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GEOLOGICAL SURVEY

DESCRIPTIONS OF AND DIRECTIONS TO SELECTED SALINIAN BLOCK BASEMENT ROCK OUTCROPS, SANTA LUCIA AND GABILAN RANGES, CALIFORNIA

By Donald C. Ross

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This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards and nomenclature.

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INTRODUCTION

The main areas of basement rock outcrops in the Salinian block are in the Santa Lucia and Gabilan Ranges. The localities described here can be divided into two categories; 1) those that feature one particular rock type, generally granitic, where a good fresh sample can be collected, and 2) those where interrelationships between two or more rock types require interpretations and where some controversy or equivocal relations may bring out discussion or at least arching of eyebrows of visitors. One of the more frustrating aspects of field work in an area of limited exposure and abundant slope wash and vegetable cover is the inability to observe the relations between isolated outcrops. Generally, diligent search will reveal enough outcrops of fresh rock to permit recognition of and distinguishing between various lithologies, but rarely are contacts seen, or is there any continuous area of exposure that would enable variations in units to be accurately interpreted. This limitation must always be kept in mind when one is evaluating interpretations or extrapolations, such as conclusions of whether two distinctive, but isolated outcrops are separated by a contact or a gradational zone--particularly in granitic terranes.

The localities described here are all easily accessible on or near roads and can be reached by a passenger car--most localities are along hard-surfaced roads.

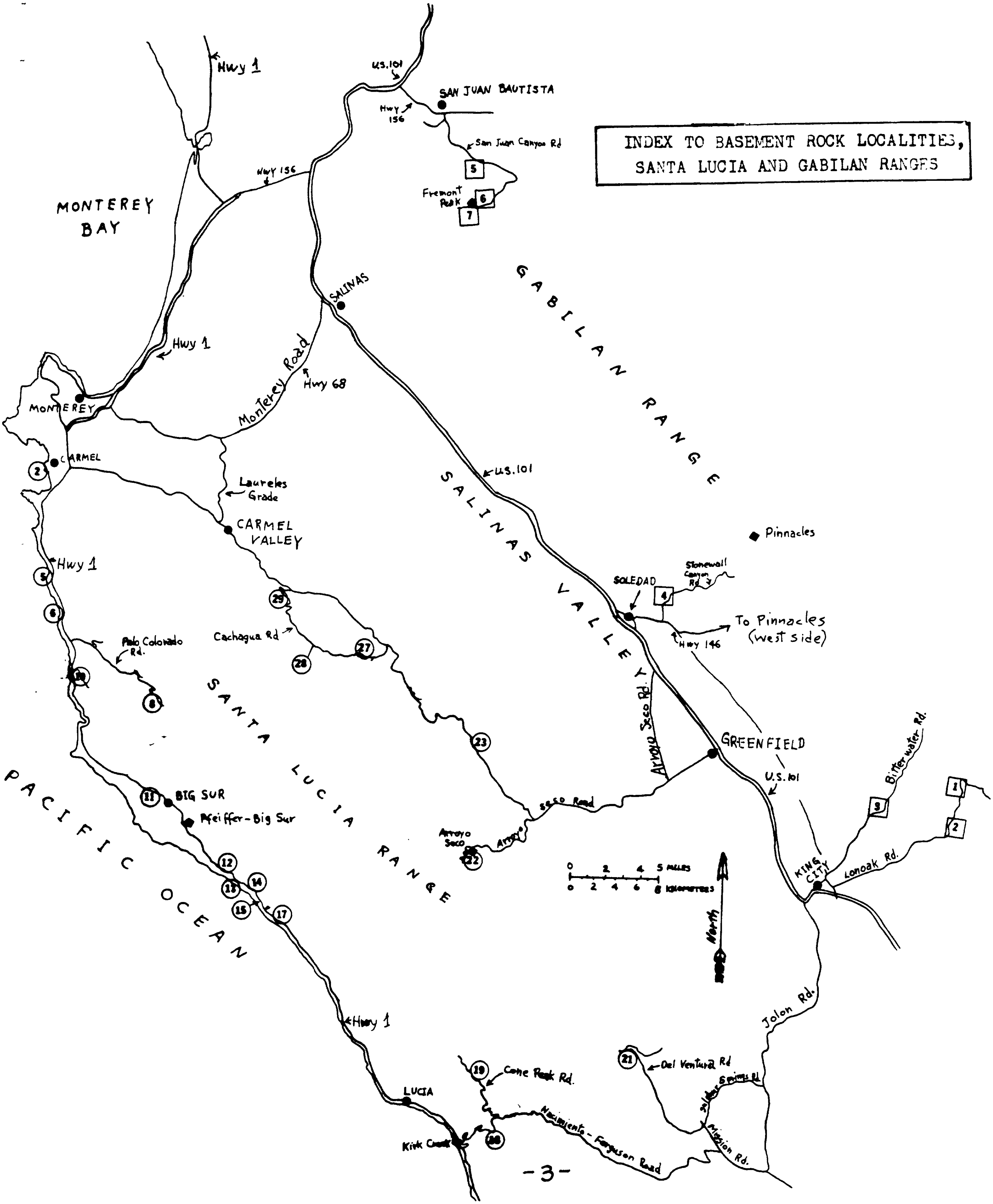
CAUTION--Several of the localities are along narrow, but surprisingly well-traveled, roads such as Highway 1. Great caution is advised in parking vehicles along these roads as well as in movement outside the vehicles. By far the largest "hazard," however, is poison oak, which is lush on and near many outcrops. Because of the presence of this plant and the rare, but possible presence of long, thin reptiles that shake their tails and make funny buzzing noises, it is best to carefully watch where you put your hands and feet.

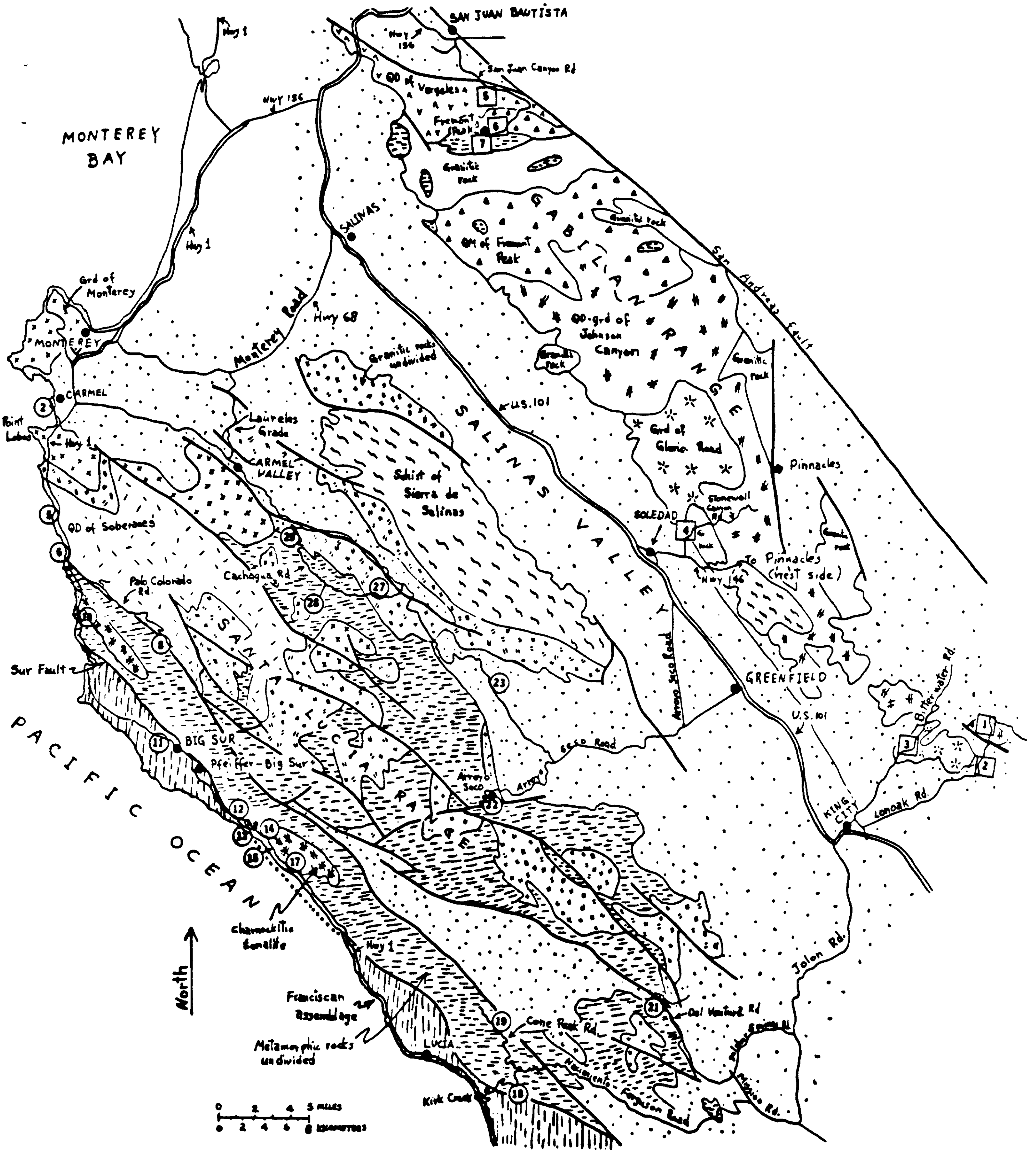
Directions are given in such a way that you can either take the entire trip or just make a few stops, depending on your interests and time. The trip as given is a long 3-day or a comfortable 4-day venture. Index maps, traced from topographic quadrangles, accompany most locality descriptions. The name of the quadrangle is shown on each index map.

Motel and restaurant facilities are available in the Monterey-Carmel area, in the Big Sur area (somewhat limited) and in King City and Salinas. Over-night camping is available in the Big Sur area (Pfeiffer-Big Sur State Park), at Kirk Creek campground (south of Lucia on Hwy. 1--where the Ferguson-Nacimiento Road starts), and at Arroyo Seco campground; all in the Santa Lucia Range. In addition there are camping facilities at the Pinnacles National Monument and at Fremont Peak State Park in the Gabilan Range. Advance reservations may be required at some of these campgrounds at some times of the year.

Hopefully the following locality descriptions and directions to reach them are relatively clear--Good luck and I hope you have good weather!

