

Middle Miocene Foraminifera
and Stratigraphic Relations
in the Adelaida Quadrangle
San Luis Obispo County
California

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Middle Miocene Foraminifera and Stratigraphic Relations in the Adelaida Quadrangle San Luis Obispo County California

By PATSY B. SMITH and DAVID L. DURHAM

CONTRIBUTIONS TO GENERAL GEOLOGY

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*Foraminifera and rocks near
the type areas of the Relizian
and Luisian Stages are described
and their age and environments
inferred*



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CONTRIBUTIONS TO GENERAL GEOLOGY

MIDDLE MIOCENE FORAMINIFERA AND STRATIGRAPHIC RELATIONS IN THE ADELAIDA QUADRANGLE, SAN LUIS OBISPO COUNTY, CALIFORNIA

BY PATSY B. SMITH and DAVID L. DURHAM

ABSTRACT

The Salinas Valley region contains the type areas of the Monterey Shale and the Santa Margarita and Pancho Rico Formations, as well as the type areas of the Relizian and Luisian Stages of Kleinpell. Only in and very near the Adelaida 7½-minute quadrangle do strata representing all these stratigraphic units crop out in close proximity. In addition, beds that contain fossil marine mollusks of Paleocene age crop out in the quadrangle. Of particular significance in Coast Range stratigraphy are the wide range in Tertiary age of fossils found in the Adelaida quadrangle and the geographic position of the quadrangle between the type areas of the Relizian and Luisian Stages of Kleinpell.

INTRODUCTION

The Adelaida 7½-minute quadrangle is in the southern Salinas Valley region on the northeast flank of the Santa Lucia Range (fig. 1). It is of particular stratigraphic interest because fossiliferous marine beds of Late Cretaceous, Paleocene, Miocene, and Pliocene age crop out there in close proximity, a circumstance unusual in so small an area of the Coast Ranges. About one-third of the beds exposed in the quadrangle belong to the Sandholdt Member of the Monterey Shale. These rocks are particularly significant because they contain middle Miocene foraminiferal faunas of both the Relizian and Luisian Stages of Kleinpell, and because they lie between the type areas of the two stages. This paper presents the results of studies on Foraminifera collected during mapping of the Adelaida quadrangle and summarizes stratigraphic relations determined by the mapping and by study of fossils. It includes only a generalized geologic map (fig. 2); a more detailed map is published separately (Durham, 1968b).

