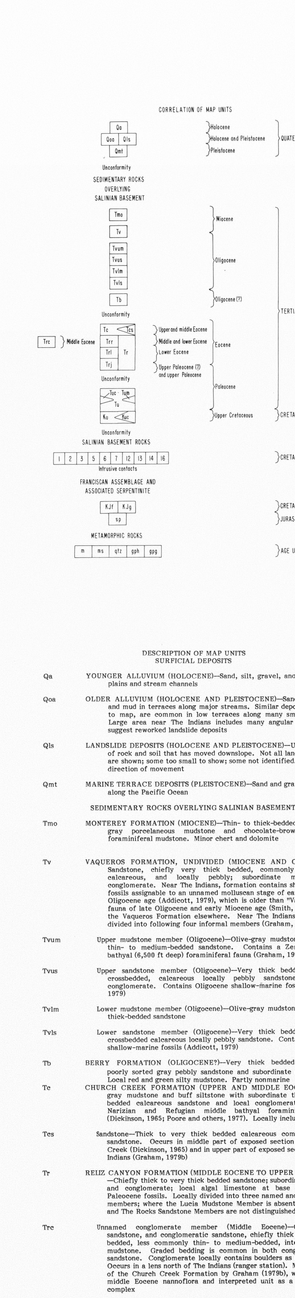

DESCRIPTION OF MAP UNITS
SURFICIAL DEPOSITS

Qa YOUNGER ALLUVIUM (HOLOCENE)—Sand, silt, gravel, and mud in flood plains and stream channels

Qoa OLDER ALLUVIUM (HOLOCENE AND PLEISTOCENE)—Sand, silt, gravel, and mud in terraces along major streams. Similar deposits, too small to map, are common in low terraces along many smaller streams. Large areas near The Indians includes many angular boulders that suggest reworked landslide deposits

Qls LANDSLIDE DEPOSITS (HOLOCENE AND PLEISTOCENE)—Unsorted rubble of rock and soil that has moved downslope. Not all landslide deposits are shown; some too small to show; some not identified. Arrows show direction of movement

Qmt MARINE TERRACE DEPOSITS (PLEISTOCENE)—Sand and gravel in terraces along the Pacific Ocean

SEDIMENTARY ROCKS OVERLYING SALINIAN BASEMENT

Tmo MONTEREY FORMATION (MIOCENE)—Thin- to thick-bedded light-yellow-gray porcelaneous mudstone and chocolate-brown calcareous foraminiferal mudstone. Minor chert and dolomite

Tv VAQUEROS FORMATION, UNDIVIDED (MIOCENE AND OLIGOCENE)—Sandstone, chiefly very thick bedded, commonly crossbedded, calcareous, and locally pebbly; subordinate mudstone and conglomerate. Near The Indians, formation contains shallow- marine fossils assignable to an unnamed molluscan stage of early and middle Oligocene age (Addicott, 1970), which is older than "Vaqueros" stage fauna of late Oligocene and early Miocene age (Smith, 1975) found in the Vaqueros Formation elsewhere. Near The Indians, formation is divided into following four informal members (Graham, 1979b):

Tvum Upper mudstone member (Oligocene)—Olive-gray mudstone and graded thin- to medium-bedded sandstone. Contains a Zemorrian lower bathyal (6,500 ft deep) foraminiferal fauna (Graham, 1979b)

Tvus Upper sandstone member (Oligocene)—Very thick bedded commonly crossbedded, calcareous locally pebbly sandstone and minor conglomerate. Contains Oligocene shallow-marine fossils (Addicott, 1979)

Tvlm Lower mudstone member (Oligocene)—Olive-gray mudstone and thin- to thick-bedded sandstone

Tvls Lower sandstone member (Oligocene)—Very thick bedded commonly crossbedded calcareous locally pebbly sandstone. Contains Oligocene shallow-marine fossils (Addicott, 1979)

Tb BERRY FORMATION (OLIGOCENE?)—Very thick bedded crossbedded, poorly sorted gray pebbly sandstone and subordinate conglomerate. Local red and green silty mudstone. Partly nonmarine

