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RECENT TERTIARY AND CRETACEOUS NANNOPLANKTON COLLECTIONS FROM THE SAN FRANCISCO BAY REGION

by

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Abstract

Nannoplankton ages and outcrop sample locations used for new (1990-1997) geologic mapping of thirty quadrangles around San Francisco Bay are listed here. Most of the collections are from Paleocene and Eocene strata, but a few Cretaceous and Miocene localities are reported.

Introduction

Cretaceous and Tertiary rocks in the San Francisco Bay region are generally poorly exposed, structurally complex, and lithologically similar, so that mapping them is a considerable challenge. In addition, many of the geologic maps in the region were prepared in the 1930's when microfossils were not widely used to help date the rocks. Consequently, new mapping by geologists in the U. S. Geological Survey, California Division of Mines and Geology, petroleum companies and universities have resulted in geologic maps that differ substantially from their predecessors. Maps published for the Santa Cruz Mountains that relied extensively on microfossils include those by Cummings, Touring and Brabb (1962), Brabb and Pampeyan (1983), Brabb (1989), and Clark (1981). Nannoplankton and other microfossils collected in support of this mapping were reported by Bukry, Brabb and Vedder (1977); by Haq (in Brabb, ed., 1983), Clark (1981), and Brabb, Clark and Throckmorton (1977).

Field work and the collection of microfossils during the past eight years has resulted in the release of new geologic maps for Contra Costa County (Graymer, Jones and Brabb, 1994), and Alameda County (Graymer, Jones and Brabb, 1996). We report here on nannoplankton used to help prepare these maps and to improve the quality of other geologic maps in the region for eventual publication (Figures 1 and 2). Work on additional collections is in progress.

The information is arranged in alphabetical order by 7.5' quadrangle to provide quick access to a particular area. Zone determinations follow the nomenclature of Bukry (1973 and 1991), Okada and Bukry (1980) and Perch-Nielsen (1985) (Figures 3a and 3b). An asterisk indicates that foraminifers were also recovered from rocks at the locality (see Appendix). The nannoplankton floras identified may be one or two biostratigraphic guide species or a fuller representative list.

7.5' QUADRANGLES	SAMPLES	ZONES	AGES
Antioch South	10	CC8/13, CP4, CP9-14	Cretaceous, Pal., Eocene
Benicia	1	-	Paleocene
Big Basin	1	CP7/8	Paleocene
Briones Valley	4	CP10, CP10/12	Eocene
Byron Hot Springs	6	CP14	Cretaceous, Eocene
Clayton	17	CP11-CP14	Eocene
Cordelia	9	CP12-CP14	Mesozoic, Eocene
Denverton	1	CP13	Eocene
Diablo	4	CP10-CP12	Eocene
Elmira	3	CP7	Cretaceous, Paleocene
Gilroy	1	CN1	Miocene
Gilroy Hot Spring	2	CP8, CP11	Paleocene, Eocene
Gualala	3	CP9, CP10	Eocene
Honker Bay	5	CP14	Eocene
La Costa Valley	3	-	Cenozoic
Lick Observatory	2	CP14	Eocene
Mindego Hill	4	CP11, CP12	Eocene
Morgan Hill	1	CP11	Eocene
Mt. Madonna	1	CP11	Eocene
Mt. Sizer	1	-	Cretaceous
Mt. Vaca	7	CP7, CP11, CP13	Paleocene, Eocene
Niles	3	CP8	Paleocene
Oakland East	8	CP9, CP11, CP13	Eocene
Palo Alto	2	CP9	Eocene
Point Arena	3	CN3/4, CN5	Miocene
Saunders Reef	3	CP11	Eocene, Oligo-Miocene
Spreckles	1	-	Miocene
Vine Hill, was Port Chicago	3	-	Cretaceous
Walnut Creek	8	CP5, CP10, CP11	Paleocene, Eocene
Woodside	2	CP12	Eocene

Figure 1.--NANNOPLANKTON SITES NEAR SAN FRANCISCO BAY

Antioch South 7.5' quadrangle

*Field No.—91CB3171. In creek cut, NE of dog kennel along Balfour Road, in good exposure of thin bedded and laminated siltstone and very fine grained sandstone.
Latitude.—37°55'33" N Longitude.—121°45'59" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as Meganos Formation, upper member, by Graymer, Jones and Brabb (1994).
Flora.—Coccolithus crassus.

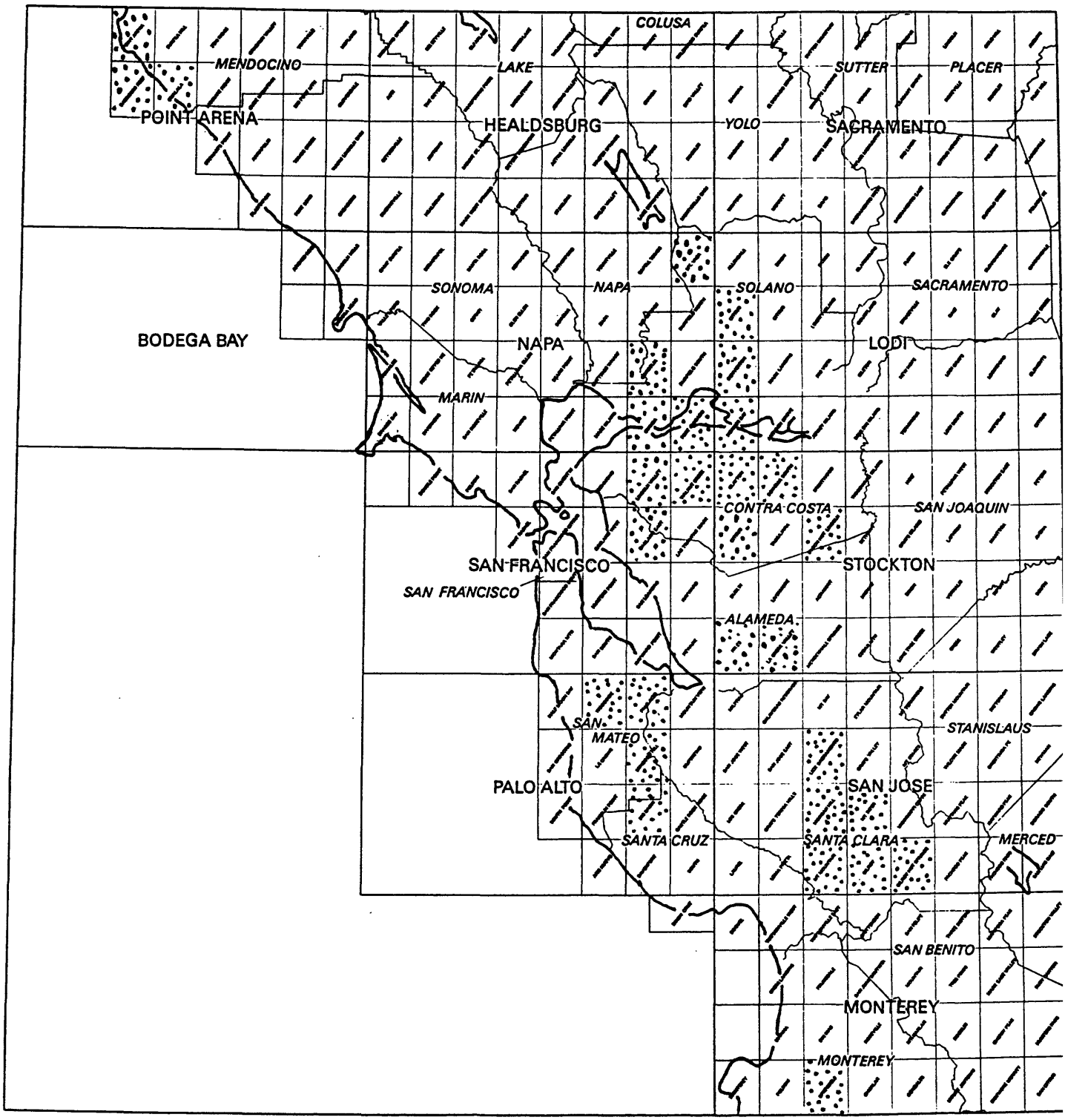

Figure 2.--INDEX MAP SHOWING THE LOCATION OF COUNTIES, 1:100,00 AND 1:24,000 QUADRANGLES, AND QUADRANGES (DOTTED) WITH NEW NANNOPLANKTON INFORMATION. BASE MAP PREPARED BY C. M. WENTWORTH.

NEOGENE COCCOLITH ZONATION

EPOCH	SUBEPOCH	ZONE	SUBZONE
PLIOCENE	LATE	CN 12	d
			c
			b
			a
	EARLY	CN 11	b
			a
		CN 10	d
			c
			b
			a
MIOCENE	LATE	CN 9	b
			a
		CN 8	b
			a
	MIDDLE	CN 7	b
			a
		CN 6	
		CN5	b
			a
		CN 4	
		CN 3	
	EARLY	CN 2	
		CN 1	c
			b
			a

Figure 3A.--GEOLOGIC AGES FOR NEOGENE COCCOLITH ZONATION (BUKRY, 1991).

