U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT
95-554

DESCRIPTION OF MAP UNITS
SOUTH OF BIG PINE FAULT

QUATERNARY DEPOSITS

Holocene and Pleistocene deposits

Qya Young alluvium--Gravel, sand, and silt along active and intermittent stream channels; locally incised

Qoa Old alluvium--Gravel, sand, and silt perched above stream channels or in dissected fan remnants; depositional surfaces generally preserved

TERTIARY SEDIMENTARY ROCKS

Miocene sedimentary rocks

Tm Monterey Formation--calcareous and siliceous shale, clayey mudstone, and subordinate fine-grained sandstone; laminated to thin bedded; lowermost part locally contains limestone-clast conglomerate and glauconitic sandstone overlain by indistinctly bedded mudstone; unconformable on Cretaceous and Eocene rocks; Saucesian and N5-N6 foraminifers and CN2 to CN2-CN3 calcareous nannofossils in lower part; Relizian and Luisian foraminifers in upper part

Eocene sedimentary rocks

Te Sandstone and subordinate mudstone, interbedded; sandstone fine-to very coarse-grained, locally pebbly; thin-to thick-bedded, lenticular; mudstone laminated to indistinctly bedded, ellipsoidal or hackly fracture, lenticular chiefly in lower part; conformable on and intertongues with unit TKs; CP11 and CP12a calcareous nannofossils and P9 and Laiming C to pseudo-C foraminifers in mudstone exposed along Big Pine Road

TERTIARY AND CRETACEOUS SEDIMENTARY ROCKS

Lower Eocene, Paleocene, and Upper Cretaceous sedimentary rocks

Tsb Sierra Blanca Limestone--limestone, algal, massive to thin-bedded, lenticular; commonly brecciated and recemented, sparingly glauconitic at places; locally contains abundant large orbitoids; forms resistant outcrops; on north limb of Loma Pelona syncline locally thin-bedded, lenticular and interbedded with mudstone; on south limb, massive to indistinctly bedded and nearly continuous; late Paleocene foraminifers (P3a-P4) in type section at Indian Creek and along Big Pine Road, late Paleocene calcareous nannofossils (CP8) and foraminifers (Laiming E) in interbedded mudstone near Bluff Campground; conformable within unit TKs on north limb of Loma Pelona syncline, unconformable on unit Kms on south limb

TKs Mudstone and subordinate sandstone; mudstone clayey to silty, micaceous, thin-bedded or laminated to indistinctly bedded, splintery or hackly to ellipsoidal fracture, locally concretionary; contains "Poppin" shale-like zones in upper part; includes interbedded very thin beds of very fine-grained micaceous sandstone at places; sandstone, fine-to very coarse-grained, thin-to thick-bedded, increasing amounts upsection, commonly calcareous, locally contains algal detritus in lower part; base not exposed in map area; Late Cretaceous calcareous nannofossils in lower part 1.7 km east of Bluff Campground, CP5, CP6-CP7, CP7, CP8, CP9, CP10, CP10/11 calcareous nannofossils, and P3b/P4, P4, P6, P7, P8/9, P9 and Laiming E, C foraminifers; unit assigned to the Anita (?) and part of the Juncal (?) Formation by Comstock (1975, fig. 2); contact with unit Te is gradational

UPPER CRETACEOUS SEDIMENTARY ROCKS

Kms Mudstone, clayey and silty, micaceous, faintly laminated to thin-bedded or indistinctly bedded, hackly or ellipsoidal fracture, concretionary; includes interbedded very thin-bedded fine-grained sandstone at places; conformable on unit Ks; Maastrichtian calcareous nannofossils and Campanian-Danian palynomorphs along Big Pine Road; correlates with upper part of Nelson's (1925) Mono shale

Ks Sandstone and subordinate mudstone and conglomerate; sandstone quartzofeldspathic, micaceous, fine-to very coarse-grained, locally pebbly, concretionary at places, thin-to-thick-bedded and massive, lenticular; mudstone partings and rip-up clasts common; mudstone micaceous, indistinctly bedded, lenticular, splintery fracture, generally present as thin zones interbedded in sandstone; conglomerate, highly lenticular, common well-rounded pebbles and cobbles of porphyritic siliceous metavolcanic and granitoid rocks in sandy matrix