Te CHURCH CREEK FORMATION (UPPER AND MIDDLE EOCENE)—Olive-gray mudstone and buff siltstone with subordinate thin- to thick-bedded calcareous sandstone and local conglomerate. Contains Narizian and Refugian middle bathyal foraminiferal faunas (Dickinson, 1965; Poore and others, 1977). Locally includes:

Tes Sandstone—Thick to very thick bedded calcareous commonly graded sandstone. Occurs in middle part of exposed section along Church Creek (Dickinson, 1965) and in upper part of exposed section near The Indians (Graham, 1979b)

Tr REILZ CANYON FORMATION (MIDDLE EOCENE TO UPPER PALEOCENE)—Chiefly thick to very thick bedded sandstone; subordinate mudstone and conglomerate; local algal limestone at base contains late Paleocene fossils. Locally divided into three named and one unnamed members; where the Lucia Mudstone Member is absent, the Junipero and The Rocks Sandstone Members are not distinguished :

Tre Unnamed conglomerate member (Middle Eocene)—Conglomerate, sandstone, and conglomeratic sandstone, chiefly thick to very thick bedded, less commonly thin- to medium-bedded, interbedded with mudstone. Graded bedding is common in both conglomerate and sandstone. Conglomerate locally contains boulders as large as 20 ft. Occurs in a lens north of The Indians (ranger station). Mapped as part of the Church Creek Formation by Graham (1979b), who reported a middle Eocene nannoflora and interpreted unit as a slope-channel complex

Trr The Rocks Sandstone Member (middle and lower Eocene)—Sandstone, thick to very thick bedded; typically pebbly and conglomeratic. Sandstone beds commonly amalgamated, locally contain mudstone rip-up clasts. Subordinate conglomerate, mudstone, and thin- to thick-bedded graded sandstone

Trl Lucia Mudstone Member (lower Eocene)—Olive-gray silty mudstone and local thin- to thick-bedded graded sandstone. Locally contains abundant planktic foraminifera of early Eocene age and middle to lower bathyal benthic foraminifers of Ulatisian age (Durham, 1963; Dickinson, 1965; Poore and others, 1977)

Trj Junipero Sandstone Member (lower Eocene and upper Paleocene?)—Discontinuous unit of very thick bedded crossbedded sandstone, conglomeratic sandstone, and conglomerate locally contains clasts as large as 6 ft. Shallow-water algae remains and orbitoid foraminifers of probable Penutian age occur at one locality (Dickinson, 1965)

Tu UNNAMED FORMATION OF COMPTON (1957) (PALEOCENE)—Dark-gray to olive-gray mudstone; Paleocebbed to very thick bedded commonly graded sandstone and conglomeratic sandstone; and very thick bedded conglomerate. Contains Paleocene megafossils and middle and lower bathyal foraminiferal faunas. Near The Indians, Ruetz (1979) interpreted formation as deposits of a retrograding deep-sea fan. Locally includes:

Tum Mudstone—Dark- to olive-gray mudstone and sparse thin-bedded graded sandstone. Contains lower bathyal Ynezian foraminiferal faunas (Poore and others, 1977). Locally occurring dark-gray limestone at base of unit contains Paleocene mollusks (L. R. Saul, written commun., 1982)

Tue Conglomerate and conglomeratic sandstone—Occurs as small isolated remnants on basement between the Junipero Serra and Lucia faults

Ku UNNAMED FORMATION (UPPER CRETACEOUS)—Dark- to olive-gray mudstone; thin to very thick bedded commonly graded sandstone and conglomeratic sandstone; and very thick bedded conglomerate. Lithologically similar to the overlying unnamed formation of Compton (1957) south of the Indians preserve. Contains mapped contact on megafossil localities and local lithologic variations (Ruetz, 1979). We traced contact northwest with some uncertainty on aerial photographs. Locally includes:

Kuc Conglomerate—Cobble and boulder conglomerate, conglomeratic sandstone, and sandstone. Composed chiefly of clasts of granitic rocks but includes other basement rock types and, locally, volcanic rocks

SALINIAN BASEMENT ROCKS

PLUTONIC ROCKS (CRETACEOUS AND OLDER?)—Number symbols are the same as those used by Ross (1976, 1977) for corresponding map units. Divided into:

1 ULTRAMAFIC ROCKS AND SERPENTINITE—Generally small bodies of ultramafic rock of variable composition, commonly coarse to very coarse grained. Some bodies partly to completely serpentinized. Compton (1966) noted variation in mineralogy from granulite-facies assemblages to serpentinite and suggested that bodies were emplaced at various times during plutonism and metamorphism

2 GABBRO AND DIORITE—Chiefly composed of hornblende and plagioclase; locally contains clinopyroxene and biotite

3 CHARNOCKITIC TONALITE OF COMPTON (1960)—Medium- to dark-gray greenish-gray-weathering, medium-grained foliated rocks. According to Compton (1960), average modal composition (in percent) is: andesine 62, quartz 18, hypersthene, 9; hornblende, 7, biotite, 3; K-feldspar, 0.5; and opaque minerals, 0.5. Occurs in several bodies near coast. Poorly exposed and apparently used as gneiss

5 GRANODIORITE AND QUARTZ DIORITE OF BEAR MOUNTAIN—Medium-gray well- foliated granodiorite and quartz diorite. In part occurs in composite plutons with more felsic rocks. Commonly deeply weathered

6 PORPHYRITIC GRANODIORITE OF JUNIPERO SERRA PEAK—Light-colored well-foliated granodiorite with K-feldspar phenocrysts to 0.6 in. May be gradational into the nonporphyritic quartz monzonite of Pinyon Peak. Occurs on south slope of Junipero Serra Peak and in small bodies to east

7 QUARTZ MONZONITE OF PINYON PEAK—Massive light-colored equigranular quartz monzonite. Occurs in composite plutons with more mafic rocks. Locally intrudes the Bear Mountain unit

12 PORPHYRITIC GRANODIORITE OF MONTEREY—Medium- to coarse-grained moderately well foliated granodiorite with 0.4-0.8 in. phenocrysts of K-feldspar. Locally nonporphyritic. Occurs only in northwestern part of area

13 VARIABLE QUARTZ MONZONITE-GRANODIORITE OF BIG PINES AND ISLAND MOUNTAIN (WIEBE, 1960) AND SIMILAR(?) MASS OF WILLOW CREEK—Medium-grained quartz monzonite or granodiorite, in part with K-feldspar phenocrysts. Only Willow Creek body occurs in map area

14 GARNETIFEROUS QUARTZ MONZONITE OF LITTLE SUR AND SOUTH VENTANA CONE (WIEBE, 1966), AND POSSIBLY RELATED ROCKS NEAR ARROYO SECO—Coarse-grained light-colored quartz monzonite containing 1-3 percent garnet that occurs in part as clusters rimmed by biotite. Grades to granodiorite locally. West of Arroyo Seco (Arroyo Center on map) unit includes north-trending sill-like body, two smaller bodies to south, and a larger mass at Tassajara Hot Springs, 3 mi to west

16 HETEROGENEOUS GRANITIC COMPLEX OF WIEBE (1966)— Unit defined by Wiebe (1966) to characterize areas of diverse granitic rocks that were not separable by his detailed mapping. It is here extended to include granitic rocks of variable composition that we recognized by less detailed mapping, some only from distant views and on aerial photographs. Consists chiefly of quartz monzonite, granodiorite, and tonalite; minor diorite and gabbro. Locally may include septa of metasedimentary rocks

FRANCISCAN ASSEMBLAGE AND ASSOCIATED SERPENTINITE

KJf FRANCISCAN ASSEMBLAGE (CRETACEOUS AND JURASSIC)—Chiefly thin- to thick-bedded sandstone, siltstone, and shale, with minor greenstone and thin-bedded chert. Rocks are highly sheared and faulted. Contains metamorphic minerals of the lawsonite-albite facies (Gilbert, 1973). Locally includes:

KJg Greenstone—Dark-green massive to weakly foliated metabasalt; pillow structure locally preserved

sp SERPENTINITE (JURASSIC?)—Black to green massive to intensely sheared serpentinite. Commonly occurs as slivers along faults