*Field No.—91CB3171A. About 3 ft stratigraphically below 91CB3171, in creek cut, NE of dog kennel along Balfour Road, in good exposure of thin bedded and laminated siltstone and very fine grained sandstone.
Latitude.—37°55'33" N Longitude.—121°45'59" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as Meganos Formation, upper member, by Graymer, Jones and Brabb (1994).

*Field No.—91CB3172. W side of Deer Valley Road, about 10 ft S of yellow post, in same unit as 91CB3171.
Latitude.—37°55'53" N Longitude.—121°46'34" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as Meganos Formation, upper member, by Graymer, Jones and Brabb (1994).
Flora.—Coccolithus crassus and Tribrachiatus orthostylus.

*Field No.—91CB3194. Good outcrop of well-bedded siltstone with foraminifers, mollusk fragments and a crinoid column. In fault contact with Deer Valley Sandstone of Colburn (1961).
Latitude.—37°56'05" N Longitude.—121°50'27" W.
Age.—early Paleocene, Zone CP4?
Formation.— Mapped as lower part of the Martinez Formation by Graymer, Jones and Brabb (1994).
Flora.—Fasciculithus tympaniformis.

PALEOGENE COCCOLITH ZONATION

EPOCH	SUBEPOCH	ZONE	SUBZONE
OLIGOCENE	LATE	CP 19	b
			a
	EARLY	CP 18	
		CP 17	
		CP 16	c
			b
			a
EOCENE	LATE	CP 15	b
			a
	MIDDLE	CP 14	b
			a
		CP 13	c
			b
			a
		CP 12	b
	EARLY		a
		CP 11	
		CP 10	
		CP 9	b
			a
PALEOCENE	LATE	CP 8	b
			a
		CP 7	
		CP 6	
		CP5	
		CP 4	
		CP 3	
	EARLY	CP 2	
		CP 1	b
			a

Figure 3b.--GEOLOGIC AGES FOR PALEOGENE COCCOLITH ZONATION (BUKRY, 1991).

*Field No.—91CB3194A. About 5 ft stratigraphically lower than 91CB3194, in good outcrop of well-bedded siltstone with foraminifers, mollusk fragments and a crinoid column. In fault contact with Deer Valley Sandstone of Colburn (1961).
Latitude.—37°56'05" N Longitude.—121°50'27" W.
Age.—Paleocene?
Formation.— -Mapped as lower part of the Martinez Formation by Graymer, Jones and Brabb (1994).
Flora.—Coccolithus pelagicus, Ellipsolithus distichus, Fasciculithus sp. and Neochiastozygus sp.

*Field No.—91CB3192. Tiny outcrop in drainage ditch, in thin bedded siltstone and mudstone.
Latitude.—37°56'10" N Longitude.—121°50'10" W.
Age.—early Eocene, Zone CP9b?
Formation.— Mapped as Meganos Formation, shale member, by Graymer, Jones and Brabb (1994).
Flora.—Coccolithus pelagicus, Discoaster binodosus?, Discoaster multiradiatus and Tribrachiatus orthostylus.

*Field No.—91CB3191. Lenzner Ranch, in dark gray mudstone carried there by a landslide.
Latitude.—37°56'15" N Longitude.—121°50'11" W.
Age.—middle Eocene, Zone CP9b.
Formation.— Formation.— Mapped as Meganos Formation, shale member, by Graymer, Jones and Brabb (1994).
Flora.—Discoaster diastypus, Discoaster binodosus, Ellipsolithus macellus and Tribrachiatus orthostylus.

Field No.—91CB3173. From housing pad under construction, in fresh exposure of dark gray siltstone with abundant wood fragments, mud pectens and foraminifers.
Latitude.—37°57'27" N Longitude.—121°46'25" W.
Age.—middle Eocene, Zone CP13c/14a.
Formation.— Mapped as Meganos Formation, upper member, by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus, Discoaster bifax s. ampl., Reticulofenestra samodurovii and Syracosphaera labrosa.

*Field No.—91CB3174B. Along west side of Deer Valley Road, near sign 29, in thin bedded, olive gray mudstone.
Latitude.—37°57'42" N Longitude.—121°46'40" W.
Age.—middle Eocene, Zone CP14a.
Formation.— Mapped as Markley Formation, lower Sydney Flat Shale member by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus, Discoaster bifax and Reticulofenestra umbilica?

Field No.—93CB3847. N bank of Marsh Creek, in unnamed greenish-gray mudstone.
Latitude.—37°53'10" N Longitude.—121°53'10" W.
Age.—mid-Cretaceous (Albian to Coniacian), Zone CC8 to CC13.
Formation.—Mapped as unit B of Cretaceous age by Graymer, Jones and Brabb (1994).
Flora.—Prediscosphaera sp. and Micula sp.

Benicia 7.5' quadrangle

*Field No.—91CB3114. Twenty feet from telephone pole and RR light stand, in sandstone.
Latitude.—38°03'24" N Longitude.—122°14'31" W.
Age.—Paleocene.
Formation.—Mapped as lower Vine Hill Sandstone by Graymer, Jones and Brabb (1994).
Flora.—Ellipsolithus distichus.

Big Basin 7.5' quadrangle

Field No.—EB337B. In a gully tributary to Scott Creek, in siltstone.
Latitude.—37°08'38" N Longitude.—122°13'16" W.
Age.—late Paleocene, Zone CP7/8.
Formation.—Locatelli Formation of Cummings, Touring and Brabb (1962), type area.
Flora.—Neochiastozygus chiastus, N. distentus and Toweius craticulus.

Briones Valley 7.5' quadrangle

*Field No.—93CB3721A. Castro Ranch Road, in measured section with 93CB3721 at the base, about 120 ft W of electric power pole #JP86, and about 40 ft stratigraphically above 93CB3721.
Latitude.—37°57'51" N Longitude.—122°14'34" W.
Age.—early Eocene, Zone CP10/12a.
Formation.— Mapped as unnamed shale and claystone of Eocene age by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus grandis, Discoaster lodoensis, Discoasteroides kuepperi, Sphenolithus moriformis and Tribrachiatus orthostylus.

*Field No.—93CB3721C. About 25 ft above 93CB3721A.
Age.—early Eocene, Zone CP10.
Flora.—Discoaster lodoensis, Discoasteroides kuepperi and Tribrachiatus orthostylus.

*Field No.—93CB3721N. About 80 ft above 93CB3721A.
Age.—early Eocene, Zone CP10.
Flora.—Helicosphaera seminulum, Lophodolithus mochlophorus and Toweius magnicrassus.

*Field No.—93CB3721Q. About 94 ft above 93CB3721A.
Age.—early Eocene, Zone CP10.
Flora.—Helicosphaera seminulum, Lophodolithus mochlophorus and Toweius magnicrassus.

Byron Hot Springs 7.5′ quadrangle

Field No.—91CB3281A. Contra Costa Water District, Vaqueros Dam site, in WCC boring
SA88-2, at a depth of 155 ft, in hard, olive gray mudstone containing radiolaria and *Inoceramus* prisms.
Latitude.— 37°50′06″ N Longitude.—121°43′36″ W.
Age.—Late Cretaceous (Coniacian or Santonian).
Formation.— Mapped as Lower Unit C shale of Cretaceous age by Graymer, Jones and Brabb (1994).
Flora.—Marthasterites furcatus and Micula sp.

Field No.—91CB3282. Contra Costa Water District, Vaqueros Dam site, in WCC boring
D88-3 at a depth of 61 ft, olive gray mudstone.
Latitude.—37°50′07″ N Longitude.—121°43′38″ W.
Age.—Late Cretaceous (Coniacian or Santonian?).
Formation.— Mapped as Lower Unit C shale of Cretaceous age by Graymer, Jones and Brabb (1994).
Flora.—Marthasterites furcatus? and Micula sp.

Field No.—91CB3282A. Contra Costa Water District, Vaqueros Dam site, in WCC boring D88-3 at a depth of 178 ft, in gray shale with *Inoceramus* prisms and *Buchia*.
Latitude.—37°50′07″ N Longitude.—121°43′38″ W.
Age.—Late Cretaceous (Coniacian or Santonian?).
Formation.— Mapped as Lower Unit C shale of Cretaceous age by Graymer, Jones and Brabb (1994).
Flora.—Marthasterites furcatus? and Micula sp.

Field No.—91CB3283. Contra Costa Water District, Vaqueros Dam site, in WCC boring D88-4 at a depth of 115 ft, in soft, gray shale with abundant radiolaria.
Latitude.—37°50′08″ N Longitude.—121°43′44″ W.
Age.—Late Cretaceous (Coniacian or Santonian).
Formation.— Mapped as Lower Unit C shale of Cretaceous age by Graymer, Jones and Brabb (1994).
Flora.—Marthasterites furcatus and Micula sp.

