Ingle (1980) indicates the upper depth limit of B. bradburyi is in the upper bathyal biofacies, 150-500 m.

OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Las Juntas, Muir)

Buliminella grata Parker and Bermudez

Buliminella grata Parker and Bermudez, 1937, Jour. Paleo., v. 11, p. 515, pl. 59, fig. 6a-c.

- - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 163-165, p. 54, figs. 1-2.

RANGE: An early Paleocene (P1) through middle Miocene (N12) range is given by van Morkhoven and others (1986).

ECOLOGY: Buliminella grata is primarily a bathyal species; maximum abundances occurred at depths of 1-2 km in Atlantic (Tjalsma and Lohmann, 1983; von Morkhoven and others, 1986)

OCCURRENCE: Loma Prieta Quad. (Te_1)

Chilostomella oolina Schwager

Chilostomella oolina Schwager, 1878, Uff. Geol. (R. Com. Geol. Ital.), Boll. Roma, Italia, v. 9, p. 527, pl. 1, fig. 16.

- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 34.

ECOLOGY: The upper depth limit of Chilostomella oolina is in the upper bathyal biofacies (C. cylindroides, Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tsl)

Chilostomella ovoidea Reuss

Chilostomella ovoidea Reuss - - Kleinpell, 1938, Miocene Stratigraphy of California, AAPG, p. 338, pl. 22, fig. 8; pl. , fig. 2; pl. 31, fig. 4.

ECOLOGY: Chilostomella ovoidea occurs in the upper middle bathyal biofacies in anaerobic bottom conditions (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te1)

Chrysalogonium laeve Cushman and Bermudez

Chrysalogonium laeve Cushman and Bermudez, 1936, Cushman Lab. Foram. Res., Contr., v. 12, p. 27, pl. 5, figs. 1, 2.
- - Bermudez, 1949, Cushman Lab. Foram. Res., Spec. Publ., no. 25, p. 150, pl. 10, fig. 5.

COMMENTS: The Loma Prieta specimens have rectangular shaped chambers without costae and the sutures not indented. They resembles C. arkansasanum Cushman and Todd (see Cushman, 1951, p. 25, pl. 7, figs. 11-12). Similar specimens of C. laeve are found in the Devils Den section (sample DDM-14, McDougall, unpublished data, 1989)

OCCURRENCE: Loma Prieta Quad. (Te1)

Chrysalogonium tenuicostatum Cushman and Bermudez

Chrysalogonium tenuicostatum Cushman and Bermudez, 1936, Cushman Lab. Foram. Res., Contr., v. 12, p. 27, pl. 5, figs. 3-5.
- - Bermudez, 1949, Cushman Lab. Foram. Res., Spec. Pub., no. 25, p. 151, pl. 10, fig. 2.

OCCURRENCE: Loma Prieta Quad. (Te1)

Cibicides elemaensis Rau

Cibicides elmaensis Rau, 1948, Jour. Paleo., v. , p. 173, pl. 31, figs. 18-21.
- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 34.

OCCURRENCE: Loma Prieta Quad. (Tsl)

Cibicides haydoni (Cushman and Schenck)

Planulina haydoni Cushman and Schenck, 1928, Univ. Calif. Pub. Geol. Sci., v. 17, p. 316, pl. 45, fig. 7a-c.

Cibicides haydoni (Cushman and Schenck) - - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 34.

ECOLOGY: Cibicides haydoni has an upper depth limit in the outer shelf biofacies (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Tsl)

Cibicides martinezensis Cushman and Barksdale

Cibicides martinezensis Cushman and Barksdale, 1930, Stanford Univ., Dept. Geol., Contr., v. 1, p. 88, pl. 12, fig. 9a-c.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 267, pl. 35, fig. 7a-c; pl. 38, fig. 7a-c.

Cibicides cf. C. martinezensis Cushman and Barksdale - - Almgren and others, 1988, Paleogene of the West Coast, SEPM, Pacific Section, fig. 5 (list).

RANGE: Almgren and others (1988) give range as zones C through A-2 (rare) which is equivalent to nannofossil zones CP9 through CP14 (planktic foraminiferal zones P6b-P14).

OCCURRENCE: Loma Prieta Quad. (Te1)

Cibicidoides coalingensis (Cushman and Hanna)

Anomalina coalingensis Cushman and Hanna, 1927, Calif. Acad. Sci., Proc., 4th ser. v. 16, p. 221, pl. 14, figs. 10-12.

Cibicides coaleningensis (Cushman and Hanna) - - Almgren and others, 1988, Pleogene of the West Coast, SEPM, Pacific Section, fig. 5 (list).

Cibicidoides coalingensis (Cushman and Hanna) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 273, pl. 38, fig. 11a-c.

RANGE: Mallory (1959) gives range as lower Bulitian through upper Narizian. Almgren and others (1988) give range oas restricted to zone B-1 (equivalent to nannofossil zones CP11-CP12a and planktic foraminiferal zones upper P9-lower P10).

ECOLOGY: The upper depth limit of Cibicidoides coalingensis is given as both outer shelf and lower middle bathyal biofacies by Ingle (1980).

OCCURRENCE: Loma Prieta Quad. (Te1)

Cibicidoides eocaenus (Gumbel)

Rotalia eocaena Gumbel, 1868, K. Bayer. Akad. Wiss., Math.-Physik. Cl., Abh., 10, p. 650, pl. 2, fig. 87.

Cibicidoides eocaenus (Gumbel) - - van Morkhoven and others, 1986, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 256-263, pl. 86A, figs. 1-4; pl. 86B, figs. 1-2; pl 86C, figs. 1-3; pl. 86D, figs. 1-2.

Cibicides tuxapamensis Cole, 1928, Bull. American Paleo., v. 14, p. 219, pl. 32, figs. 2-3; pl. 3, figs. 5-6.

Cibicides perlucida Nuttall, 1932, Jour. Paleo., v. 6, p. 33, pl. 8, figs. 10-12.

Cibicides spiropunctatus Galloway and Morrey - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 270, pl. 25, fig. 3.

COMMENTS: Mallory (1959, p. 272) believes that C. whitei may belong in the same group as C. perilucidus and C. spiropunctatus, and may not be a valid species. Cibicidoides whitei figured by Berggren and Aubert (1983).

RANGE: An early Eocene (P6b) through late Oligocene (P22) range is given by van Morkhoven and others (1986).

ECOLOGY: Cibicidoides eocaenus was primarily a bathyal species although it ranged from outer neritic to abyssal depths. Ingle (1980) condsidered the upper depth limit of C. perilucidus to be in the lower middle bathyal and of C. spiropunctatus to be in the upper bathyal biofacies.
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Cibicidoides grimsdalei (Nuttall)

Cibicides grimsdalei Nuttall, 1930, Jour. Paleo., v. 4, p. 291, pl. 25, figs. 7, 8, 11.
Cibicidoides grimsdalei (Nuttall) - - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 247-251, pl. 83A, figs. 1-3; pl. 83B, figs. 1-7.
RANGE: An early Eocene (P8) through Miocene (N4) range is given by van Morkhoven and others (1986).
ECOLOGY: Cibicidoides grimsdalei was a lower bathyal and abyssal species. Ingle (1980) gives the upper depth limit of this species along the Pacific Margin as in the lower bathyal biofacies. Greatest abundances of this species are reported at paleodepths of 2,000-4,000 m in the Atlantic by Tjalsma and Lohmann (1983).
OCCURRENCE: Loma Prieta Quad. (Te_1 cf.)

Cibicidoides praemundulus Berggren and Edwards

Cibicidoides praemundulus Berggren and Edwards, 1985, in van Morkhoven and others, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 264-266, pl. 87, figs. 1-2.
Cibicides ungerianus (d'Orbigny) - - Tjalsma and Lohman, 1983, Micropaleo., Spec. Pub., no. 4, p. 28-29, pl. 18, fig. 1; pl. 21, figs. 5-6.
Cibicides cf. C. ungerianus (d'Orbigny) - - Almgren and others, 1988, Paleogene of the West Coast, SEPM, Pacific Section, fig. 5 (list).

probably not Cibicides cf. C. ungeriana - - Mallory, 1959, p. - - Mallory, 1970, Burke Museum, Res. Rept., no. 2,
RANGE: An early Eocene (P6b) through late Oligocene (P22) range is given by van Morkhoven and others (1986). Almgren and others (1988) restrict this species to zone D which is equivalent to nannofossil zone CP9 and planktic foraminiferal zone P6b.
ECOLOGY: Cibicidoides praemundulus was primarily a lower bathyal and abyssal form, but occurs sporadically in middle bathyal sediments. Greatest abundances are found at abyssal depths (van Morkhoven and others, 1986).
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas)

Cibicidoides subspiralis (Nuttall)

Cibicides subspirata Nuttall, 1930, Jour. Paleo., v. 4, p. 292, pl. 25, figs. 9,10, 14.

Cibicidoides subspiratus (Nuttall) - - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 314-316, pl. 102, figs. 1a-c.

RANGE: A late early Eocene (P9) through late middle Eocene (P13) range is given by van Morkhoven and others (1986).

ECOLOGY: Cibicidoides subspiralis is a bathyal and abyssal species (van Morkhoven and others, 1986).

OCCURRENCE: Loma Prieta Quad. (Te1, Tme)

Cibicidoides venzuelanus (Nuttall)

Cibicides venzuelana Nuttall, 1935, Jour. Paleo., v. 9, p. 131, pl. 15, figs. 25-27.

Cibicides venezuelanus (Nuttall) - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 32, pl. 6, fig. 8a-c.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 274, pl. 31, fig. 6a-c.

Cibicidoides venzuelana (Nuttall) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 197, pl. 1a-c, 5a-c.

COMMENTS: Type discription of this species as given by Nuttall (1935, p. 131) is:

"Test planoconvex, coarsely perforate, dorsal surface [unbo side] flattened, ventral convex. On the dorsal surface the earlier whorls are obscured by shell growth, the sutures being either raised or depressed and gently curved. Ventrally sutures thick, limbate, elevated, chamber surface fairly coarsely perforate; about twelve chambers in the last whorl. At the center of the ventral surface some protruding shell growth, which consists usually of circularly arranged protuberances. Aperture a narrow arched slit extending over the periphery, which is subacute near the dorsal border. Average diameter 0.6 mm., thichness 0.2 mm.

Ventrally this species resembles Anomalina cocoaensis Cushman but is quite distinct dorsally."

Specimens assigned to this species from the Loma Prieta Quad. (Te1) do not have protruding shell material on the ventral side as illustrated by Nuttall (1935, pl. 15, fig. 25). The ventral surface is, however, thickened and covered with additional shell material. Sutures on the ventral side are thin and depressed to thickened and flush.

Specimens assigned to this species from the Las Juntas Shale (EB599, McDougall, memo 6/27/88) probably not this species because dorsal side is not flattened and ventral side is not overgrown.

RANGE: Mallory gives range as lower Bulitian through upper Narizian.
OCCURRENCE: Loma Prieta Quad (Te_1)

<u>Clavulinoides</u> <u>californicus</u> Mallory

<u>Clavulinoides</u> <u>californicus</u> Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 123, pl. 4, fig. 6a-b.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 35, pl. 2, fig. 5a-c.

<u>Clavulinoides</u> sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 8, pl. 1, fig. 20.
RANGE: Mallory (1959) gives range as lower Ynezian through lower Narizian.
ECOLOGY: <u>Clavulinoides</u> <u>californicus</u> has an upper depth limit on the outer shelf biofacies, 50-150 m (<u>Clavulinoides</u> spp., Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1)

<u>Cyclammina</u> <u>incisa</u> (Stache)

<u>Haplophragmoides</u> <u>incisa</u> Stache, 1864, Geol. Theil., Bd. 1, Abt. 2, p. 165, pl. 21, fig. 1.
<u>Cyclammina</u> <u>incisum</u> (Stache) - - Cushman and Laiming, 1931, Jour. Paleo., v. 5, p. 93, pl. 9, fig. 6a-b.
<u>Cyclammina</u> <u>incisa</u> (Stache) - - Smith, 1971, Univ. Calif. Pubs. Geol. Sci., v. 91, p. 30.
- - McDougall, 1980, SEPM Paleo Monograph no. 2, p. 34.

OCCURRENCE: Loma Prieta Quad. (Tsl)

<u>Cyclammina</u> <u>pacifica</u> Beck

<u>Cyclammina</u> <u>pacifica</u> Beck, 1943, Jour. Paleo., v. 17, p. 591, pl. 98, figs. 2, 3.
- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 34.

RANGE: Mallory (1959) gives range as upper Ulatisian through upper Narizian.
ECOLOGY: <u>Cyclammina</u> <u>pacifica</u> has an upper depth limit in the lower middle bathyal biofacies, 1500-2000m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Tbs, Tsl)

<u>Cyclammina</u> <u>samanica</u> Berry

<u>Cyclammina</u> <u>samanica</u> Berry, 1928, Eclog. Geol. Helv., v. 21, p. 393, text fig. 5a-c.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 115, pl. 2, fig. 15a-b.

COMMENTS: Several previous whorls are visible on the test.
RANGE: Mallory (1959) gives range as upper Bulitian through upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1)

Cyclammina simiensis

Cyclammina simiensis Cushman and McMasters, 1936, Jour. Paleo., v. 10, p. 509, pl. 74, fig. 3a-b.
- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 9.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, pl. 2, fig. 17.

COMMENTS: Cyclammina simiensis is more involute than C. samanica; only final whorl visible in C. simiensis (see Mallory, 1959, pl. 2, fig. 17).

OCCURRENCE: Loma Prieta Quad. (Te_1, Te_2, Tme); Pacheco Syncline (Vine Hill)

Dentalina communis (d'Orbigny)

Nodosaria (Dentalina) communis d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p.

Dentalina communis (d'Orbigny) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 162, pl. 12, fig. 11; pl. 41, fig. 6.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 78.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Dentalina consobrina (d'Orbigny)

Nodosaria (Dentalina) consobrina d'Orbigny, 1846, Foraminiferes fossiles du bassin tertiaire de Vienne (Sutriche), Gide et Comp., Paris, p. 46, pl. 2, figs. 1-3.

Nodosaria consobrina d'Orbigny - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p.

Dentalina consobrina (d'Orbigny) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 163, pl. 12, fig. 12; pl. 41, fig. 5.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 78.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Dentalina delicatula Cushman

Dentalina delicatula Cushman, 1983, Cushman Lab. Foram. Res., Contr., v. 14, p. 40, pl. 6, figs. 19-20.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 163, pl. 12, fig. 16.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 79.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Ulatisian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Dentalina hexacostata Howe

Dentalina hexacostata Howe, 1939, Louisiana Geol. Soc. Bull., v. 14, p. 44, pl. 5, fig. 13.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 164, pl. 12, fig. 15; pl. 28, fig. 2.

RANGE: Mallory (1959) gives range as upper Ulatisian through lower Narizian.

OCCURRENCE: Loma Prieta Quad. (Te1)

Dentalina hispidocostata Cushman and Siegfus

Dentalina hispidocostata Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 15, p. 25, pl. 6, figs. 4,5.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 164, pl. 12, fig. 4; pl. 28, fig. 3.

RANGE: Mallory (1959) gives range as lower Ulatisian through lower Narizian with rare occurrences in the upper Ynezian and lower Penutian.

OCCURRENCE: Loma Prieta Quad. (Te1)

Dentalina jacksonensis (Cushman and Applin)

Nodosaria jacksonensis Cushman and Applin, 1926, AAPG Bull., v. 10, p. 170, pl. 7, figs. 14-16.

Dentalina jacksonensis (Cushman and Applin) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 165, pl. 12, fig. 18.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 80.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Te1 cf.)

Dentalina mucronata Neugeboren

Dentalina mucronata Neugeboren, 1856, K. Akad. Wiss., Math.-Naturw. Cl., Denschr., Osterreich, Bd. 12, Abth. 2, p. 83, pl. 3, figs. 8-11.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 166.

OCCURRENCE: Loma Prieta Quad. (Te1)

Dentalina multilineata Bornemann

Dentalina multilineata Bornemann, 1855, Deutsch. Geol. Ges., Zeitschr., Deutschland, Bd. 7, Heft. 2, p. 325, pl. 13, fig. 12.

OCCURRENCE: Loma Prieta Quad. (Te1 cf.)

Dentalina soluta Reuss

Dentalina soluta Reuss, 1851, Deutsch. Geol. Ges., Zeitschr., Deutschland, Bd. 3, p. 60, pl. 3, fig. 4.
Dentalina soluta (?) Reuss - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 167, pl. 12, fig. 18.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 82.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1)

Discorbis baintoni Mallory

Discorbis baintoni Mallory,1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 228, pl. 19, fig. 16a-c.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 125, pl. 9, figs. 5-6, 8.

RANGE: Mallory (1959) gives range as lower Bulitian through upper Ulatisian.
ECOLOGY: Discorbis baintoni has an upper depth limit on the inner shelf (Discorbis spp., Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1)

Dorothia bulletta (Carsey)

Dorothia bulletta (Carsey) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 125, pl. 4, fig. 9a, b.
Dorothia asiphonia (Andreae) - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 9, pl. 1, fig. 25.

RANGE: Mallory (1959) gives range as lower Ynezian to lower Penutian with rare occurrences noted in the lower Ulatisian and the Narizian.
OCCURRENCE: Loma Prieta Quad. (Ku_1, Te_1, Te_2)

Dorothia principiensis Cushman and Bermudez

Dorothia principiensis Cushman and Bermudez, 1936, Cushman Lab. Foram. Res., Contr. v. 12, p. 57, pl. 10, figs. 3-4.
- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 9, pl. 1, fig. 26.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 154, pl. 19, fig. 4.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 125, pl. 27, fig. 8; pl. 33, fig. 2; pl. 36, fig. 3.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Vine Hill Sandstone, Alhambra)

Eggerella elongata Blaisdell

Eggerella elongata Blaisdell, 1965, Cushman Found. Foram. Res., Contr., v. 16, p. 27, pl. 2, figs. 1-3.
- - Smith, 1971, Univ. Calif. Pub. Geol. Sci., v. 91, p. 34, pl. 2, fig. 5.

Eggerella sp. Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 124.

ECOLOGY: Mallory (1959) gives range as upper Ulatisian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tsl)

Eggerella subconica Parr

Eggerella subconica Parr, 1950, B.A.N.Z. Antarct. Res. Exped. 1929-31, Rept. Adelaide, v. 5, p. 281, pl. 5, fig. 22.
- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 35.

RANGE: Mallory (1959) gives range as lower Narizian through upper Narizian.