INDEX TO BASEMENT ROCK LOCALITIES, SANTA LUCIA AND GABILAN RANGES





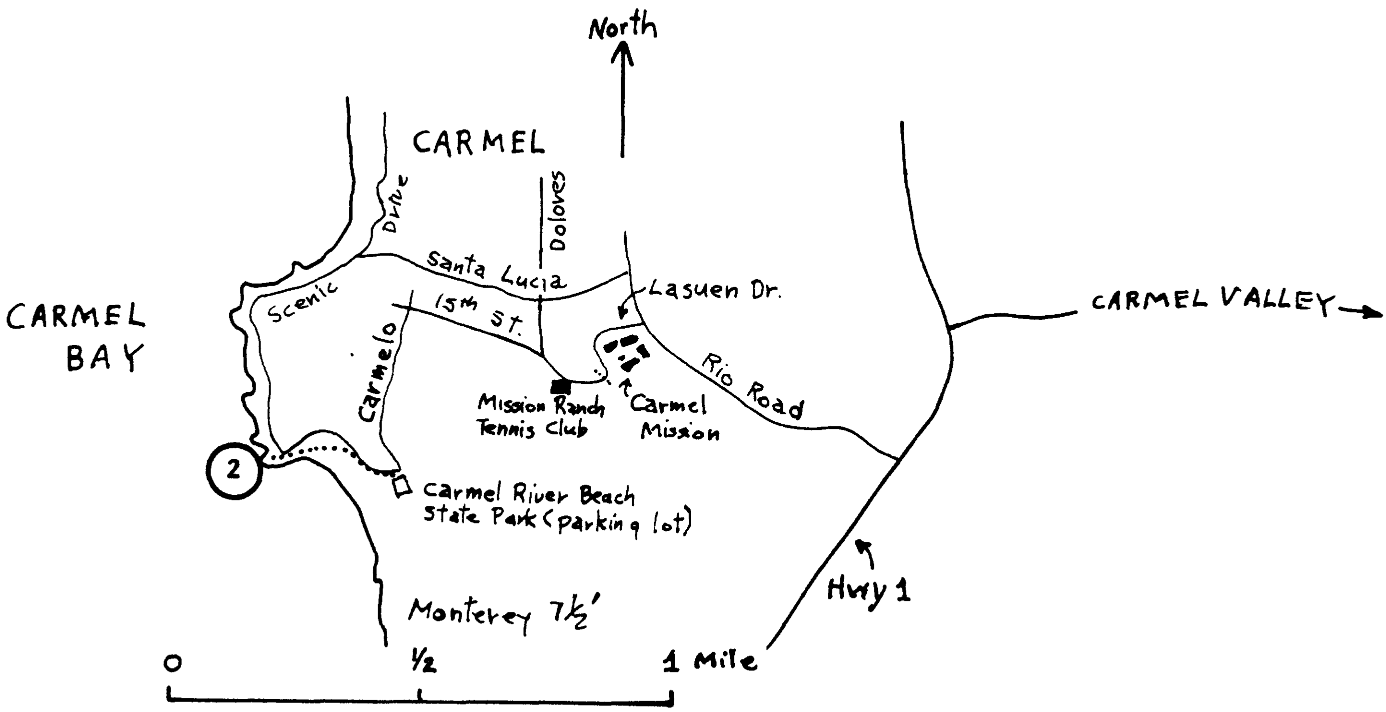
SIMPLIFIED GEOLOGIC MAP OF BASEMENT ROCKS.
SANTA LUCIA AND GABILAN RANGES
(Showing localities described in road log)

KEY TO OUTCROPS

Directions to locality (2): Take the Rio Road turnoff from California Highway 1. After 0.6 mi. turn left onto Lasuen Drive just past the Carmel Mission (Lasuen becomes Dolores St. behind the Mission). At 0.2 mi. bear left onto 15th St., continue 0.3 mi. on 15th and turn left onto Carmelo Street. Continue for 0.5 mi. to the parking lot of the Carmel River Beach State Park. Walk about 0.3 mi. west along the beach to the outcrops.

Geologic feature emphasized: Porphyritic granodiorite of Monterey.

Descriptive notes and locality map: Relatively fresh to weathered granodiorite "hob-nailed" with coarse phenocrysts is exposed here. Bold outcrops have some interesting swarms of phenocrysts. The following mode was determined for the groundmass of a sample of this rock type taken at Point Pinos (about 7 mi. north in Pacific Grove): plagioclase, 43; K-feldspar, 22; quartz, 28; biotite, 7; locally small amounts of primary muscovite are also found.[1] This strikingly porphyritic rock with K-feldspar phenocrysts up to 10 cm long, extends north from the Monterey Peninsula under Monterey Bay and South into the higher Santa Lucia Range for a total outcrop area of about 500 km^2. Possible correlative units in the Gabilan Range, in the subsurface at the San Ardo oil field, and in the La Panza Range, make this an important basement rock in the Salinian block.



[1] Note the dark sand concentrations on the beach in which pink garnet is abundant. Garnet was not noted in numerous thin sections, hand specimens, and stained slabs that were examined from the granodiorite of Monterey. A heavy mineral concentrate from a crushed sample from locality (2), however, did reveal several pink garnet fragments. Some of the beach garnet is undoubtedly locally derived, but I suspect that the largest contribution is from the garnet-bearing metamorphic and granitic terrane upstream in the Carmel River drainage.

Supplementary scenic and historic stop: South from the Carmel Valley turnoff on Highway 1 about 2.5 miles is the turnoff right to the Point Lobos Reserve State Park. There is a nominal charge to visit the Reserve, NO GEOLOGIC HAMMERS SHOULD BE CARRIED, AND NO COLLECTING IS PERMITTED.

Point Lobos has been described as; "The greatest meeting of land and water in the world." The porphyritic granodiorite of Monterey of locality (2) is exposed in spectacular headlands on the north side of the point. No one who hasn't seen Point Lobos should pass by on Highway 1 without stopping. The scenery is spectacular, and for a geologist it is also classic from an historic standpoint. A. C. Lawson mapped and studied this area, and in 1893 published a report on the work. The report was the first publication in the California University Department of Geology Bulletin, which has since been renamed: University of California Publications in the Geological Sciences. Local geologists may be interested in looking at the article in the bound volume in the library of the U. S. Geological Survey in Menlo Park--the article contains some interesting marginal notes by another venerable, Frank C. Calkins.

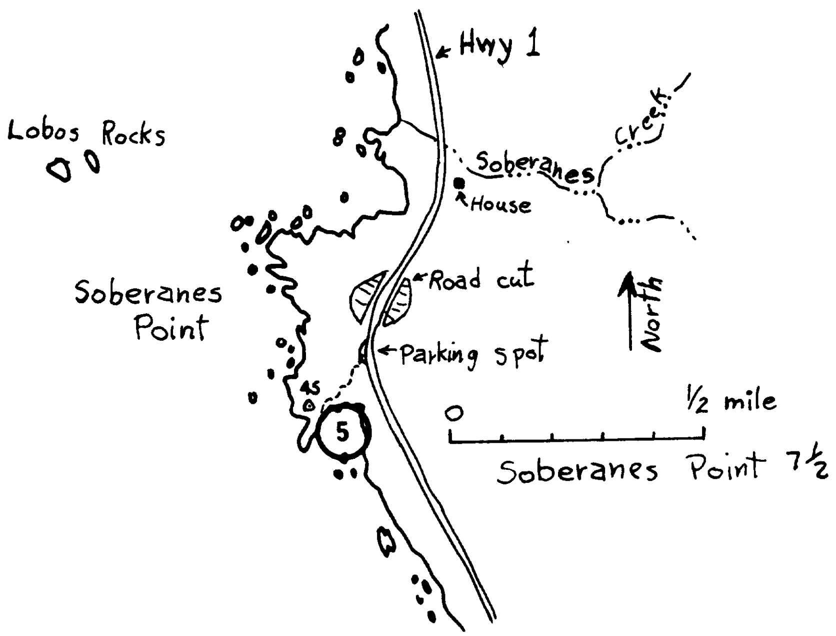
Directions to locality (5): About 5 mi. south of the Point Lobos turn-off, Highway 1 goes through a road cut in granitic rock on Soberanes Point. Just south of the road cut is a small pull-off spot on the west side of the road. From here a trail leads down to the shoreline at the south end of Soberanes Point (less than a 10-minute walk).

Geologic features emphasized: Hornblende-biotite quartz diorite of Soberanes Point and large dioritic inclusion mass.

Descriptive notes, analytical data, and locality map: A good bouldery outcrop of the quartz diorite of Soberanes Point is present at BM 45 on the terrace just above the sea cliffs. From the terrace there are "scrambleways" down to the picturesque cove and good sea cliff exposures. The quartz diorite is foliated with well-aligned ellipsoidal diorite inclusions similar to the large sugary diorite mass. Intrusive interaction between the quartz diorite of Soberanes Point and the diorite forms local intrusion breccia and migmatite. It is interesting to speculate on the lithologic character of the protolith from which these large dioritic inclusions, which are scattered through the quartz diorite of Soberanes Point, were derived--are the dioritic inclusions partially assimilated amphibolitic metamorphic rock, refractory parts of the magma, or something else? Note also local pinkish areas that in part represent "soaking" with K-feldspar. Initially, I interpreted isolated outcrops of such rocks as felsic plugs into the Soberanes mass, but good exposures such as these suggest that they formed by localized metasomatic replacement. This area also exposes abundant felsic dikes as well as thin gougy shear zones. A rather prominent "sea slot" (probably developed by erosion along a shear zone) has abundant rounded fresh quartz diorite boulders at its head. The following chemical analysis and mode were made from a quartz diorite specimen from this locality:

Chemical analysis and mode from locality (5) (DR-2165A)

SiO_2	62.81		
Al_2O_3	16.58		
Fe_2O_3	1.13		
FeO	3.64	Plagioclase	54
MgO	2.20	K-feldspar	9
CaO	4.85	Quartz	19
Na_2O	3.66	Biotite	13
K_2O	2.40	Hornblende	5
H_2O^+	.50		100
H_2O^-	.02		
TiO_2	.87		
P_2O_5	.21		
MnO	.074		
CO_2	.24		
	99.16		


Hwy 1
Lobos Rocks
Creek
Soberanes
House
Soberanes
Point
Road cut
North
Parking spot
45
5
0
½ mile
Soberanes Point 7½'

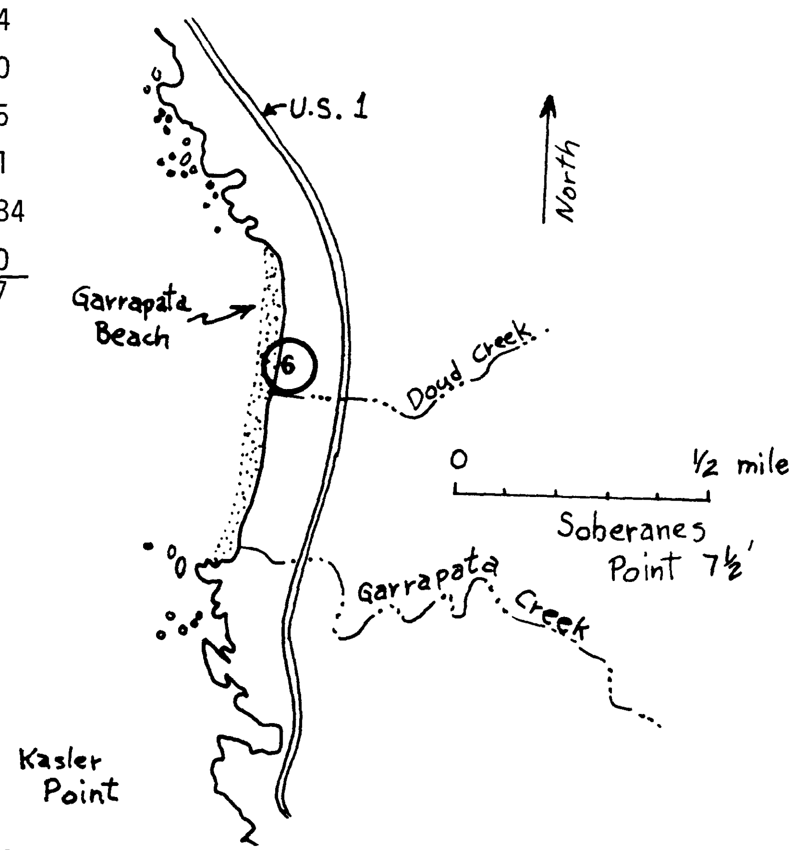
Directions to locality (6): 2.3 miles south on Highway 1 from the locality (5) parking spot is a long wide parking shoulder on the west side of the road for Garrapata Beach, less than 5 minutes west of the road. This is a very nice and popular beach that is frequented by both clothed and unclothed people. Turn north to view granitic rocks where the main trail enters the beach area--to the south is sandstone.