Field No.—91CB3275. Contra Costa Water District, Vaqueros Dam site, in WCC boring SA88-6 at a depth of 62 ft, in hard, olive gray mudstone.
Latitude.—37°50′21″ N Longitude.—121°43′41″ W.
Age.—Late Cretaceous (Coniacian or Santonian).

Formation.— Mapped as Lower Unit C shale of Cretaceous age by Graymer, Jones and Brabb (1994).
Flora.—Marthasterites furcatus and Micula desussata.

Field No.—93CB3846. In ditch along Camino Diablo Road, in white diatomite.
Latitude.—37°51'50" N Longitude.—121°40'12" W.
Age.—middle Eocene, Zone CP14a.
Formation.— Mapped as Nortonville Shale by Graymer, Jones and Brabb (1994).
Flora.—Discoaster bifax.

Clayton 7.5' quadrangle

*Field No.—90CB2945A. Along farm road in Pine Canyon, about 150 ft upstream from culvert in Pine Creek, olive gray mudstone.
Latitude.—37°53'13" N Longitude.—121°13'16" W.
Age.—early Eocene, Zone CP11/12a.
Formation.— Mapped as lower part of the Domengine Formation by Graymer, Jones and Brabb (1994).
Flora.—Discoasteroides kuepperi.

*Field No.—90CB2943. In Pine Creek near junction with Little Pine Creek, in olive gray mudstone with some interbeds of thin-bedded sandstone.
Latitude.—37°53'43" N Longitude.—121°59'32" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as lower part of the Domengine Formation by Graymer, Jones and Brabb (1994).
Flora.—Coccolithus crassus and Discoaster lodoensis.

*Field No.—90CB2944. In Pine Creek, about 100 ft upstream from junction with Little Pine Creek. Section folded so stratigraphic position uncertain, but close to underlying sandstone and shale of Cretaceous age. Mostly olive gray mudstone and some thin-bedded sandstone.
Latitude.—37°53'41" N Longitude.—121°59'32" W.
Age.—early Eocene, Zone CP11?
Formation.— Mapped as lower part of the Domengine Formation by Graymer, Jones and Brabb (1994).
Flora.—Coccolithus crassus?, Discoaster lodoensis, Discoasteroides kuepperi and Ellipsolithus lajollaensis.

*Field No.—91CB3147. Exposure in ditch along road in housing subdivision under construction. Thin, gray mudstone within sandstone
Latitude.—37°57'16" N Longitude.—121°55'08" W.
Age.—Eocene?
Formation.— Mapped as Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Micrantholithus, Pontosphaera and Rhabdosphaera.

*Field No.—91CB3154. Cut and modified slope and housing pads in housing subdivision under construction. Paper-thin gray shale float
Latitude.—37°57'11" N Longitude.—121°54'51" W.
Age.—middle Eocene, Zone CP14a.
Formation.— Mapped as Nortonville Shale by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus, Discoaster bifax, Helicosphaera heezenii and Reticulofenestra umbilica?.

*Field No.—91CB3154A. Cut in road under construction near 91CB3154. Same lithology
Age.—middle Eocene, Zone CP13c.
Flora.—Coccolithus staurion, Discoaster distinctus, Pemma sp., Rhabdosphaera sp. and Syracosphaera labrosa.

*Field No.—91CB3154B. Cut in road under construction near 91CB3154. Same lithology
Age.—middle Eocene, Zone CP13?
Flora.—Helicosphaera bramlettei, Reticulofenestra samodurovii, Sphenolithus furcatolithoides? and Syracosphaera wechesensis.

*Field No.—91CB3202A. In gully near Kirker Pass Highway, in diatomaceous shale with planktic foraminifers.
Latitude.—37°57'51" N Longitude.—121°56'13" W.
Age.—middle Eocene, Zone CP13.
Formation.— Mapped as lower part of Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Campylosphaera dela, Chiasmolithus solitus, Discoaster wemmelensis, Helicosphaera neolophota, Nannotetrina cristata and Zygolithus dubius.

*Field No.—91CB3203A. On E bank of Kirker Creek, opposite barn, and east of Nortonville Road, and in laminated shale.
Latitude.—37°58'45" N Longitude.—121°53'43" W.
Age.—early or middle Eocene.
Formation.— Mapped as lower Sidney Flat Shale Member of Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus and Cyclicargolithus pseudogammation.

*Field No.—91CB3211A. Nortonville Shale, type locality. From uppermost part of section exposed in sidewall scarp of landslide.
Latitude.—37°57'21" N Longitude.—121°52'31" W.
Age.—middle Eocene.
Formation.— Mapped as Nortonville Shale by Graymer, Jones and Brabb (1994).
Flora.—Campylosphaera dela, Chiasmolithus solitus, C. formosus and Reticulofenestra samodurovii.

*Field No.—91CB3212. Lowermost beds of shale exposed in landslide scarp, perhaps 100 ft stratigraphically below 91CB3211A.

Latitude.—37°57'19" N Longitude.—121°52'30" W.
Age.—middle Eocene, Zone CP13c.
Formation.— Mapped as Nortonville Shale by Graymer, Jones and Brabb (1994).
Flora.—Coccolithus staurion, Nannotetrina quadrata, Reticulofenestra samodurovii, Rhabdosphaera sp., Syracosphaera wechesensis and Zygolithus dubius.

*Field No.—91CB3214. NW side of Kirker Pass Highway, in sandstone with thin shale beds.
Latitude.—37°58'17" N Longitude.—121°55'07" W.
Age.—early or middle Eocene.
Formation.— Mapped as lower part of Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Braarudosphaera bigelowii, Chiasmolithus solitus, Discoaster elegans, Helicosphaera lophota and Zygolithus dubius.

*Field No.—91CB3232. Poor exposure along Ignacio Valley Road about 50 ft E of sign "City of Walnut Creek." Rocks there mostly gray shale.
Latitude.—37°56'35" N Longitude.—121°59'46" W.
Age.—middle Eocene, Zone CP13.
Formation.— Mapped as Nortonville Shale by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus, Discoaster distinctus, D. elegans, Nannotetrina quadrata and Reticulofenestra samodurovii.

*Field No.—93CB3805. Area shown on topographic map as Camp Stoneman. Surface shale sample from float in a ravine with good exposures of Markley sandstone and shale. Estimated to be about 600 ft stratigraphically above 93CB3812.
Latitude.—37°59'26" N Longitude.—121°55'36" W.
Age.—middle Eocene, Zone CP14a.
Formation.— Mapped as lower part of Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus and Reticulofenestra samodurovii.

*Field No.—93CB3812. From cores at BFI Keller Canyon dump site provided by Tim Bray. This sample is from Well P-11D at a depth of 33 ft. Shale interbeds in carbonaceous sandstone with fragments of a deep water snail.
Latitude.—37°59'25" N Longitude.—121°56'22" W.
Age.—late middle Eocene, Zone CP14a.
Formation.— Mapped as lower part of Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Discoaster bifax, Reticulofenestra umbilica and R. gladius.

*Field No.—93CB3815. From cores at BFI Keller Canyon dump site provided by Tim Bray. BFI Well MW-9 at a depth between 113 ft and 121 ft. Estimated to be about 1,000 ft strati-graphically above 93CB3812. Sample from mudstone containing abundant snails and foraminifers.
Latitude.—37°59'31" N Longitude.—121°56'32" W.
Age.—late middle Eocene. Zone.—CP14a

Formation.— Mapped as lower part of Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus, Syracosphaera labrosa and S. wechesensis.

*Field No.—93CB3821. From cores at BFI Keller Canyon dump site provided by Tim Bray. BFI Well KL-13 at a depth of 81 ft to 92 ft, in shale with foraminifers and mollusks. Estimated to be about 800 ft stratigraphically above 93CB3812.
Latitude.—37°59'44" N Longitude.—121°55'56" W.
Age.—late middle Eocene, Zone CP14a.
Formation.— Mapped as lower part of Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus, Reticulofenestra umbilica, Lophodolithus acutus, Syracosphaera labrosa and Braarudosphaera.

Cordelia 7.5' quadrangle

Field No.—91CB3301. Shale exposure in Sky Valley Development collected by Sandy Figuers.
Latitude.—38°09'44" N Longitude.—122°11'02" W.
Age.—Mesozoic.
Formation.—Mapped as Great Valley sequence (KJgvm) by Sims and others (1973).
Flora.—Watznaueria barensae only.