METAMORPHIC ROCKS

ms METASEDIMENTARY ROCKS (AGE UNKNOWN)—High-grade metamorphic rocks, chiefly medium to dark gray quartzofeldspathic gneiss, and less abundant biotite-feldspar quartzite, subordinate amphibolite, calc-silicate rock, marble, and pelitic schist; abundant veins and pods of pegmatite. Gneiss is composed chiefly of quartz, plagioclase, K-feldspar, and biotite; garnet in more than trace amounts is present in about half the rocks. Sillimanite occurs in some gneiss concentrated with biotite in discreet layers. Sillimanite occurs widely and is not absent west of the Coast Ridge fault, as reported by Ross (1976). Cordierite occurs locally. Orthopyroxene occurs in gneiss near plutons of charnockitic tonalite (Compton, 1960). Muscovite is uncommon, nowhere abundant, and may be secondary. Minerals in calcareous assemblages (in amphibolite, calc-silicate rocks, and marble) include quartz, feldspar, calcite, biotite, hornblende, tremolite, diopside, garnet, scapolite, wollastonite, and idocrase. Pelitic schist is rare

m MARBLE (AGE UNKNOWN)—Finely to coarsely crystalline light-gray marble, in part with varying amounts of calc-silicate minerals; commonly contains sparse graphite. May include some interlayered calc-silicate rock, amphibolite, and gneiss. Occurs in lenses, locally as long as 4 mi. Most abundant southwest of Coast Ridge fault

qtz QUARTZITE (AGE UNKNOWN)—Light- to medium-gray thoroughly recrystallized quartzite commonly containing 5-10 percent each K-feldspar, plagioclase, and biotite. Forms nappable unit north of The Peak

gph GRAPHITIC AND PYRITIC ROCKS (AGE UNKNOWN)—Thin- to thick-layered fine- to medium-grained quartzofeldspathic gneiss, biotite-feldspar quartzite, and calc-silicate rock; uncommon marble. Contains sparse to abundant small graphite flakes and pyrite. Weathers rusty. North of Willow Creek fault, unit forms stratigraphic marker and several lenses. Equivalent to the Los Padres unit of Wiebe (1970b)

ggg GRAPHITIC GNEISS (AGE UNKNOWN)—Medium- to coarse-grained quartzofeldspathic biotite gneiss and less common biotite-feldspar quartzite, both containing graphite flakes; some rocks pyritic, rusty weathering. Locally contains sillimanite. Occurs in several lenses west of Coast Ridge fault and in two small lenses in Bear Canyon, in southeastern part of area

CONTACT—Queried where uncertain

FAULT—Queried where inferred; dotted where concealed. U, upthrown side; D, downthrown side

ANTICLINE—Showing direction of plunge; queried where uncertain

SYNCLINE—Showing direction of plunge

BEARING AND PLUNGE OF LINEATION—Combined with symbol for strike and dip of foliation; C, crenulations, S, sillimanite

BEARING AND PLUNGE OF SMALL FOLD—Point of observation at tail of arrow; combined with strike and dip of foliation where applicable

STRIKE AND DIP OF BEDS

Inclined

Horizontal

Vertical

Overturned

STRIKE AND DIP OF METAMORPHIC FOLIATION

Inclined

Horizontal

Vertical

STRIKE AND DIP OF SHEAR FOLIATION (FRANCISCAN ASSEMBLAGE)

Inclined

Vertical

APPROXIMATE BOUNDARY OF STUDY AREA

APPROXIMATE EXTENT OF MAPPING—where different from boundary

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a geologic survey of part of the Ventana Wilderness and the Black Butte, Bear Mountain, and Bear Canyon Roadless Areas in the Los Padres National Forest, Monterey County, California. The Ventana Wilderness was established by Public Law 91-58; this report discusses additions to the Ventana Wilderness that were established by Public Law 95-237 in 1978. The Black Butte (5102), Bear Mountain (5103), and Bear Canyon (5104) Roadless Areas were identified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

INTRODUCTION

The Ventana Wilderness encompasses approximately 159,000 acres, of which 98,000 acres was initially designated as a primitive area and 61,000 acres was later added. This report deals with the areas added to the wilderness together with the Black Butte, Bear Mountain, and Bear Canyon Roadless Areas (fig. 1). In all, they comprise about 116,000 acres in the Los Padres National Forest, Monterey County, Calif. For the purpose of this report the areas will be referred to collectively as the study area.