ECOLOGY: Ingle (1980) gives the upper depth limit of Eggerella bradyi (= E. subconica) as in the upper middle bathyal biofacies, 500-1500 m.

OCCURRENCE: Loma Prieta Quad. (Tsl)

Ellipsoglandulina abbreviata Sequenza

Ellipsoglandulina abbreviata Sequenza, 1859, Eco Peloritano, Giornale di Sci., ser. 2, anno 5, fasc. 9, p. 14, fig. 5.
- - Bermudez, 1949, Cushman Lab. Foram. Res., Special Pub. no. 25, p. 227, pl. 14, figs. 44-45.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Ellipsoglandulina labiata (Schwager)

Glanudlina labiata Schwager, 1866, Norara-Exped., Geol. Thril, v.2, p. 237, pl. 6, fig. 77.

Ellipsoglandulina labiata (Schwager) - - Bermudez, 1949, Cushman Lab. Foram. Res., Special Pub., no. 25, p. 228, pl. 14, figs. 42-43.
- - Beckmann, 1953, Eclog. Geol. Helv., v. 46, p. 379, Pl. 23, figs. 9-11.

OCCURRENCE: Loma Prieta (Te_1)

Ellipsoglandulina principiensis Cushman and Bermudez

Ellipsoglandulina principiens Cushman and Bermudez, 1937, Contr. Cushman Lab. Foram. Res., v. 13, p. 18, pl. 2, figs. 1-3.
- - Bermudez, 1949, Cushman Lab. Foram. Res., Special. Pub. no. 25, p. 228, pl. 14, figs. 40-41.
- - Beckmann, 1953, Eclog. Geol. Helv., v. 46, p. 380.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Eponides dorfi Toulmin

Eponides dorfi Toulmin, 1941, Jour. Paleo., v. 15, p. 601, pl. 81, figs. 8-9.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 237, pl. 30, fig. 2.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 132, pl. 11, fig. 4.

RANGE: Mallory (1959) gives range as lower Ulatisian through lower Narizian with rare occurrences in the upper Ynezian and lower Penutian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Fissurina orbignyana Sequenza

Fissurina orbignyana Sequenza, 1862, Deii terreni Terziarii del distretto di Messina; Parte II - Descriptione dei foraminiferi monotalamici delle marne mioceniche del distretto de Messina T. Capra, p. 66, pl. 2, figs. 25-26.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Fursenkoina bramletti (Galloway and Morrey)

Virgulina bramletti Galloway and Morrey, 1929, Bull. American Paleo., v. 15, p. 37, pl. 5, fig. 14a-b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 198.

Fursenkoina bramletti - - McDougall, 1980, SEPM, Paleo. Monograph, no. 2, p. 35.

RANGE: Mallory (1959) gives range as lower Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tsl cf.)

Gaudryina laevigata Franke

Gaudryina laevigata Franke, 1914, Geol. Ges., Zeitschr., A., Abh., Deutschland, Bd. 66, Heft #, p. 431, pl. 27, figs. 1-2.
- - Smith, 1957, Univ. Calif. Pub. Geol. Sci., v. 32, p. 152, pl. 18, fig. 8.
- - Smith, 1971, Univ. Calif. Pub. Geol. Sci., v. 91, p. 32.

ECOLOGY: Ingle (1980) gives the upper depth limit of Gaudryina laevigata as outer shelf.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Globobulimina pacifica Cushman

Globobulimina pacifica Cushman, 1927, Cushman Lab. Foram. Res., Contr., v. 3, p. 67, pl. 14, fig. 12.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 198, pl. 16, fig. 17.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 111-112.

Guttulina (?) sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 170, pl. 23, fig. 13.

RANGE: Mallory (1959) gives range as upper Ulatisian through upper Narizian with rare occurrences in the upper Bulitian.

ECOLOGY: Globobulimina pacifica has an upper depth limit in the upper bathyal biofacies, 150-500 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Tsl)

Globocassidulina globosa Hantken

Cassidulina globosa Hantken, 1875, K. Ungar. Geol. Anst., Mitt. Jahrb., Bd. 4, Heft. 1, p. 64, pl. 16, figs. 2a-b.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 226, pl. 33, fig. 11a-b.

Globocassidulina subglobosa (Brady) - - Tjalsma and Lohmann, 1983, Micropaleo. Special Publication no. 4, p. 31, pl. 16, fig. 9.

RANGE: Mallory (1959) gives range as lower Penutian through upper Narizian. Tjalsma and Lohmann (1983) indicate that this species first appears in the Paleocene planktic zone P4 and ranges throughout the Eocene and into younger strata.

ECOLOGY: The upper depth limit of G. globosa is in the outer shelf biofacies, 50-150 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Glomospira charoides (Jones and Parker)

Trochammina squamata charoides Jones and Parker, 1860, Geol. Soc. London, Quart. Jour., v. 16, p. 304.

Glomospira charoides (Jones and Parker) - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 7.

Glomospira charoides corona Cushman and Jarvis - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 109.

RANGE: Mallory (1959) gives range as lower Ynezian through upper Narizian.

ECOLOGY: Glomospira charoides has an upper depth limit in the lower bathyal biofacies, $\geq$ 2000 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Guttulina problema d'Orbigny

Guttulina problema d'Orbigny, 1826, Ann. Sci. Nat., v. 7, p. 266.

- - Cushman and Ozawa, 1931, Proceedings U.S. Nat. Mus., v. 77, p. 19-22, pl. 2, figs. 1-6; pl. 3, fig. 1a-c.

ECOLOGY: Guttulina problema has an upper depth limit in the outer shelf biofacies, 50-150 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Gyroidina soldanii d'Orbigny

Gyroidina soldanii d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 278.

ECOLOGY: Gyroidina soldanii has an upper depth limit in the lower bathyal biofacies, $\geq$ 200 m (Ingle, 1980)

OCCURRENCE: Loma Prieta Quad. (Tei, Tme, Tsl)

Hanzawaia ammophila (Gumbel)

Rotalia ammophila Gumbel, 1868, K. Bayer. Akad. Wiss., Math.-Physik. Cl. Abh., Munchen, v. 10, p. 652, pl. 2, fig. 90.

Hanzawaia ammophila (Gumbel) - - van Morkhoven and others, 1986, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 168-171, pl. 56, figs. 1-3.

Cibicidies cushmani Nuttall, 1930, Jour. Paleo., v. 4, p. 168, pl. 25, figs. 3, 5, 6.

- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 192, pl. 31, fig. 4.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 264, pl. 31, fig. 3.

Hanzawaia cushmani (Nuttall) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 32, pl. 17, fig. 1.

Cibicides americanus (Cushman) - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 31, pl. 6, fig. 1.

Anomalina sampsoni Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 262, pl. 23, fig. 7.

Anomalina crassisepta (Cushman and Siegfus) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 258, pl. 32, fig. 4.

COMMENTS: Tjalsma and Lohmann (1983) note the similarity between H. ammophila and H. cushmani but separate species because H. ammophila has a more rapidly uncoiling spire and thus a flatter test. Van Morkhoven and others (1986) note this morphologic variation only in the Miocene forms and consider H. cushmanni to be a junior synonym of H. ammophila.

Specimens assigned to A. crassiseptus and A. sampsoni by Mallory should be placed in synonomy with H. ammophila. Mallory lists the difference between these two species as the number of chambers in the final whorl, size, thickening of the periphery, and curvature of the chambers. The range of these features falls within the scope of H. ammophila.

RANGE: A range of latest Paleocene (P6a) through middle Miocene (N11) is given by van Morkhoven and others (1986). The form frequently assigned to H. cushmanni is most commonly found in the Eocene (P6a) to Oligocene (P18). Mallory (1959) gave the range as upper Bulitian through upper Narizian.

ECOLOGY: The depth range of this species is outer neritic to upper bathyal; it may also be found at abyssal depths (van

Morkhoven and others, 1986). Ingle (1980) gives the upper dpeth limit of this species along the Pacific Margin as in the lower middle bathyal biofacies, 1500-2000 m.

OCCURRENCE: Loma Prieta Quad. (Tme)

Haplophragmoides deflata Sullivan

Haplophragmoides deflata Sullivan, 1962, Univ. Calif. Pub. Geol. Sci, v. 37, p.251, pl. 1, figs. 11-12.

- - McDougall, 1980, SEPM, Paleo. Monograph, no. 2, p. 35.

OCCURRENCE: Loma Prieta Quad. (Tsl)

Haplophragmoides eggeri Cushman

Haplophragmoides eggeri Cushman,

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 111, pl. 2, fig. 6.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 32.

Haplophragmoides sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 10.

RANGE: Mallory (1959) gives range as Ynezian through lower Narizian.

OCCURRENCE: Loma Prieta Quad. (?Ku_1, Te_1, Te_2, Tme, Tbs)

Hyperammina elongata Brady

Hyperammina elongata Brady, 1878, Ann. Mag. Nat. Hist., England, ser. 5, v. 1, p. 433, pl. 20, fig. 2a-b.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 106, pl. 1, fig. 8; pl. 27, fig. 2.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tbs)

Karreriella chapapotensis (Cole)

Textularia chapatoensis Cole, 1928, Bull. American Paleo., v. 14, p. 206, pl. 33, fig. 9.

Karreriella chapapotensis (Cole) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 32.

Karreriella chapapotensis monumentensis Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 126, pl. 5, fig. 3.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 47.

COMMENTS: Tjalsma and Lohmann (1983) consider Mallory's variation to represent the microspheric form of K. chapapotensis which ranges from the early Eocene to Oligocene.

RANGE: Mallory (1959) gives the range of K. chapapotensis monumentensis as lower Ulatisian through lower Narizian. Tjalsma and Lohmann give the range of K. chapapotensis as from early Eocene (P6b) into the Oligocene.

ECOLOGY: Karreriella chapapotensis has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Karreriella elongata Mallory

Karreriella elongata Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 127, pl. 5, fig. 4a-c.

COMMENTS: Differs from *K. chilostoma* in narrower test, greater length, more oblique chambers (Mallory, 1959). *Karreriella elongata* is probably a junior synonym of *Karreriella subglabra* (Gumbel).

RANGE: Mallory (1959) finds this species restricted to the lower Narizian. The range of *K. subglabra* is P8 through Oligocene (Tjalsma and Lohmann, 1983).

ECOLOGY: *Karreriella elongata* has an upper depth limit in the lower middle bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Lagena costata (Williamson)

Entosolenia costata Williamson, 1858, On the Recent Foraminifera of Great Britian, R. Soc. Lond., p. 9, pl. 1, fig. 18.

Lagena costata (Williamson) - - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 35.

RANGE: Mallory (1959) gives range as lower Bulitian through lower Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Lagena gracilis Williamson

Lagena gracilis Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, v. 1, p. 13, pl. 1, fig. 5.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lagena vulgaris Williamson

Lagena vulgaris Williamson, 1858, On the Recent Foraminifera of Great Britian, R. Soc. Lond., p. 3, pl. 1, figs. 5-5a.
- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 35.

RANGE: Mallory (1959) gives range as lower Ynezian through lower Bulitian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina altolimbatus (Gumbel)

Robulina alto-limbata Gumbel, 1868, K. Acad. Wiss Munchen, Math.-Physik. Cl., Abh., Bd. 10, Abt. 2, p. 641, pl. 2, fig. 70.

Robulus alto-limbata (Gumbel) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 156, pl. 20, fig. 1.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 133, pl. 6, fig. 16; pl. 27, fig. 11.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 54.

RANGE: Mallory (1959) gives range as lower Penutian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina antipodum (Stache)

Robulus antipodum (Stache) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 134, pl. 6, fig. 2.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina carolinianus Cushman

Robulus arcuatostriatus carolinianus Cushman, 1933, Contr. Cushman Lab. Foram. Res., v. 9, p. 4, pl. 1, fig. 9.

ECOLOGY: Mallory (1959) gives range as upper Ulatisian through upper Narizian with rare occurrences in the lower Penutian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina kincaidi Beck

Robulus kincaidi Beck, 1943, Jour. Paleo., v. 17, p. 595, pl. 102, figs. 1, 7.

RANGE: Mallory (1959) gives range as upper Penutian through upper Narizian with rare occurrences in the upper Bulitian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina laimingi (Isralesky)

Robulus laimingi Isralesky, 1955, U.S.G.S. Prof. Paper 240-B, p. 41, pl. 13, figs. 37, 38.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 138, pl. 7, fig. 12.

COMMENTS: Characteristics important in recognition of this species are: 1) suboblate side view, 2) acutely pointed apertural end, 3) chambers strongly inflated near umbilicus, swollen portion with circular outlines in early chambers and transversly subelliptical in later chambers, 4) sutures ratiate from umbilicus, strongly reflexed, 5) umbilicus eccentic, and 6) well-defined thin keel present on all chambers. Specimen figured by Mallory (1959; pl. 7, fig.

12) is circular in outline and swellings on chambers not as distinct as typical.
RANGE: Mallory (1959) gives range as upper Bulitian through lower Penutian.
OCCURRENCE: Loma Prieta Quad. (Te_1, Te_2)

Lenticulina limbosus hockleyensis (Cushman and Applin)
Cristellaria limbosus hockleyensis Cushman and Applin, 1926, AAPG, v. 10, p. 171, pl. 8, figs. 3-4.
Robulus limbosus hockleyensis (Cushman and Applin) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 139, pl. 6, fig. 15.
ECOLOGY: Mallory (1959) gives range as upper Ulatisian through upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina pseudocultratus (Cole)
Robulus pseudocultratus Cole, 1927, Bull. American Paleo., v. 14, p. 19, pl. 1, fig. 5.
RANGE: Mallory (1959) gives range as upper Bulitian through upper Narizian.
OCCURRENCE: Loma Prieta Quad (Te_1)

Lenticulina pseudovortex (Cole)
Robulus pseudovortex Cole, 1927, Bull. American Paleo., v. 14, p. 19, pl.1, fig. 12.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 158, pl. 20, figs. 12-13.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 141, pl. 7, figs. 2-3; pl. 27, fig. 13.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 60.
RANGE: Mallory (1959) gives range as lower Bulitian through lower Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1); Vine Hill Sandstone, Las Juntas, Muir)

Lenticulina terryi (Coryell and Embich)
Robulus terryi Coryell and Embich, 1937, Jour. Paleo., v. 11, p. 299, pl. 41, fig. 17.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 141, pl. 6, fig. 1.
RANGE: Mallory (1959) gives range as upper Ynezian through lower Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina ulatisensis Boyd

Robulus ulatisensis Boyd, in Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 142, pl. 6, fig. 10a-b; pl. 40, fig. 4a-b.

RANGE: Mallory (1959) gives range as upper Penutian through lower Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lituotuba cf. L. lituiformis (Brady)

Lituotuba cf. L. lituiformis (Brady) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 109, pl. 1, fig. 17.

?Trochamminoides sp. A - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 7, pl. 1, fig. 11.

?Trochamminoides sp. B - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 7, pl. 1, fig. 12.

RANGE: Mallory (1959) gives range as Ulatisian with rare occurrences in the upper Ynezian and lower Penutian.

OCCURRENCE: Loma Prieta Quad (Te_1)

Marginulina dominica Bermudez

Marginulina dominica Bermudez, 1949, Cushman Lab. Foram. Res., Special Pub., no. 25, p. 140, pl. 9, fig. 26.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Marginulina exima Neugeboren

Marginulina exima Neugeboren, 1851, Siebenb. Ver. Naturw. Hermannstadt. Verh. Mitt., Jahrg. 2, p. 129, pl. 4, fig. 17.

RANGE: Mallory (1959) gives range as lower Bulitian through lower Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tsl)

Marginulina inconspicua Hussey

Marginulina inconspicua Hussey, 1949, Jour. Paleo., v. 23, p. 123, pl. 26, fig. 10.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Marginulina subbullata Hantken

Marginulina subbullata Hantken, 1875, K. Ungar. Geol. Anst., Mitt., Jahrb., v. 4, p. 46, pl. 4, figs. 9-10.; pl. 5, fig. 9.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 151, pl. 9, figs. 13-15.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 69.

Marginulina bullata augens Cushman and Todd - - Smith, 1957,

Univ. Calif. Publ. Geol. Sci., v. 32, p. 161, pl. 21, fig. 15.
Enantiomarginulina sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 170, pl. 23, fig. 16.
RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Te1)

Marginulina subrecta Franke

Marginulina subrecta Franke, 1927, Danmarks Geol. v. 2, p. 19, pl. 1, fig. 28.
OCCURRENCE: Loma Prieta Quad. (Te1)

Marssonella oxycona (Reuss)

Gaudryina oxycona Reuss, 1860, Sitz. Akad. Wiss. Wien., v. 40, p. 229, pl. 12, fig. 3.
- - Cushman and Church, 1929, p. 502, pl. 36, figs. 3-4.
Marssonella oxycona (Reuss) - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 9, pl. 1, fig. 28.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 124, pl. 4, fig. 8a, b.
RANGE: Mallory (1959) gives range as lower Ynezian to lower Penutian, with questionable occurrence in the lower Ulatisian.
OCCURRENCE: Loma Prieta Quad. (?Ku1, Te1)

Martinotiella eocenica Cushman and Bermudez

Listerella gracillima cushman and Bermudez, 1973, Contr. Cushman Lab. Foram. Res., v. 13, p. 6, pl. 1, figs. 27-28.
Martinotiella eocenica Cushman and Bermudez in Cushman, 1947,Cushman Lab. Foram. Res., Spec. Pub., no. 8A, p. 48.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 128, pl. 5, fig. 8a-b.
RANGE: Mallory (1959) gives range as lower Penutian through upper Narizian.
ECOLOGY: upper middle bathyal biofacies (Ingle, 1980)
OCCURRENCE: Loma Prieta Quad. (Te1, Tme, Tsl cf.)