Field No.—97CB4661. From CALTRANS cores (TD less than 200 ft) along N side of Highway 80 about 2 miles SW of Cordelia Junction. From laminated gray shale and laminated light gray sandstone within a landslide.
Latitude.—38°11'40" N Longitude.—122°09'54" W.
Age.— middle Eocene, Zone CP14.
Formation.— Mapped as Nortonville Shale Member of Kreyenhagen Formation by Sims and others (1973).
Flora.—Abundant, warm-water flora has Campylosphaera dela, Chiasmolithus grandis, C. solitus, Coccolithus formosus, Discoaster deflandrei, D. elegans, D. nodosus, Helicosphaera neolophota, Reticulofenestra samodurovii, R. umbilica, Sphenolithus furcatolithoides, S. radians, Syracoshpaera labrosa, Transversopontis pulcher, and Zygolithus dubius. Also includes reworked Rhabdosphaera inflata (CP12) and Nannotetrina quadrata (CP13).

Field No.—97CB4672. From laminated dark brown mudstone exposed in creek SE of Highway 80 about 2.6 miles SW of Cordelia Junction.
Latitude.—38°11'17" N Longitude.—122°10'10" W.
Age.— middle Eocene, Zone CP14a.
Formation.— Mapped as landslide deposits by Sims and others (1973), but is probably the same unit as at 97CB4661.
Flora.—Abundant, slightly overgrown flora has Chiasmolithus solitus, Discoaster barbadiensis, D. bifax, Helicosphaera heezenii, Reticulofenestra samodurovii, Syracosphaera labrosa and Transversopontis pulcher.

Field No.—97CB4673. From laminated dark brown mudstone exposed in creek about 600 ft NE of 97CB4672.
Latitude.—38°11'17" N Longitude.—122°10'06" W.
Age.— middle Eocene, Zone CP14a.
Formation.— Mapped as landslide deposits by Sims and others (1973), but is probably the same unit as at 97CB4661.
Flora.—Abundant flora has Braaudosphaera bigelowii, Chiasmolithus solitus, Discoaster bifax, Helicosphaera heezenii, Micrantholithus sp., Reticulofenestra samodurovii and Transversopontis pulcher.

Field No.—97CB4683. Gray mudstone and micaceous sandstone about 2.8 miles SSW of Cordelia Junction.
Latitude.—38°11'45" N Longitude.—122°11'00" W.
Age.— middle Eocene.
Formation.— Mapped as Markely Sandstone Member of Kreyenhagen Formation by Sims and others (1973.
Flora.-Common, low diversity flora predominated by small placoliths and calcareous debris. Includes Braaudosphaera bigelowii, Chiasmolithus solitus, Coccolithus formosus. C. pelagicus, Cyclicargolithus pseudogammation, Helicosphaera seminulum, Pontosphaera plana, Reticulofenestra samodurovii, Rhabdosphaera sp. and Transversopontis pulcher.

Field No.—97CB4721. Good exposures of brown shale along a dirt road about 2 miles ESE of Napa Junction.
Latitude.—38°10'35" N Longitude.—122°12'57" W.
Age.—late middle Eocene, Zone CP14a.
Formation.— Mapped as Nortonville Shale Member of Kreyenhagen Formation by Sims and others (1973).
Flora.—Chiasmolithus solitus, Discoaster bifax, D. elegans and Helicosphaera heezenii.

Field No.—97CB4722. Laminated brown shale with a slabby parting, in a tributary of Fagan Creek about 50 ft. downstream from a road crossing, about 2 miles ENE of Napa Junction.
Latitude.—38°12'06" N Longitude.—122°13'13" W.
Age.— middle? Eocene.
Formation.— Mapped as Markley Sandstone Member of Kreyenhagen Formation by Sims and others (1973).
Flora.—Meager, poorly diagnostic flora with Coccolithus formosus and Sphenolithus spiniger. Nearly all placoliths.

Field No.—97CB4725. Gray mudstone along unnamed creek about 3.6 miles SSW of Cordelia, about 30 ft. stratigraphically above the Domengine Sandstone.
Latitude.—38°09'28" N Longitude.—122°08'57" W.
Age.— middle Eocene, Zone CP12b.
Formation.— Mapped as Nortonville Shale Member of Kreyenhagen Formation by Sims and others (1973).

Flora.—Chiasmolithus grandis, Braarudosphaera discula, Discoaster sublodoensis, Micrantholithus inaequalis, Rhabdosphaera inflata and Zygrhablithus bijugatus.

Field No.—97CB4734. Greenish gray shale in a shallow pit near the railroad tracks about 1.5 miles NNE of Napa Junction..
Latitude.—38°12'27" N Longitude.—122°13'07" W.
Age.— middle Eocene, Zone CP14a.
Formation.— Mapped as Markley Sandstone Member of Kreyenhagen Formation by Sims and others (1973).
Flora.—Radiolarian and diatom debris with common coccoliths including Chiasmolithus solitus?, Discoaster bifax, Reticulofenestra samodurovii and Sphenolithus spiniger.

Denverton 7.5' quadrangle

Field No.—92CB3543. Potrero Hills, from siltstone float in bank of gully.
Latitude.—38°12'15" N Longitude.—121°56'31" W.
Age.—middle Eocene, Zone CP13.
Formation.—Mapped as Nortonville Shale Member of the Kreyenhagen Formation by Sims and others (1973).
Flora.—Abundant, well-preserved flora with Chiasmolithus grandis, Chiasmolithus solitus, Discoaster elegans, Nannotetrina cristata, Reticulofenestra samodurovii, Rhabdosphera spp. and Zygolithus dubius.

Diablo 7.5' quadrangle

*Field No.—90CB2932. N side of South Gate Road, in shale interbeds in massive to thin- bedded light brown sandstone.
Latitude.—37°51'01" N Longitude.—121°55'45" W.
Age.—early Eocene, Zone CP12a.
Formation—Mapped as upper part of Domengine Sandstone by Graymer, Jones and Brabb (1994).
Flora.—Discoaster sublodoensis and Discoasteroides kuepperi.

*Field No.—90CB2934. S side of South Gate Road, from olive gray mudstone
Latitude.—37°51'12" N Longitude.—121°55'44" W.
Age.—early Eocene, Zone CP11/12.
Formation.— Mapped as lower part of Domengine Sandstone by Graymer, Jones and Brabb (1994).
Flora.—Discoasteroides kuepperi.

*Field No.—90CB2935. S side of South Gate Road, in olive gray claystone.
Latitude.—37°51'18" N Longitude.—121°55'54" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as lower part of Domengine Sandstone by Graymer, Jones and Brabb (1994).
Flora.—Coccolithus crassus, Discoaster lodoensis, Rhabdosphaera perlonga and

Toweius magnicrassus.

*Field No.—90CB2935A. S side of South Gate Road, 100 ft SE of sign "Buckeye Camp," in olive gray claystone.
Latitude.—37°51'18" N Longitude.—121°55'54" W.
Age.—early Eocene, Zone CP10.
Formation.— Mapped as lower part of Domengine Sandstone by Graymer, Jones and Brabb (1994).
Flora.— Discoaster lodoensis, Discoasteroides kuepperi, Toweius magnicrassus and Tribrachiatus orthostylus.

Elmira 7.5' quadrangle

Field No.—92CB3531B. E bank of Putah South irrigation canal, opposite ladder with yellow paint, in olive gray mudstone. A contact there between rocks of Paleocene and Cretaceous age was reported to Brabb by Al Almgren in 1991.
Latitude.—38°18'48" N Longitude.—121°57'47" W.
Age.—late Paleocene, Zone CP7.
Formation.—Mapped as Markley Formation by Sims and others (1973).
Flora.—Abundant flora includes Chiasmolithus bidens, Coccolithus robustus, Discoaster nobilis, Ellipsolithus macellus, E. distichus, Fasciculithus tympaniformis, Heliolithus riedelii and Zygodiscus sigmoides.

Field No.—92CB3531C. E bank of Putah South canal, on same bank as ladder with yellow paint, but 100 ft S, in siltstone. The contact between this siltstone and the mudstone at 92CB3531B was not exposed in 1992.
Age.—Late Cretaceous (Coniacian to Maestrichtian).
Formation.—Mapped as unnamed sandstone and shale of Cretaceous age by Sims and others (1973).
Flora.—Very low diversity, extensively-dissolved residue flora predominated by Micula decussata with sparse Watznaueria barnesae.

Field No.—92CB3531D. Ten ft S of 92CB3531C, in siltstone.
Age.—Late Cretaceous (Campanian?).
Formation.—Mapped as unnamed sandstone and shale of Cretaceous age by Sims and others (1973).
Flora.—Low diversity, dissolution residue predominated by Micula decussata. Also includes Broinsonia sp. cf. B. parca, Cribrosphaera ehrenbergii, Prediscosphaera cretacea and Watznaueria barnesae.

Gilroy 7.5' quadrangle

Field No.—96CB4393. Bank at SW end of church parking lot, off Hecker Pass Highway, west of Gilroy, in poor exposure of brown mudstone.
Latitude.—37°00'49" N Longitude.—121°36'10" W.
Age.—Miocene, Zone CN1.