Km Mudstone and subordinate sandstone; mudstone clayey to silty, micaceous, indistinctly bedded to thin-bedded, hackly to ellipsoidal fracture; lenticular, locally concretionary; sandstone, micaceous, silty, very fine-grained, thin-bedded, locally interbedded as thick zones in mudstone, grades laterally into unit Ks; Coniacian to Maastrichtian and upper Campanian to Maastrichtian calcareous nannofossils, Goudkoff D2 and D2-E foraminifers along Big Pine Road; unit incompletely mapped on dip slopes northwest of Big Pine Road

Kci Conglomerate and subordinate sandstone; conglomerate lenticular, interbedded with sandstone; well rounded pebbles, cobbles, and boulders include abundant porphyritic siliceous metavolcanic rocks, common granitoid rocks, and sparse quartzite in sandy matrix; sandstone lenticular, thick-bedded, similar to sandstone of unit Ks; westernmost position and extent of unit inferred; Nelson (1925) applied the name Indian conglomerate to the lenses that cross Indian Creek

TERTIARY IGNEOUS ROCKS

Ti Basaltic rocks; diabase, forms sill-like body as much as 30m thick in Monterey Formation at west edge of map; altered vesicular basalt, forms dike about 1 m wide near Tm/Te fault contact in Indian Creek; may be Miocene in age

DESCRIPTION OF MAP UNITS BETWEEN BIG PINE FAULT AND SUR-NACIMIENTO FAULT ZONE

QUATERNARY DEPOSITS

Qya Young alluvium--Gravel, sand, and silt along active and intermittent stream channels; locally incised

Qoa Old alluvium--Gravel, sand, and silt; in dissected alluvial apron near Lower Bear Campground at head of Sisquoc River

TERTIARY SEDIMENTARY ROCKS

Eocene sedimentary rocks

Tes Sandstone and subordinate mudstone and conglomerate; sandstone, quartzofeldspathic, micaceous, poorly sorted, medium-to coarse-grained, locally pebbly, generally thick-bedded to massive with mudstone and siltstone partings; mudstone, clayey to silty, micaceous, includes interbedded thin-bedded sandstone, lenticular; conglomerate, pebble-cobble, well rounded, quartzite and porphyritic siliceous metavolcanic clasts common; lenticular; conformable on unit TKm; rare "Capay" and "Capay" or "Domengine" mollusks in sandstone; rare early-middle Eocene foraminifers in mudstone

TERTIARY AND CRETACEOUS SEDIMENTARY ROCKS

Lower Eocene to Upper Cretaceous sedimentary rocks

TKm Mudstone and subordinate sandstone; mudstone silty, clayey, micaceous, indistinctly bedded to thin-bedded, hackly to ellipsoidal fracture, locally concretionary, includes thin interbedded fine-grained sandstone; sandstone, quartzofeldspathic, medium-to coarse-grained, present as thin lentils in middle part; conformable on unit Kss; Campanian and (or) Maastrichtian foraminifers and upper Campanian or Maastrichtian mollusks in lower part at Big Pine Mtn., late Paleocene palynomorphs in middle part; CP9, CP10, CP11 calcareous nannofossils and P7, P8, P9 foraminifers in upper part; Cretaceous beds may be absent along lower Big Pine Creek and Sisquoc River

UPPER CRETACEOUS SEDIMENTARY ROCKS

Kss Sandstone and subordinate mudstone; sandstone quartzofeldspathic, micaceous, fine-to very coarse-grained, locally conglomeratic, thin-to thick-bedded, lenticular; includes mudstone partings and rip-up clasts at places; mudstone, micaceous, thin-bedded, lenticular, generally present as thin zones interbedded in sandstone; rare Maastrichtian (?) mollusks in sandstone in upper part