Nodosarella advena Cushman and Siegfus

Nodosarella advena Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 15, p. 30, pl. 6, figs. 19-20.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 220, pl. 18, fig. 22a-b; pl. 29, fig. 12a-b.
RANGE: Mallory (1959) gives range as lower Ulatisian through lower Narizian. Nodosarella advena has been found in

strata assigned to nannofossil zone CP12 in the Devils Den section, sample DDM-14-89 (McDougall and Bukry, unpublished data, 1989) and strata assigned to planktic foraminiferal zone P8 through P9 in the Media Agua Creek section (Mallory, 1959; Poore, 1980).
OCCURRENCE: Loma Prieta Quad. (Tei)

Nodosarella decurta (Bermudez)

Ellipsonodosaria decurta Bermudez, 1937, Mem. Soc. Cubana Hist. Nat., v. 11, p. 144, pl. 17, figs. 13-14.
Nodosarella decurta (Bermudez) - - Bermudez, 1949, Cushman Lab. Foram. Res., Special Pub., no. 25, p. 231, pl. 14, fig. 32.
OCCURRENCE: Loma Prieta Quad. (Tei)

Nodosarella mappa (Cushman and Jarvis)

Ellipsonodosaria mappa Cushman and Jarvis, 1934, Contr. Cushman Lab. Foram. Res., v. 10, p. 73, pl. 10, fig. 8.
Nodosarella mappa (Cushman and Jarvis) - - Beckmann, 1953, Eclog. Geol. Helv., v. 46, p. 376, pl. 22, fig. 22-23.
OCCURRENCE: Loma Prieta Quad. (Tei)

Nodosaria cf. N. amphioxys Reuss

Nodosaria cf. N. amphioxys Reuss - - Cushman, 1951, U.S.G.S. prof. Paper 232, p. 24, pl. 7, fig. 8.
COMMENTS: The type of this species are from the upper Cretaceous of Saxony. Cretaceous specimens have also been noted in the Taylor marl and Navarro group in the southeastern United States. Paleocene forms questionably assigned to this species are from the southeastern United States.
RANGE: Several specimens were found in the Devils Den section (McDougall, unpublished data, 1989) in association with calcareous nannofossils diagnostic of zone CP12 (Bukry, unpublished data, 1989).
OCCURRENCE: Loma Prieta Quad. (Tei)

Nodosaria deliciae Martin

Nodosaria deliciae Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 17, pl. 6, fig. 3.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 167, pl. 22, fig. 18.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 170, pl. 13, fig. 13; pl. 36, fig. 10.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 85.

Nodosaria deliciae murensis Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 167, pl. 22, figs. 19-20.

COMMENTS: Strongly resembles Stilostomella paleocenica (Cushman and Todd) in Berggren and Aubert (1983, pl. 2, fig. 2).
RANGE: Mallory (1959) gives range as upper Bulitian through upper Penutian with rare occurrences in the lower Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir, and Alhambra)

Nodosaria gyrata Mallory

Nodosaria? gyrata Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 170, pl. 13, fig. 18; pl. 28, fig. 5.
RANGE: Mallory (1959) gives range as lower Bulitian through upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Tsl cf.)

Nodosaria latejugata Gumbel

Nodosaria latejugata Gumbel, 1868, K. Acad. Wiss Munchen, Math.-Physik. Cl., Abh., Bd. 10, Abt. 2, p. 619, pl. 1, fig. 32.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 167, pl. 22, fig. 23.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 171, pl. 13, fig. 20; pl. 28, fig. 8; pl. 41, fig. 1.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 85.
RANGE: Mallory (1959) gives range as lower Ynezian through upper Ulatisian.
OCCURRENCE: Loma Prieta Quad. (Te_1)

Nodosaria longiscata d'Orbigny

Nodosaria longiscata d'Orbigny, 1846, Foraminiferes fossiles du bassin tertiaire de Vienne, Gide et Comp., France, p. 32, pl. 1, figs. 10, 12.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 171.
Nodosaria arundinea Schwager - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 169, pl. 13, fig. 10; pl. 28, fig. 7; pl. 41, fig. 4.
Nodosaria arundinea Schwager (?) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 166, pl. 22, fig. 21.
Nodosaria ewaldi Reuss - - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 85.
RANGE: Mallory (1959) gives range as lower Bulitian through upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Vine Hill Sandstone and Las Juntas)

Nodosaria macneili Cushman

Nodosaria macneili Cushman, 1944, Cushman Lab Foram. Res., Contr., v. 20, p. 37, pl. 6, fig. 9.

- - Cushman, 1951, U.S.G.S. Prof. Paper 232, p. 24, pl. 7, fig. 7.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 172, pl. 13, fig. 16.

RANGE: Mallory (1959) gives range as upper Bulitian with rare occurrences in the upper Ynezian.

OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Vine Hill Sandstone)

Nodosaria pyrula d'Orbigny

Nodosaria pyrula d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 253.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 172, pl. 13, fig. 19; pl. 41, fig. 2.

RANGE: Mallory (1959) gives range as upper Penutian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Nodosaria velascoensis Cushman

Nodosaria velascoensis Cushman,

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 172, pl. 13, fig. 24.

RANGE: Mallory (1959) gives range as lower Penutian through lower Narizian, with rare occurrences in the upper Ynezian.

OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Las Juntas)

Nuttaloides truempyi (Nuttall)

Eponides truempyi Nuttall, 1930, Jour. Paleo., v. 4, p. 287, pl. 24, figs. 9, 13, 14.

Nuttaloides truempyi (Nuttall) - - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 288-295, pl. 96A, figs. 1-4; pl. 96B, figs. 1-3; pl. 96C, figs. 1-4; pl. 96D, figs. 1-2.

Astigerina crassaformis Cushman and Siegfus, 1935, Cushman Lab. Foram. Res., Contr., v. 11, p. 94, pl. 14, fig. 10.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 242, pl. 37, fig. 13a-c.

Astigerina crassaformis umbilicatula Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 242, pl. 22, fig. 1a-c.

Astigerina crassaformis umbilicatula Mallory - - Almgren and others, 1988, Paleogene of the West Coast, SEPM, Pacific Section, fig. 5 (list).

COMMENTS: Astigerina crassaformis umbilicatula which ranges from lower Penutian through lower Narizian, has the large clear umnbilical boss which is characteristic of many middle and late Eocene forms of the species Nuttalides truempyi.
RANGE: A late Cretaceous (Campanian) through late Eocene (P17) range is given by van Morkhoven and others (1986). Berggren and Aubert (1983) considered the extinction of N. truempyi a useful event for identification of the Eocene/Oligocene boundary in deep-water sediments. Mallory (1959) gave the range of Astigerina crassaformis as lower Ulatisian through upper Narizian and the range of A. crassaformis umbilicatulum as lower Penutian through lower Narizian. Both ranges fall witnin the broader range given for Nuttalides truempyi. The range of Astigerina crassaformis umbilicatula given by Almgren and others (1988) is zones C through A-2 which are equivalent to nannofossil zones CP9through CP14 (planktic foraminiferal zones P7-P14) and also falls within the broader range of Nuttalides truempyi.
ECOLOGY: The upper depth limit of Nuttalides truempyi is in the lower bathyal biofacies, 1500-2000 m (Ingle, 1980) but Nuttalides truempyi is most common at abyssal depths (van Morkhoven and others, 1986).
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas)

Oridorsalis umbonatus (Reuss)

Rotalina umbonata Reuss, 1851, Deutsch. Geol. Ges., Zeitschr., Berlin, Bd. 3, p. 75, pl. 5, fig. 35.
Eponides umbonata (Reuss) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 183, pl. 27, figs. 12, 14.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 239, pl. 30, fig. 3; pl. 37, fig. 11.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 133.
Oridorsalis umbonatus (Reuss) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 18, pl. 6, fig. 8.
RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.
ECOLOGY: Ingle (1980) gives upper dpeth limit of Oridorsalis umbonatus as upper bathyal in the Paleogene and as upper middle bathyal in the Neogene.
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas)

Osangularia mexicana (Cole)

Pulvinulinella culter mexicana Cole, 1927, Bull. American Paleo., v. 14, p. 31, pl. 1, figs. 15-16.
Eponides lodoensis martini Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 182 (in part).

RANGE: Similar forms identified by Mallory (1959) as Parrella culter midwayana and Parrella tenuicarinata range from lower Ynezian through the lower Narizian and upper Bulitian through upper Narizian.
ECOLOGY: upper middle bathyal (Ingle, 1980)
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco syncline (Las Juntas, and Muir)

Plectina garzaensis Cushman and Siegfus

Plectina garzaensis Cushman and Siegfus, 1935, Cushman Lab. Foram. Res., Contr., v. 11, p. 92, pl. 14, figs. 3,4.
- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 9, pl. 1, fig. 29.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 126, pl. 4, fig. 13.

RANGE: Mallory (1959) gives range as lower Ulatisian through upper Narizian with rare occurrences in the lower Penutian.
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme, Tsl)

Plectofrondicularia garzaensis Cushman and Siegfus

Plectofrondicularia garzaensis Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 15, p. 26, pl. 6, fig. 9.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 212, pl. 18, fig. 1.

RANGE: Mallory (1959) gives range as lower Ulatisian through upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1)

Plectofrondicularia miocenica Cushman

Plectofrondicularia miocenica Cushman, 1926, Cushman Lab. Foram. Res., Contr., v. 2, p. 58, pl. 7, figs. 10, 11; pl. 8, figs. 11, 12.
- - Kleinpell, 1938, Miocene Stratigraphy of California, AAPG, p. 240, pl. 7, fig. 12.

COMMENTS: Since the single specimen found in San Lorenzo Formation, Loma Prieta Quadrangle is represented by only a portion of the test, the specimen is listed on the checklist as "cf.".

RANGE: Kleinpell (1938) gives range of P. miocenica as Zemorrian through Relizian (late Oligocene through middle Miocene).
ECOLOGY: Ingle (1980) lists Plectofrondicularia miocenica laimingi as having an upper depth limit in the lower bathyal biofacies, 2,000 + m. This variety has a broad flat periphery instead of the acute keeled periphery of P. miocenica, and thus, probably has a shallower upper depth limit.
OCCURRENCE: Loma Prieta Quad. (Tsl)

Plectofrondicularia packardi Cushman and Schenck

Plectofrondicularia packardi Cushman and Schenck, 1928, Univ. Calif. Pub. Geol. Sci., v. 17, p. 311, pl. 43, figs. 14-15.
- - McDougall, 1980, SEPM, Paleo. Monograph, no. 2, p. 37.

RANGE: Mallory (1959) gives range as upper Narizian into the Oligocene.

OCCURRENCE: Loma Prieta Quad. (Tsl)

Plectofrondicularia paucicostata Cushman and Jarvis

Plectofrondiuclaria paucicostata Cushman and Jarvis, 1929, Contr. Cushman Lab. Foram. Res., v. 5, p. 10, pl. 2, figs. 11-12, 13.
- - van Morkhoven and others, 1986, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 273, pl. 91, figs. 1-2.

Plectofrondicularia kerni Cook - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 212, pl. 18, fig. 2; pl. 33, fig. 10a-b.

RANGE: Mallory (1959) gives range as lower Penutian through lower Narizian. The range of middle Eocene (P12) through early Oligocene (P20) with doubtful occurrence from early Eocene P8 through middle Eocene P11 (van Morkhoven and others, 1986) is broader.

ECOLOGY: Plectofrondicularia paucicostata is a middle bathyal to abyssal species (van Morkhoven and others, 1986).

OCCURRENCE: Loma Prieta Quad. (Te1); Pacheco Syncline (Las Juntas)

Plectofrondicularia vokesi Cushman, Stewart and Stewart

Plectofrondicularia vokesi Cushman, Stewart and Stewart, 1949, Oregon Dept. Geol. Miner. Ind. Bull, v. 36, p. 132, pl. 15, fig. 4.

RANGE: Mallory (1959) gives range as Narizian.

OCCURRENCE: Loma Prieta Quad. (Tsl)

Pleurostomella acuta Hantken

Pleurostomella acuta Hantken, 1875, K. Ungar. Geol. Anst., Mitt. Jahrb., Budapest, Bd. 4, p. 44, pl. 13, fig. 18.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.

ECOLOGY: Pleurostomella acuta has an upper depth limit in the lower bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te1, Tme)

Pleurostomella alternans Schwager

Pleurostomella alternans Schwager, 1866, Novara Exped., Geol. Theil, Bd. 2, Abt. 2, p. 238, pl. 6, figs. 79-80.

OCCURRENCE: Loma Prieta Quad. (Te1)

Pleurostomella gredalensis Cook

Pleurostomella gredalensis Cook in Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 218, pl. 18, fig. 15; pl. 35, fig. 3a-b.

OCCURRENCE: Loma Prieta Quad. (Tei)

Pleurostomella nuttalli Cushman and Siegfus

Pleurostomella nuttalli Cushman and Siegfus, 1939, Contr. Cushman Lab. Foram. Res., v. 15, p. 29, pl. 6, figs. 17, 18.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 219, pl. 18, fig. 16.

RANGE: Mallory (1959) gives range as lower Bulitian through lower Narizian.

ECOLOGY: Pleurostomella nuttalli has an upper depth limit in the lower bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Tei)

Praeglobobulimina pupoides (d'Orbigny)

Bulimina pupoides d'Orbigny, 1846, Foraminiferes fossiles du bassin tertiaire de Vienne (Autriche), Paris, Gide et Comp., p. 185, pl. 11, figs. 11-12.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 195, pl. 28, fig. 16a-c; pl. 36, fig. 17a-c.

RANGE: Mallory (1959) gives range as lower Penutian through upper Narizian.

ECOLOGY: Praeglobobulimina pupoides has an upper depth limit in the upper bathyal biofacies, 150-500 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Tei, Tme)

Pseudonodosaria conica (Neugeboren)

Glandulina conica Neugeboren, 1850, Siebenb. ver. Naturw. Hermannstadt, Verh. Mitt., Hermanstadt, v. 1, p. 51, pl. 1, fig. 5a-b.

Pseudonodosaria conica (Neugeboren) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 173, pl. 33, fig. 4; pl. 36, fig. 11.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 87.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Tei)

Pseudonodosaria inflata (Bornemann)

Glandulina inflata Bornemann, 1855, Deutsch. Geol. Ges., Zeitschr., Berlin, v. 7, p. 320, pl. 12, figs. 6-7.

Pseudonodosaria inflata (Costa) - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 37.
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme, Tsl)

Pullenia eocenica Cushman and Siegfus

Pullenia eocenica Cushman and Siegfus, 1939, Contr. Cushman LAb. Foram. Res., v. 15, p. 31, pl. 7, fig. 1a-b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 246, pl. 30, fig. 4a-b.
- - Tjalsma and Lohmann, 1983, p. 36, pl. 16, fig. 2.

RANGE: Mallory (1959) gives range as upper Bulitian through upper Narizian. Pullenia eocenica is common from early Eocene zone P9 through late Eocene P17 with rare occurrences as old as P6a (late Paleocene) (Tjalsma and Lohmann, 1983).
ECOLOGY: Pullenia eocenica has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Pullenia quinqueloba (Reuss)

Nonionina quinqueloba Reuss, 1851, Deutsch. Geol. Ges., Zeitschr., Berlin, v. 3, p. 71, pl. 5, fig. 31.
Pullenia quinqueloba (Reuss) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 246, pl. 34, fig. 1a-b.
RANGE: Mallory (1959) gives range as upper Ynezian through lower Narizian.
ECOLOGY: Ingle (1980) gives the upper depth limit of this species as in both outer shelf and upper middle bathyal biofacies. The upper middle bathyal depth is preferred.
OCCURRENCE: Loma Prieta Quad. (Te_1)

Pullenia salisburyi Stewart and Stewart

Pullenia salisburyi Stewart and Stewart, 1930, Jour. Paleo., v. 4, p. 72, pl. 8, fig. 2.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 188, pl. 28, fig. 11.

RANGE: Mallory (1959) gives range as Narizian.
ECOLOGY: Pullenia salisburyi has an upper depth limit in the outer shelf biofacies, 50-150 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Las Juntas)

Pyrulina cylindroides (Roemer)

Polymorphina cylindroides Roemer, 18538, Neues Jahrb. Min. Geogn. Geol. Petref.-Kund, p. 385, pl;. 3, fig. 26a-b.
Pyrulina cylindroides (Roemer) - - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 37.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Quinqueloculina minuta Beck

Quinqueloculina minuta Beck, 1943, Jour. Paleo., v. 17, p. 593, pl. 99, figs. 5-7.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 130.

RANGE: Mallory (1959) gives range as Narizian.
ECOLOGY: *Quinqueloculina minuta* has an upper depth limit in the inner shelf biofacies 0-50 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Tsl)

Reophax pilulifera Brady

Reophax pilulifera Brady, 1883 Rep. Scientific Results Explor. Voyage HMS Challenger, Zool., v. 9, p. 292, pl. 30, figs. 18-20.
- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 37.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Reussella elongata (Terquem)

Reussella cf. *R. elongata* (Terquem) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 203, pl. 16, fig. 26.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 114.

Bulimina minsseni Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 194, pl. 15, fig. 17.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 108, pl. 6, fig. 11.

COMMENTS: *Bulimina minsseni* Mallory appears to be a well preserved *Reussella elongata* whereas specimens assigned to *Reussella elongata* are poorly preserved. Both species have approximately the same range and types are from the same samples.
RANGE: Both *Reussella* cf. *R. elongata* and *Bulimina minsseni* range from the Bulitian to Penutian (Mallory, 1959).
OCCURRENCE: Loma Prieta Quad. (Te_1)

Rhabdammina eocenica Cushman and Hanna

Rhabdammina eocenica Cushman and Hanna, 1927, Calif. Acad. Sci. Proc., 4th ser., v. 16, p. 209, pl. 13, fig. 3.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 104, pl. 1, figs. 1-2; pl. 27, fig. 1.

Rhabdammina sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 148, pl. 17, fig. 3 (in part).
ECOLOGY: *Rhabdammina eocenica* has an upper depth limit in the upper middle bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme, Tbs, Tsl); Pacheco Syncline (Vine Hill Sandstone)

<u>Saracenaria</u> <u>hantkeni</u> Cushman

<u>Saracenaria</u> <u>arcuata</u> <u>hantkeni</u> Cushman, 1933, Cushman Lab. Foram. Res., Contr., v. 9, p. 4, pl. 1, figs. 11-12.

OCCURRENCE: Loma Prieta Quad. (Te_1)

<u>Schenckiella</u> <u>suteri</u> Cushman and Stainforth

<u>Schenckiella</u> <u>suteri</u> Cushman and Stainforth, 1945, Cushman Lab. Foram. Res., Special Pub., no. 14, p. 19, pl. 2, fig. 26.

OCCURRENCE: Loma Prieta Quad. (Te_1)

<u>Silicosigmoilina</u> <u>californica</u> Cushman and Church

<u>Silicosigmoilina</u> <u>californica</u> Cushman and Church, 1929, Calif. Acad. Sci. Proc., 4th ser., v. 18, p. 502, pl. 36, figs. 10-12.

- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 10, pl. 1, fig. 32.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 155, pl. 19, figs. 8 and 12.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 129.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 50.
- - Almgren and others, 1988, Paleogene of the West Coast, SEPM, Pacific Section, fig. 5 (list).