Formation.—Monterey Shale of Dibblee (1973a).
Flora.—Coccolithus pelagicus, Cyclicargolithus abisectus, C. floridanus, Dictyococcites bisectus?, D. scrippsae, Discoaster deflandrei, Helicosphaera carteri and Reticulofenestra gartneri.

Gilroy Hot Spring 7.5′ quadrangle

*Field No.—96CB4432 At top of hill SW of Ca ada Road, in glauconitic gray mudstone faulted against Miocene volcanic rock. Large foraminifers and algae in sandstone; red and green mudstone nearby collected for nannoplankton.
Latitude.—37°00′45″ N Longitude.—121°29′14″ W
Age.—late Paleocene, Zone CP8b.
Formation.—Incorrectly mapped as Santa Clara Formation by Dibblee (1973b).
Flora.—Braarudosphaera bigelowii, Campylosphaera eodela, Coccolithus pelagicus, Discoaster multiradiatus and Zygrhablithus bijugatus.

Field No.—96CB4421 Ca ada Road, about 200 ft E of ranch entrance, in steeply dipping sandstone and shale.
Latitude.—37°02′00″ N Longitude.—121°27′21″ W.
Age.—early Eocene, Zone CP11.
Formation.—Mapped by Dibblee (1973b) as Berryessa Formation of Late Cretaceous age.
Flora.—Coccolithus crassus, Discoasteroides kuepperi and Toweius magnicrassus.

Gualala 7.5′ quadrangle

*Field No.—97CB4601. Northeast side of Havens Neck, at base of cliff, in red mudstone.
Latitude.—38°48′32″ N Longitude.—123°35′58″ W.
Age.—early Eocene, Zone CP9 or 10.
Formation.— Mapped as Paleocene part of German Rancho Formation by Wentworth (1966).
Flora.—Odd, abundant flora has Chiasmolithus consuetus, Coccolithus pelagicus, Sphenolithus radians, Transversopontis pulcher, Tribrachiatus orthostylus and Zygrhablithus bijugatus.

*Field No.—97CB4601A. 7 ft stratigraphically above 97CB4601, from olive gray mudstone.
Age.—early Eocene, Zone CP10.
Flora.— Abundant flora has Coccolithus pelagicus, Discoaster barbadiensis, D. binodosus, D. lodoensis, Ellipsolithus macellus, Lophodolithus reniformis, Sphenolithus radians, Transversopontis pulcher, Tribrachiatus orthostylus and Zygrhablithus bijugatus.

*Field No.—97CB4601C. A few feet stratigraphically below 97CB4601, from dark gray mudstone.
Age.—early Eocene, Zone CP10.

Flora.— Flora has Chiasmolithus consuetus, Discoaster barbadiensis, D. lodoensis, Discoasteroides kuepperi , Ellipsolithus macellus, Sphenolithus radians, and Tribrachiatus orthostylus.

Eleven samples collected by R. W. Filewicz, Unocal, in the Steens Landing area, from the German Rancho Formation as mapped by Wentworth (1966) were examined. Most of these samples are early Eocene, zone CP11, and some are early Eocene, CP12a and one is middle Eocene, zone CP12b.

Seven samples collected by William Reay, Unocal, in the Havens Neck area, from the German Rancho Formation as mapped by Wentworth were examined. Of these, one is early Eocene, zone CP9b and four are early Eocene, CP10.

Honker Bay 7.5′ quadrangle

*Field No.—93CB3811. From cores at BFI Keller Canyon dump site provided by Tim Bray. Well MW-5D at a depth of 275 ft. Estimated 1,400 ft stratigraphically above 93CB3812 (in Clayton Quadrangle). Gray mudstone with snails.
Latitude.—38°00′06″ N Longitude.—121°55′54″ W.
Age.—late middle Eocene.
Formation.— Mapped as Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Discoaster sp. cf. D. bifax and Chiasmolithus solitus.

*Field No.—93CB3813. Well KL-3 at a depth of 73 ft to 84 ft. Estimated 1,500 ft stratigraphically above 93CB3812. Mostly dark gray shale with some sandstone.
Latitude.—38°00′05″ N Longitude.—121°56′01″ W.
Age.—late middle Eocene, Zone CP14a.
Formation.— Mapped as Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus, Discoaster bifax and Reticulofenestra umbilica.

*Field No.—93CB3814. Well MW-4D at a depth of 72 ft to 82 ft. Estimated 2,000 ft stratigraphically above 93CB3812. Mainly mudstone and claystone with snails and foraminifers.
Latitude.—38°00′08″ N Longitude.—121°55′58″ W.
Age.—late middle Eocene, Zone CP14a.
Formation.— Mapped as Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Chiasmolithus solitus, Discoaster bifax, Reticulofenestra umbilica and R. gladius.

*Field No.—93CB3814A. From well MW-4D at a depth of 256 ft. Dark gray mudstone with snails and foraminifers.
Latitude.—38°00′08″ N Longitude.—121°55′58″ W.
Age.—late middle Eocene.
Formation.— Mapped as Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Placoliths abundant.

*Field No.—93CB3816. From well KL-2 at a depth of 33 ft to 43 ft. Estimated to be at the same stratigraphic level as 93CB3814. Mainly gray shale with snails.
Latitude.—38°00'08" N Longitude.—121°55'56" W.
Age.—late middle Eocene, Zone CP14a.
Formation.— Mapped as Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Discoaster bifax.

*Field No.—94CB4061. Along dirt road, opposite culvert, up Lawlor Ravine, west Pittsburg, in punky shale.
Latitude.—38°00'16" N Longitude.—121°56'05" W.
Age.—late middle Eocene, Zone CP14a.
Formation.— Mapped as upper part of Markley Formation by Graymer, Jones and Brabb (1994).
Flora.—Discoaster bifax and Chiasmolithus solitus.

La Costa Valley 7.5' quadrangle

*Field No.—90CB2972. SW side of Calaveras Creek near junction with Alameda Creek. Sample from shale.
Latitude.—37°30'12" N Longitude.—121°49'16" W.
Age.—Cenozoic.
Formation.—Mapped as Claremont Formation by Graymer, Jones and Brabb (1996).
Flora.—Coccolithus pelagicus.

*Field No.—90CB2971B. SW side of Calaveras Creek in a spectacular cliff section where Claremont shale and siliceous shale is thrust over stream gravels and Oursan Sandstone. 90CB2971B is about 20 ft above a carbonate bed and a few inches beneath the basal bed of the Oursan Sandstone resting unconformably on the Claremont Formation. Sample from shale.
Latitude.—37°30'15" N Longitude.—121°49'27" W.
Age.—Cenozoic.
Formation.—Mapped as Claremont Formation by Graymer, Jones and Brabb (1996).
Flora.—Coccolithus pelagicus.

*Field No.—90CB2971C. Same formation, siliceous shale, separated from 90CB2971B by a fault, and overlain by Quaternary gravel.
Age.—Cenozoic.
Flora.—Coccolithus pelagicus and Braarudosphaera bigelowii.

Lick Observatory 7.5' quadrangle

Field No.—95CB4193. Along farm road near San Felipe Creek, in olive gray mudstone.
Latitude.— 37°15'36" N Longitude.—121°39'25" W
Age.—late middle Eocene, Zone CP14a.
Formation.—Mapped incorrectly as Monterey Shale by Dibblee (1972)
Flora.—Chiasmolithus solitus and Discoaster bifax.

Field No.—95CB4193A. About 5 ft stratigraphically lower than 95CB4193.
Age.—late middle Eocene, Zone CP14a.
Flora.—Chiasmolithus solitus and Discoaster bifax.

Mindego Hill 7.5′ quadrangle

*Field No.—JC67-21A. About 50 ft upstream from mouth of Coal Creek, in Corte Madera Creek, in siltstone. Collected by Jon Cummings in 1967.
Latitude.—37°20′36″ N Longitude.—122°12′22″ W
Age.—early middle Eocene, Zone CP12b.
Formation.—Mapped as shale in Butano Sandstone by Brabb and Pampeyan (1983).
Flora.—Rhabdosphaera inflata.

Field No.—97CB4821. Dark gray shale exposed in Corte Madera Creek at a prominent switchback of Alpine Road, about one mile ENE of Mt. Melville.
Latitude.—37°20′25″ N Longitude.—122°12′00″ W.
Age.—early or middle Eocene, Zone CP11/12 or CP12/CP13.
Formation.— Mapped as shale in Butano Sandstone by Brabb and Pampeyan (1983).
Flora.—Diverse flora lacking CP11/12 marker species. The occurrence of Discoaster lodoensis and Toweius magnicrassus and the absence of Discoaster sublodoensis suggests CP11/12a.

Field No.—97CB4821A. Dark gray shale float in the road topographically several feet above 97CB4821.
Age.—early Eocene, Zone CP11.
Flora.— Abundant flora includes Chipragmalithus calathus, Coccolithus crassus, Discoaster lodoensis, Discoasteroides kuepperi, Helicosphaera seminulum and Toweius magnicrassus.