The study area is located in the Santa Lucia Range between U.S. Highway 101, which passes through Greenfield, and California Highway 1 on the Pacific coast. Paved roads from U.S. Highway 101 provide access from the east and the paved road crosses the range just south of the area. The area has rugged topography and a dense cover of brush with local groves of oak, madrone, pine, and redwood. Elevations range from near sea level along the coast to 5,155 ft at Cone Peak, just 3.2 mi inland, and to 5,862 ft at Junipero Serra Peak, the highest point in the range.

The geologic map was compiled from existing maps and modified by fieldwork and study of aerial photographs. Geologic maps used in the compilation are indicated in figure 2. Numerous other reports deal with various aspects of the geology of the area. The igneous and high-grade metamorphic rocks making up the basement have been described by Compton (1960, 1966) and by Wiebe (1970a, b). A recent reconnaissance geologic map of the northern Santa Lucia Range includes the study area and contains a review of the basement rocks (Ross, 1976). Regional aspects of the basement rocks are discussed by Ross (1977, 1978) and by Page (1981). The Franciscan assemblage on the southwest edge of the study area has been described by Gilbert (1973). Sedimentary rocks are described by Durham (1974) and by several authors in a recent guidebook edited by Graham (1979a). The economic geology is described by Hart (1966), Pearson and others (1967), and Seiders and others (1983).

The large Marble Cone fire of 1977 burned much of the area except for the southwestern part of the Ventana Wilderness. The fire which temporarily eliminated much nearly inpenetrable brush facilitated fieldwork. Excellent aerial photographs made for the U.S. Forest Service a year after the fire (1978, scale about 1:20,000) were used in this study.

We are grateful to the many employees of the U.S. Forest Service who provided advice and assistance during the course of fieldwork. We thank the many property owners who granted access through their land. Our special thanks go to the people at the Zen Mountain Center, Tassajara Hot Springs, and the Landels-Hill Big Creek Reserve (University of California, Santa Cruz) for many kindnesses.

GEOLOGY

Most of the study area is underlain by intrusive igneous rocks and high-grade metamorphic rocks that form the basement of the Salinian block. This basement is unconformably overlain by Cretaceous and Tertiary sedimentary rocks. Along the southwest edge of the area a complex fault system juxtaposes an entirely different basement that consists of low-grade metamorphic rocks of the Franciscan assemblage.

High-grade metamorphic rocks

The high-grade metamorphic rocks are chiefly quartzofeldspathic biotite gneiss, and, in some places, contain sillimanite and (or) garnet. Hypersthene occurs locally in gneiss in the southwestern part of the area (Compton, 1960). Subordinate rock types are biotite-feldspar quartzite, amphibolite, calc-silicate rock, and sillimanite-biotite schist. Lenses and layers of marble, which make up a small part of the metamorphic sequence, are most abundant southwest of the Coast Ridge fault.

Near Tassajara Hot Springs and to the northwest, graphite and pyrite occur in gneiss, quartzite, and calc-silicate rock, and distinguish these rocks as a marker unit (Los Padres unit of Wiebe, 1970b) that can be traced for several miles. Peirce and others (1967) noted that these graphite-pyrite-bearing rocks contain anomalously high values of certain metals, especially molybdenum and vanadium, that are chemically similar to many unmetamorphosed carbonaceous sedimentary rocks. The protoliths probably included carbonaceous sandstone and mudstone. The original rocks were calcareous and their metamorphosed equivalents contain varying amounts of diopside, tremolite, and calcite. Sillimanite, an expected metamorphic product of most black shale, is absent however, because aluminum is fixed in calcium or magnesian minerals, such as scapolite, calcic plagioclase, and spinel.

Graphite also occurs southwest of the Coast Ridge fault in mappable lenses of graphitic gneiss. These rocks differ from the graphitic rocks near Tassajara Hot Springs in that they are generally coarser grained, somewhat less pyritic, and include fewer beds of quartzite and calc-silicate rock.