Ksm Mudstone and subordinate sandstone; mudstone silty and clayey, micaceous, hackly to ellipsoidal fracture, lenticular; includes varying amounts of interbedded thin-to thick-bedded sandstone similar to that in unit Kss; rare Santonian to Maastrichtian palynomorphs and calcareous nannofossils, sparse Late Cretaceous foraminifers, rare Campanian (?) mollusks in mudstone zones

Ksw Sandstone and subordinate mudstone; sandstone quartzofeldspathic, micaceous, resembles granite gruss, medium-to very coarse-grained, thick-bedded to massive, lenticular; includes thin mudstone zones generally upward-thickening in upper part; characteristically white in contrast to buff unit Kss; forms distinctive resistant outcrops low in the section between Coche Creek and eastern main tributary to East Fork Santa Cruz Creek

Kc Conglomerate, thick-bedded, lenticular; well rounded pebbles, cobbles, and boulders commonly include porphyritic siliceous metavolcanic, granitoid, and quartzitic rocks in varying abundance; interbedded with sandstone similar to that in unit Kss, grades laterally into unit Kss

DESCRIPTION OF MAP UNITS NORTHEAST OF SUR-NACIMIENTO FAULT ZONE

QUATERNARY DEPOSITS

Qya Young alluvium--Gravel, sand, and silt along active and intermittent stream channels; locally incised

Qoa Old alluvium--Gravel, sand, and silt perched above stream channels or in dissected fan remnants; depositional surfaces generally preserved

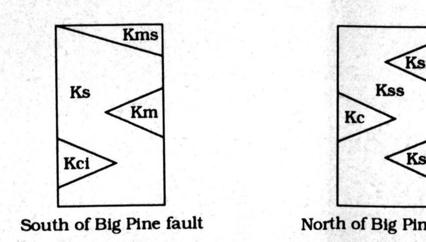
TERTIARY SEDIMENTARY ROCKS

Eocene sedimentary rocks

Tem Mudstone and subordinate sandstone, interbedded; mudstone thin-bedded to indistinctly bedded, hackly to ellipsoidal fracture; sandstone fine- to medium-grained, thin- to thick-bedded; conformable on unit Tus; contains middle Eocene foraminifers and mollusks along strike southeast of map area (Vedder, Dibblee, and Brown, 1973)

Tus Sandstone and subordinate mudstone; sandstone quartzofeldspathic, fine-to very coarse-grained, locally conglomeratic; thin-to-thick-bedded; lenticular; mudstone includes partings, thin beds, and lenticular zones; base not exposed; contains rare early(?)-middle(?) Eocene mollusks (Vedder and others, 1967)

STRATIGRAPHIC DIAGRAMS, CRETACEOUS MAP UNITS



EXPLANATORY NOTES

Reconnaissance geologic mapping of the San Rafael Primitive Area (now San Rafael Wilderness) by Gower and others (1966) and Vedder and others (1967) showed a number of stratigraphic and structural ambiguities. To help resolve some of these problems, additional field work was done on parts of the Big Pine Mountain quadrangle during short intervals in 1981 and 1984, and 1990-1994.

Because extensive areas were inaccessible owing to impenetrable chaparral and steep terrain, or closed for wildlife protection, observations from helicopter overflights and interpretations from aerial photographs were used as compilation aids. Consequently, some of the depicted contacts and structures are highly inferential. For example, the differentiation of mudstone units and sandstone units at places on the tree- and brush-covered dip slopes between the Sisquoc Condor Sanctuary and Big Pine Canyon is uncertain. Mapping is incomplete on both sides of Indian Creek at the southernmost edge of the quadrangle.

Formal stratigraphic names are used sparingly for map units in the Upper Cretaceous through lower Eocene submarine-fan sequences on both sides of the Big Pine fault. Various names, both formal and informal, have been applied to correlative strata elsewhere in the San Rafael Mountains; however, the repetitious lithology and lenticularity of these strata within the Big Pine Mountain quadrangle make formal designation somewhat artificial. These submarine-fan sequences are composed predominantly of sandstone and mudstone turbidites that were deposited in upper to lower bathyal environments. Paleocurrent data from these strata are sparse. Where measured, directional features generally indicate westward to southward flow. A noteworthy exception is in unit TKs, the lowest exposed stratigraphic unit south of the Big Pine fault, where both northward and southward flow directions were measured. Unit TKm north of the Big Pine fault consists of Upper Cretaceous, upper Paleocene, and lower Eocene mudstone at Big Pine Mountain where the unit is about 350 m thick. A very slow rate of deposition is indicated for this mudstone unit, and the absence of physical evidence for hiatuses suggests that unit TKm may represent a condensed succession.