Field No.—97CB4822. Tiny outcrop of gray mudstone in ditch along Alpine Road, about one mile E of Mt. Melville.
Latitude.—37°20′17″ N Longitude.—122°11′52″ W.
Age.—early? Eocene.
Formation.— Mapped as shale in Butano Sandstone by Brabb and Pampeyan (1983).
Flora.—Very sparse flora with Discoasteroides sp.cf. D. kuepperi, Helicosphaera seminulum, Pontosphaera pectinata and Transversopontis pulcheroides.

Morgan Hill 7.5′ quadrangle

Field No.—69CB591 From Carlin Canyon Creek, in olive gray mudstone.
Latitude.—37°13.9′ N Longitude.—121°38.25′ W.
Age.—early Eocene, Zone CP11.
Foramtion.— Mapped as unnamed formation of Cretaceous or Eocene age by Dibblee (1973c).
Flora.—Coccolithus crassus, Discoaster lodoensis and Discoasteroides kuepperi.

Mt. Madonna 7.5′ quadrangle

Field No.—96CB4514A. N side of Hecker Pass Highway about 800 ft SW of Spring Lake, near telephone pole 1212022, in olive gray and red mudstone.
Latitude.—37°00′13″ N Longitude.—121°40′57″ W
Age.—early Eocene, Zone CP11.
Formation.—Mapped by Dibblee (1973d) as unnamed shale of Cretaceous or Eocene age.
Flora.—Coccolithus crassus, Discoaster lodoensis and Ellipsolithus macellus.

Mt. Sizer 7.5′ quadrangle

Field No.—95CB4205. On creek bank SW of Oak Flat Ranch, in olive gray mudstone and sandstone.
Latitude.—37°10′11″ N Longitude.—121°33′58″ W
Age.—Late Cretaceous.
Formation.—Mapped by Dibblee (1973e) as unnamed formation of early Eocene, Paleocene and/or Late Cretaceous age.
Flora.—Broinsonia sp. cf. B. parca, Micula decussata and Watznaueria barnesae.

Mt. Vaca 7.5′ quadrangle

Field No.—97CB4684. Gray mudstone on hill about one mile S of Oakdale School, about 10 ft stratigraphically below a two-foot thick glauconitic sandstone.
Latitude.—38°24′57″ N Longitude.—122°02′45″ W.
Age.—late Paleocene, Zone CP7.
Formation.—Mapped as unnamed sandstone of Cretaceous age by Sims and others (1973). More likely belongs in the Capay Formation or another unit.
Flora.—Chiasmolithus consuetus, Coccolithus pelagicus, Discoaster helianthus, D. mohleri, Ellipsolithus macellus, Fasciculithus involutus, F. tympaniformis, Heliolithus riedelii, Neochiastozygus junctus, Zygodiscus herlynii and Z. sp. cf. Z. sigmoides.

Field No.—97CB4694. About 1400 ft NNW of Oakdale School, gray siltstone float on hill.
Latitude.—38°25′56″ N Longitude.—122°03′34″ W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as Capay Formation by Sims and others (1973).
Flora.—Abundant flora includes Coccolithus crassus, Discoaster barbadiensis, D. lodoensis, Discoasteroides kuepperi and Toweius? gammation.

Field No.—97CB4695. About 1700 ft N of Oakdale School, exposures of gray mudstone in dry reservoir.
Latitude.—38°26′02″ N Longitude.—122°02′52″ W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as Capay Formation by Sims and others (1973).
Flora.—Abundant flora includes Braarudosphaera bigelowii, Campylosphaera dela,

Cepekiella lumina, Chiasmolithus grandis, Discoaster barbadiensis, D. lodoensis, D. mediosus, Discoasteroides kuepperi, Ellipsolithus macellus, Helicosphaera seminulum, Rhabdosphaera perlonga, Toweius magnicrassus, T? gammation, Transversopontis pulcher, Sphenolithus radians, Zygolithus dubius and Zygrhablithus bijugatus (abundant).

Field No.—97CB4695A . About 100 ft stratigraphically above 97CB4695, in olive gray mudstone with reddish streaks.
Latitude.—38°26'02" N Longitude.—122°02'52" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as Capay Formation by Sims and others (1973).
Flora.—Common flora has Campylosphaera dela, Chiasmolithus grandis, Coccolithus crassus, C.cribellum, C. formosus, Discoaster barbadiensis, D. lodoensis, D. cruciformis, Discoasteroides kuepperi, , Helicosphaera seminulum , Lophodolithus mochlophorus, Micrantholithus sp., Rhabdosphaera sp., Sphenolithus radians, Toweius magnicrassus, Transversopontis pulcher, Tribrachiatus orthostylus, Zygolithus dubius, and Zygrhablithus bijugatus.

Field No.—97CB4701. About 1600 ft NNE of Oakdale School, in olive gray mudstone.
Latitude.—38°25'58" N Longitude.—122°02'43" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as Capay Formation by Sims and others (1973).
Flora.—Common flora has Chiasmolithus solitus, Coccolithus crassus, Discoaster lodoensis, D. cruciformis, Discoasteroides kuepperi, Helicosphaera seminulum , Lophodolithus mochlophorus, Micrantholithus sp., Rhabdosphaera sp., Sphenolithus radians, Transversopontis pulcher, Tribrachiatus orthostylus and Zygolithus dubius.

Field No.—97CB4702. About 1600 ft NE of Oakdale School, in olive gray mudstone.
Latitude.—38°25'56" N Longitude.—122°02'37" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as Capay Formation by Sims and others (1973).
Flora.—Meager flora has Chiasmolithus solitus. Coccolithus crassus, Discoaster lodoensis, Discoasteroides kuepperi, Helicosphaera seminulum and Sphenolithus radians.

Field No.—97CB 4705. In Pleasants Creek about 0.6 mile ENE of Pleasants Valley School, from dark gray laminated shale.
Latitude.—38°28'15" N Longitude.—122°02'17" W.
Age.—middle Eocene, Zone CP13.
Formation.—Mapped as Capay Formation by Sims and others (1973).
Flora.—Abundant flora with radiolarians and Chiasmolithus grandis, Discoaster deflandrei, D. martinii, Helicosphaera neolophota, Nannotetrina quadrata and Syracosphaera labrosa.

Niles 7.5′ quadrangle

*Field No.—90CB3004. W side of dirt road parallel to Niles Canyon Road, SW of Dresser, underneath power lines, in olive gray mudstone.
Latitude.—37°35′20″ N Longitude.—121°57′50″ W.
Age.—late Paleocene, Zone CP8.
Formation.—Mapped by Graymer, Jones, and Brabb (1996) as unnamed shale and glauconitic sandstone of Paleocene age. This sandstone rests disconformably on rocks of Cretaceous age.
Flora.—Discoaster multiradiatus, D. mediosus and Fasciculithus spp.

Field No.—92CB3632A. At or very close to 90CB3004. Same lithology and formation.
Age.—late Paleocene, Zone CP8.
Flora.— Braarudosphaera bigelowii, Discoaster multiradiatus, D. mediosus, Fasciculithus clinatus, F. tympaniformis, F. schaubii, Neochiastozygus junctus and N. chiastus.

Field No.—91CB3634. Along unmapped farm road nearly two miles NNW of Niles Junction, in massive siltstone.
Latitude.—37°36′09″ N Longitude.—121°58′50″ W.
Age.—late Paleocene.
Formation.— Mapped as unnamed siltstone and sandstone of Paleocene age by Graymer, Jones and Brabb (1996).
Flora.—Abundant flora includes Discoaster multiradiatus, Ellipsolithus distichus, Fasciculithus clinatus, F. tympaniformis, F. schaubii, Neochiatozygus junctus, Toweius craticulus and T. eminens.

Oakland East 7.5′ quadrangle

*Field No.—94CB4074. N side of Sayre Road, opposite house #6959, and about 0.8 mi E of Thornhill School, in olive gray mudstone.
Latitude.—37°50′04″ N Longitude.—122°11′47″ W.
Age.—early Eocene, Zone CP9b.
Formation.— Mapped within unnamed sandstone and green mudstone of Eocene age by Graymer, Jones and Brabb (1996).
Flora.—Discoaster binodosus, Discoaster diastypus, Discoaster multiradiatus, Tribrachiatus orthostylus and Zygrhablithus bijugatus.

*Field No.—90CB2964. Skyline Boulevard across from house #8291, in olive gray mudstone.
Latitude.—37°50′05″ N Longitude.—122°11′00″ W.
Age.—early or middle Eocene.
Formation.— Mapped within unnamed sandstone and green mudstone of Eocene age by Graymer, Jones and Brabb (1996).
Flora.—Campylosphaera dela.