COMMENTS: <u>Silicosigmoilina</u> <u>californica</u> is probably a junior synonym of <u>Rzehakina</u> <u>epigona</u> (Rzehak). Sliter (1968) seperates these species in the Cretaceous and lists several differences between the two species: <u>S</u>. <u>californica</u> is larger, less circular in outline and has sigmoidal chambers and an apertural tooth.

RANGE: The range of <u>Rzehakina</u> <u>epigona</u> is late Cretaceous (Campanian through early Eocene (P9) doubtful occurrence in middle Eocene zones P10 through P13 (van Morkhoven and others, 1983). The range of <u>Silicosigmoilina</u> <u>californica</u> given by Mallory is Ynezian through Narizian and it is most characteristic of the Paleocene. Almgren and others give range as zones D through A-2 which is equivalent to nannofossil zone CP4 through CP14 (planktic foraminiferal zones P4 through P14). Only rare or questionable occurrences of <u>S</u>. <u>californica</u> are noted in zone A-2 (P10-P14) (Almgren and others, 1988).

ECOLOGY: <u>Rzehakina</u> <u>epigona</u> is common in bathyal and abyssal environments (van Morkhoven and others, 1986).

OCCURRENCE: Loma Prieta Quad. (?Ku_1, Te_1, Te_2, Tme, Tbs); Pacheco Syncline (Vine Hill Sandstone and Las Juntas)

Spiroloculina texana Cushman and Ellisor

Spiroloculina texana Cushman and Ellisor, 1944, Cushman Lab. Foram. Res., Contr., v. 20, p. 51, pl. 8, figs. 14-15.

Spiroloculina sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 9, pl. 1, fig. 24.

OCCURRENCE: Loma Prieta Quad. (Tei, Tme)

Spiroplectammina directa (Cushman and Siegfus)

Spiroplectoides directa Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 15, p. 26, pl. 6, figs. 7-8.

Spiroplectammina directa (Cushman and Siegfus) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 116, pl. 3, fig. 5a-b.

Spiroplectammina sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 7, pl. 1, figs. 14, 15, 16.

RANGE: Mallory (1959) lists this species as occurring in the Ulatisian and Narizian Stages. This species has, however, been found in early Eocene assemblages in association with calcareous nannofossil assemblages which are diagnostic of Zone CP11 (early Eocene) (McDougall and Bukry, unpublished data, 1988).

OCCURRENCE: Loma Prieta Quad. (Tei, Tme, Tsl)

Spiroplectammina richardi Martin

Spiroplectammina richardi Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 14, pl. 5, fig. 3a-b.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 118, pl. 3, fig. 9; pl. 27, fig. 5.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 38.

Spiroplectammina? cf. S. richardi Martin - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 118, pl. 3, fig. 10.

Spiroplectammina adamsi Lalicker - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 7, pl. 1, fig. 13.

Spiroplectammina gryzbowski Frizzel - - Almgren and others, 1988, Paleogene of the West Coast, SEPM, Pacific Section, fig. 5 (list).

Textularia mississippiensis (Cushman) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 151-152, pl. 18, figs. 1-3.

COMMENTS: Spiroplectammina? cf. S. richardi of Mallory (1959) is from the lower Point of Rocks in the Media Agua Creek Section. This form is a variation of the type; additional specimens have been identified from lower in the Lodo Formation at Media Agua Creek (Cox material).

RANGE: Mallory (1959) gives range as lower Bulitian through lower Narizian. Almgren and others (1988) give the range as zones E through A-2 which is equivalent to nannofossil zones

CP4 through CP14 (planktic foraminiferal zones P4 through P14).
ECOLOGY: Spiroplectammina richardi has an upper depth limit in the outer shelf biofacies, 50-150 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir, Alhambra)

Spiroplectammina tejonensis Mallory

Spiroplectammina tejonensis Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 118, pl. 3, fig. 6-8.
RANGE: Mallory (1959) gives range as upper Ulatisian through upper Narizian.
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme, Tsl)

Stilostomella advena (Cushman and Siegfus)

Nodosarella advena Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 15, p. 30, pl. 6, figs. 19, 20.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 220, pl. 18, fig. 22a-b; pl. 29, fig. 12a-b.
RANGE: Mallory (1959) gives range as lower Ulatisian through lower Narizian.
ECOLOGY: Stilostomella advena has an upper depth limit in the lower middle bathyal biofacies, 1500-200 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1)

Stilostomella gracilis (Palmer and Bermudez)

Ellipsonodosaria gracilis Palmer and Bermudez, 1936, Soc. Cubana Hist. Nat. Mem., v. 10, p. 296, pl. 18, figs. 18-19.
OCCURRENCE: Loma Prieta Quad. (Te_1 cf.)

Stilostomella lepidula (Schwager)

Nodosaria lepidula Schwager, 1866, Wien Osterreich, Geol. Theil., Bd. 2, Abt. 2, p. 210, pl. 5, figs. 27-28.
Nodogenerina lepidula (Schwager) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 217, pl. 18, fig. 10.
RANGE: Mallory (1959) gives range as upper Ulatisian through upper Narizian.
ECOLOGY: Stilostomella lepidula has an upper depth limit in the lower middle bathyal biofacies, 1500-2000 m (Ingle, 1980).
OCCURRENCE: Loma Prieta Quad. (Te_1)

Textularia adalta Cushman

Textularia adalta Cushman, 1926, Cushman Lab. Foram. Res., Contr., v. 2, p. 29, pl. 4, fig. 2.

Textularia cf. T. adalta Cushman - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 51, pl. 18, fig. 5.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 119.
Karreriella chilostoma (Reuss) - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 9, pl. 1, fig. 27.

RANGE: Mallory (1959) gives range as lower Ynezian through lower Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Tritaxilina colei Cushman and Siegfus

Tritaxilina colei Cushman and Siegfus, 1935, Cushman Lab. Foram. Res., Contr., v. 11, p. 92, pl. 14, figs. 5-6.
- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 10, pl. 1, figs. 30, 31.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 128, pl. 27, fig. 9a-b.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Trochammina globigeriniformis (Parker and Jones)

Lituola globigeriniformis Parker and Jones, 1865, R. Soc. London Philos. Trans., v. 155, p. 407, pl. 15, figs. 46-47.
Trochammina globigeriniformis (Parker and Jones) - - McDougall, 1980, p. 38.
Trochammina cf. T. globigeriniformis (Parker and Jones) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 156, pl. 19, fig. 14-16.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 133, pl. 5, fig. 16.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 51.
?Trochammina sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 10, pl. 1, figs. 33, 34.

OCCURRENCE: Loma Prieta Quad. (Te_1, Te_2; Tsl)

Trochamminoides contortus Mallory

Trochamminoides contortus Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 110, pl. 2, fig. 1a-b.

RANGE: Mallory (1959) gives range as upper Bulitian through lower Narizian with questionable occurrences in the upper Ynezian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Uvigerina atwilli Cushman and Simonson

Uvigerina atwilli Cushman and Simonson, 1944, Jour. Paleo., v. 18, p. 200, pl. 33, figs. 2-4.

COMMENTS: Uvigerina atwilli is closely related to and probably conspecific with U. glabrans. Both species are large, smooth, and have remnant costae on the initial chambers. The costae on Uvigerina atwilli are less well developed (Boersma, 1984, p. 65-66).

RANGE: Boersma (1984) finds U. glabrans occurring from the late Eocene (P15) into early Oligocene (P18).

ECOLOGY: Uvigerina glabrans is common at upper bathyal depths in carbonate rich foraminieral sands. Alng the Pacific Margin Uvigerina atwilli occurs most freguently in association with outer shel and upper bathyal assemblages (McDougall, 1980).

OCCURRENCE: Loma Prieta Quad. (Tsl)

Uvigerina lodoensis miriamae Mallory

Uvigerina lodoensis miriamae Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 209, pl. 17, figs. 8-9; not pl 40, fig. 9.

Uvigerina spp. Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 179, pl. 25, fig. 10, not pl. 26, fig. 3.

COMMENTS: Boersma (1984) suggest that U. lodoensis Mallory is conspecific with U. elongata Cole representing the completely triserial form of this species. She notes that U. lodoensis does have a compressed final chamber which is not found in U. elongata.

RANGE: Mallory (1957) lists range as Penutian and Ulatisian. Specimens occur in the Penutian of Media Agua Creek (Cox sample BT-142-2; Mallory, 1959, pl. 17, figs. 8, 9), and the Pacheco Syncline (A6662, pl. 25, figs. 10 and 12 of Smith, 1957). The "Poppin Shale" sample (DDM-14-89, McDougall, unpublished data, 1989) is early Ulatisian (CP12a, Bukry, unpublished data, 1989). The Ulatisian specimen figured by Mallory (1959, pl. 40, fig. 9) has convolute sutures and does not appear to be as triangular in outline as the Penutian specimens. Smith (1957) included several species under Uvigerina spp. and thus the specimens from the Muir Sandstone may not belong to this species. Other Ulatisian occurrences given by Mallory have not be confirmed.

The range of U. elongata is P9 through P20 (Boersma, 1984). This range is much broader than the occurrences of U. lodoensis documented in California.

ECOLOGY: Boersma (1984) finds U. elongata in shallow shelf depth sediments, frequently in warmer regions and associated with glauconite.

OCCURRENCE: Loma Prieta Quad. (Te1); Pacheco Syncline (Las Juntas)

Vaginulinopsis asperuliformis (Nuttall)

Cristellaria asperuliformis Nuttall, 1930, Jour. Paleo., v. 4, p. 282, pl. 23, figs. 9, 10.

Vaginulinopsis asperuliformis (Nuttall) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 155, pl. 27, fig. 20a-b.

- - Almgren and others, 1988, Paleogene of the West Coast, SEPM, Pacific Section, fig. 5 (list).

RANGE: Mallory (1959) gives range as upper Bulitian through lower Narizian. Almgren and others (1988) give range as zone C through A-2 (rare) which correspond to nannofossil zones CP9 through CP14 (planktic foraminiferal zones P6b-P14).

ECOLOGY: Vaginulinopsis asperuliformis has an upper depth limit in the outer shelf biofacies, 50-150 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Vaginulinopsis saundersi (Hanna and Hanna)

Cristellaria saundersi Hanna and Hanna, 1924, Univ. Washington Pub. Geol. Sci., v. 1, p. 61, pl. 13, figs. 5, 6, 15.

Vaginulinopsis mexicana var. C of Laiming - - Almgren and others, 1988, Paleogene of the West Coast, SEPM, PAcific Section, fig. 5 (list).

Vaginulinopsis saundersi (Hanna and Hanna) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 162, pl. 22, figs. 1-2.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 157, pl. 11, fig. 10.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 74, pl. 4, fig. 13.

RANGE: Almgren and others (1988) give range as zones B-4 through B-2 which is equivalent to nannofossil zones CP10 through CP11 (planktic foraminiferal zones late P7-P9).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Valvulineria childsi (Martin)

Gyroidina childsi Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 22, pl. 6, fig. 6a-c.

Valvulineria childsi (Martin)- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 230, pl. 20, fig. 9a-c.

RANGE: Mallory (1959) gives range as lower Penutian through lower Ulatisian, with rare occurrences in the upper Ynezian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Verneuilina triangulata Cook

Verneuilina triangulata Cook in Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 120, pl. 4, fig. 1a-c; pl. 33, fig. 1a-b.

RANGE: Mallory (1959) gives range as lower Penutian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Vulvulina curta Cushman and Siegfus

Vulvulina curta Cushman and Siegfus, 1935, Cushman Lab. Foram. REs., Contr., v. 11, p. 91, pl. 14, figs. 1, 2.

- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 8, pl. 1, fig. 19.

RANGE: Mallory (1959) gives range as upper Ynezian through upper Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1, Te_2)

Figures

(Blow, 1969; Berggren, 1972; Okada and Bukry, 1980). Modified from Poore (1976).

Figure 5 Modified Mallory stages, emended Laiming zones, and key benthic foraminiferal species of Almgren and others (1988) plotted against the planktic foraminiferal and calcareous nannofossil zones (Blow, 1969; Berggren, 1972; Okada and Bukry, 1980). Some species names used by Almgren and others (1988) have been changed to conform with taxonomic nomenclature used in this paper (see Appendix II). Ranges of species from Almgren and others (1988) are indicated by dotted pattern enclosed in bar; range of cosmopolitan deep-water species not recognized by Almgren and others (1988) in heavily dotted pattern enclosed in bar; and range of cosmopolitan deep-water species used by Almgren and others (1988) but not recognized worldwide is shown by dotted pattern not enclosed in bar. An asterisk (*) indicates cosmopolitan deep-water benthic foraminieral species.

Figure 6 Lower Media Agua Creek Section. The distribution of age diagnostic benthic foraminiferal species from the Media Agua Creek Section are shown. The benthic foraminiferal zonations of Mallory (1959, 1970), Almgren and others (1988), McDougall (1988) in the Media Agua Creek Section are compared. Also shown are the planktic microfossil zonal assignments of Poore (1976).

Figure 7 Correlation of Eocene strata in selected sections throughout California. Correlation of these sections is based on nannofossils. Distribution of the benthic foraminiferal stages as recognized by McDougall (1988) is shown by the patterns. Nannofossil age interpretations follow Poore (1976) with some additional data provided by Bukry (unpublished data, 1988).

Figure 8 Ranges of cosmopolitan deep-water species plotted against the planktic chronologies (Blow, 1969; Berggren, 1972; Okada and Bukry, 1980). The placement of the Mallory stages as modified by McDougall (1988) is also shown.

Figure 9 Ranges of selected California benthic foraminiferal species which are useful in recognition of the benthic foraminiferal stages as modified by McDougall (1988) are plotted against the planktic chronologies (Blow, 1969; Berggren, 1972; Okada and Bukry, 1980).

Figure 10 Comparision of the benthic foraminiferal stages and zones as modified by Almgren and others (1988) with the stages as modified by McDougall (1988). The benthic foraminiferal stages and zones are plotted against the planktic chronologies (Blow, 1969; Berggren, 1972;

Okada and Bukry, 1980) and the coastal onlap curve of Haq and others (1987).

Figure 11 Location of selected California sections containing benthic foraminiferal faunas coeval with the faunas observed in the Loma Prieta Quadrangle (section 1).

Figure 12 Late Paleocene and early Eocene bathymetric history of Lodo Gulch, Devils Den and the Loma Prieta areas. Bathymetric interpretations of the Lodo Gulch and Devils Den areas are from Berggren and Aubert (1983).