Geologic features emphasized: Hornblende-biotite quartz diorite of Soberanes Point and messy, sheared, calaclasite areas in the quartz diorite.

Descriptive notes, analytical data, and locality map: Directly north of the trail there is much shearing in the quartz diorite, with some well-defined shears as well as masses of greenish epidote-bearing calaclasite. Further north the outcrop is much less structurally disturbed. Small ellipsoidal dark inclusions are relatively common and some larger diorite masses are also present. The following chemical analysis and mode have been determined on an unsheared quartz diorite from this locality (DR-2169):

SiO_2	60.89
Al_2O_3	16.38
Fe_2O_3	1.27
FeO	4.29
MgO	2.92
CaO	4.94
Na_2O	3.58
K_2O	2.22
H_2O^+	.74
H_2O^-	.10
TiO_2	1.05
P_2O_5	.21
MnO	.084
CO_2	.10
	98.77

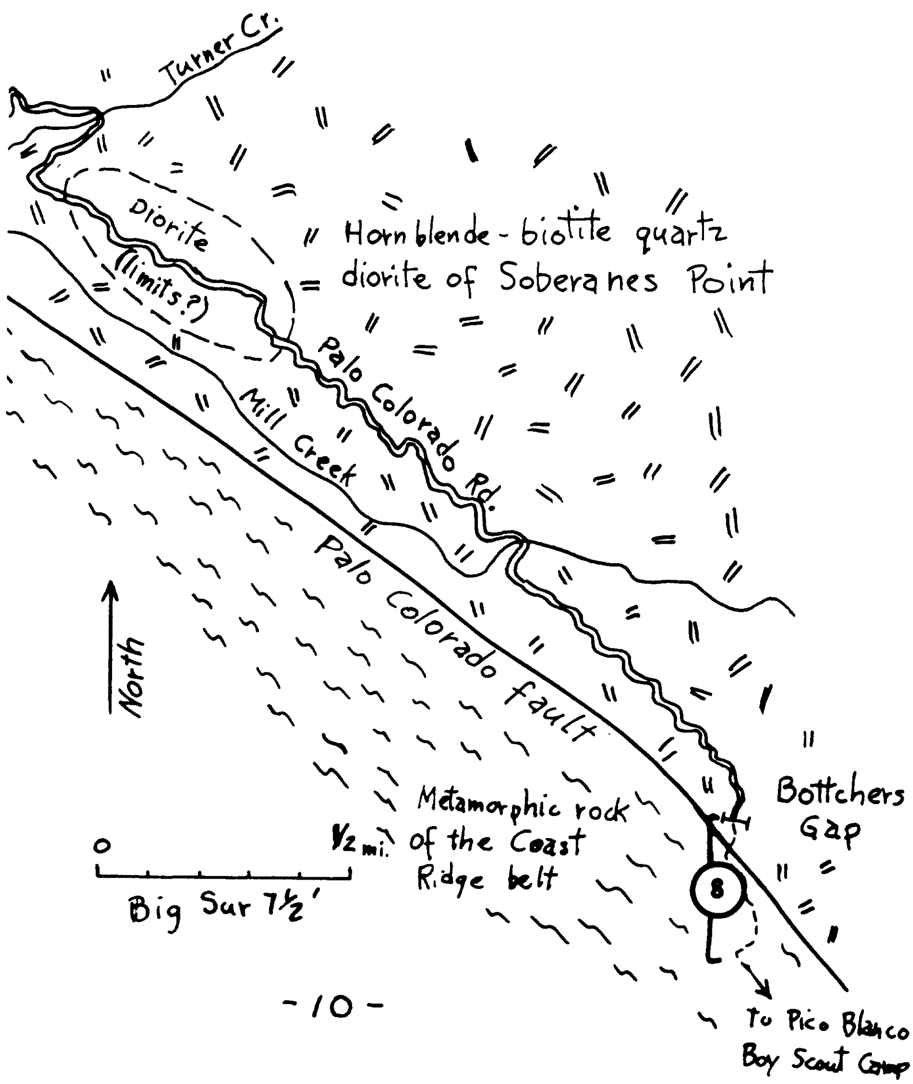
Plagioclase	52
K-feldspar	7
Quartz	19
Biotite	12
Hornblende	10
	100



Directions to locality (8): 1.6 mi. south of locality (6) turn left off Highway 1 onto Palo Colorado Road. The road is very narrow and it snakes through redwoods and past interesting cabins. Be extremely alert for on-coming traffic (on my last trip I met a large flatbed "semi" that used up about 98% of the road). 1.6 mi. up the road the Garrapata Road branches left--keep right (really straight ahead). At 7.7 miles park at the camp-ground by the locked gate on the road that continues south to the Pico Blanco Boy Scout Camp.

Geologic feature emphasized: Faulted contact between hornblende-biotite quartz diorite of Soberanes Point and metamorphic rocks of the Coast Ridge belt (Palo Colorado fault).

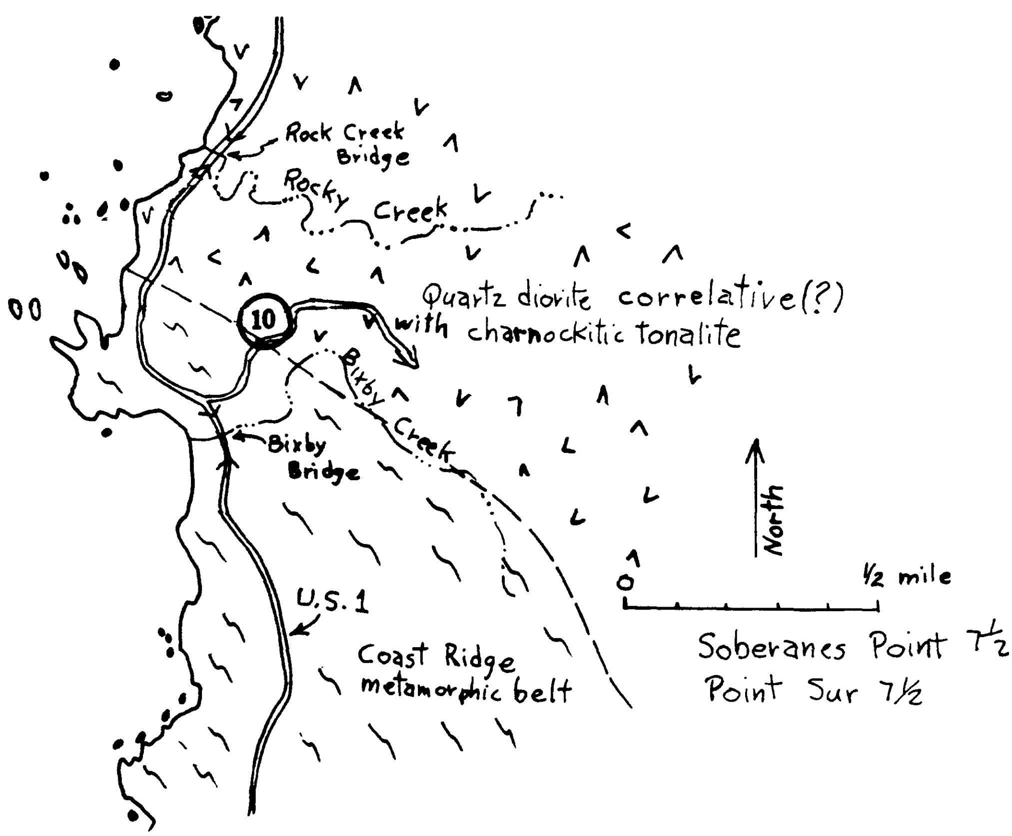
Descriptive notes and locality map: Just below gate at Bottchers Gap is weathered and possibly sheared rocks of the Soberanes mass. Where the road first bends to the right (west)--about 60 m from the gate--is some cataclasite. Metamorphic rocks appear rather abruptly and they feature graphite-bearing granofels and "garnet-eye" sills and dikes (felsic rocks studded with small pink to red garnets). There are some northwest-trending shear zones in the metamorphic rocks and though there is abundant felsic and garnetiferous granitic intrusive material in the metamorphic rocks, I have seen no apophyses of the quartz diorite of the Soberanes mass. This is hardly a textbook example of a fault contact, but the shearing and lack of evidence for intrusion is suggestive of a fault. In the real world of the Santa Lucia Range this is about all you see!



Directions to locality (10): Return to Highway 1 and continue south about 2 miles to pull-off spot on right just north of Bixby Bridge. Walk up Old Coast Road, which branches left from Highway 1 here.

Geologic features emphasized: Weathered and busted up metamorphic rocks of the Coast Ridge belt and quartz diorite related(?) to the charnockitic tonalite. A reminder of the sort of "messy" rocks that are common in this region!

Descriptive notes and locality map: Near the start of the Old Coast Road the exposure (such as it is) consists of quartz diorite, garnet-eye dikes, and patches of garnet-bearing granofels and gneiss. A short distance up the road the outcrop is dominantly "messy" quartz diorite that contains garnet. Note that dioritic inclusions are rare here and that ghost gneiss texture is locally present in the quartz diorite. The granofels and gneiss with patches of coarse garnet approaches the appearance of the garnet-bearing quartz diorite, which suggests the quartz diorite may be an ultrametamorphosed (granitized) rock?



Directions to locality (11): About 10 miles south of Bixby Bridge on Highway 1 a black top road branches left (east) to Captain Cooper School. Park near the junction.

Geologic feature emphasized: Laumontite veinlets in Franciscan rocks.

Descriptive notes: This is the only locality described that is not in Salinian block rocks. It is included because it is, to my knowledge, the only known occurrence of laumontite in the Coastal Belt Franciscan rocks, though laumontite has been reported from numerous localities in the Franciscan terrane east of the Salinian block. The white veinlets containing laumontite are common near the first telephone pole on the east side of Highway 1 north of the road junction. Veinlets are also abundant near the third telephone pole north of the intersection.

I found this locality while making a reconnaissance search of Franciscan rocks immediately west of the Sur fault to see if prehnite veinlets (Ross, 1976), which are so abundant in this area in the Salinian block rocks (east of the fault), are also present in the Franciscan. I found no prehnite in the Franciscan rocks during my cursory search; Gilbert (1973), however, noted prehnite in the Franciscan, but it is rare.