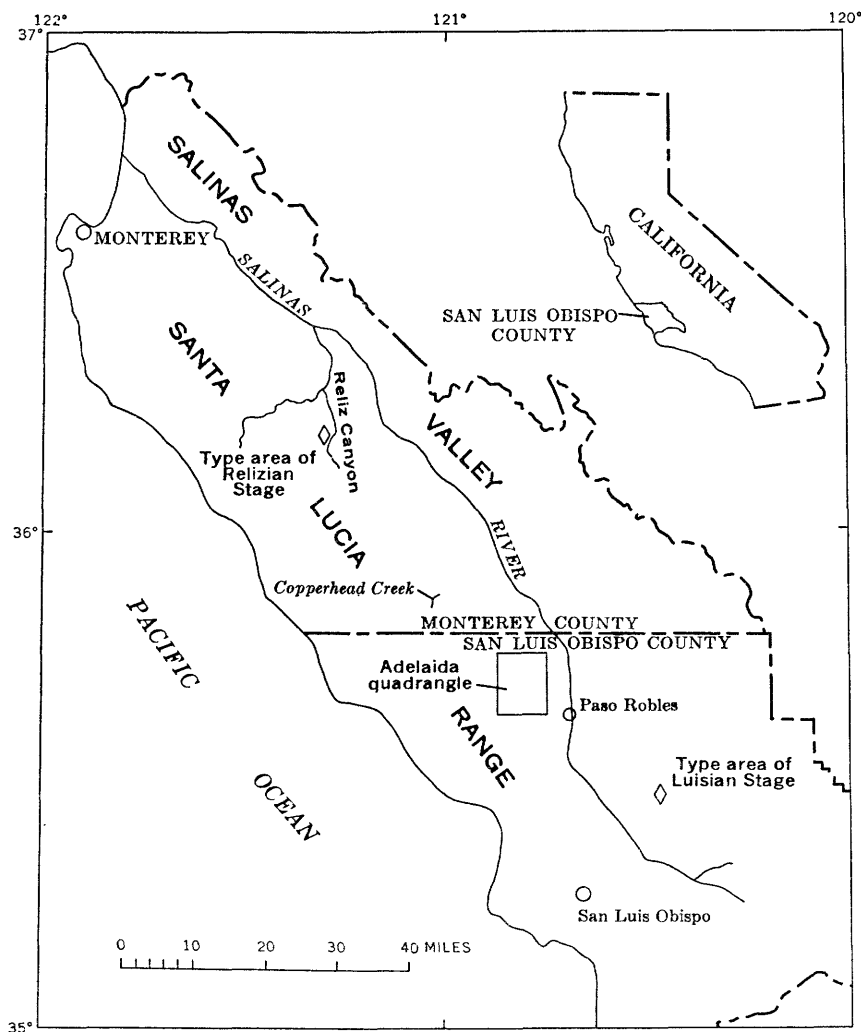


FIGURE 1.—Index map showing location of Adelaida 7½-minute quadrangle and type areas of the middle Miocene stages of Kleinpell.

PREVIOUS WORK

Published records of previous work on fossil Foraminifera from the Adelaida 7½-minute quadrangle are meager. Wilson (1931, p. 103) reported that "At Chimney Rock (sec. 9, T. 26 S., R. 11 E.), the *Siphogenerina hughesi* subzone of the *Uvigerinella californica* zone [of Kleinpell] occurs 514 feet above the base of the [Monterey] shale * * *" and (p. 104) " * * * at least part of the [Monterey] shale in the Adelaida district is the correlative of the lower part of the Monterey

formation at its type locality." Kleinpell (1938, table 8) gave a check list of Foraminifera collected by Wilson at five localities in the Adelaida quadrangle, and (p. 116) mentioned that his "*Siphogenerina transversa* and *Plectofrondicularia miocenica* Zones [early Miocene Saucesian Stage] are well developed on * * * Las Tablas Creek * * *," which is partly in the Adelaida quadrangle. Kleinpell also mentioned (p. 121) that his *Siphogenerina hughesi* Zone (middle Miocene Relizian Stage) "is well developed" at Chimney Rock in the Adelaida quadrangle. Bramlette and Daviess (1944) showed on columnar sections that beds at the base of the Sandholdt Shale (Sandholdt Member of the Monterey Shale of this paper) at two localities in the Adelaida 7½-minute quadrangle belong to the early Miocene Saucesian Stage of Kleinpell.

GEOLOGIC SETTING

The diversity of Tertiary formations in the Adelaida quadrangle is due partly to the proximity of two unlike stratigraphic sequences separated by the Jolon fault. Figure 2 shows the distribution of rock units in the Adelaida 7½-minute quadrangle and their general structural relations. Southwest of the fault the oldest exposed rocks are strata of an unnamed formation of Cretaceous and Paleocene age. The Tierra Redonda Formation lies unconformably on this unnamed unit, and is succeeded by a conformable sequence comprising the Monterey Shale, Santa Margarita Formation, and Paso Robles Formation, although at some places the Paso Robles lies unconformably on the Monterey. Granitic rocks of the pre-Tertiary basement complex crop out northeast of the Jolon fault, where a conformable sequence comprising the upper part of the Monterey Shale, the Pancho Rico Formation, and the Paso Robles Formation is also exposed. At some places the Paso Robles lies directly on the Monterey Shale or on the basement complex.