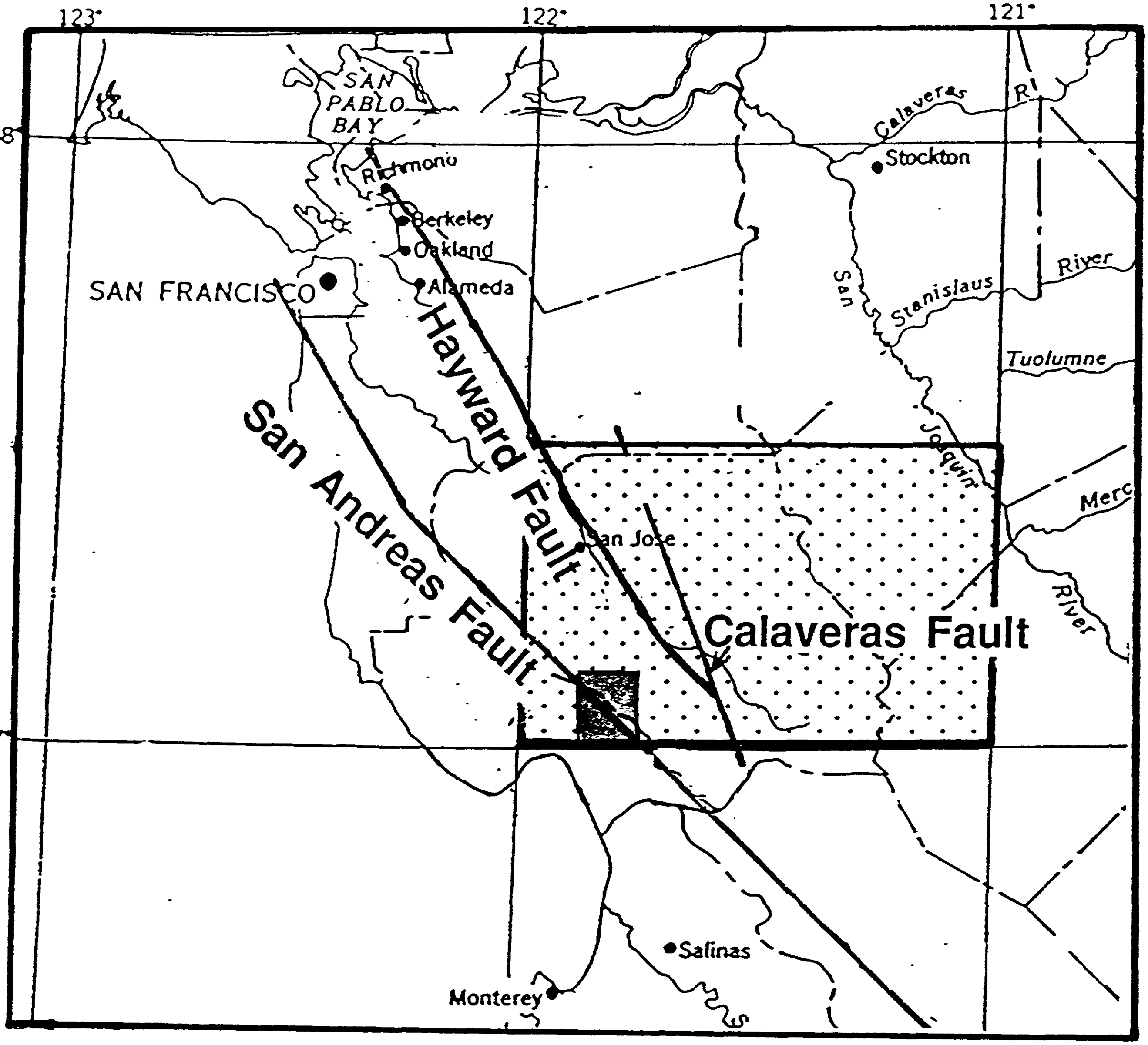
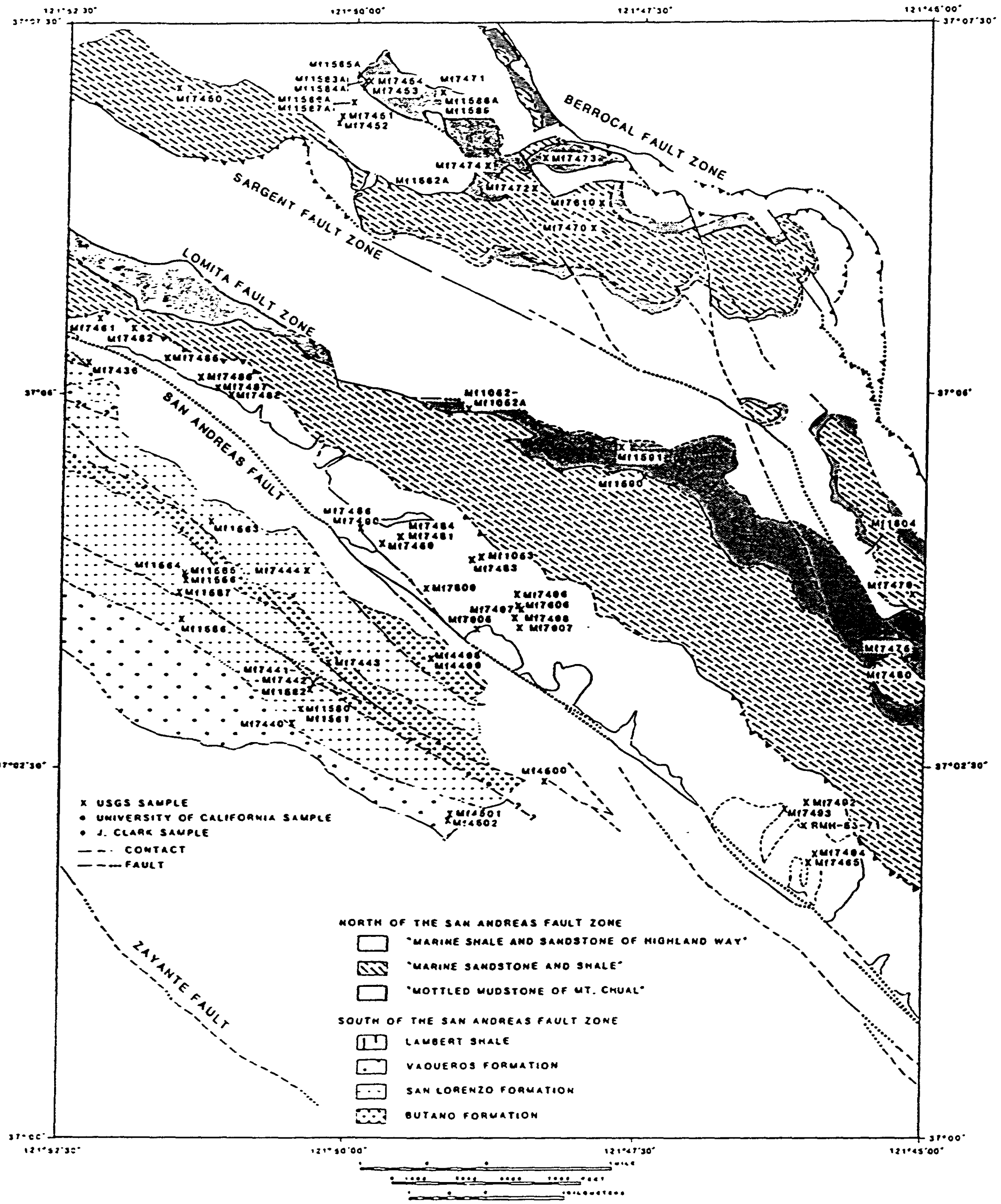
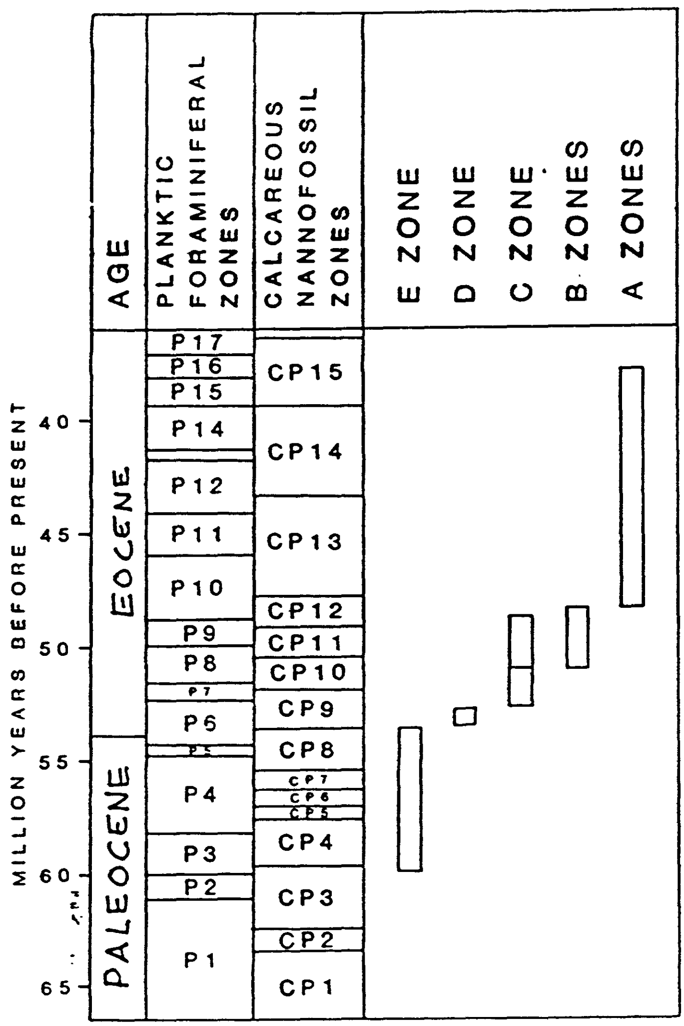

123°
122°
121°
38°
37°
SAN PABLO BAY
Richmond
Berkeley
Oakland
Alameda
SAN FRANCISCO
Stockton
Calaveras R.
San
Stanislaus
River
Tuolumne
Joaquin
Merc
River
San Jose
Hayward Fault
San Andreas Fault
Calaveras Fault
Salinas
Monterey

FIG 1



MADE FROM BEST AVAILABLE COPY

FIG 2



AGE
PLANKTIC FORAMINIFERAL ZONES
CALCAREOUS NANNOFOSSIL ZONES
E ZONE
D ZONE
C ZONE
B ZONES
A ZONES
MILLION YEARS BEFORE PRESENT
40
45
50
55
60
65
EOCENE
PALEOCENE
P17
P16
P15
P14
P12
P11
P10
P9
P8
P7
P6
P4
P3
P2
P1
CP15
CP14
CP13
CP12
CP11
CP10
CP9
CP8
CP7
CP6
CP5
CP4
CP3
CP2
CP1

FIG. 3

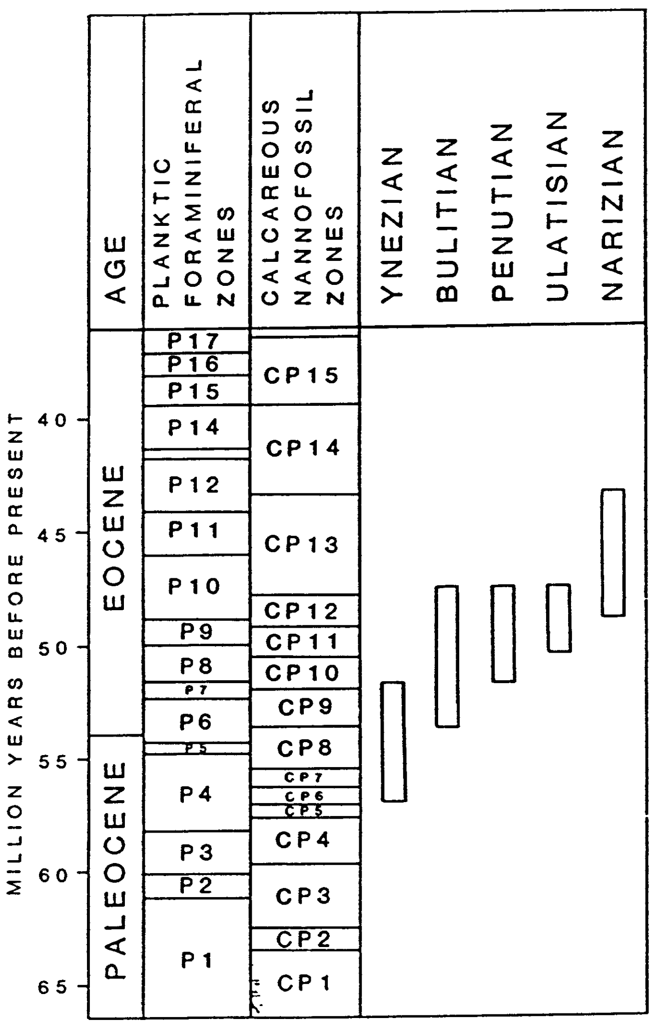
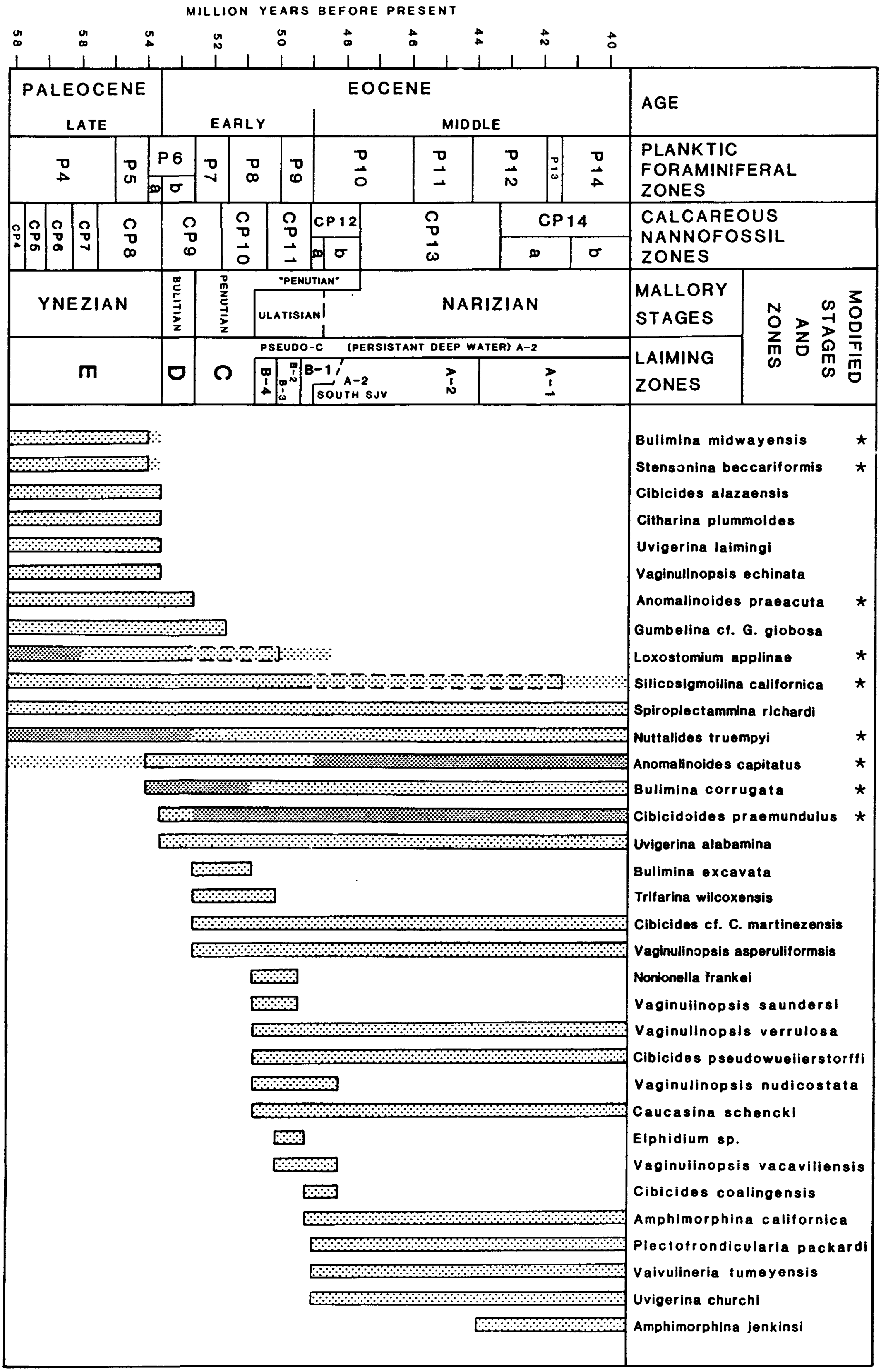
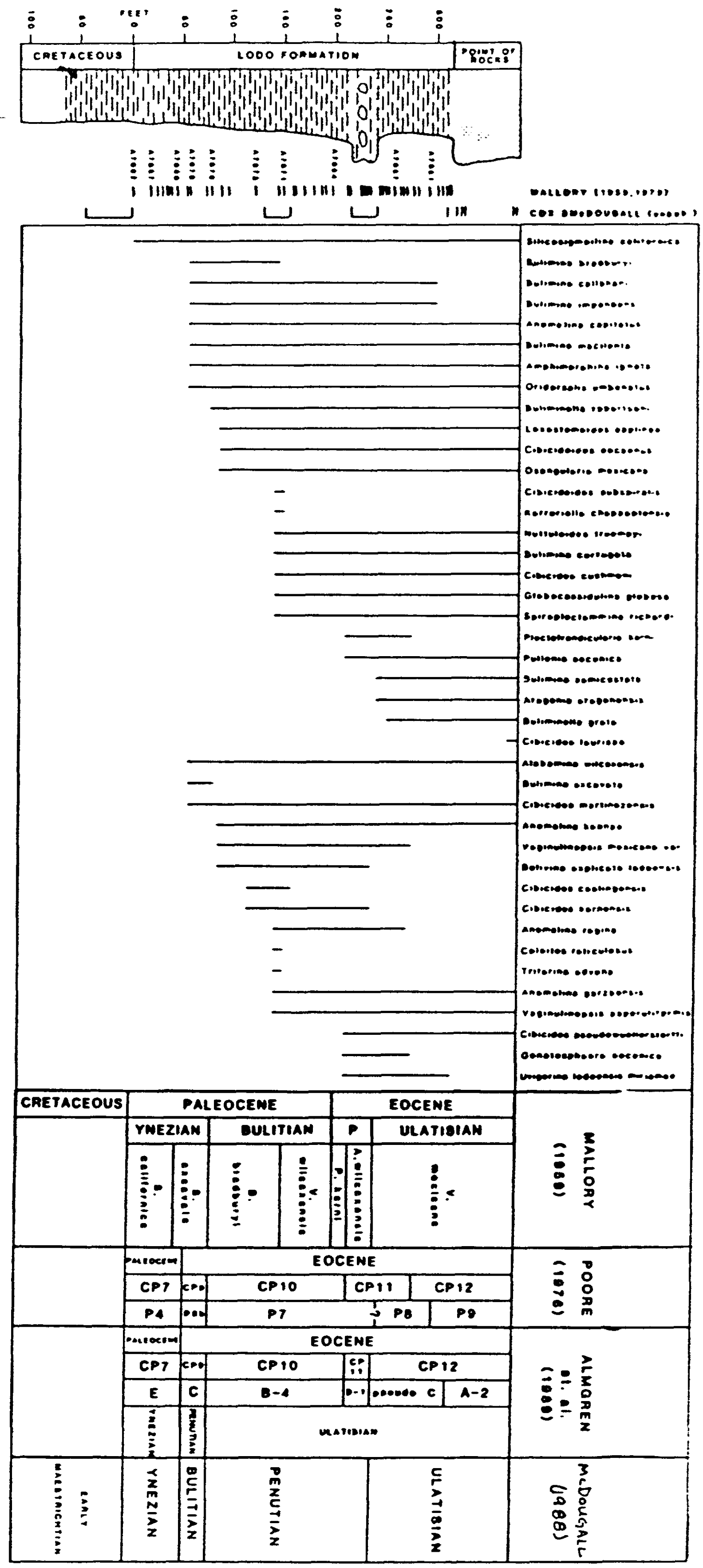

AGE
PLANKTIC FORAMINIFERAL ZONES
CALCAREOUS NANNOFOSSIL ZONES
YNEZIAN
BULITIAN
PENUTIAN
ULATISIAN
NARIZIAN
MILLION YEARS BEFORE PRESENT
40
45
50
55
60
65
EOCENE
PALEOCENE
P17
P16
P15
P14
P12
P11
P10
P9
P8
P7
P6
P5
P4
P3
P2
P1
CP15
CP14
CP13
CP12
CP11
CP10
CP9
CP8
CP7
CP6
CP5
CP4
CP3
CP2
CP1

FIG 4


MILLION YEARS BEFORE PRESENT
PALEOCENE
EOCENE
LATE
EARLY
MIDDLE
AGE
PLANKTIC FORAMINIFERAL ZONES
CALCAREOUS NANNOFOSSIL ZONES
YNEZIAN
BULITIAN
PENUTIAN
"PENUTIAN"
ULATISIAN
NARIZIAN
MALLORY STAGES
PSEUDO-C (PERSISTANT DEEP WATER) A-2
SOUTH SJV
LAIMING ZONES
MODIFIED STAGES AND ZONES
Bulimina midwayensis *
Stensonina beccariformis *
Cibicides alazaensis
Citharina plummoides
Uvigerina laimingi
Vaginulinopsis echinata
Anomalinoides praeacuta *
Gumbelina cf. G. globosa
Loxostomium applinae *
Silicosigmoilina californica *
Spiroplectammina richardi
Nuttalides truempyi *
Anomalinoides capitatus *
Bulimina corrugata *
Cibicidoides praemundulus *
Uvigerina alabamina
Bulimina excavata
Trifarina wilcoxensis
Cibicides cf. C. martinezensis
Vaginulinopsis asperuliformis
Nonionella frankei
Vaginulinopsis saundersi
Vaginulinopsis verrulosa
Cibicides pseudowuellerstorffi
Vaginulinopsis nudicostata
Caucasina schencki
Elphidium sp.
Vaginulinopsis vacavillensis
Cibicides coalingensis
Amphimorphina californica
Plectofrondicularia packardi
Valvulineria tumeyensis
Uvigerina churchi
Amphimorphina jenkinsi