*Field No.—94CB4081. N side of Saroni Road, opposite house #6870 and opposite telephone pole #22022, in red mudstone.
Latitude.—37°50'06" N Longitude.—122°11'55" W.
Age.—early Eocene, Zone CP9b.
Formation.— Mapped within unnamed sandstone and green mudstone of Eocene age by Graymer, Jones and Brabb (1996).
Flora.—Discoaster binodosus, Discoaster diastypus, Discoaster multiradiatus, Tribrachiatus orthostylus and Zygrhablithus bijugatus.

*Field No.—94CB4081A. About 5 ft stratigraphically below 94CB4081, same lithology and unit
Age.—early Eocene, Zone CP9b.
Flora.—Discoaster binodosus, Discoaster diastypus, Discoaster multiradiatus, Tribrachiatus orthostylus and Zygrhablithus bijugatus.

*Field No.—90CB2955. Near intersection of Snake and Thornhill Roads, in olive gray mudstone.
Latitude.—37°50'18" N Longitude.—122°11'59" W.
Age.—early Eocene, Zone CP11?
Formation.— Mapped within unnamed sandstone and green mudstone of Eocene age by Graymer, Jones and Brabb (1996).
Flora.—Discoaster lodoensis, Discoasteroides kuepperi and Tribrachiatus orthostylus.

*Field No.—90CB2955A. About 10 ft E of 90CB2855, same lithology and unit
Age.—early Eocene, Zone CP11?
Flora.—Discoaster lodoensis, Discoasteroides kuepperi and Zygrhablithus bijugatus.

*Field No.—92CB3431. Excavation for garage or house at intersection of Charing Cross and Tunnel Roads, in glauconitic siltstone.
Latitude.—37°51'28" N Longitude.—122°13'16" W.
Age.—middle Eocene, Zone CP13.
Formation.— Mapped within unnamed sandstone and green mudstone of Eocene age by Graymer, Jones and Brabb (1996).
Flora.—Discoaster barbadiensis, D. martinii, Nannotetrina quadrata, Reticulofenestra samodurovii and Sphenolithus sp.

Field No.—90CB2946. W side of Tunnel Road, in mudstone.
Latitude.—37°51'29" N Longitude.—122°13'16" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped within unnamed sandstone and green mudstone of Eocene age by Graymer, Jones and Brabb (1996).
Flora.—Coccolithus crassus?, Discoaster lodoensis, Discoasteroides kuepperi and Tribrachiatus orthostylus.

Palo Alto 7.5′ quadrangle

*Field No.—94CB4071A. E side of Frenchmans Road, due W of Provost's house constructed by Frank Lloyd Wright, and in a trench dug to examine a fault zone. Geology of the trench has been described by Page, Ingle and Kovach (1996). This sample is from the red part of their unnamed, diapiric, gray and red claystone.
Latitude.—37°25′00″ N Longitude.—122°09′46″ W.
Age.—early Eocene, Zone CP9b.
Flora.—Discoaster binodosus, Discoaster diastypus, Ellipsolithus macellus and Tribrachiatus contortus.

Field No.—94CB4071B. A few inches from 94CB4071A, in same unit, but from olive gray part.
Age.—early Eocene, Zone CP9b.
Flora.—Coccolithus pelagicus, Discoaster binodosus, Lophodolithus spp. and Tribrachiatus orthostylus.

Point Arena 7.5′ quadrangle

Field No.—96CB4462. At mouth of Moat Creek, in semi-siliceous brown mudstone.
Latitude.—38°52′55″ N Longitude.—123°40′32″ W.
Age.—early Miocene, Zone CN3/4.
Formation.—Locality within Point Arena Formation of Miller (1981).
Flora.—Cyclicargolithus floridanus, Discoaster deflandrei, D. variabilis and Sphenolithus heteromorphus.

Field No.—96CB4622. Along sea cliff about 800 ft S of mouth of Ross Creek, brown mudstone 2 ft below a dolomite bed, estimated 150 ft below the top of the Galloway Formation.
Latitude.—38°52′34″ N Longitude.—123°39′52″ W.
Age.—early or middle Miocene, Zone CN3.
Formation.—Galloway Formation.
Flora.—Cyclicargolithus floridanus, Discoaster deflandrei, Helicosphaera ampliaperta?, H. carteri, H. scissura, Sphenolithus heteromorphus and S. abies.

Field No.—96CB4643. Along the sea cliffs about 800 ft S of the wharf at Arena Cove, from semi-siliceous brown mudstone.
Latitude.—38°52′55″ N Longitude.—123°40′32″ W.
Age.—middle Miocene, Zone CN5.
Formation.—Locality possibly within Point Arena Formation of Miller (1981).
Flora.—Cyclicargolithus floridanus, Discoaster exilis, D. variabilis and Reticulofenestra pseudoumbilicus.

Saunders Reef 7.5′ quadrangle

*Field No.—97CB4592. Along the north side of Highway 1 about 200 ft W of Walker Creek, from olive gray mudstone within a massive sandstone.

Latitude.—38°50'44" N Longitude.—123°38'15" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as the Eocene part of the German Rancho Formation by Wentworth (1966).
Flora.—Coccolithus crassus, Discoaster lodoensis and Discoasteroides kuepperi.

*Field No.—97CB4602. 7 ft stratigraphically above 97CB4601, from olive gray mudstone.
Latitude.—38°50'46" N Longitude.—123°39'16" W.
Age.—early Eocene, Zone CP11.
Formation.— Mapped as the Eocene part of the German Rancho Formation by Wentworth (1966).
Flora.— Abundant flora has Chiasmolithus grandis, Coccolithus crassus, C. pelagicus, Discoaster sp. cf. D. lodoensis, Discoasteroides kuepperi, Helicosphaera lophota, Sphenolithus radians and Zygrhablithus bijugatus.

*Field No.—97CB4621. 7 ft stratigraphically above 97CB4601, from olive gray mudstone.
Latitude.—38°52'03" N Longitude.—123°35'58" W.
Age.—Oligocene or early Miocene.
Formation.— Mapped as Galloway Formation by Wentworth (1966).
Flora.— Etched flora includes Cyclicargolithus floridanus, Discoaster deflandrei and Sphenolithus moriformis.

Spreckles 7.5' quadrangle

*Field No.—96CB4891. West side of Laureles Grade Road. Semi-siliceous mudstone about 10 ft E of 1-foot thick chert bed.
Latitude.—36°33'12" N Longitude.—121°44'52" W.
Age.—late Miocene.
Formation.—Canyon del Rey diatomite member of Monterey Formation.
Flora.- Sparse, non-diagnostic Reticulofenestra. Silicoflagellates in this sample, such as Bachmannocena dumitricae, suggest late Miocene.

Vine Hill (formerly Port Chicago) 7.5' quadrangle

Field No.—91CB3293A. From International Technology Corporation toxic waste site "Panoche," east of Benicia, in boring MW-13, at a depth of 100 ft, dark gray mudstone and siltstone.
Latitude.—38°06'12" N Longitude.—122°07'18" W.
Age.—Cretaceous (late Albian to Coniacian).
Formation.—Mapped as unnamed formation in Great Valley sequence (KJgum?) by Sim· and others (1973).
Flora.— Eprolithus floralis and Eiffellithus turriseiffeli.

Field No.—91CB3293B. Same data as for 91CB3293A except that depth is 88ft.
Age.—Cretaceous (late Albian to Coniacian).

Flora.— Eprolithus floralis and Eiffellithus turriseiffeli.

Field No.—91CB3292. From International Technology Corporation toxic waste site "Panoche," east of Benicia, in boringWO-13, at a depth of 18 to 30 ft, dark gray mudstone and siltstone.
Latitude.—38°06'33" N Longitude.—122°07'18" W.
Age.—Cretaceous (Albian to Santonian).
Formation.—Mapped as unnamed formation in Great Valley sequence (KJgum?) by Sims and others (1973).
Flora.—Eprolithus floralis.

Walnut Creek 7.5' quadrangle

*Field No.—91CB3233. S side of Mallard Drive and SE corner of Encanto Place, in hillside next to house, in siltstone and shale float.
Latitude.—37°55'22" N Longitude.—122°04'58" W.
Age.—early Eocene, Zone CP10.
Formation.—Upper Vine Hill Sandstone of Graymer, Jones, and Brabb (1994).
Flora.—Chiasmolithus grandis, Discoaster lodoensis, Discoasteroides kuepperi, Lophodolithus reniformis, Tribrachiatus orthostylus and Zygrhablithus bijugatus.

*Field No.—91CB3234. S side of Mallard Drive and SE corner of intersection with Ross Place, in olive gray mudstone.
Latitude.—37°55'22" N Longitude.—122°04'53" W.
Age.—early Eocene, Zone CP11.
Formation.—Upper Vine Hill Sandstone of Graymer, Jones, and Brabb (1994).
Flora.—Chiasmolithus consuetus, C. grandis, Coccolithus crassus s.str., Discoaster lodoensis, Discoaster kuepperi, Rhabdosphaera perlonga, Tribrachiatus orthostylus and Zygrhablithus bijugatus.