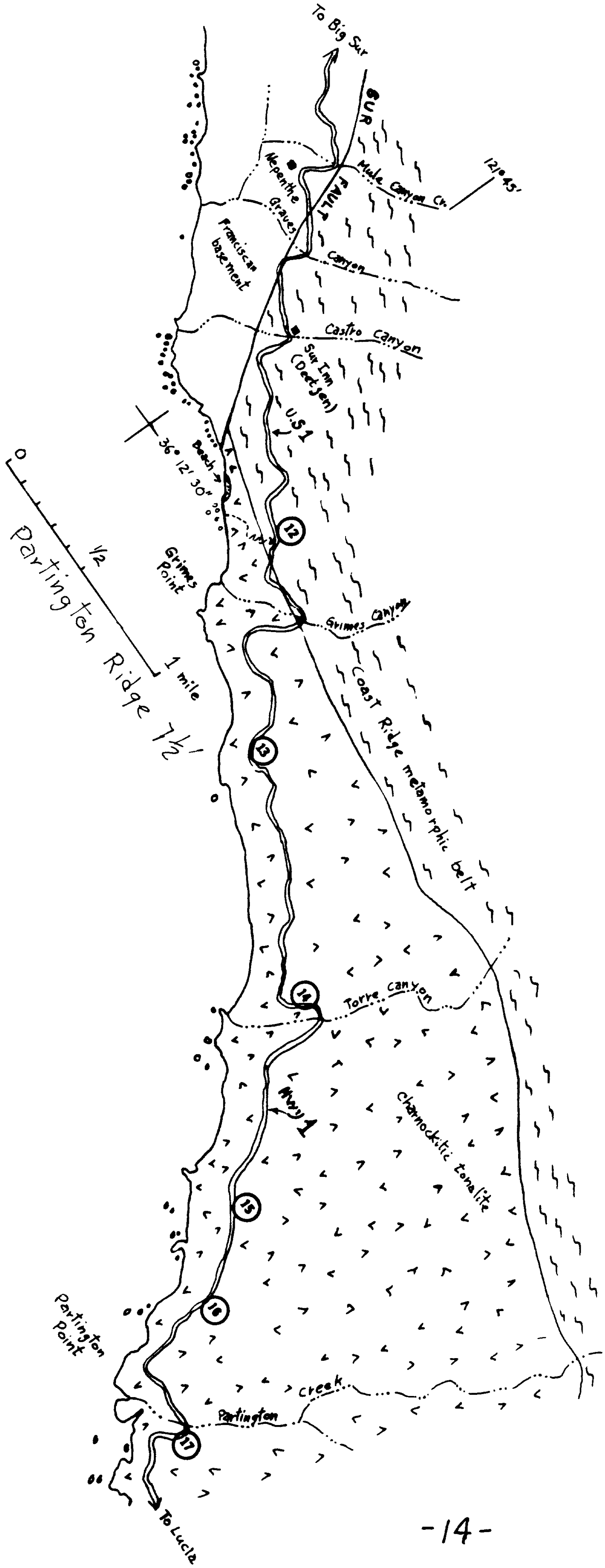
Directions to locality (12): Proceed south on Highway 1 beyond Pfeiffer-Big Sur State Park past Nepenthe and Sur Inn (Deetjen)--about 6 to 7 miles. About 1 mi. south of Sur Inn pull into turn-off spot next to steep draw on east side of road.

Geologic feature emphasized: Mixed gneissic and granitic rocks that typify the Coast Ridge metamorphic belt near the charnockitic tonalite.

Descriptive notes and locality map: This steep draw was flushed out in the winter of 1977-78 and contained good exposures as of June, 1978. The draw is rather "spooky" with loose and hanging rocks and care should be taken in climbing. Undoubted intrusive rocks (felsic) are present at this exposure, but the relation of the garnetiferous gneiss and the rocks that resemble the charnockitic tonalite raises the question of whether the charnockitic tonalite is truly an intrusive rock or is a partially "homogenized" metamorphic rock?

A wooden post on the east side of the road across from the draw marks the start of a "surfer trail" which descends 600 feet to an isolated beach that is a good spot for picnicking and nude sun bathing, but it is probably only average for surfing. There are both gneissic and charnockitic rocks exposed in the sea cliffs, but there is nothing there that isn't exposed along Highway 1--it is a nice beach, however, and makes a nice lunch stop in good weather.

The attached index map shows the location of this stop (12), as well as localities (13) through (17) in the charnockitic tonalite.


To Big Sur
SUR
FAULT
Mule Canyon Cr.
121° 45'
Nepenthe
Graves
Canyon
Franciscan basement
Castro canyon
Sur Inn (Deetjen)
U.S.1
36° 12' 30"
Beach
0
1/2
1 mile
Partington Ridge 7½'
12
Grimes Point
Grimes Canyon
Coast Ridge metamorphic belt
13
14
Torre canyon
Hwy 1
Charnockitic tonalite
15
16
Partington Point
creek
Partington
17
To Lucia

Directions to locality (13): Continue 1.2 mi. south on Highway 1 and park in a boulder-edged pull-off spot on the east side of the highway. Because of the curve in the highway at this point, it's a good idea to leave one person near the car to tell others when it's safe to cross the road.

Geologic features emphasized: Charnockitic tonalite and "basic granulite" of Compton (1960), as well as gneissic rocks.

Descriptive notes and analytical data: This is a good spot to see the variety within the body called charnockitic tonalite. Much dark material (amphibolite or "basic granulite") is present, as well as layers of gneissic rock, and charnockitic tonalite with coarse garnet patches.

Across the highway and just south of the northernmost of the two boulder-lined pull-off spots is migmatite consisting of tonalite that is either injected into the darker rocks or is a recrystallized and coarsened equivalent of layers of an originally gneissic sequence? Either this is a metamorphic terrane irregularly invaded by tonalite or an ultrametamorphosed terrain in which the tonalite has "grown in place"--or some of both (local mobilization). The first culvert north of the northernmost pull-off spot marks a good exposure of "basic granulite"; the second culvert north marks an exposure of the gneissic rocks.

The following mode and chemical analysis were determined from a sample of tonalite at this locality (DR-2283). Compton (1960, p. 618) has published two analyses of hypersthene-bearing tonalite from just north of locality 13 . In addition a mode is shown for the dark massive "basic granulite" (DR-1001).

Chemical Analyses

	loc. (13) (DR-2283)	Compton 1-1	Compton 1-3	DR-1001 ("basic granulite")
SiO_2	59.62	60.39	52.08	
Al_2O_3	17.00	17.76	21.39	
Fe_2O_3	2.18	.75	1.04	
FeO	5.27	5.92	6.88	NO
MgO	2.25	2.41	2.84	CHEMICAL
CaO	5.68	6.26	8.03	ANALYSIS
Na_2O	3.76	3.33	3.92	
K_2O	1.52	.72	.86	
H_2O^+	1.10	.96	.48	
H_2O^-	.12	.15	.16	
TiO_2	.99	.86	1.45	
P_2O_5	.20	.27	.38	
MnO	.12	tr.	.02	
CO_2	.09	--	.23	
	99.90	99.78	99.76	

Mode

Plagioclase	64	No mode	No mode	68
K-feldspar	4			1
Quartz	10			1
Biotite	3.5			2
Hornblende	6			16
Hypersthene	11.5			5
Opaques	1			1
Garnet				6
	100			100

Directions to locality (14): Continue 1.3 mi. south on Highway 1 and park in pull-off spot by mailbox just north of the Torre Canyon Bridge.

Geologic feature emphasized: Charnockitic tonalite.

Descriptive notes and analytical data: This may be one of the better spots for looking at the charnockitic tonalite and the highway shoulder is wide enough to make viewing a bit more relaxed than at some spots on the highway. Just north of the Torre Canyon Bridge is a private locked blacktop driveway. From the culvert marker at the driveway to the next culvert marker to the west is strongly foliated charnockitic tonalite, which is about as homogeneous as this rock gets; here is where the mode specimen (DR-2286) was collected. Between the second and third culvert markers the tonalite is much more messy with dark, streaky zones, but very few discrete ellipsoidal inclusions. Between the third and fourth culvert markers there is in addition some foliated felsic rock, which is a common associate of the charnockitic tonalite.

Mode (DR-2286)

Plagioclase	55
K-feldspar	--
Quartz	10
Biotite	5
Hornblende	13
Alteration products*	17
	100

*Largely actinolite and chlorite ("uralitic" alteration of hypersthene in part).

Directions to locality (15): Drive 1 mile further south on Highway 1 and park on east side of highway by large boulders and road and Forest Service Trail off to east.

Geologic feature emphasized: Abundant prehnite veins in charnockitic tonalite.

Descriptive notes and analytical data: Mono-mineralic veins of prehnite as much as several cm thick criss-cross the tonalite. The large boulders lining the parking area display the veins very well. In addition conspicuous veins in place can be seen about 50 m north of the culvert marker just north of the road leading east from the highway. A virtual boxworks of prehnite veins can also be seen in tonalite corestones in the weathered cut on the south side of the pull-off embayment. Further data on their significance and possible genesis can be found in Ross (1976, p. 561-568).

The following mode was determined from a tonalite specimen at locality 15 (DR-2287):

Plagioclase	56
K-feldspar	--
Quartz	11
Biotite	1
Hornblende	19
Alteration products*	13
	100

*"Uralitic" alteration of hypersthene in part.

Directions to locality (17): Continue south on Highway 1 for 1 mi. and park just across Partington Creek.

Geologic features emphasized: Variety in the charnockitic tonalite.

Descriptive notes and analytical data: Fresh streaky to homogeneous charnockitic tonalite with prehnite veins both in outcrop and on large talus slope. Nothing exceptional about this outcrop, but it is an easy pull-off spot and the following mode and chemical analysis were determined here:

SiO_2	54.59			
Al_2O_3	18.49			
Fe_2O_3	1.36	Plagioclase	61	
FeO	6.89	K-feldspar	<1	
MgO	3.86	Quartz	8	(DR-2315)
CaO	7.02	Biotite	1	
Na_2O	3.55	Hornblende	21	
K_2O	1.02	Alteration products*	9	
H_2O^+	2.16		100	
H_2O^-	<.02			
TiO_2	1.05			
P_2O_5	.24			
MnO	.14			
CO_2	.22			
	100.59			

*In part "uralitic" alteration of hypersthene.

Directions to locality (18): Continue south on Highway 1 to the metropolis of Lucia; about 4 mi. south of Lucia at the Kirk Creek Campground take blacktop Ferguson-Nacimiento Road east from Highway 1. Continue up the Ferguson-Nacimiento Road for 5.3 miles and park at south end of big curve at about El.2000'. The green mile post (5.5) is just above where you should park.

If you plan to take the Ferguson-Nacimiento Road across to King City it is best to contact the Military Police at Hunter Liggett Military Reservation (408-385-5911). Although this is a public road, there can be temporary closures during the day when they are playing soldier! This is the only public road across the range from Carmel to Cambria!