95

Fig. 5



FEET
CRETACEOUS
LODO FORMATION
POINT OF ROCKS
CRETACEOUS
PALEOCENE
EOCENE
YNEZIAN
BULITIAN
P
ULATISIAN
MALLORY (1959)
PALEOCENE
EOCENE
CP7
CP10
CP11
CP12
P4
P7
P8
P9
POORE (1976)
CP7
CP10
CP12
E
C
B-4
A-2
ULATISIAN
ALMGREN et. al. (1988)
EARLY MAESTRICHTIAN
YNEZIAN
BULITIAN
PENUTIAN
ULATISIAN
McDOUGALL (1988)

Fig. 6

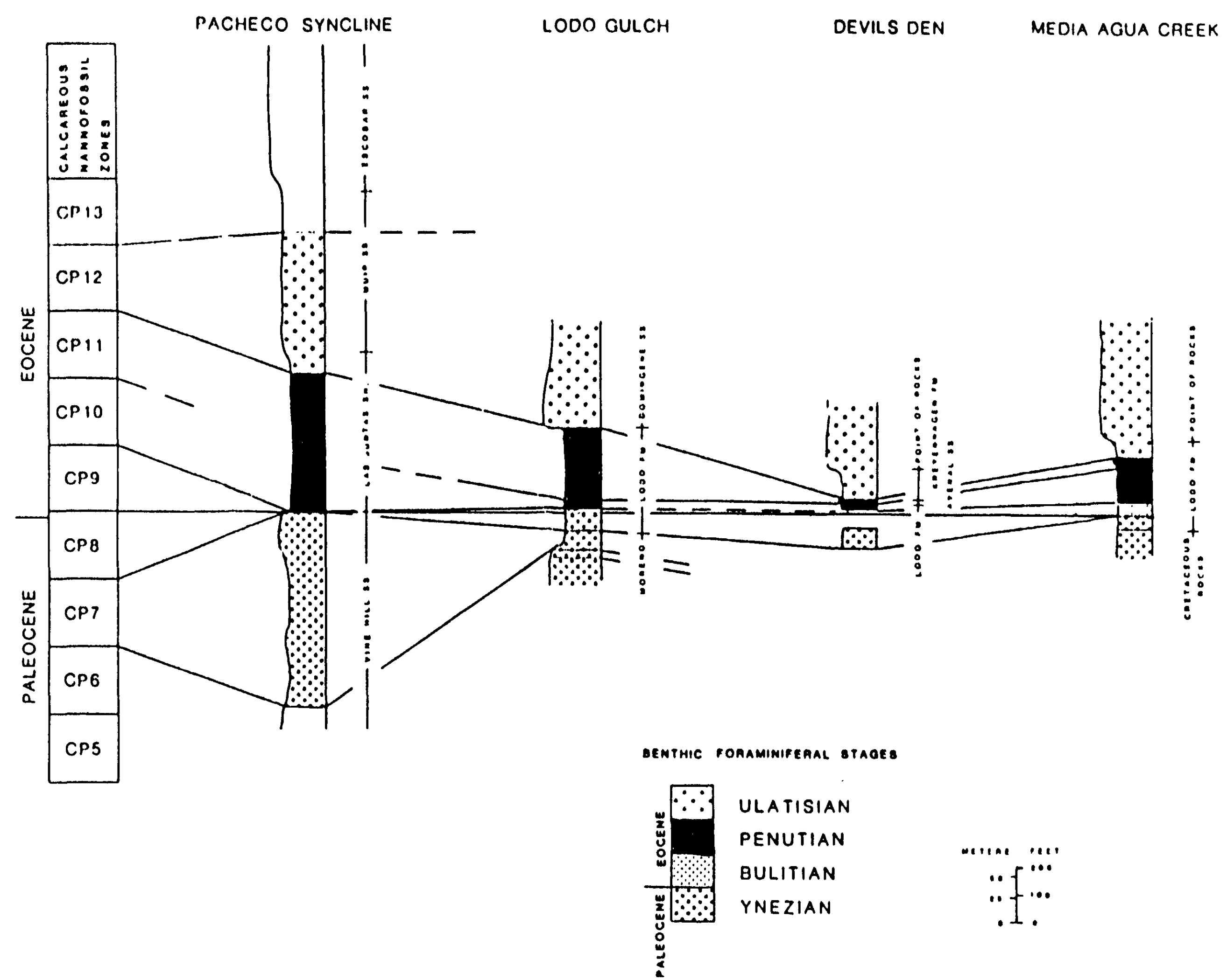
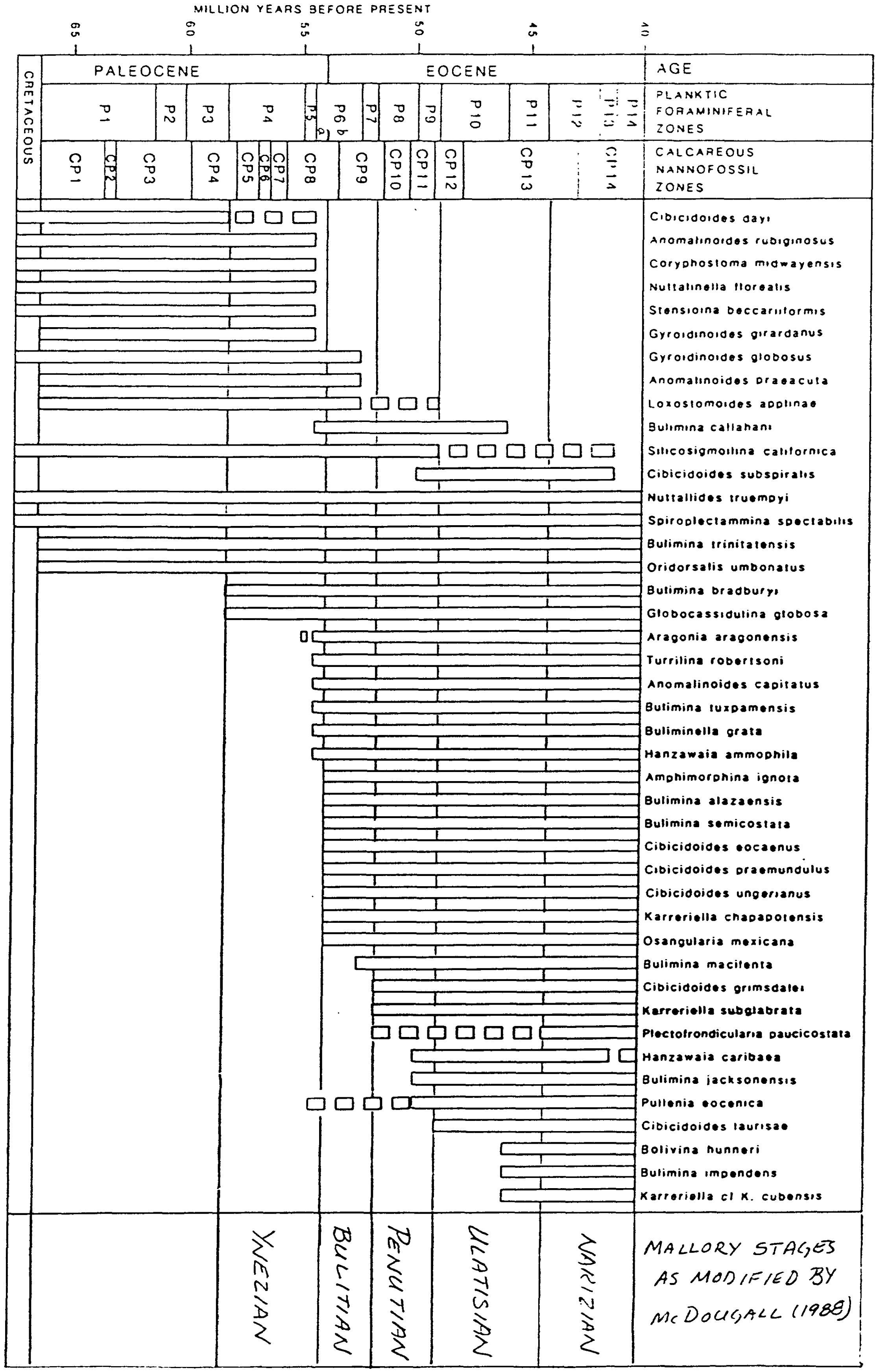

PACHECO SYNCLINE
LODO GULCH
DEVILS DEN
MEDIA AGUA CREEK
CALCAREOUS NANNOFOSSIL ZONES
CP13
CP12
CP11
CP10
CP9
CP8
CP7
CP6
CP5
EOCENE
PALEOCENE
BENTHIC FORAMINIFERAL STAGES
ULATISIAN
PENUTIAN
BULITIAN
YNEZIAN

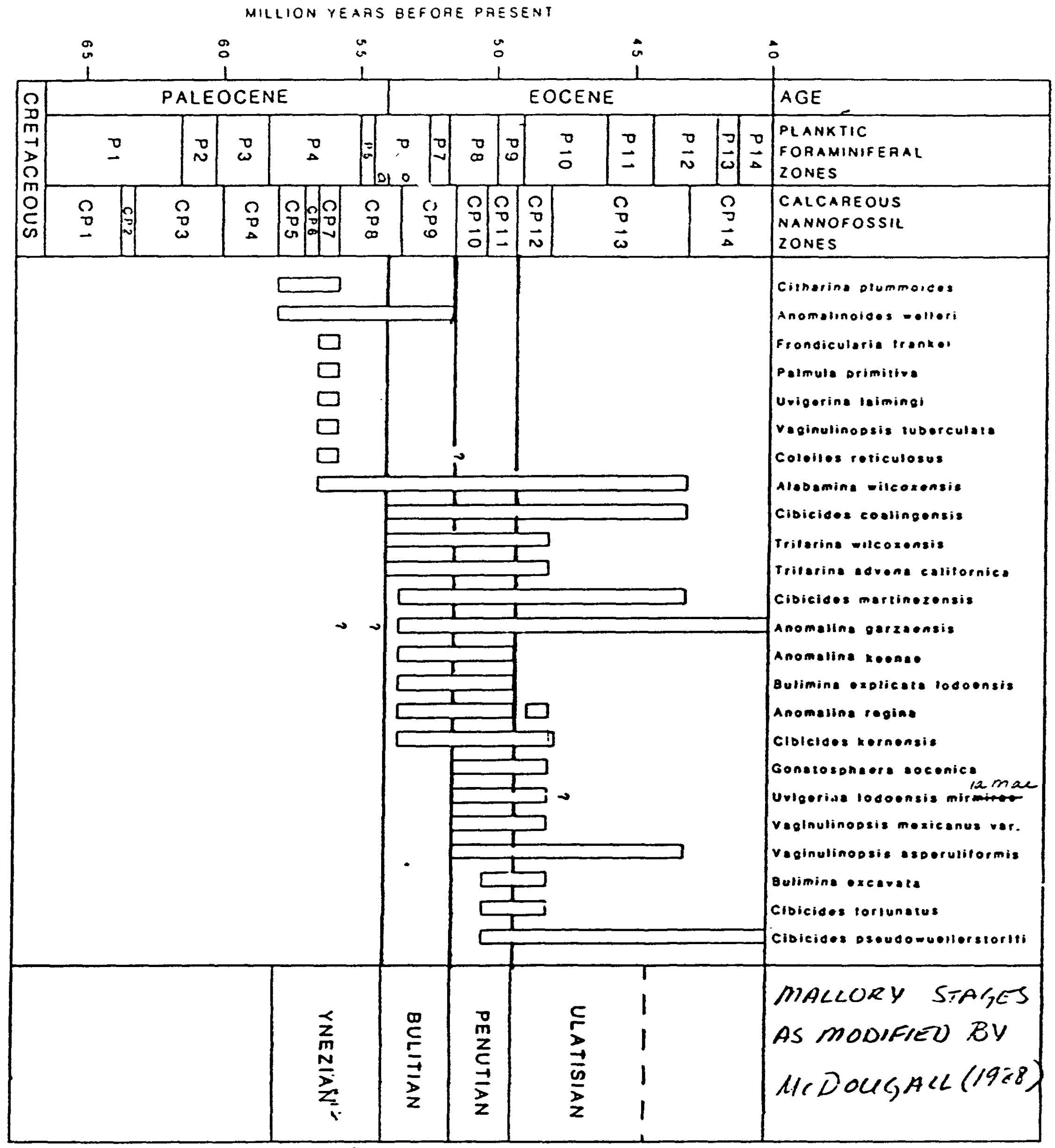
Fig. 7

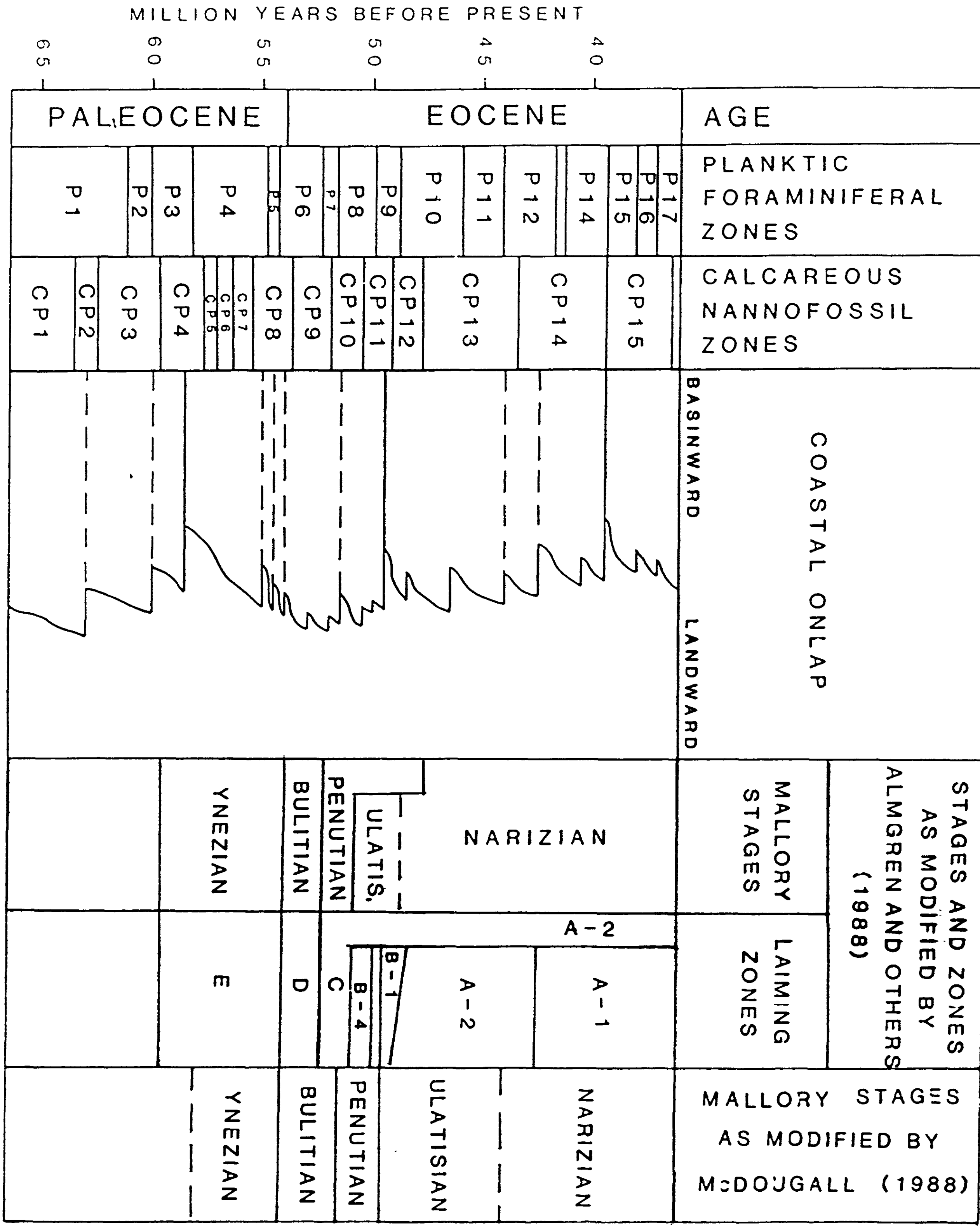
97


MILLION YEARS BEFORE PRESENT
65
60
55
50
45
40
CRETACEOUS
PALEOCENE
EOCENE
AGE
PLANKTIC FORAMINIFERAL ZONES
P1
P2
P3
P4
P5
P6 a b
P7
P8
P9
P10
P11
P12
P13
P14
CALCAREOUS NANNOFOSSIL ZONES
CP1
CP2
CP3
CP4
CP5
CP6
CP7
CP8
CP9
CP10
CP11
CP12
CP13
CP14
Cibicidoides dayi
Anomalinoides rubiginosus
Coryphostoma midwayensis
Nuttalinella florealis
Stensioina beccariiformis
Gyroidinoides girardanus
Gyroidinoides globosus
Anomalinoides praeacuta
Loxostomoides applinae
Bulimina callahani
Silicosigmoilina californica
Cibicidoides subspiralis
Nuttallides truempyi
Spiroplectammina spectabilis
Bulimina trinitatensis
Oridorsalis umbonatus
Bulimina bradburyi
Globocassidulina globosa
Aragonia aragonensis
Turrilina robertsoni
Anomalinoides capitatus
Bulimina tuxpamensis
Buliminella grata
Hanzawaia ammophila
Amphimorphina ignota
Bulimina alazaensis
Bulimina semicostata
Cibicidoides eocaenus
Cibicidoides praemundulus
Cibicidoides ungerianus
Karreriella chapapotensis
Osangularia mexicana
Bulimina macilenta
Cibicidoides grimsdalei
Karreriella subglabrata
Plectofrondicularia paucicostata
Hanzawaia caribaea
Bulimina jacksonensis
Pullenia eocenica
Cibicidoides laurisae
Bolivina hunneri
Bulimina impendens
Karreriella cf K. cubensis
YNEZIAN
BULITIAN
PENUTIAN
ULATISIAN
NARIZIAN
MALLORY STAGES AS MODIFIED BY McDOUGALL (1988)