One distinctive and nearly persistent unit is the Paleocene Sierra Blanca Limestone, which is present south of the Big Pine fault and has its type section in Indian Creek (Nelson, 1925; Keenan, 1932; Walker, 1950; and Vedder, 1972). Recent biostratigraphic work on the limestone mapped here indicates a Paleocene age (D. Bukry, W. V. Sliter, written communs., 1993) rather than Eocene, as formerly supposed. On the south limb of the Loma Pelona syncline, the belt of Sierra Blanca Limestone, which includes the type section, is bounded by unconformities above and below, whereas the northern belt, which parallels the Big Pine fault, lies within a continuous depositional succession. Bedding features and mixed paleoecologic indicators suggest that the limestone is largely downslope-transported detritus from algal banks no longer preserved.

Although the Miocene sedimentary rocks are assigned to the Monterey Formation, atypical lithologies including conglomerate, glauconitic sandstone, and massive clayey mudstone are present in the lower part. The distribution of these rock types is incompletely known. However, platy siliceous shale that typifies the Monterey Formation throughout coastal California is commonly present in the upper part.

Fault nomenclature follows the usage of Nelson (1925) for the Big Pine and Hildreth faults and Page (1970) for the Sur-Nacimiento fault zone. West of Grapevine Creek, where the Big Pine fault splits into two main branches, the names North Branch and South Branch are used as modifiers. Fold names follow the usage of Walker (1950) for the Loma Pelona syncline and Gower and others (1966), Vedder and others (1967), and Vedder, Dibblee, and Brown (1973) for the Mission Pine anticline and Madulce syncline. The syncline in Cretaceous rocks along the northwestern edge of the map presumably is the southeastern continuation of the Hurricane Deck syncline (Gower and others, 1966; Vedder and others, 1967), and the syncline that downfolds the Monterey Formation between Coche and Grapevine Creeks may be the western continuation of the Loma Pelona syncline.

The north- and northeast-trending faults in the area between the Sur-Nacimiento and Big Pine faults are mainly small, high-angle normal faults with dip separations of less than 15 m. The curved east-trending faults that cut the Miocene and older rocks south of the Big Pine fault are moderately to steeply north-dipping reverse and oblique-slip (?) structures, some segments of which may be reactivated pre-Miocene faults with unknown amounts and direction of slip. These curved faults apparently have foreshortened the north limb of the Loma Pelona syncline.

PALEONTOLOGIC INFORMATION

Identifications and age assignments of the microfossils collected during the field work were furnished by D. Bukry, N.O. Frederiksen, K.A. McDougall, R.L. Pierce, W.V. Sliter, and P.J. Smith of the U.S. Geological Survey and by M.L. Cotton, M.V. Filewicz, and D.R. Vork of Unocal Corporation. A.A. Almgren, consulting geologist and paleontologist, contributed information on Cretaceous and Eocene microfossil assemblages collected at sites along Big Pine Road that are not shown here. Reports on the megafossils were provided by W.P. Elder, D.L. Jones, and J.G. Vedder.