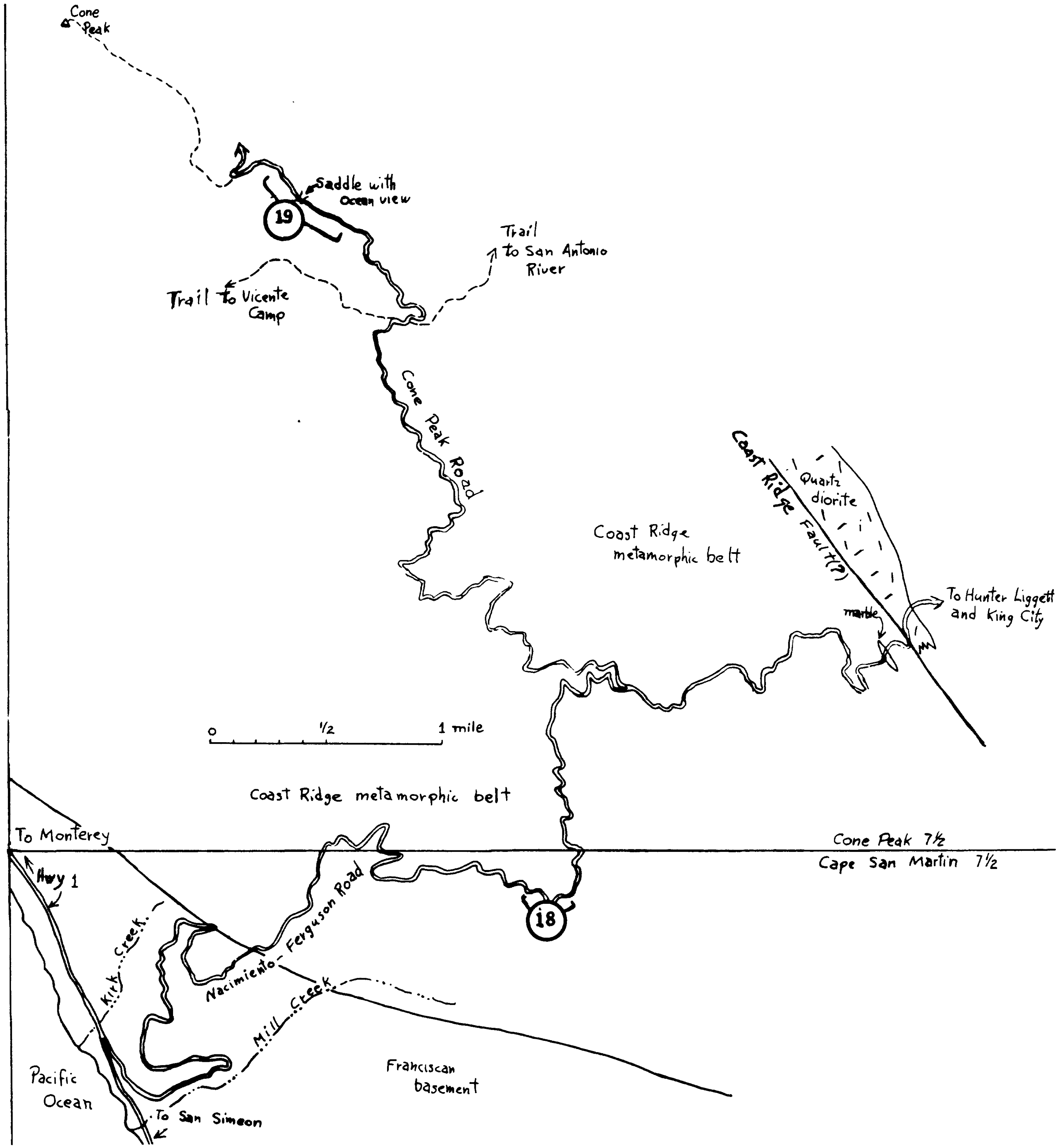
Geologic feature emphasized: Metamorphic rocks of the Coast Ridge belt.

Descriptive notes, analytical data and locality map: Both above and below the parking spot for a couple tenths of a mile are preserved segments of interbedded marble, impure quartzite, gneiss, amphibolite, and felsic granitic material in road cuts that are much weathered, broken, and slumped. The overall aspect to me is one of a thinly bedded sedimentary sequence now impressively metamorphosed. Rocks in the road cuts appear to be metamorphosed to the amphibolite grade, but a somewhat coarser reddish weathering layer very near the green 5.5 mile marker has a mineral composition suggestive of metamorphism to the granulite grade as indicated by the following modal analysis:

Plagioclase	41
Quartz	30
Biotite	2
Hornblende	8
Orthopyrozene	13
Graphite	4
Stilpnomelane	2
	100

Compton (1960) noted similar granulitic rock in the Cone Peak area. The graphite and the fact that this sort of rock seems to grade into more quartz-rich graphitic rocks, suggests it is a metasediment. It has been suggested (Compton, 1960) that the sporadically distributed granulitic rocks represent relatively "dry" spots in the general amphibolite facies terrane rather than localized spots of hotter or higher grade metamorphism. More road cuts and somewhat better exposures of these same lithologies can be seen a few 10ths of a mile further up the road, but there are no parking pull-offs.

The accompanying location map shows not only this stop (18), but also related stop (19) of the Coast Ridge metamorphic belt in the Cone Peak area.


Cone Peak
Saddle with Ocean view
19
Trail to San Antonio River
Trail to Vicente Camp
Cone Peak Road
Coast Ridge Fault(?)
Quartz diorite
Coast Ridge metamorphic belt
To Hunter Liggett and King City
0
1/2
1 mile
Coast Ridge metamorphic belt
To Monterey
Cone Peak 7½
Cape San Martin 7½
Hwy 1
Kirk Creek
Nacimiento-Ferguson Road
18
Mill Creek
Pacific Ocean
Franciscan basement
To San Simeon

Directions to locality (19): Continue up Ferguson-Nacimiento Road to saddle and junction with Cone Peak Road (about 1.8 mi. from stop (18)). Follow Cone Peak Road (fairly well graded in part, but this is a long and bumpy grind), at 3.8 miles the Vicente and San Antonio Trails branch off from the road, and at 4.8 miles from the start of Cone Peak Road park and turn around in saddle with good view of the ocean (on a clear day).

Geologic feature emphasized: Metamorphic rocks of the Coast Ridge belt in area of Compton's (1960) granulite rocks near Cone Peak.

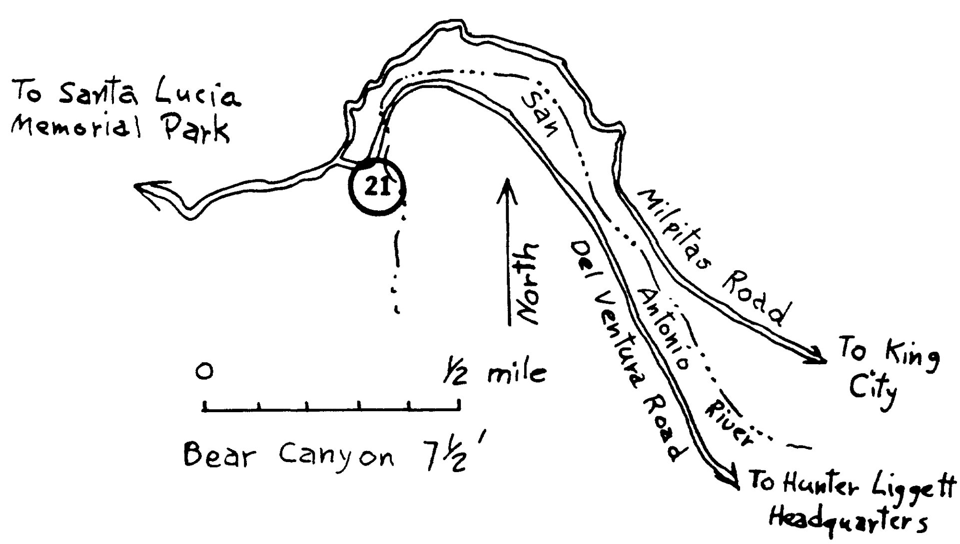
Descriptive notes: Walk a couple tenths of a mile north on the road to look at thinly layered gneiss, marble, amphibolite, and garnet-eye felsic granitic layers. Similar rocks are exposed about 0.3 mi. south of the saddle. Do these compositionally layered rocks reflect original bedding in a sedimentary sequence or is the layering strictly a result of metamorphic segregation--or is it some combination of the two? Are the dark sugary diorite (amphibolite) masses and layers derived from metavolcanic rocks, metapelitic rocks, or calcareous sedimentary rocks?

Directions to locality (21): Return to Nacimiento-Ferguson Road and proceed eastward to Hunter Liggett Military Reservation Headquarters area--intersection of Mission, Sulphur Springs, and Del Ventura Roads; take Del Ventura Road west and then north for 7.5 mi. to stream ford. Park on left west of ford.

Geologic feature emphasized: Quartzo-feldspathic metamorphic rocks of the Junipero Serra area.

Descriptive notes and locality map: In the stream bed and on both sides of the stream west of the ford (access dependent on water level) are layers of relatively fresh gneissic rock, mica-rich layers, and impure quartzite as well as some migmatite. The stream boulders here also show the upstream rock types. Are these rocks different from those of the Coast Ridge belt?

West of the parking spot (0.2 mi) a gravel road branches off to the right (north). From 0.3 to 0.6 mi. up this road are road cuts that provide fair exposures of micaceous quartzo-feldspathic gneiss and sugary hornfels criss-crossed with granitic dikes. Some areas of migmatitic rocks are also seen. Some dark micaceous layers about 0.3 mi. from intersection with black-top road contain garnet and sillimanite. Note also the granodiorite(?) mass on south side of Del Ventura Road just east of ford. Such "intermediate composition" granitic rocks are not found in the Coast Ridge belt. Return to Highway 101, and take Broadway turnoff in King City.



Directions to locality [1]: In King City go east on Broadway to east edge of town, turn right on old U.S. 101 and continue to Lonoak Road turn-off (about 0.6 mi.) turn left on Lonoak and continue for 10.5 mi. to north end of prominent granitic cuts and outcrops along San Lorenzo Creek. Park on west side of road just beyond big cuts. A good turn-around spot is 0.2 mi. ahead.

Geologic feature emphasized: Quartz diorite-granodiorite of Johnson Canyon.

Descriptive notes, analytical data, and locality map: Walk south along road to see darker-than-average granitic rocks of the Johnson Canyon mass with common inclusions and schlieren, which define a good foliation. Rocks in road cuts range from fresh to badly weathered with scattered corestones. There are fresher and in part more felsic rocks exposed along the Creek, but this is private land and the road cuts show nearly everything that is exposed along the creek. A chemical analysis and 6(!) modes were determined from specimens collected from these cuts--overkill brought on by the ecstasy of having good exposure and public access. The numerous modes, however, do point out the considerable variation in the Johnson Canyon unit.