98

Fig 8


MILLION YEARS BEFORE PRESENT
65
60
55
50
45
40
CRETACEOUS
PALEOCENE
EOCENE
AGE
P1
P2
P3
P4
P5
P6 a
P6 b
P7
P8
P9
P10
P11
P12
P13
P14
PLANKTIC FORAMINIFERAL ZONES
CP1
CP2
CP3
CP4
CP5
CP6
CP7
CP8
CP9
CP10
CP11
CP12
CP13
CP14
CALCAREOUS NANNOFOSSIL ZONES
Citharina plummoides
Anomalinoides welleri
Frondicularia frankei
Palmula primitiva
Uvigerina laimingi
Vaginulinopsis tuberculata
Coleites reticulosus
Alabamina wilcoxensis
Cibicides coalingensis
Trifarina wilcoxensis
Trifarina advena californica
Cibicides martinezensis
Anomalina garzaensis
Anomalina keenae
Bulimina explicata lodoensis
Anomalina regina
Cibicides kernensis
Gonatosphaera eocenica
Uvigerina lodoensis mirlamae
Vaginulinopsis mexicanus var.
Vaginulinopsis asperuliformis
Bulimina excavata
Cibicides fortunatus
Cibicides pseudowuellerstorfi
YNEZIAN
BULITIAN
PENUTIAN
ULATISIAN
MALLORY STAGES AS MODIFIED BY McDOUGALL (1978)


MILLION YEARS BEFORE PRESENT
65
60
55
50
45
40
PALEOCENE
EOCENE
AGE
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P14
P15
P16
P17
PLANKTIC FORAMINIFERAL ZONES
CP1
CP2
CP3
CP4
CP5
CP6
CP7
CP8
CP9
CP10
CP11
CP12
CP13
CP14
CP15
CALCAREOUS NANNOFOSSIL ZONES
BASINWARD
LANDWARD
COASTAL ONLAP
YNEZIAN
BULITIAN
PENUTIAN
ULATIS.
NARIZIAN
MALLORY STAGES
E
D
C
B-4
B-1
A-2
A-2
A-1
LAIMING ZONES
STAGES AND ZONES AS MODIFIED BY ALMGREN AND OTHERS (1988)
YNEZIAN
BULITIAN
PENUTIAN
ULATISIAN
NARIZIAN
MALLORY STAGES AS MODIFIED BY McDOUGALL (1988)

100 Fig. 1C

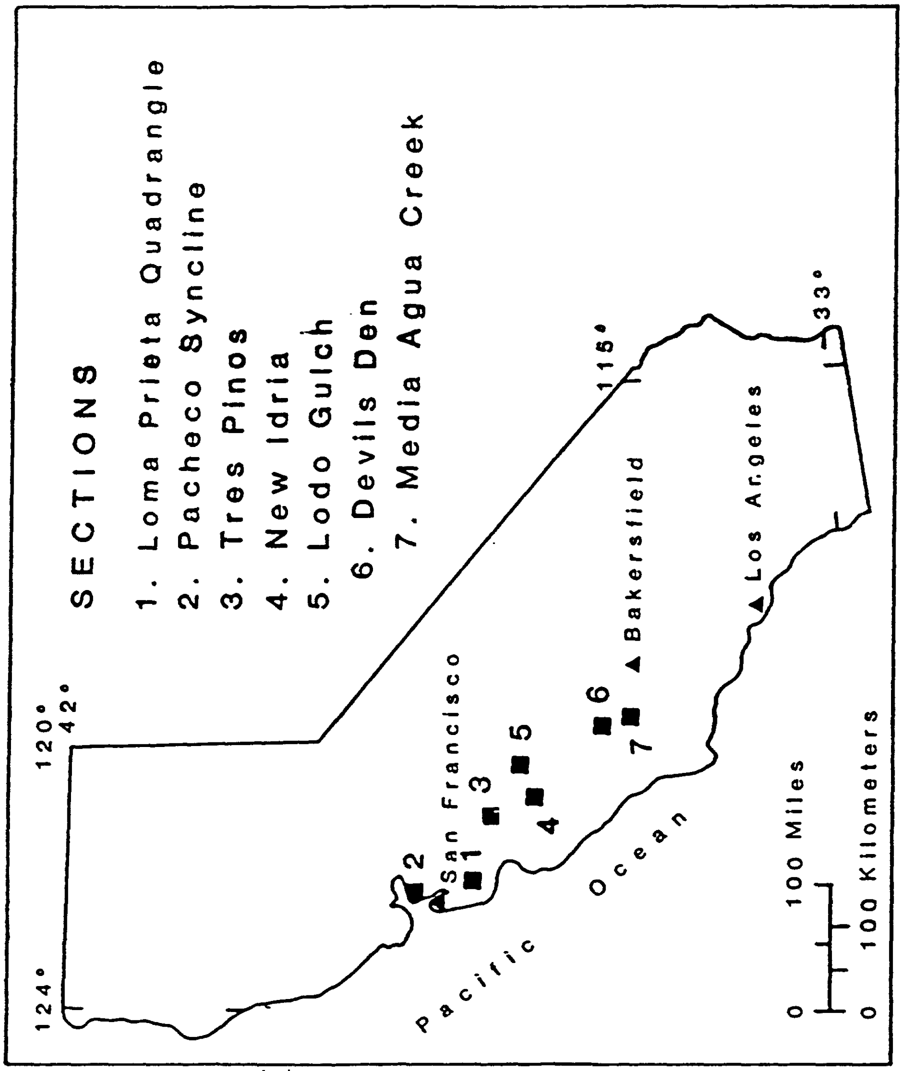

SECTIONS
1. Loma Prieta Quadrangle
2. Pacheco Syncline
3. Tres Pinos
4. New Idria
5. Lodo Gulch
6. Devils Den
7. Media Agua Creek
124°
120°
42°
115°
33°
San Francisco
Bakersfield
Los Angeles
Pacific Ocean
1
2
3
4
5
6
7
0 100 Miles
0 100 Kilometers

FIG. 11

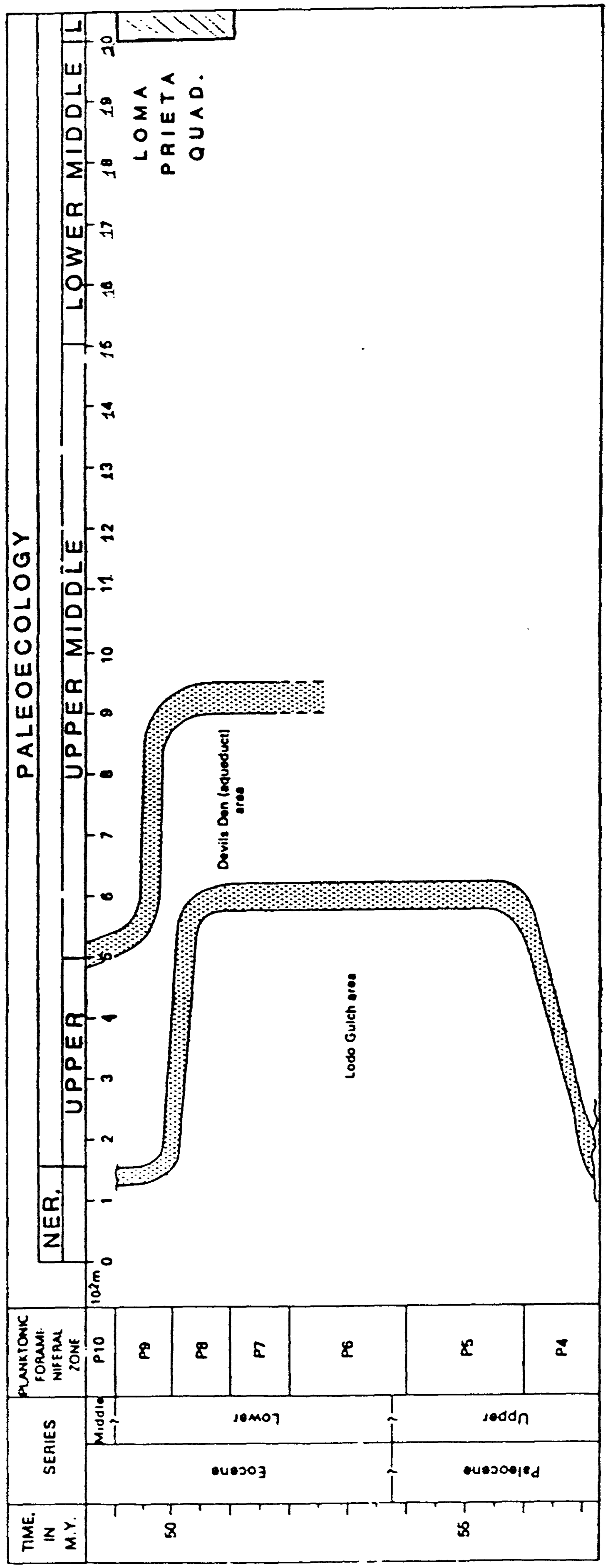

PALEOECOLOGY
NER.
UPPER
UPPER MIDDLE
LOWER MIDDLE
L
LOMA PRIETA QUAD.
Devils Den (aqueduct) area
Lodo Gulch area
10²m
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
TIME, IN M.Y.
50
55
SERIES
Eocene
Paleocene
Middle
Lower
Upper
PLANKTONIC FORAMI-NIFERAL ZONE
P10
P9
P8
P7
P6
P5
P4

FIG 12

TABLES

Table 1

Benthic foraminifers from the Butano Sandtone, (Tbs), Loma Prieta Quadrangle

SPECIES \ SAMPLES	Mf4498	Mf4499	Mf7443
Allomorphina cf. A. macrostoma	X	.	.
Bathysiphon eocenicus	X	X	.
Bathysiphon sp. (coarse)	X	.	.
Chilostomella oolina	X	.	.
Cyclammina pacifica	.	.	X
Globocassidulina globosa	X	.	.
Haplophragmoides eggeri	X	.	.
Hyperammina elongata	X	.	.
Lenticulina spp.	.	X	.
Rhabdammina eocenica	X	X	.
Silicosigmoilina californica	X	.	.
Unidentified arenaceous fragments	X	X	X

Table 2
Benthic foraminifers from the San Lorenzo Formation, (Tsl), Loma Prieta Quadrangle

SPECIES \ SAMPLES	Buzzard Lagoon Road	Aptos Creek Section					
	Mf1582	Mf1588	Mf1587	Mf1586	Mf1585	Mf1584	Mf1583
Allomorphina trigonia	X	.	.	.	.	.	.
Ammobaculites sp. of Smith	X	.	.	.	.	.	.
Bathysiphon eocenicus	X	.	.	.	.	.	.
Bathysiphon spp.	.	X	.	.	.	.	X
Boldia hodgei	.	.	.	X	.	.	.
Bolivina marginata	.	.	.	.	.	X	X
Budashaevella multicamerata	X	.	.	X	.	.	.
Bulimina carnerosensis	.	.	.	.	.	.	X
Bulimina or Buliminella spp.	.	.	.	.	.	X	.
Bulimina or Globobulimina spp.	.	.	.	.	.	X	.
Chilostomella oolina	X	.	.	.	.	.	.
Cibicides elmaensis	.	.	.	X	.	.	.
Cibicides haydoni	.	.	.	X	.	.	.
Cibicides spp.	.	.	.	.	.	.	X
Cyclammina incisa	.	.	.	.	.	.	X
Cyclammina pacifica	.	.	X	X	.	.	.
Eggerella elongata	X	X	.	.	.	.	.
Eggerella subconica	X	X	.	.	.	.	.
Fursenkoina bramletti	cf	cf	.	.	.	.	.
Globobulimina pacifica	X	.	.	.	.	.	.
Gyroidina soldanii	.	.	X	X	.	.	X
Gyroidina spp.	.	.	.	.	.	X	.
Haplophragmoides deflata	X	X	.	.	.	.	.
Haplophragmoides spp.	X	.	X	X	X	.	.
Lenticulina spp.	.	.	X	X	X	X	X
Marginulina exima	X	.	.	.	.	.	.
Martinotiella eocenica	cf	.	.	.	.	.	.
Nodosaria gyrata	cf	.	.	.	.	.	.
Plectina garzaensis	X	.	.	.	.	.	.
Plectofrondicularia miocenica	.	.	.	.	.	.	cf
Plectofrondicularia packardi	.	.	.	X	.	.	X
Plectofrondicularia vokesi	.	.	.	X	.	.	.
Pseudonodosaria inflata	X	.	.	.	.	.	.
Quinqueloculina minuta	.	.	X	.	.	.	.
Reophax spp.	X	.	.	.	.	.	.
Rhabdammina eocenica	X	.	.	.	.	.	.
Spiroplectammina directa	X	.	.	.	.	.	.
Spiroplectammina tejonenesis	X	.	.	.	.	.	.
Trochammina globigeriniformis	X	.	.	.	.	.	.
Trochammina spp.	X	.	.	.	.	.	.
Uvigerina atwilli	.	.	.	X	.	.	.
Uvigerina spp.	X	.	.	.	.	.	.

Table 3
Benthic foraminifers from the
"Cretaceous Shale", (?Ku1), near Mt. Chual

SPECIES \ SAMPLES	Mf1586A	Mf1587A
Bathysiphon santecruis	X	X
Dorothia bulletta	X	X
Haplophragmoides eggeri	X	X
Marssonella oxycona	X	cf
Silicosigmoilina californica	X	X
Spiroplectammina directa	X	X

Table 4 (continued)

SPECIES \ SAMPLES	Mf1583A	Mf1584A	Mf1585A	Mf1588A	Mf1589	Mf7453	Mf7454	Mf7471	Mf7473	Mf7474
Dentalina mucronata	.	X	.	X	X	.	.	.	.	.
Dentalina cf. D. multilineata	.	X	.	X	.	.	.	.	.	.
Dentalina soluta	.	.	.	X	.	.	.	.	.	.
Discorbis baintoni	.	X	.	X	X	.	.	.	.	.
Discorbis sp.	.	X	.	.	.	.	.	.	.	.
Dorothia bulletta	X	X	X	X	X	.	X	X	X	X
Dorothia principiensis	X	X	.	X	X	.	.	.	.	.
Eggerella elongata	.	.	.	.	X	.	X	.	.	.
Ellipsoglandulina abbreviata	.	X	.	.	.	.	.	.	.	.
Ellipsoglandulina labiata	.	X	.	.	.	.	.	X	.	.
Ellipsonglandulina principiensis	.	X	.	X	.	.	.	.	.	.
Eponides dorfi	X	X	.	X	X	.	.	.	.	.
Fissurina orbignyana	.	X	.	.	.	.	.	.	.	.
Fissurina spp.	.	X	.	.	.	.	.	.	.	.
Fursenkoina bramletti	.	X	.	.	.	.	.	.	.	.
Gaudryina laevigata	.	.	.	.	.	.	.	cf	cf	.
Globocassidulina globosa	X	X	.	X	X	.	.	.	.	.
Glomospira charoides	X	X	X	X	X	X	.	.	X	X
Guttulina problema	X	X	.	X	.	.	.	.	.	.
Gyroidina soldanii	X	X	.	X	.	.	X	X	X	X
Haplophragmoides eggeri	X	X	.	X	X	.	X	X	X	X
Haplophragmoides spp.	.	.	.	.	.	X	.	X	.	.
Hyperammina elongata	X	X	X	X	X	.	.	.	.	.
Karreriella chapapotoensis	X	X	.	X	X	.	?	X	X	X
Karreriella elongata	.	.	.	.	.	.	X	.	.	.
Karreriella spp.	.	.	.	.	.	.	X	X	X	X
Lagena costata	.	.	.	.	X	.	.	X	.	.
Lagena gracilis	.	X	.	.	.	.	.	.	.	.
Lagena spp.	.	.	.	X	.	.	.	.	.	.
Lagena vulgaris	.	X	.	.	.	.	.	.	.	.
Lenticulina altolimbatus	X	X	.	X	X	.	X	.	.	.
Lenticulina antipodum	.	.	.	X	X	.	.	.	.	.
Lenticulina carolinianus	.	X	.	.	.	.	X	.	.	.
Lenticulina kincaidi	X	.	.	aff.	.	.	.	.	.	.
Lenticulina laimingi	X	X	.	.	.	.	.	.	.	.
Lenticulina limbosus hockleyensis	X	X	.	X	X	.	.	.	.	.
Lenticulina spp.	.	.	.	X	X	.	.	X	.	X
Lenticulina pseudocultratus	X	X	.	X	X	.	.	.	.	.
Lenticulina pseudovortex	.	.	.	X	X	.	.	.	.	.
Lenticulina terryi	.	.	.	.	X	.	.	.	.	.
Lituotuba cf. L. lituiformis	X	X	.	X	X	.	.	.	.	.

Table 4
Benthic foraminifers from the "mottled mudstone of Mt. Chual", (Te1), Loma Prieta Quadrangle

SPECIES \ SAMPLES	Mf1583A	Mf1584A	Mf1585A	Mf1588A	Mf1589	Mf7453	Mf7454	Mf7471	Mf7473	Mf7474
Allomorphina conica	.	.	.	.	X	.	X	X	.	.
Allomorphina paleocenica	.	.	.	.	X	.	.	X	.	.
Ammobaculites cubensis	.	.	.	X	.	.	.	.	.	.
Ammodiscoides turbinatus	.	X	.	.	.	.	.	.	.	.
Ammodiscus incertus	X	X	X	X	X	.	.	.	X	.
Ammodiscus spp.	.	.	.	.	.	X	.	.	.	.
Amphimorphina ignota	.	X	.	.	X	.	.	X	.	.
Anomalina garzaensis	.	.	.	.	.	.	.	X	X	.
Anomalina regina	X	X	.	X	X	.	X	.	.	X
Anomalinoides capitatus	X	X	.	X	X	.	X	X	X	X
Aragonia aragonensis	.	X	.	.	X	.	.	.	.	.
Astacolus sp.	X	.	.	.	.	.	.	X	.	.
Bathysiphon eocenicus	X	cf	X	cf	X	.	X	.	X	.
Bathysiphon santecruis	X	.	.	.	.	.	X	X	X	.
Bathysiphon sp. (coarse)	X	X	.	X	X	.	.	X	.	X
Bathysiphon spp.	.	.	.	.	.	X	X	.	X	.
Bifarina eleganta	.	X	.	.	.	.	.	.	.	.
Bulimina callahani	.	.	.	.	X	.	.	.	.	.
Bulimina macilenta	X	X	.	X	X	.	.	X	.	X
Bulimina semicostata	X	X	.	X	X	.	X	X	X	X
Bulimina trintatensis	.	.	.	.	.	.	.	X	.	.
Bulimina tuxapamensis	.	.	.	X	.	.	.	.	.	.
Buliminella grata	X	.	.	.	X	.	X	.	X	X
Chilostomella ovoidea	.	X	.	.	.	.	.	X	.	.
Chrysalongonium laeve	X	X	.	X	X	.	.	.	.	.
Chrysalongonium tenuicostatum	X	.	.	.	X	.	.	.	.	.
Cibicidoides eocaenus	X	X	.	X	X	.	.	X	X	.
Cibicidoides grimsdalei	.	.	.	.	.	.	.	cf	.	.
Cibicidoides praemundulus	X	.	.	.	X	.	.	.	.	.
Cibicidoides subspiralis	X	X	.	X	X	.	X	X	X	X
Cibicides-Cibicidoides spp.	.	X	.	.	.	.	X	X	X	X
Cibicidoides venzuelana	.	X	.	.	X	.	.	.	.	.
?Clavulinoides spp.	.	.	.	.	.	.	.	X	.	.
Cyclammina samanica	.	.	.	.	.	.	.	.	X	X
Cyclammina simiensis	X	X	X	X	X	.	X	.	.	.
Cyclammina spp.	.	.	.	.	.	X	.	.	.	.
Dentalina communis	X	X	.	X	X	.	.	.	.	.
Dentalina consobrina	.	.	.	.	.	.	X	X	.	.
Dentalina hexacostata	.	.	.	.	X	.	.	.	.	.
Dentalina hispidocostata	.	X	.	.	X	.	.	.	.	.
Dentalina cf. D. jacksonensis	X	X	.	X	X	.	.	.	.	.