The occurrence of these unlike stratigraphic sequences in the Adelaida quadrangle is attributed to their juxtaposition by lateral displacement along the Jolon fault. The regional distribution of both the Santa Margarita and Pancho Rico Formations indicates that the displacement was in a right-lateral sense and amounted to at least 11 miles (Durham, 1965).

SEDIMENTARY ROCK UNITS

The unnamed formation of Cretaceous and Paleocene age is mainly medium- to coarse-grained arkosic sandstone and pebble to boulder conglomerate, although hackly mudstone is locally abundant in the unit. The base of the formation is concealed, but the unit is probably

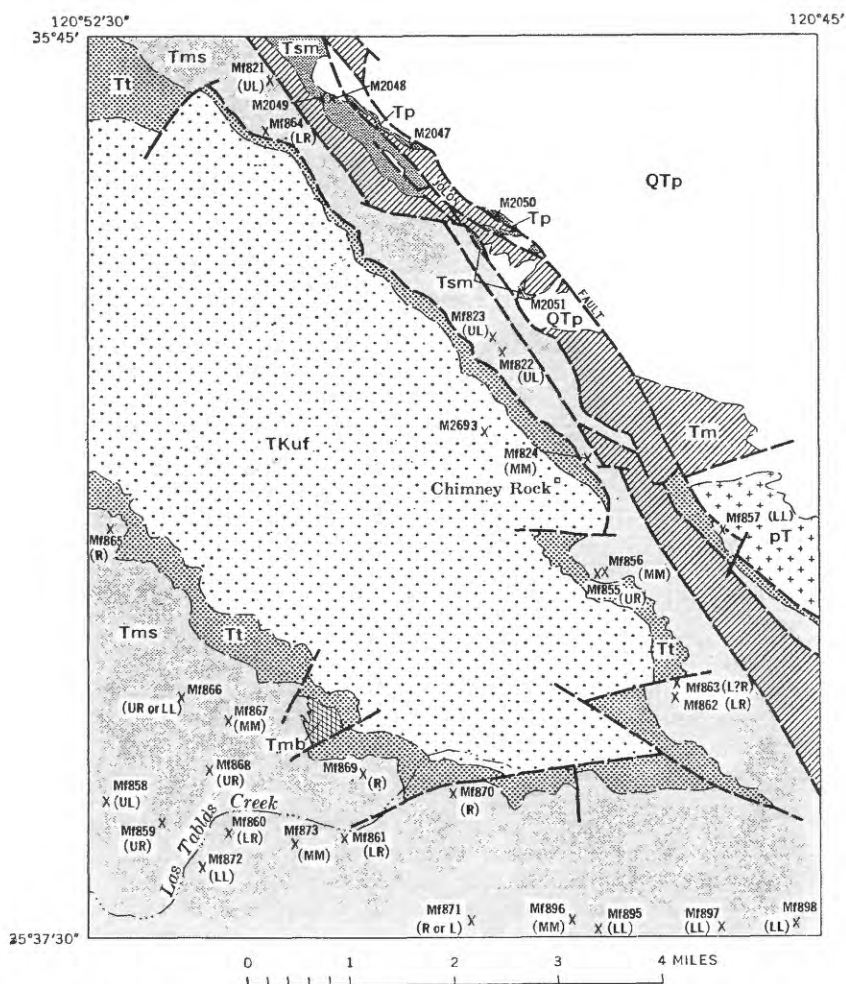
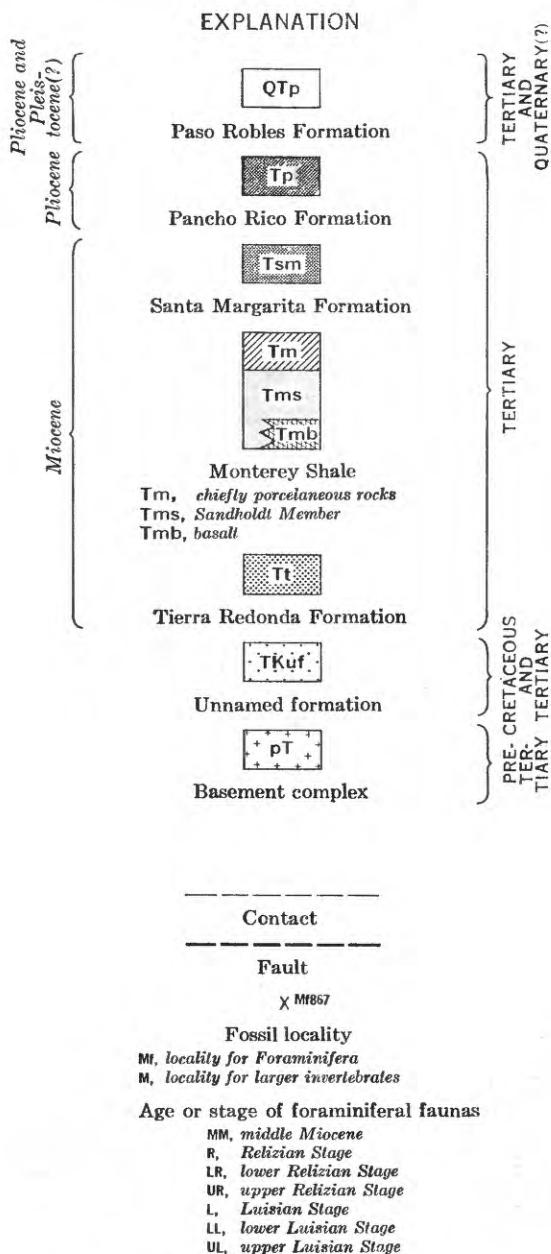