Chemical Analysis

SiO_2	61.6
Al_2O_3	16.9
Fe_2O_3	1.6
FeO	3.7
MgO	2.6
CaO	5.8
Na_2O	3.6
K_2O	1.9
H_2O^+	1.0
H_2O^-	.07
TiO_2	.90
P_2O_5	.24
MnO	.12
CO_2	<.05
	100.03

Modes

	DR-570	DR-571	DR-572A	DR-572B	DR-1160	DR-1160-1
Plagioclase	54	52	55	39	41	57
K-feldspar	2	14	7	24	22	3
Quartz	19	23	18	30	30	24
Biotite	12	--	13	--	--	14
Hornblende	10	--	7	--	--	2
Chlorite	--	11	--	7	7	--
Epidote	3	--	--	--	--	--
	100	100	100	100	100	100

Directions to locality [2]: Drive south on Lonoak Road 2.2 miles from parking spot of locality [1]. Park alongside road--rather narrow shoulder! If you are coming from King City this spot is 8.3 miles up Lonoak Road.

Geologic feature emphasized: Schist of Sierra de Salinas.

Descriptive notes, analytical data, and locality map: The schist of Sierra de Salinas is exposed over an area of more than 250 km^2 in the Santa Lucia and Gabilan Ranges, yet it is frustratingly difficult to visit on a casual basis for all the access is on private land. This locality is probably the easiest place to view the schist and the outcrops are surprisingly fresh. Float pieces and mere traces of road gutter outcrop can be seen along the road. There are good exposures in the small gully just east of the road, but this is on private property.

The schist here is very "typical"; homogeneous, fresh, and contains "sills" of quartz, which are so characteristic of the schist throughout its entire area of exposure. It is interpreted as a metagraywacke (Ross, 1976). A small road cut just north of San Lorenzo Creek also has minor exposures of the schist (DR-1614). A mode was determined from that road cut and a chemical analysis and mode were determined from a specimen from the small gully (DR-1615) of locality [2].

Chemical Analysis (DR-1615)

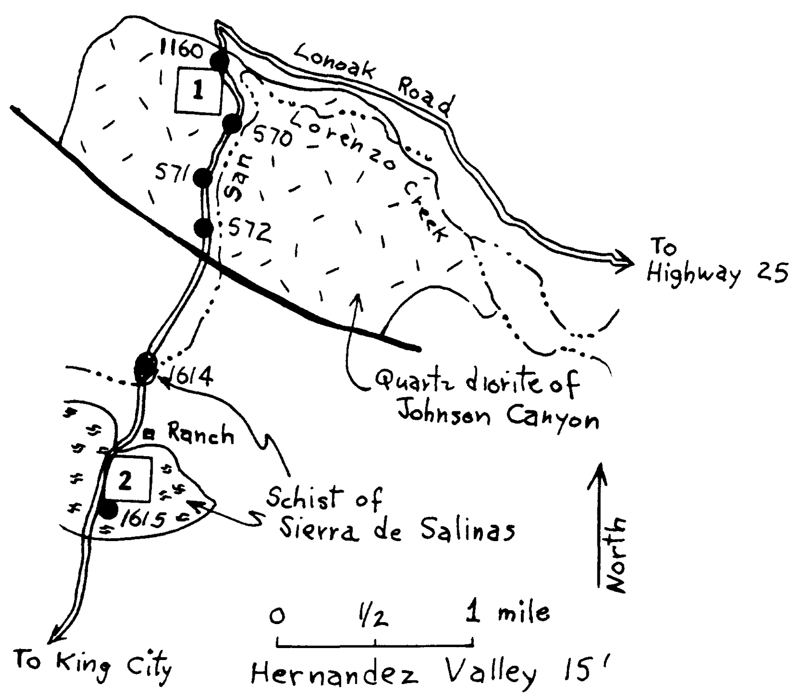
SiO_2	70.22
Al_2O_3	14.92
Fe_2O_3	.53
FeO	2.74
MgO	1.39
CaO	2.54
Na_2O	3.19
K_2O	2.21
H_2O^+	1.08
H_2O^-	.08
TiO_2	.51
P_2O_5	.11
MnO	.05
CO_2	<.05
	99.57

Modes

	DR-1615	DR-1614
Plagioclase	41.5	48
K-feldspar	<1	4
Quartz	40	29
Biotite	16.5	19
Muscovite	2	tr.
	100	100

Details of the petrography, distribution, and regional significance of this distinctive metagraywacke unit can be found in Ross (1976).

A bit of homespun wisdom Ross-style: Where it is necessary to go through a fence onto private property I have found it easiest on the fence and on farmer-rancher dispositions to slip between the strands rather than to climb over the fence near a post. Climbing over can be hard on the fence and furthermore it's easy to slip and cause yourself embarrassing and painful injuries. Almost always a short walk along a fence will reveal fairly "loose" spots between posts where you can slip through. On a really tightly strung fence you can generally go under the lower strand with a little agility--if there is no poison oak around. Incidentally the deer almost always slide under the lower strand, they only seem to jump over fences in Disney movies!



Directions to locality [3]: Take the Bitterwater Road east from King City. 5 miles from the railroad tracks is a large unmistakable road cut. Park west of cut on the south side of the road.

Geologic features emphasized: Quartz diorite-granodiorite of Johnson Canyon and granodiorite of Gloria Road.

Descriptive notes, analytical data, and locality map: Granitic rocks in this large cut show considerable lithologic variation and two separate rock types probably are represented. Alternatively, one mass of variable granitic rock may be present as I formerly believed. From the car, cross the road and walk easterly along the road. These rocks, in part weakly porphyritic, I consider to be granodiorite of Gloria Road--and possibly correlative with the granitic rocks of the La Panza Range (120 km to the southeast). Near the east end of the cut are streaky schlieren-rich rocks with some hornblende, which I interpret as the edge of a large "inclusion" of Johnson Canyon rocks. Now cross the road and note that the granitic rock has abundant well-formed hornblende characteristic of Johnson Canyon rocks. As you walk west along the south side of the road this lithology persists to a dark, soft zone, west of which the more felsic rocks similar to the Gloria Road type reappear.

Now if you walk west down the highway about ¼ mile you will pass a blacktop road branching north from the highway. Immediately west of the road is a small "indentation" (old quarry?) that exposes mostly hornblende-bearing granitic rock with some smeared inclusions. I interpret this as Johnson Canyon type (G-1 area). At the east side of the "indentation" there is a vertical dike of felsic granitic rock into the hornblende-bearing rocks. To me the dike rock looks like the Gloria Road rock type. There are aplite-alaskite-pegmatite dikes here also, which make the correlation to the Gloria Road rocks questionable.

These outcrops are a good sample of the sort of "incomplete data" that are available for evaluation in this region of limited exposure.

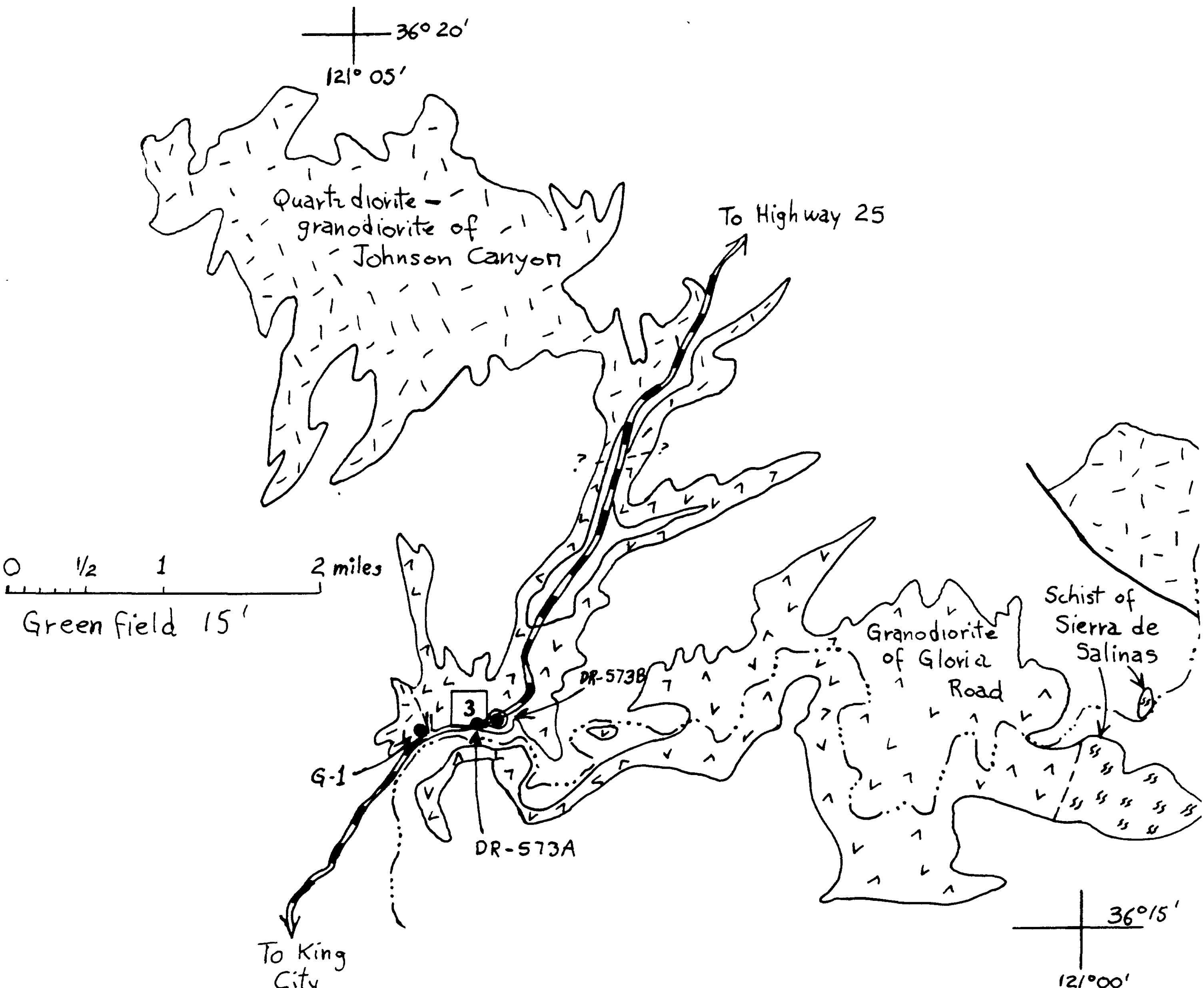
The following chemical analyses and modes were determined here in the road cut (DR-573) and in the small "indentation" (G-1):

Chemical Analysis

	G-1B (Johnson)	G-1A (Gloria)
SiO_2	66.4	71.5
Al_2O_3	16.2	14.7
Fe_2O_3	1.6	.79
FeO	2.2	1.1
MgO	1.4	.68
CaO	3.7	2.3
Na_2O	3.5	3.2
K_2O	3.0	4.4
H_2O^+	.88	.51
H_2O^-	.02	.05
TiO_2	.78	.31
P_2O_5	.18	.07
MnO	.05	.25
CO_2	<.05	<.05
	99.91	99.86