Both Wiebe (1970b) and Ross (1976) believed that the rocks immediately east of the graphitic and pyritic unit near Tassajara Hot Springs, in the northern part of the other high-grade metamorphic rocks in the study area, and they mapped a pelitic schist unit there. Our observations, however, do not support this distinction and we have not mapped the unit.

A mappable belt of biotite-feldspar quartzite about 3 mi long occurs north of Pinyon Peak in the Bear Mountain Roadless Area (Compton, 1966; Compton and Dibblee, 1974). Sillimanite is especially abundant in exposures just north of the summit of the unit on the ridge crest 2.5 mi northwest of Pinyon Peak, but the extent of the sillimanite schist is not known.

Compton (1966) and Wiebe (1970b) have suggested that the metamorphic-rock sequence formed from platform-type sedimentary rocks, and Wiebe (1970b) proposed that the sequence is correlative with miogeosynclinal sequences of Paleozoic rocks of the western Mojave Desert and Tehachapi Mountains rocks 180 mi southeast of the study area, that would lie adjacent to the Salinian block if San Andreas fault movement was restored. Ross (1977), however, pointed out that the metamorphic rocks of the Santa Lucia Range contrast with the miogeosynclinal sequence of the western Mojave in that they lack thick and continuous units of pure marble and limestone. On the other hand, Dickinson (1983) noted that little-studied metamorphic rocks adjacent to the San Andreas fault in the western Mojave area differ from Mojave miogeosynclinal rocks farther east, and these rocks may have offset counterparts in the Salinian block. Thus, age and correlation of the metamorphic rock sequence remain uncertain. No fossils have been found. We sampled four crystalline limestone bodies for conodonts but found none (A. G. Harris, written commun., 1982).

Intrusive rocks

Intrusive igneous rocks constitute half as much area as do metamorphic rocks and are mainly granodiorite, quartz monzonite, and quartz diorite, with subordinate diorite and gabbro. Small ultramafic intrusions, some with unusual zoned structure, occur sparsely over broad areas. The igneous rocks of the area have been discussed in considerable detail by Compton (1960, 1966), Wiebe (1966, 1970a), and Ross (1976, 1977, 1978). We have used the plutonic-rock map units used by Ross (1976, 1977), but have made some changes in map distribution and one minor change in definition. The heterogeneous granitic complex of Wiebe (1966) was used by Ross (1976) for areas of granitic rocks that had great lithologic variety and where data were insufficient to draw internal contacts. Whereas Ross (1976) largely limited the heterogeneous granitic complex to the areas mapped by Wiebe (1966), we have used the unit to include areas with granitic rocks of uncertain correlation or lithology. The numerical map symbols used by Ross (1976, 1977) are followed here to facilitate correspondence with more detailed descriptions. We have followed Ross' (1976, 1977) usage of plutonic-rock terms rather than the now widely accepted nomenclature of Streckeisen (1974). Note that the numbers of the map units have no relation to age; the chronologic relations of the various intrusive igneous rocks are not well known. Isotopic age determinations suggest that most of the granitic rocks are of Cretaceous age (Evernden and Kistler, 1970; Ross, 1978; Mattinson, 1978).

Salinian basement structure

Both Compton (1966) and Wiebe (1970b) have suggested that the Salinian basement rocks of the area have been subjected to two episodes of folding with accompanying high-grade metamorphism. In the northwestern part of the study area, where our mapping overlaps the area mapped by Wiebe (1970b), we confirm in considerable detail the complex fold pattern that he reported. In the remainder of the area, however, our observations are too sparse to adequately characterize the fold pattern or to determine the orientation and sequence of the deformational events.