FIGURE 2.—Generalized geologic map of the Adelaida 7½-minute quadrangle showing approximate location of fossil localities.

thicker than 10,000 feet. The formation contains the marine Paleocene fossils *Amauropsis martinezensis* Dickerson?, *Cucullaea mathewsoni* Gabb, *Mesalia martinezensis* (Gabb), *Nemocardium* cf. *N. linteum* (Conrad), *Priscoficus* cf. *P. caudata* (Gould), *Tornatella pinguis* (Gabb), and *Turritella infragranulata* Gabb at fossil locality M2693 (W. O. Addicott, written commun., 1967), and Schenck (1936, p. 48) reported the Late Cretaceous marine fossil *Acila demessa* Finlay from a locality within the formation 2 miles to the northwest.

The Tierra Redonda Formation is chiefly fine- to medium-grained, locally conglomeratic, arkosic sandstone that is generally nearly white



and that ranges from friable to well cemented. The unit, which is about 600 feet thick, lacks fossils. It is considered of early and middle Miocene age because northwest of the Adelaida quadrangle the Tierra Redonda lies conformably on the lower Miocene Vaqueros Formation

and conformably underlies and locally intertongues with middle Miocene beds of the Sandholdt Member of the Monterey Shale (Durham, 1968a).

The Monterey Shale is divided into two parts. The lower part, the Sandholdt Member, is mainly calcareous shale and mudstone with interbeds of cherty rock and dolomitic carbonate rock. The top of the member is concealed, but the unit probably is at least as thick as 2,000 feet. It contains abundant Foraminifera indicative of the middle Miocene Relizian and Luisian Stages of Kleinpell. The upper part of the Monterey is porcelanite and porcelaneous mudstone with associated dolomitic carbonate rock and chert. The thickness of the upper part of the Monterey is unknown because the contact between the upper and lower parts is concealed. Fossils suitable for age determination are lacking in the upper part of the formation.