Table 4 (continued)

SPECIES \ SAMPLES	Mf1583A	Mf1584A	Mf1585A	Mf1588A	Mf1589	Mf7453	Mf7454	Mf7471	Mf7473	Mf7474
Marginulna dominicana	X	X	.	.	.	.	.	.	.	.
Marginulina exima	.	X	.	X	X	.	.	X	.	.
Marginulina inconspicua	.	X	.	.	X	.	.	.	.	.
Marginulina sp.	.	.	.	X	.	.	.	.	.	.
Marginulina subbullata	.	X	.	.	.	.	.	X	.	.
Marssonella oxycona	.	.	.	.	.	.	.	.	X	.
Martinotiella eocenica	?	X	.	X	.	.	.	.	X	.
Nodosarella decurta	.	.	.	X	.	.	.	.	.	.
Nodosarella mappa	.	cf	.	cf	.	.	.	.	.	.
Nodosaria cf. N. amphioxy	.	.	.	.	X	.	.	.	.	.
Nodosaria delicae	.	X	.	.	.	.	X	.	.	.
Nodosaria latejugata	.	.	.	.	.	.	.	X	.	.
Nodosaria longiscata	.	X	.	X	X	.	.	.	.	.
Nodosaria macneili	X	.	.	X	.	.	.	.	.	.
Nodosaria pyrula	.	X	.	.	X	.	.	.	.	.
Nodosaria spp.	.	X	.	X	.	.	X	X	X	X
Nodosaria velascoensis	.	X	.	.	.	.	.	X	.	.
Nodosarella advena	X	X	.	X	.	.	X	.	.	.
Nuttaloides truempyi	X	X	.	X	X	.	X	X	X	X
Oridorsalis umbonatus	X	X	.	X	X	.	X	X	X	X
Osangularia mexicana	X	X	.	X	X	.	.	X	.	.
Plectina garzaensis	X	X	.	.	X	.	.	.	.	.
Plectofrondicularia garzaensis	X	X	.	X	.	.	.	.	.	X
Plectofrondicularia spp.	.	.	.	X	.	.	.	.	.	.
Pleurostomella acuta	.	X	.	.	X	.	.	cf	.	.
Pleurostomella alternans	X	.	.	.	.	.	.	.	.	.
Pleurostomella gredalaensis	X	X	.	X	X	.	.	X	.	.
Pleurostomella nuttalli	X	X	.	X	X	.	.	X	.	.
Praeglobobulimina pupoides	X	X	.	.	.	.	.	.	.	.
Pseudonodosaria conica	.	.	.	.	.	.	.	X	.	.
Pseudonodosaria inflata	.	X	.	X	X	.	.	.	.	.
Pullenia eocenica	X	X	.	X	.	.	X	X	.	.
Pullenia salisburyi	.	.	.	.	.	.	.	X	X	X
Pyrulina clindreacea	X	X	.	X	.	.	.	.	.	.
Pyrulina sp.	.	X	.	.	.	.	.	X	.	.
Reophax pilulifera	X	X	.	X	X	.	.	.	.	.
Reusella elongata	.	.	.	.	.	.	.	X	.	.
Rhabdammina eocenica	.	X	.	.	X	.	.	.	.	.
Saccammina spp.	X	.	.	.	X	.	.	.	.	.
Saracenaria hantkeni	.	X	.	.	.	.	.	.	.	.
Schenkiella suteri	.	.	.	X	X	.	.	.	.	.
Silicosigmoilina californica	X	X	X	X	X	.	.	.	X	.
Spiroloculina texana	X	.	.	.	.	.	.	.	.	.

Table 4 (continued)

SPECIES \ SAMPLES	Mf1583A	Mf1584A	Mf1585A	Mf1588A	Mf1589	Mf7453	Mf7454	Mf7471	Mf7473	Mf7474
Spiroplectammina directa	X	X	.	.	X	.	X	.	X	.
Spiroplectammina richardi	.	X	.	.	.	.	.	X	.	.
Spiroplectammina spp.	.	.	.	.	.	.	.	X	X	.
Spiroplectammina tejonensis	.	X	.	.	.	.	.	.	.	.
Stilostomella advena	.	X	.	.	.	.	.	.	.	.
Stilostomella gracilis	.	.	.	.	.	.	cf	.	.	.
Stilostomella lepidula	.	X	.	.	.	.	.	.	.	.
Textularia adalta	X	X	.	X	X	.	X	.	.	.
Tritaxilina colei	X	X	.	X	X	.	.	X	.	.
Trochammina globigeriniformis	X	.	.	X	X	.	X	.	X	X
Trochammina spp.	.	.	.	.	.	.	X	X	X	X
Uvigerina spp.	.	X	.	.	.	.	.	.	.	.
Vaginulinopsis asperuliformis	.	.	.	.	cf	.	.	.	.	.
Vaginulinopsis saundersi	.	.	.	X	.	.	.	X	.	.
Vernuilina triangulata	X	X	.	X	X	.	X	X	.	X
Vulvulina curta	.	X	.	X	X	.	.	.	.	.

Table 5
Benthic foraminifers from the "mottled mudstone", (Te1), Loma Prieta Quadrangle

SPECIES \ SAMPLES	Mf1052	Mf1052A	Mf1591	Mf7475	Mf7480	Mf1604
Allomorphina conica	.	.	.	X	.	.
Allomorphina paleocenica	.	.	.	X	.	.
Ammodiscus incertus	X	.	.	.	X	.
Anomalina garzaensis	.	.	.	X	X	.
Anomalina regina	X	X	.	X	X	.
Anomalinoides acutus	.	.	.	?	.	.
Anomalinoides capitatus	.	X	.	X	X	.
Aragonia aragonensis	.	.	.	X	.	.
Astacolus sp.	.	.	.	X	X	.
Bathysiphon santecruis	.	X	.	X	.	X
Bathysiphon sp. (coarse)	.	.	.	X	.	X
Bathysiphon spp.	.	.	X	X	X	.
Bulimina callahani	.	.	.	X	X	.
Bulimina corrugata	.	.	.	.	X	.
Bulimina excavata	.	X	.	.	.	.
Bulimina macilenta	.	.	.	.	X	.
Bulimina trintatensis	.	X	.	X	X	.
Buliminella grata	.	.	.	X	X	.
Chrysalongonium laeve	.	X	.	.	.	.
Chrysalongonium tenuicostatum	.	X	.	.	.	.
Cibicides martinezensis	.	.	.	.	X	.
Cibicidoides coalingensis	cf	.	.	.	.	.
Cibicidoides eocaenus	.	X	.	X	X	X
Cibicidoides praemundulus	.	X	.	.	.	.
Cibicidoides subspiralis	.	X	.	X	X	.
Cibicides-Cibicidoides spp.	.	X	.	X	X	.
Clavulinoides californicus	.	X	.	X	.	.
Clavulinoides spp.	.	.	.	X	.	.
Cyclammina samanica	.	.	.	.	X	.
Cyclammina simiensis	X	X	.	.	.	.
Dentalina communis	.	X	.	.	.	.
Dentalina consobrina	.	.	.	X	X	.
Dentalina delicatula	cf	.	.	.	.	.
Dorothia bulletta	X	X	.	X	X	.
Dorothia principiensis	.	X	.	.	.	.
Eggerella elongata	.	X	.	.	.	.
Elphidium sp.	.	X	.	.	.	.
Gaudryina laevigata	.	.	.	.	X	.
Globocassidulina globosa	.	.	.	.	X	X
Glomospira charoides	X	X	.	X	.	.
Gyroidina soldanii	X	X	.	.	X	.

Table 5 (continued)

SPECIES \ SAMPLES	Mf1052	Mf1052A	Mf1591	Mf7475	Mf7480	Mf1604
Haplophragmoides eggeri	X	X	X	X	X	.
Haplophragmoides spp.	.	X	.	X	X	.
Karreriella chapapotoensis	.	X	.	X	X	X
Karreriella spp.	.	.	.	X	X	.
Lagena costata	.	.	.	X	.	.
Lenticulina altolimbatus	.	X	.	.	.	.
Lenticulina spp.	.	X	.	X	X	.
Lenticulina ulatisensis	.	X	.	.	.	.
Marginulina exima	.	.	.	X	.	.
Marginulina sp.	.	.	.	X	.	.
Marginulina subbullata	.	.	.	X	.	.
Marginulina subrecta	.	.	.	X	.	.
Marssonella oxycona	.	.	.	.	X	.
Nodosaria latejugata	.	.	.	X	.	.
Nodosaria longiscata	.	cf	.	.	.	.
Nodosaria pyrula	.	X	.	.	.	.
Nodosaria spp.	.	.	.	X	X	.
Nodosaria velascoensis	.	X	.	X	.	.
Nuttaloides truempyi	.	X	X	X	X	.
Oridorsalis umbonatus	.	X	.	X	X	.
Osangularia mexicana	.	X	.	X	X	X
Plectofrondicularia garzaensis	.	.	.	X	X	.
Plectofrondicularia pacicostata	.	X	.	.	.	.
Pleurostomella acuta	.	.	.	cf	.	.
Pleurostomella gredalaensis	.	.	.	X	.	.
Pleurostomella nuttalli	.	.	.	X	.	X
Pullenia eocenica	.	X	.	.	.	.
Pullenia quinuqlobata	.	.	.	X	X	.
Pyrulina sp.	.	.	.	X	.	.
Reusella elongata	.	.	.	X	.	.
Rhabdammina eocenica	X	X	.	.	.	.
Schenkiella suteri	.	X	.	.	.	.
Silicosigmoilina californica	X	X	X	X	X	.
Spiroloculina texana	.	.	.	X	.	.
Spiroplectammina directa	X	.	.	.	X	.
Spiroplectammina richardi	.	X	.	X	X	.
Stilostomella lepidula	.	.	.	.	X	.
Textularia adalta	.	X	.	.	.	.
Tritaxilina colei	.	X	.	X	X	.
Trochammina globigeriniformis	X	.	.	.	X	.
Trochammina spp.	.	.	.	.	X	.
Trochamminoides contortus	X	.	.	.	.	.
Uvigerina lodoensis miriamae	.	X	.	.	.	X

Table 5 (continued)

SPECIES \ SAMPLES	Mf1052	Mf1052A	Mf1591	Mf7475	Mf7480	Mf1604
Vaginulinopsis asperuliformis	.	.	.	X	X	.
Vaginulinopsis saundersi	.	.	.	X	.	.
Valvulineria childsi	.	X	.	.	.	.
Valvulineria spp.	?	.	.	.	.	.
Vernuilina triangulata	.	.	.	X	X	.
Vulvulina curta	.	X	.	.	.	.

Table 6
Benthic foraminifers from the
"marine sandstone and shale", (Te2), Loma Prieta Quadrangle

SPECIES \ SAMPLES	Mf1582A	Mf1590
Ammodiscus incertus	X	.
Bathysiphon eocenicus	.	X
Bathysiphon santecruis	.	X
Baythsiphon spp.	X	.
Cyclammina simiensis	X	.
Dorothia bulletta	X	.
Haplophragmoides eggeri	X	X
Lenticulina laimingi	X	.
Silicosigmoilina californica	X	X
Trochammina globigeriniformis	X	.
Vulvulina curta	X	.

Table 7
Benthic foraminifers from the "marine shale and sandstone of Highland Way", (Tme), Loma Prieta Quadrangle

SPECIES \ SAMPLES	Mf1053	Mf7481	Mf7482	Mf7485	Mf7486	Mf7487	Mf7489	Mf7490	Mf7493	Mf7495	Mf7497
Alabamina wilcoxensis	.	.	.	.	.	.	.	X	.	.	.
Ammodiscus incertus	.	.	.	X	.	.	.	.	.	.	.
Amphimorphina spp.	.	.	.	.	.	.	.	?	.	.	.
Anomalina regina	.	.	X	X	.	.	.	X	.	.	.
Anomalina spp.	.	.	.	.	.	.	.	.	X	.	.
Aragonia argonensis	.	.	.	X	.	.	.	.	.	.	.
Bathysiphon eocenicus	X	X	.	.	.	.	.	.	.	.	.
Bathysiphon spp.	.	.	X	X	.	.	X	X	.	.	.
Bulimina corrugata	X	.	.	.	.	.	.	X	.	.	.
Bulimina macilenta	.	.	X	.	.	.	.	.	.	.	.
Bulimina semicostata	.	.	.	X	.	.	.	.	.	.	.
Bulimina trinitatensis	.	.	.	.	.	.	.	X	.	.	.
Buliminella subfusiformis	.	.	.	.	.	.	.	.	.	X	.
Cibicides-Cibicidoides spp.	.	.	X	.	.	.	.	X	.	.	.
Cibicidoides eocaenus	X	.	.	X	.	.	.	X	.	.	.
Cibicidoides praemundulus	X	.	.	.	.	.	.	.	.	.	.
Cibicidoides subspiralis	.	.	.	.	.	.	.	X	.	.	.
Cyclammina simiensis	.	.	.	.	.	.	.	X	.	.	.
Dentalina consobrina	.	.	X	X	.	.	.	X	.	.	.
Dentalina spp.	.	.	X	X	.	.	.	X	.	.	.
Dorothia principiensis	.	.	.	.	.	.	.	X	.	.	.
Dorothia spp.	.	.	.	X	.	.	.	.	.	.	.
Fissurina spp.	.	.	.	.	.	.	.	X	.	.	.
Fursenkoina californiensis	.	.	.	.	.	.	.	.	.	X	.
Globocassidulina globosa	.	.	.	X	.	.	.	.	.	.	.
Gyroidina soldanii	.	.	.	X	.	.	.	X	.	.	.
Gyroidina spp.	.	.	.	.	.	.	.	.	X	.	.
Hanzawaia ammophila	.	.	.	.	.	.	.	X	.	.	.
Haplophragmoides eggeri	X	.	.	.	.	.	.	.	.	.	.
Haplophragmoides spp.	.	X	.	.	.	.	.	X	.	.	.
Karreriella chapapotensis	.	.	.	.	.	.	.	X	.	.	.
Karreriella elongata	.	.	.	.	.	.	.	X	.	.	.
Lagena costata	.	.	.	.	.	.	.	X	.	.	.
Lenticulina spp.	X	.	.	.	.	.	.	X	.	.	.
Martinottiella eocenica	.	.	.	X	.	.	.	X	.	.	.
Nodosaria longiscata	.	.	X	.	.	.	.	X	.	.	.
Nodosaria pyrula	.	.	.	.	.	.	.	X	.	.	.
Nuttaloides truempyi	.	.	X	X	.	.	.	X	.	.	.
Oridorsalis umbonatus	.	.	X	X	.	.	.	X	.	.	.
Osangularia mexicana	.	.	X	X	.	.	.	.	.	.	.

Table 7 (continued)

SPECIES \ SAMPLES	Mf1053	Mf7481	Mf7482	Mf7485	Mf7486	Mf7487	Mf7489	Mf7490	Mf7493	Mf7495	Mf7497
Plectina garzaensis	X	.	.	.	.	.	.	X	.	.	.
Pleurostomella acuta	.	.	.	.	.	.	.	X	.	.	.
Pleurostomella spp.	.	.	.	X	.	.	.	.	.	.	.
Praeglobobulimina pupoides	.	.	.	.	.	.	.	X	.	.	.
Pseudonodosaria inflata	.	.	.	.	.	.	.	X	X	.	.
Pullenia eocenica	.	.	.	X	.	.	.	X	.	.	.
Pyrulina spp.	.	.	.	.	.	.	.	X	.	.	.
Quiqueloculina spp.	.	.	X	.	.	.	.	.	.	.	.
Rhabdammina eocenica	.	.	.	X	.	.	.	.	.	.	.
Silicosigmoilina californica	.	.	.	.	.	.	.	X	.	.	.
Spiroloculina texana	.	.	.	X	.	.	.	.	.	.	.
Spiroplectammina directa	X	.	.	.	.	.	.	X	.	.	.
Spiroplectammina tejonensis	.	.	.	.	.	.	.	X	.	.	.
Stilostomella spp.	.	.	.	.	.	.	.	.	.	.	?
Tritaxilina colei	X	.	.	.	.	.	.	X	.	.	.
Trochammina spp.	X	.	X	X	X	X	.	.	.	.	.
Uvigerina spp.	.	.	.	.	.	.	.	.	.	X	.

Table 8
Benthic foraminifers from the "marine shale and sandstone of Highland Way", (Tme), Loma Prieta Quadrangle
by R.L. Pierce, August 9, 1971

SPECIES \ SAMPLES	RMH-55-71
Benthic foraminifers	
Bolivina marginata	X
Bulimina carneroensis	X
Buliminella curta	X
Buliminella subfusiformis	X
Cyclammina incisa	X
Cyclammina cancellata obesa	X
Cyclammina sp.	X
Plectofrondicularia advena	X
Plectofrondicularia californica	X
Plectofrondicularia miocenica	cf
Plectofrondiuclaria vaughani	cf
Fish	
Etringus sp. 66	X
Etringus sp. 75	X
Etrumeus sp.	?
Ganolytes sp.	X
Lampancytus sp.	X
Promacrurus sp.	X
Promacrurus sp. or Pyknolepidus sp.	X