Sedimentary rocks

The sedimentary-rock sequence ranges in age from Late Cretaceous to Miocene and is interrupted by several unconformities. In the southwestern part of the area Upper Cretaceous marine sedimentary rocks rest unconformably on the crystalline rocks of the basement. Isotopic dating shows that the basement rocks remained at elevated temperatures well into the Late Cretaceous and points to very rapid uplift and erosion just before deposition of the Upper Cretaceous sedimentary rocks (Mattinson, 1978). The Cretaceous rocks are overlain conformably by Paleocene beds informally called the "Merle Formation" by Graham (1979b) and Ruetz (1979). The Cretaceous and Paleocene rocks remain informally named in this report. The two together are interpret-ed by Ruetz (1979) to be deposits of a southwest-dispersing submarine-fan system. The succession of fan-facies associations recognized by Ruetz (1979) shows a shift with time to more distal fan environments. The sequence transgresses to the northeast; northeast of a line between The Indians and the Escondido Campground, Cretaceous rocks are absent and Paleocene beds rest directly on basement.

An interval of erosion and faulting preceded deposition of the overlying, largely Eocene strata. This interval was first noted by Dickinson (1965) in the area near the junction of the Willow Creek and Church Creek faults. South of the Willow Creek fault, Paleocene rocks occur in an east-west trending belt, resting on basement, and dip north against the high-angle Willow Creek fault. Just north of the fault, Eocene rocks lie directly on basement, suggesting that the block north of the fault was uplifted and Paleocene rocks eroded prior to deposition of the Eocene strata. The Church Creek fault is much younger than the Willow Creek fault even though it appears to terminate against the latter. As noted by Dickinson (1965), the Church Creek fault is a high-angle reverse fault formed when the block in the obtuse angle between the two faults was uplifted. This uplift also reactivated the Willow Creek fault east of the junction with the Church Creek fault.

Similar stratigraphic relations are also shown across the broken east-southeast-trending fault just south of Escondido Campground. South of the fault a very thick section of Cretaceous and Paleocene beds are exposed. Just north of the fault small areas of basement are overlain by Eocene beds, locally with a thin Paleocene limestone at the base.

Eocene and local Paleocene rocks in the area are represented by the Reliz Canyon and Church Creek Formations. The Reliz Canyon Formation was named by Durham (1963), who designated three informal members: a lower member corresponding to the Junipero Sandstone of Thorup (1941), a middle member corresponding to the Lucia Shale of Thorup (1941), and an upper member corresponding to the Rocks Sandstone of Thorup (1941). Thorup's names correspond to the three members of Durham that have been widely used (see, for example, Poore and others, 1977; Graham, 1979b, and Link and Nilsen, 1979) and are here adopted as the Junipero Sandstone, Lucia Mudstone Member, and The Rocks Sandstone Member (of the Reliz Canyon Formation). The respective type localities for these members (in upper Reliz Canyon, near the eastern edge of the area) are those as noted by Thorup (1941); the stratigraphic relations of the members are the same as those described by Durham (1963). Where the Lucia Mudstone Member is absent, the Junipero and The Rocks Sandstone Members are not distinguished and are mapped together as the undivided Reliz Canyon Formation. The Church Creek Formation, with its type locality in the northwestern part of the area, is used here as defined by Dickinson (1965) and adopted by Brabb and others (1971).

The Reliz Canyon Formation consists chiefly of sandstone with subordinate mudstone and conglomerate, whereas the overlying Church Creek Formation is mainly mudstone and siltstone with subordinate sandstone. Sandstone of the Reliz Canyon is largely very thick bedded and forms bold outcrops. Our mapping, based on these lithologic characteristics, differs in some respects from that of previous workers. One-half mile north of Escondido Campground, near the southern tip of the Black Butte Roadless Area, we mapped the Reliz Canyon Formation in a north-dipping sequence resting on basement. The same sequence was described by Ruetz (1979) who reported a 460-ft section composed of a lower unit of sandstone and conglomerate, a medial unit of mudstone, and an upper unit of very thick bedded sandstone. Ruetz (1979) interpreted these rocks as deposits in a submarine canyon. In support of his conclusion, we have observed excellent exposures in a cliff showing the upper sandstone unit to buttress against basement to the north. Ruetz (1979) found no fossils and correlated the sequence with Paleocene rocks to the southeast. However, benthic foraminifers collected by us from the medial mudstone unit have an Eocene age (Kristin McDougall, written commun., 1983). We correlate the sequence with the Junipero Sandstone, Lucia Mudstone, and The Rocks Sandstone Members, but have not mapped the units separately herein because of their thinness in this area.