The Santa Margarita Formation is fine- to coarse-grained or granitic arkosic sandstone that commonly contains grains of dark-colored chert. The rock is mainly calcareous and ranges from friable to well cemented. The formation is about 500 feet thick and contains abundant marine fossils of late Miocene age. According to W. O. Addicott (written commun., 1964), fossil locality USGS M2048 contains: *Forreria* cf. *F. carisaensis* (Anderson), *Chlamys hodgei* (Hertlein), *Lyropecten estrellanus* (Conrad), and *Mytilus* cf. *M. schencki* Hanna and Hertlein; fossil locality M2049 contains: ?*Forreria* sp., *Lyropecten estrellanus* (Conrad), *Ostrea titan* Conrad, *Terebratalia arnoldi quaylei* Hertlein and Grant, *Astrodapsis* cf. *A. margaritanus* Kew, and *Balanus gregarius* (Conrad); and fossil locality USGS M2051 contains: *Lyropecten estrellanus* (Conrad), *Ostrea titan* Conrad, and *Astrodapsis* cf. *A. margaritanus* Kew.

The Pancho Rico Formation is fine- to coarse-grained arkosic sandstone that ranges from noncalcareous to calcareous and from friable to well cemented. The unit is probably no thicker than 50 feet. The apparent thickness of the Pancho Rico is exaggerated on the geologic map (fig. 2) in order to depict the unit at the scale of the map. The Pancho Rico contains marine fossils of early Pliocene age. Fossils identified by W. O. Addicott from localities USGS M2047 and M2050 are listed elsewhere (Durham and Addicott, 1965, table 1).

The Paso Robles Formation is composed chiefly of poorly bedded friable conglomerate and arkosic sandstone. The conglomerate contains pebbles, cobbles, and some boulders of a variety of rocks, including porcelaneous and cherty rocks derived from the Monterey Shale. The sandstone is for the most part poorly sorted. Mudstone is locally common in the Paso Robles, and limestone beds 1–3 feet thick occur in the formation at some places. The thickness of the Paso Robles is

unknown, but the unit may be as thick as several hundred feet. The Paso Robles is considered of Pliocene and probably Pleistocene age because it conformably overlies the Pliocene Pancho Rico Formation and unconformably underlies Quaternary alluvial sediments. The unit is regarded as nonmarine because it lacks fossils and has the poor sorting, poor bedding, cross-stratification, and channeling that suggest fluvial deposition.

FORAMINIFERA

Foraminifera were collected from the Sandholdt Member of the Monterey Shale at 27 localities in the Adelaida quadrangle (fig. 2 and collection-locality list). Localities shown in table 1 are listed by age; no precise stratigraphic sequence is implied as the scattered nature of the samples and complex structure make this impossible. Species are arranged alphabetically in the table.

Foraminiferal faunas older than middle Miocene are lacking in the Sandholdt Member of the Monterey Shale in the Adelaida 7½-minute quadrangle, although Foraminifera of the lower Miocene Saucian Stage occur near the base of the member about 11 miles northwest of the quadrangle along Copperhead Creek. Saucian Foraminifera also occur in the lower part of the Sandholdt at its type area in Reliz Canyon. Thorup (1941), in his original definition of the Sandholdt as a formation, pointed out that the Sandholdt in Reliz Canyon contains Saucian Foraminifera in the lower part and lower middle Miocene Foraminifera in the upper part. The Sandholdt, redefined as a member of the Monterey Shale (Durham, 1963, p. Q15), includes the Sandholdt Formation of Thorup and overlying calcareous shale beds, which contain Foraminifera of the upper middle Miocene Luisian Stage. At most places in the southern Salinas Valley area, the Sandholdt Member contains Foraminifera of only the middle Miocene Relizian or Luisian Stage.