MAPPING CREDITS

Only a few days were spent in the map area each year. The participants, types of field work, and the years during which the work was done are as follows:

Reconnaissance mapping; April, May 1965; E.E. Brabb, H.E. Clifton, T.W. Dibblee, Jr., D.L. Durham, H.D. Gower; J.G. Vedder
Reconnaissance mapping, eastern edge and contiguous area; May 1967; R.D. Brown, Jr.; J.G. Vedder
Sedimentary facies, sediment-transport directions, mapping of selected areas; September 1981, October 1984; D.G. Howell, H. McLean, J.G. Vedder
Detailed mapping, biostratigraphic sampling, sedimentary facies, sediment-transport directions; May 1990-1992, June 1993-1994; H. McLean, R.G. Stanley, J.G. Vedder

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Comstock, S.C., 1975, Upper Cretaceous and Paleocene stratigraphy along the western Big Pine fault, Santa Barbara County, California, *in* Weaver, D.W., Hornaday, G.R., and Tipton, A., eds., Paleogene symposium and selected technical papers, Conference on future energy horizons of the Pacific Coast: American Association of Petroleum Geologists—Society of Economic Paleontologists and Mineralogists—Society of Exploration Geophysicists, Pacific Sections, p. 155-168.

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Keenan, M.F., 1932, The Eocene Sierra Blanca limestone at the type locality in Santa Barbara County, California: Transactions of the San Diego Society of Natural History, v. 7, n. 8, p. 57-84.

Nelson, R.N., 1925, Geology of the hydrographic basin of the upper Santa Ynez River, California: University of California Publications in the Geological Sciences, v. 15, n. 10, p. 327-396.

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Vedder, J.G., 1972, Revision of stratigraphic names for some Eocene formations in Santa Barbara and Ventura Counties, California: U.S. Geological Survey Bulletin 1354-D, p. D1-D12.

Vedder, J.G., Dibblee, T.W., Jr., and Brown, R.D., Jr., 1973, Geologic map of the upper Mono Creek-Pine Mountain area, California, showing rock units and structures offset by the Big Pine fault: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-752, scale 1:48,000.

Vedder, J.G., Gower, H.D., Clifton, H.E., and Durham, D.L., 1967, Reconnaissance geologic map of the central San Rafael Mountains and vicinity, Santa Barbara County, California: U. S. Geological Survey Miscellaneous Geologic Investigations Map I-487, scale 1:48,000.

Walker, G.W., 1950, Sierra Blanca Limestone in Santa Barbara County, California: California Division of Mines Special Report 1-A, 5p.

SYMBOLS

Contact
Long dashes where approximately located; short dashes where inferred; intertonguing contacts diagrammatic and (or) generalized

Fault trace
U, relatively upthrown side; D, relatively downthrown side; arrows, inferred direction of strike slip; bar and number indicate dip of fault plane; long dashes where approximately located; short dashes where inferred; dots where concealed

Anticline, approximate crestline
Short dashes where inferred

Syncline, approximate troughline
Short dashes where inferred

Landslide area
Arrows show direction of movement
Interpreted mainly from aerial photographs

Strike and dip of bedding
Solid symbol, measured on the ground; broken dip line, estimated from helicopter or distant sighting; broken dip and strike lines, estimated from aerial photographs; question marks where amount of inclination is uncertain or unknown

Strike and dip of overturned beds
Solid and broken symbols explained above

Strike of vertical beds
Solid and broken symbols explained above

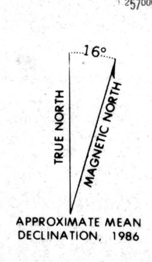
Horizontal or nearly horizontal beds
Solid and broken symbols explained above

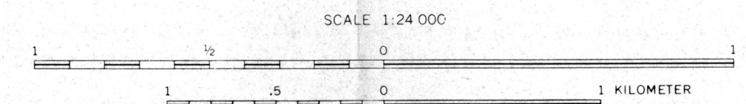
Apparent dip of beds
Estimated from the ground or aerial photographs

Sandstone lentils or thin zones in units TKs, TKm, Ksm
Shown selectively where sandstone is stratigraphically significant but too thin to depict as a map unit

Fossil locality
Shown only where age-diagnostic microfossils or megafossils have been collected and identified during the field work for this map

Base map from U.S. Geological Survey Big Pine Mtn., 1964, quadrangle





PRELIMINARY GEOLOGIC MAP OF BIG PINE MTN. QUADRANGLE, CALIFORNIA

by

J.G. Vedder, Hugh McLean, and R.G. Stanley

1995