Modes

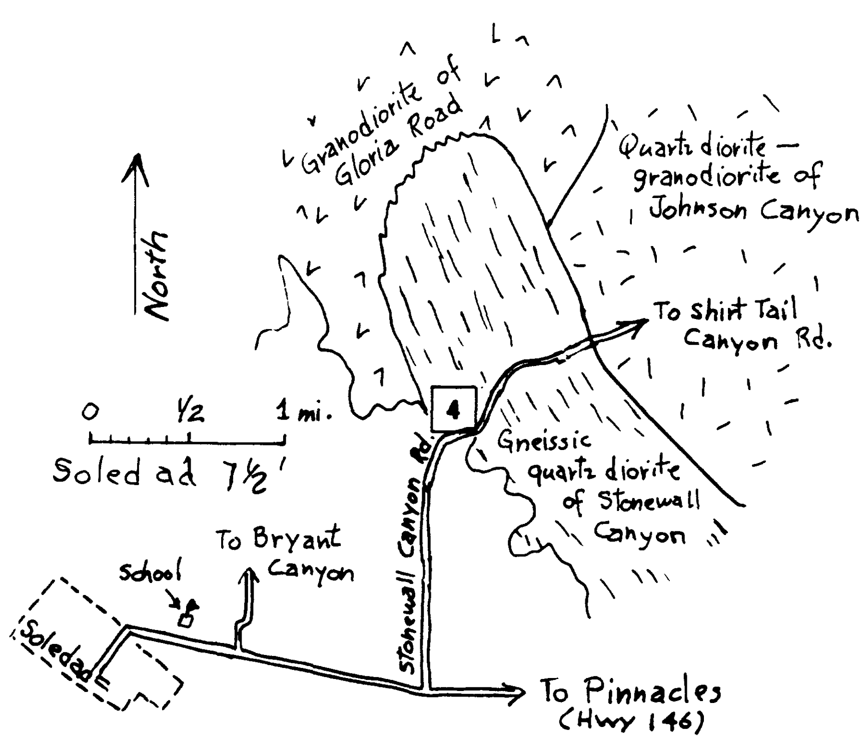
	Johnson Canyon		Gloria Road	
	G-1B	DR-573-B	G-1A	DR-573A
Plagioclase	48	42	36	44
K-feldspar	16	15	29	19
Quartz	23	31	30	32
Biotite	11	9	5	5
Hornblende	1	2	--	--
Sphene	1	1	--	--
	100	100	100	100



Directions to locality [4]: Return to Highway 101 and drive 21.3 mi. north to Soledad. From Soledad take Highway 146 toward Pinnacles National Monument, pass San Vicente Elementary School and shortly afterwards the Bryant Canyon Road turnoff and a cemetary. One mile east of Bryant Canyon Road turn left onto the Stonewall Canyon Road. The road bears somewhat right after 1 mi. and about 0.3 mi. further on park near outcrops left (north) of the road.

Geologic feature emphasized: Gneissic quartz diorite of Stonewall Canyon.

Descriptive notes, analytical data, and locality map: Exposed here north of the wash and about 100 m upstream (by the next cross fence) are rocks that I characterize as "ultrametamorphosed;" gneissic rocks that are homogenized (granitized?) to such a degree that they begin to resemble the granitic rocks of the Johnson Canyon type. Other metamorphic rock types including sillimanite schist have been found upstream. It could also be argued that these gneissic rocks are Johnson Canyon intrusive rocks that have assimilated metamorphic material or that the gneissic character is primary foliation related to intrusion. I find it hard to accept the "foliation" here as primary granitic foliation. These gneissic rocks generally are rich in biotite, but poor in hornblende. One specimen taken from this outcrop has the following mode: plagioclase, 39; quartz, 40; and biotite, 21. The average abundance of quartz in this mass is 35 percent,--rather high for a "dark" granitic rock. Return to Highway 101 by the same route.



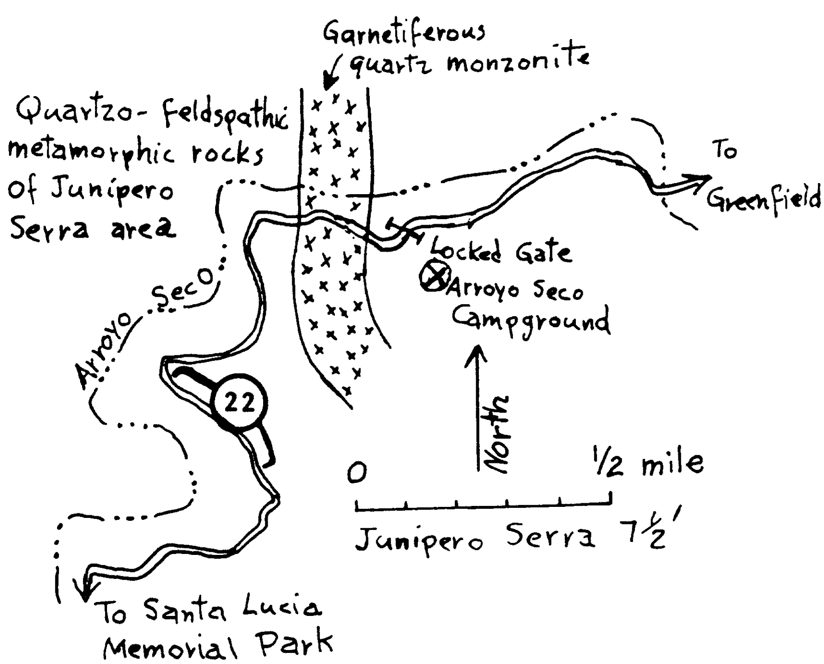
Directions to locality (22): Drive up Arroyo Seco Road from U.S. 101 either from Soledad (from north) or Greenfield (from south) to the Arroyo Seco Campground. The area traversed by Indians Road which continues on and connects with the Milpitas Road at the Santa Lucia Memorial Park is now closed (June, 1978) as a result of the Marble Cone Fire but it is permissible to walk up the road.

Geologic feature emphasized: Quartzo-feldspathic metamorphic rocks of the Junipero Serra area.

Descriptive notes and locality map: Follow the road above the locked gate through some oak and grass country to the beginning of the narrow part of the road where some amphibolite and abundant garnetiferous quartz monzonite is exposed by large road cuts. West of the granitic rock at the big bend in the road are exposures of biotite quartzo-feldspathic gneiss and impure quartzite with thin mica-rich partings. For someone in a hurry the rocks exposed in this bend are similar to those exposed farther up the road at locality (22), but if you're willing to walk along the largely covered interval from the big bend to (22) you will see a nicely exposed stack of impure quartzite in thin to thick beds (?) with thin "shaly" (micaceous) partings. I suggest this layering largely reflects relict bedding in a metasedimentary sequence. There are also abundant sills and dikes of felsic granitic material, but very little that qualifies as migmatite. These metamorphic rocks appear to have more of a sedimentary appearance than do the graphitic impure quartzites of the Coast Ridge belt.

Looking across Arroyo Seco you can get some good views of thinly layered quartzo-feldspathic gneiss and impure quartzite--the kinds of rocks that seem to typify this belt.

Drive back along Arroyo Seco Road for 5 mi. and turn left onto Carmel Valley Road.



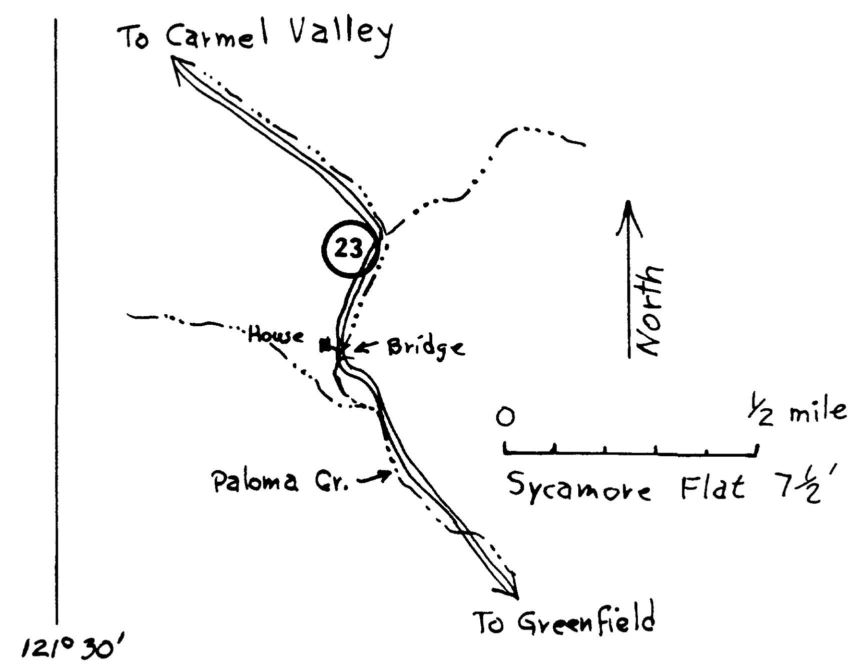
Directions to locality (23): Follow the Carmel Valley (Jamesburg) road for 6.3 miles to small bridge and house on left side (west) of road--continue 0.3 mi. and park on east side of road at bend.

Geologic feature emphasized: Hornblende-biotite quartz diorite of Paraiso-Paloma area.

Descriptive notes, analytical data, and locality map: Large road cut and cliff is composed dominantly of granitic rock with some dioritic and granofelsic patches, but only a few ellipsoidal dioritic inclusions. Salmon-pink feldspar is locally notable. Mode and chemical analysis determined from sample from this large cliff (DR-1734). Near the south abutment of the bridge the granitic rock is somewhat more felsic (Mode 1735).

Chemical Analysis (1734)	
SiO_2	62.74
Al_2O_3	16.92
Fe_2O_3	1.51
FeO	3.32
MgO	2.13
CaO	4.70
Na_2O	3.84
K_2O	2.20
H_2O^+	.82
H_2O^-	<.02
TiO_2	1.03
P_2O_5	.29
MnO	.07
CO_2	.07
	99.64

Modes	1734	1735
Plagioclase	52	47
K-feldspar	3	13
Quartz	26	32
Biotite	14	8
Hornblende	4	--
Other	1	--
	100	100



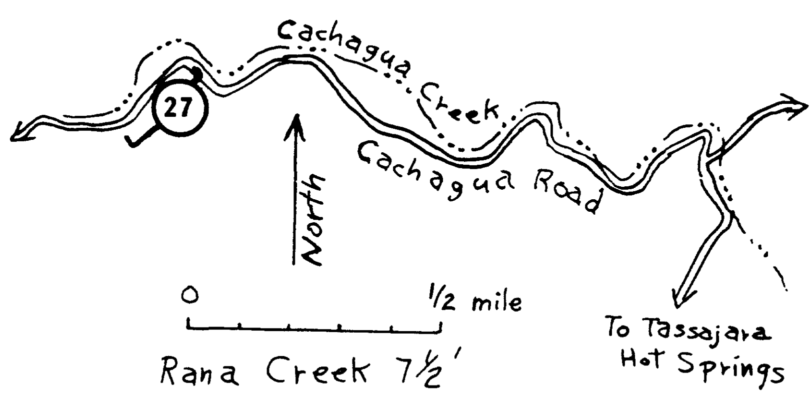
Directions to locality (27): Follow the Carmel Valley Road north for 17.2 mi. to the Cachagua Road junction. Turn left and at 1.4 mi. keep right at Tassajara Road junction; continue an additional 1.3 miles where you can squeeze onto shoulder (at least partway) at sharp bend in road just beyond a bright blue mail box (with number 103) on right (north) side of road.