The foraminiferal faunas listed in table 1 are all middle Miocene in age. The oldest faunas, collected as close to the base of the Sandholdt as possible, are assigned to the lower Relizian Stage. The Saucian faunas found in the Sandholdt in Reliz Canyon and at Copperhead Creek to the north are absent. The Relizian faunas are characterized by such species as *Siphogenerina hughesi*, *Robulus laimingi*, *Planulina baggi*, *Plectofrondicularia californica*, *Valvulineria californica appressa*, and *Baggina cancriformis*. They are similar to faunas of the type Relizian Stage. The lower Luisian is characterized by the highest occurrence of *V. depressa*, *Nonionella incisa*, *V. californica obesa*, and the lowest occurrence of *Pullenia miocenica globula*. These faunas differ from the type section of the Luisian Stage, 20 miles to the south-

east (Smith, 1968), in lacking the abundance of *V. californica* s. l. Upper Luisian faunas are characterized by *Siphogenerina collomi*, *Uvigerina hootsi*, *U. subperegrina*, *Epistominella capitansensis*, *E. gyroidinaformis*, *Eponides rosaformis*, and *Planularia luciana*. This stage also differs from that in the type area owing to the relatively rare occurrences of *V. californica*.

Using the species criteria of Bandy and Arnal (1960), most of the samples from the Relizian and Luisian Stages would indicate a bathyal environment, probably lower and middle bathyal ($2,000 \pm 1,000$ ft to $4,000 \pm 2,000$ ft). Bandy and Arnal suggest that the *Valvulineria* faunas are probably upper bathyal (100 ± 600 ft), which may mean that the faunas from the Adelaida quadrangle were deposited in water slightly deeper than that at the type area of the Luisian Stage.

Two samples, USGS Mf856 and Mf824, both from middle Miocene undifferentiated, indicate an outer shelf or upper slope environment. These faunas are dominated by small Bolivinas, Globigerinas, and Uvigerinellas. No specific age assignment can be given them.

COLLECTION-LOCALITY DESCRIPTIONS

U.S. Geological Survey (USGS) Cenozoic localities

- Mf821. Roadcut on Camp Roberts, 1,300 ft S., 2,375 ft W. of NE cor. sec. 24, T. 25 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene, upper Luisian Stage. Collectors: D. L. Durham and R. J. McLaughlin, 1964.
- Mf822. Camp Roberts, 725 ft N., 1,075 ft W. of SE cor. sec. 32, T. 25 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, upper Luisian Stage. Collectors: D. L. Durham and R. J. McLaughlin, 1964.
- Mf823. Camp Roberts, 1,450 ft N., 1,600 ft W. of SE cor. sec. 32, T. 25 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, upper Luisian Stage. Collectors: D. L. Durham and R. J. McLaughlin, 1964.
- Mf824. Camp Roberts, 525 ft N., 2,025 ft W. of SE cor. sec. 4, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene. Collectors: D. L. Durham and R. J. McLaughlin, 1964.
- Mf855. Cut on ranch road just above base of Monterey Shale, 400 ft S., 1,475 ft W. of NE cor. sec. 16, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, upper Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf856. Cut on ranch road, 250 ft S., 1,100 ft W. of NE cor. sec. 16, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf857. 2,300 ft N., 600 ft W. of SE cor. sec. 10, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, lower Luisian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf858. Cut on county road south of Adelaida, 1,125 ft S. of NE cor. sec. 27, T. 26 S., R. 10 E., on section line. Sandholdt Member of Monterey Shale, middle Miocene, upper Luisian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.