Field No.—91CB3311. Temporary exposure at base of landslide behind house at 150 Glenview Drive, in massive siltstone. Collected by S. Figures.
Latitude.—37°58'07" N Longitude.—122°06'15" W.
Age.—late Paleocene, Zone CP5.
Formation.—Upper Vine Hill Sandstone of Graymer, Jones, and Brabb (1994).
Flora.—Chiasmolithus bidens, C. californicus, Coccolithus robustus, Fasciculithus involutus, F. tympaniformis, Heliolithus kleinpellii and Zygodiscus sp. cf. Z. sigmoides.

*Field No.—93CB3822. Temporary road cut along east side Highway 680 near Trinity Road, about 300 ft S of BART trestle across highway, in about 30 ft of sheared, olive gray mudstone. Stratigraphic sequence at this outcrop uncertain. Outcrop removed and bedrock covered with concrete by 1995.
Latitude.—37°54'00" N Longitude.—122°04'10" W.
Age.—early Eocene, Zone CP11.
Formation.—Las Juntas Shale or Vine Hill Sandstone of Graymer, Jones and Brabb (1994).

Flora.—Coccolithus crassus, Discoaster lodoensis and Toweius magnicrassus.

*Field No.—93CB3822C. A few tens of feet north of 93CB3822, in siltstone with *Turritella* and other mollusks.
Age.—early Eocene, Zone CP11.
Formation.—Vine Hill Sandstone of Graymer, Jones and Brabb (1994).
Flora.—Coccolithus crassus, Discoaster lodoensis and Discoasteroides kuepperi.

*Field No.—93CB3832A. Temporary road cut along west side Highway 680 near Trinity Road, about 200 ft N of BART trestle across highway, in gray mudstone. Outcrop removed and bedrock covered with concrete by 1995.
Latitude.—37°54'02" N Longitude.—122°04'12" W.
Age.—early Eocene, Zone CP11?
Formation.—Las Juntas Shale of Graymer, Jones and Brabb (1994).
Flora.—Chiphragmalithus calathus, Discoaster lodoensis and Discoasteroides kuepperi.

*Field No.—93CB3833. Small, temporary outcrop at base of retaining wall about 50 ft N of Trinity Road overpass on west side Highway 680, in siltstone with mollusks.
Latitude.—37°54'06" N Longitude.—122°04'11" W.
Age.—early Eocene, Zone CP11.
Formation.—Vine Hill Sandstone of Graymer, Jones and Brabb (1994).
Flora.—Coccolithus crassus, Discoaster lodoensis, Discoasteroides kuepperi, Lophodolithus reniformis and Tribrachiatus orthostylus.

*Field No.—93CB3833A. About 200 ft N of 93CB3833, in olive gray mudstone.
Age.—early Eocene, Zone CP11.
Formation.—Las Juntas Shale or Vine Hill Sandstone of Graymer, Jones and Brabb (1994).
Flora.—Coccolithus crassus, Discoaster lodoensis, Discoasteroides kuepperi, Ellipsolithus macellus and Tribrachiatus orthostylus.

Woodside 7.5' quadrangle

*Field No.—96CB4362 SE side of La Honda Road about 200 ft SW of big bend, about 1,500 ft SW of the San Andreas fault. Landslide outcrops of sandstone and olive gray mudstone. Sample from mudstone.
Latitude.—37°24'03" N Longitude.—122°15'21" W.
Age.—early middle Eocene, Zone CP12b.
Formation.—The age and formation name of an extensive area of poorly exposed sandstone and shale between the San Andreas and Pilarcitos faults has not previously been well established. Arenaceous foraminifers from these rocks examined by oil company paleontologists in the 1950's were reported to be of Paleocene or Eocene age. The rocks were referred to as Butano (?) Sandstone by Brabb and Pampeyan (1983) and as unnamed sandstone resembling Butano Sandstone by Pampeyan (1993).
Flora.—Rhabdosphaera inflata.

*Field No.—96CB4363 SE side of La Honda Road, close to BM732, about 50 ft N of sign "84SM17-47" and more than 2,000 ft SW of San Andreas fault. Road cut has well bedded sandstone with interbeds of olive gray mudstone. Sample from mudstone.
Latitude.—37°24'00" N Longitude.—122°24'00" W.
Age.—early middle Eocene, Zone CP12b.
Formation.—see sample 95CB4362
Flora.—Rhabdosphaera inflata.

Analysis

One hundred nineteen samples with nannoplankton were examined from thirty 7.5' quadrangles in an area extending from Point Arena about 200 miles south to Spreckles and 60 miles east to Patterson (Figure 4). An estimated 300 samples were barren. Cretaceous floras occur in 13 samples from six of the thirty quadrangles, mostly northeast of Oakland. A majority of the samples contain Paleogene floras. Ten of the 19 Paleogene Zones recognized by Bukry (1991) are represented by the samples, which range in age from late Paleocene to middle Eocene. No nannoplankton samples correlative with late Eocene or Oligocene were found, but samples of that age from the San Francisco Bay region were reported by Poore and Bukry (1983) and Bukry and others (1977). A few samples of early and middle Miocene age were also found.

The samples have been used primarily in documenting the age of geologic formations to confirm the stratigraphic sequence or the presence of faults. Maps that have been released so far (Graymer and others,1993, 1994, 1995, 1996 and Brabb and others 1998) have relied extensively on the nannofossils in this report and on other microfossils. The most substantial difference in the new maps is the Niles Quadrangle (Graymer and others, 1993) where 34 new and potentially hazardous faults were identified. These new faults have a total length of at least 72 miles.

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APPENDIX

Foraminifera accession numbers
Associated with Coccolith CB
Field numbers for samples (in page order)

CB NUMBER	FORAMINIFERA	CB NUMBER	FORAMINIFERA
91CB3171	Mf7974	93CB3821	Mf8332
91CB3171A	Mf7975	91CB3301	-
91CB3172	Mf7976	97CB4661	-
91CB3194	Mf7984	97CB4672	-
91CB3194A	Mf7985	97CB4673	-
91CB3192	Mf7982	97CB4683	-
91CB3191	Mf7981	97CB4721	-
91CB3173	-	97CB4722	-
91CB3147B	Mf7979	97CB4725	-
93CB3847	-	97CB4734	-
91CB3114	Mf7966	92CB3543	-
EB337B	-	90CB2932	Mf7830
93CB3721A	Mf8389	90CB2934	Mf7832
93CB3721C	Mf8391	90CB2935	Mf7833
93CB3721N	Mf8401	90CB2935A	Mf7834
93CB3721Q	Mf8402	92CB3531B	-
91CB3281A	-	92CB3531C	-
91CB3282	-	92CB3531D	-
91CB3282A	-	96CB4393	-
91CB3283	-	96CB4432	-
91CB3275	-	96CB4421	-
93CB3846	-	97CB4601	Mf9086
90CB2945A	Mf7838	97CB4601A	Mf9087
90CB2943	Mf7835	97CB4601C	Mf9088

CB NUMBER	FORAMINIFERA	CB NUMBER	FORAMINIFERA
90CB2944	Mf7836	93CB3811	Mf8334
91CB3147	Mf7932	93CB3813	Mf8335
91CB3154	Mf7973	93CB3814	Mf8336
91CB3154A	Mf7988	93CB3814A	Mf8337
91CB3154B	Mf7989	93CB3816	Mf8338
91CB3202A	Mf8057	94CB4061	Mf8540
91CB3203A	Mf8059	90CB2972	Mf7863
91CB3211A	Mf8062	90CB2971A	Mf7861
91CB3212	Mf8063	90CB2971C	Mf7862
91CB3214	Mf8065	95CB4193	-
91CB3232	Mf8072	95CB4193A	-
93CB3805	Mf8331	JC67-21A	Mf8435
93CB3812	Mf8330	97CB4821	-
93CB3815	Mf8333	97CB4821A	-
97CB4822	-	93CB3822C	Mf8312
69CB591	-	93CB3832A	Mf8314
96CB4514A	-	93CB3833	Mf8315
95CB4505	-	93CB3833A	Mf8316
97CB4684	-	96CB4362	Mf8775
97CB4694	-	96CB4363	Mf8777
97CB4695	-	97CB4695A	-
97CB4701	-	97CB4702	-
97CB4705	-	90CB3004	MF7793
92CB3632A	-	91CB3634	-
94CB4074	Mf8575	90CB2964	Mf7846
94CB4081	Mf8576	94CB4081A	Mf8601
90CB2955	Mf7843	90CB2955A	Mf7844
92CB3431	Mf8120	90CB2946	Mf7839
94CB4071A	Mf8549	94CB4071B	-
96CB4462	-	96CB4622	-
96CB4623	-	97CB4592	Mf9085
97CB4602	Mf9089	97CB4621	Mf9090
96CB4891	-	91CB3292	-
91CB3293A	-	91CB3293B	-
91CB3233	Mf8073	91CB3234	Mf8074
91CB3311	-	93CB3822	Mf8309