- Mf859. Cut on Paso Robles Road, 2,200 ft S., 2,425 ft W. of NE cor. sec. 26, T. 26 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene, upper Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf860. Cut on Paso Robles Road by Las Tablas Creek, 2,575 ft S., 900 ft E. of NW cor. sec. 25, T. 26 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene, lower Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf861. Cut on Paso Robles Road by Las Tablas Creek, 2,425 ft N., 1,450 ft E. of SW cor. sec. 30, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, lower Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf862. Cut on Paso Robles Road, 850 ft S., 2,200 ft E. of NW cor. sec. 22, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, lower Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf863. Cut on Paso Robles Road, 225 ft S., 2,225 ft E. of NW cor. sec. 22, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, lower(?) Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf864. 1,250 ft N., 2,450 ft E. of SW cor. sec. 24, T. 25 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene, lower Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf865. 1,625 ft N., 300 ft E. of SW cor. sec. 11, T. 26 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene, Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf866. 1,175 ft S., 1,400 ft W. of NE cor. sec. 23, T. 26 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene, upper Relizian or lower Luisian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf867. 2,550 ft S., 1,025 ft E. of NW cor. sec. 24, T. 26 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf868. Cut along oil pipeline, 225 ft N., 50 ft E. of SW cor. sec. 24, T. 26 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene, upper Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf869. 275 ft N., 2,250 ft E. of SW cor. sec. 19, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf870. 400 ft S., 1,400 ft E. of NW cor. sec. 29, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, Relizian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf871. 1,750 ft S., 2,250 ft E. of NW cor. sec. 32, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, Relizian or lower Luisian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf872. Cut on Willow Creek Road, 750 ft N., 350 ft W. of SE cor. sec. 26, T. 26 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene, lower Luisian Stage. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf873. 1,875 ft N., 950 ft W. of SE cor. sec. 25, T. 26 S., R. 10 E. Sandholdt Member of Monterey Shale, middle Miocene. Collectors: D. L. Durham and T. L. Winder, 1965.
- Mf895. Cut on Peachy Canyon Road, 2,450 ft S., 1,450 ft W. of NE cor. sec. 33, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, lower Luisian Stage. Collector: D. L. Durham, 1966.
- Mf896. 1,950 ft S., 2,700 ft W. of NE cor. sec. 33, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene. Collector: D. L. Durham, 1966.

- Mf897. Cut on Peachy Canyon Road, 2,100 ft S., 400 ft W. of NE cor. sec. 34, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, lower Luisian Stage. Collector: D. L. Durham, 1966.
- Mf898. Cut on Peachy Canyon Road, 1,550 ft S., 3,000 ft E. of NW cor. sec. 35, T. 26 S., R. 11 E. Sandholdt Member of Monterey Shale, middle Miocene, lower Luisian Stage. Collector: D. L. Durham, 1966.
- M2047. Camp Roberts, 550 ft N., 225 ft W. of SE cor. sec. 19, T. 25 S., R. 11 E. Pancho Rico Formation, fauna of late Miocene or early Pliocene age. Collectors: W. O. Addicott, D. L. Durham, and R. J. McLaughlin, 1964.
- M2048. Cut along oil pipeline, 2,250 ft S., 875 ft E. of NW cor. sec. 19, T. 25 S., R. 11 E. Santa Margarita Formation, probably late Miocene. Collectors: W. O. Addicott, D. L. Durham, and R. J. McLaughlin, 1964.
- M2049. Cut along oil pipeline, 2,300 ft S., 500 ft E. of NW cor. sec. 19, T. 25 S., R. 11 E., stratigraphically below M2048. Santa Margarita Formation, late Miocene. Collectors: W. O. Addicott, D. L. Durham, and R. J. McLaughlin, 1964.
- M2050. Camp Roberts, 2,225 ft N., 1,250 ft W., of SE cor. sec. 29, T. 25 S., R. 11 E. Pancho Rico Formation, early Pliocene. Collectors: W. O. Addicott, D. L. Durham, and R. J. McLaughlin, 1964.
- M2051. Camp Roberts, 1,725 ft S., 150 ft W. of NE cor. sec. 32, T. 25 S., R. 11 E. Santa Margarita Formation, late Miocene. Collectors: W. O. Addicott, D. L. Durham, and R. J. McLaughlin, 1964.
- M2693. 2,050 ft N., 1,975 ft W. of SE cor. sec. 5, T. 26 S., R. 11 E. Unnamed formation, Paleocene. Collectors: D. L. Durham and T. L. Winder, 1965.

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