Geologic feature emphasized: Hornblende-biotite quartz diorite of the Paraiso-Paloma area.

Descriptive notes, analytical data, and locality map: Some faces in the road cuts here consist of very fresh relatively dark Paraiso-Paloma rocks with surprisingly few ellipsoidal inclusions. This is a good locality for a large fresh specimen and the following two modes and a chemical analysis were determined from specimens here.

Chemical Analysis (DR-1771)	
SiO_2	62.44
Al_2O_3	16.81
Fe_2O_3	.62
FeO	4.28
MgO	2.18
CaO	5.50
Na_2O	3.78
K_2O	1.62
H_2O^+	1.08
H_2O^-	<.02
TiO_2	.91
P_2O_5	.27
MnO	.07
CO_2	.11
	99.67

Modes	DR-1770	DR-1770-71
Plagioclase	59	55
K-feldspar	--	--
Quartz	19	21
Biotite	11	15
Hornblende	11	9
	100	100



Directions to locality (28): Continue west on Cachagua Road, past turn-off to "Earth Station" (communication satellite facility) at 2.5 mi. and turn left at Nason Road to Princes Camp at 3.1 mi. and drive south through Princes Camp. Stop at the Ranger Station for a Wilderness Permit if you plan to go beyond the dam and park at the locked gate of the road to Los Padres Dam (about 0.6 mi. south of Cachagua Road).

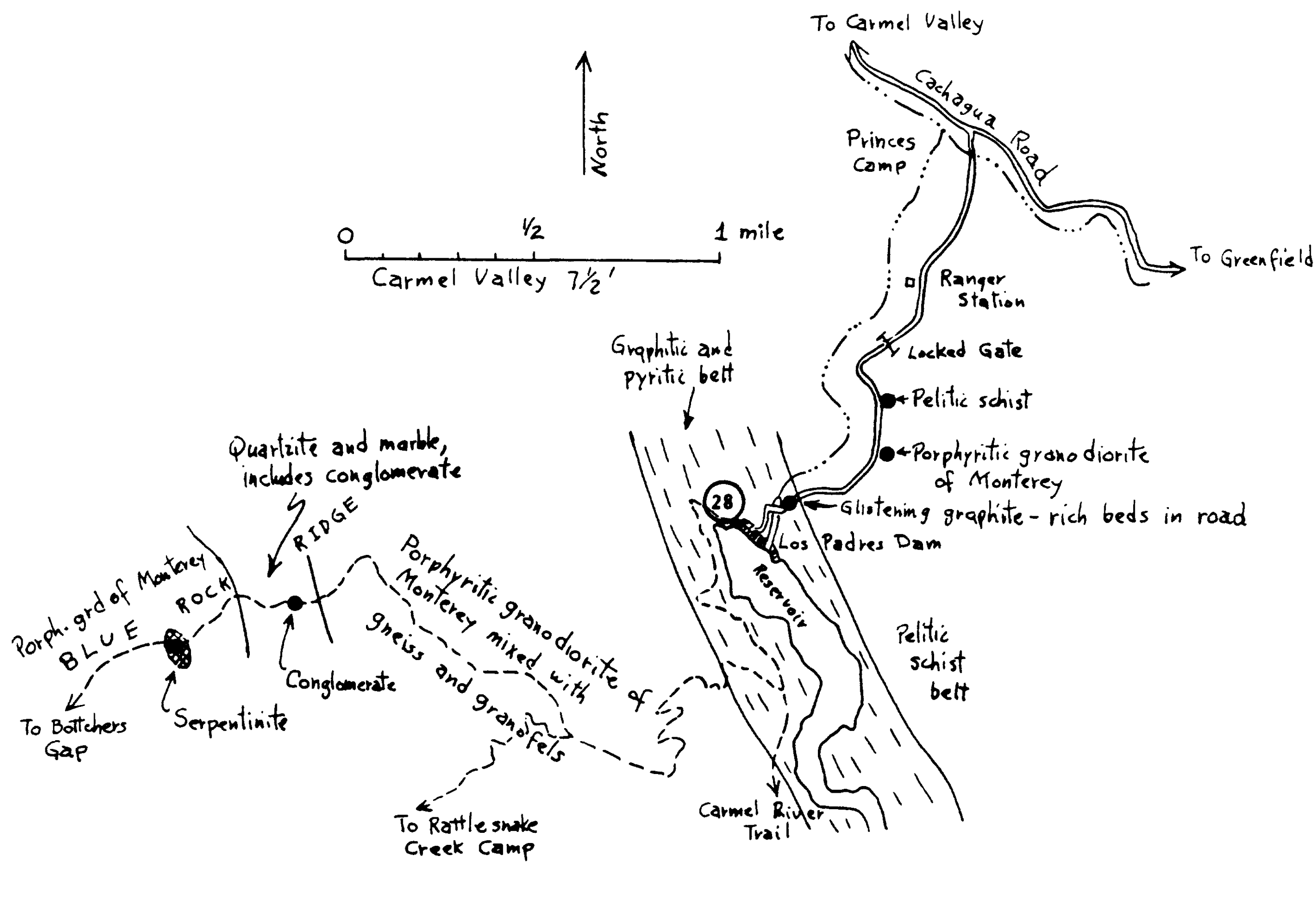
Geologic features emphasized: Graphitic and pyritic belt (Las Padres unit of Wiebe, 1970); pelitic schist belt of Wiebe (1970); porphyritic granodiorite of Monterey on the way to the dam. Also marble, quartzite, conglomerate, and serpentinite if you take the Blue Rock Ridge trail.

Descriptive notes and locality map: The first outcrops on the left above the locked gate are micaceous, thinly layered, metamorphic rocks that are part of Wiebe's (1970) pelitic belt. A short distance further up the road porphyritic granodiorite of Monterey is exposed. In the road and in the low cuts just east of the bridge that crosses the dam spillway are distinctive glistening beds of graphite-rich rock.[1/] West of the dam are cliffs of reddish weathering graphitic rocks and some dense hornfels that is gray to green on fresh surfaces. Near the dam, dark granitic to dioritic masses and sills interrupt the section. Near the first big bend in the trail (to the south) there are a couple of meter-thick sills of granitic rock in the metamorphic section that are probably part of the Cachagua mass (see locality 29). Some black zones of gouge are also seen in these reddish cliffs. Looking across at the east dam abutment you can see reddish "graphite" beds and higher on the slope light gray rocks of the pelitic unit(?).

1/ Graphite is easy to overlook or to misidentify as mica, particularly where it is fine grained. With a hand lens it has a metallic gray color that is very distinctive once you are used to it. If you can bend a flake with a knife point, it stays bent whereas mica snaps back. Also if you can scrape some flakes onto a sheet of paper, graphite will make a "lead pencil" smudge. A sure-fire lab test for graphite flakes in a rock is to grind up a small piece and dump it into water and stir it up--the floating graphite flakes are unmistakable.

Additional trail trip from locality (28): From the dam walk south along the Carmel River Trail and then branch right on the trail that climbs up to Blue Rock Ridge. (This trip involves a 6 to 8 km roundtrip and a climb of some 500 m on a trail that was in good shape when I last traversed it in 1972.) The trail ascends through rather poorly exposed porphyritic granodiorite of Monterey and some mixed gneiss and granofels. A prominent belt of marble and quartzite on Blue Rock Ridge contains the only known conglomerate in the range (first noted by Wiebe, 1970). The conglomerate contains well-rounded clasts of quartzite to several cm in a "sandy" matrix. Further along Blue Rock Ridge a bald knob of dark green to black serpentinite with irregular northeast-trending layering seems to jut out of the porphyritic granodiorite. It is this mass for which Blue Rock Ridge was named. This is one of the better exposed serpentinite blobs in the Santa Lucia Range. It consists dominantly of clinochrysotile and lizardite (none of the serpentinites from several localities contained antigorite; based on x-ray diffraction studies).

The round trip from the dam parking lot makes a nice "picnic day" trip through some interesting, if not particularly well-exposed, geology and through some nice wooded Santa Lucia Country (Carmel Valley 7½" quadrangle).



Directions to locality (29): From junction of Cachagua Road and Nason Road follow Cachagua Road west for 4.8 miles to large stepped road cut. Park on left just past small dirt road.

Geologic feature emphasized: Granodiorite of Cachagua.

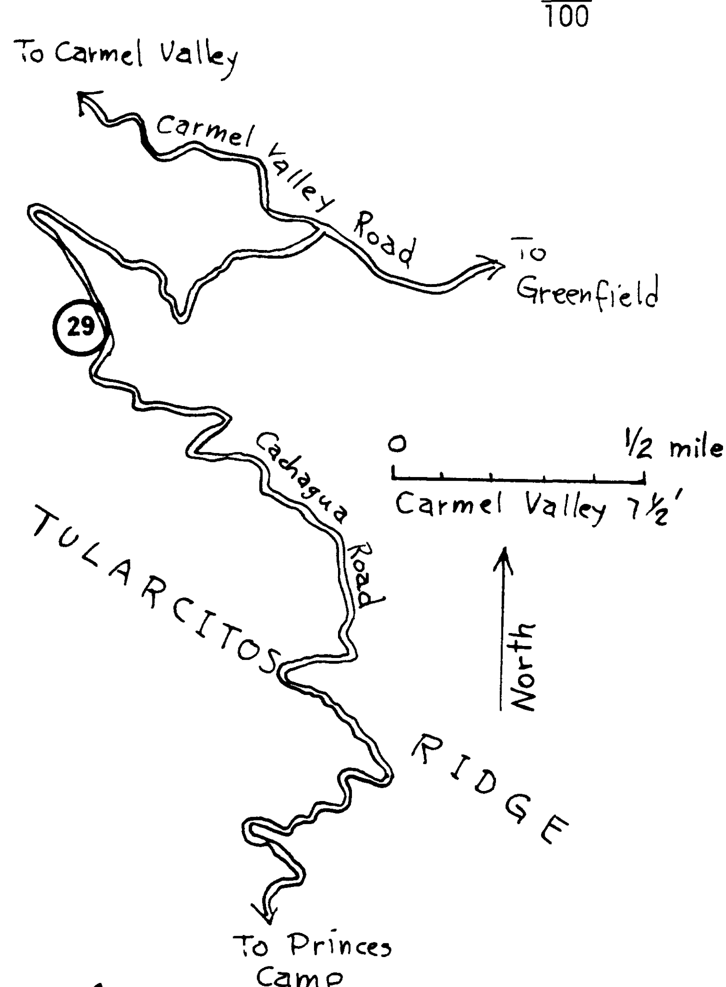
Descriptive notes, analytical data, and locality map: This road cut exposes deeply weathered rock, but there are a few relatively fresh corestones. Note that these rocks are distinctly dark, streaky, messy, variable, and contain ellipsoidal inclusions. They are distinctly different from the rocks of the Monterey mass. The following chemical analysis and mode were determined from a specimen from this locality. This is not a locality that is worth making a special trip for, but if you are passing by anyway it will show you a typical road cut of weathered granitic rock in this region.

Chemical Analysis (DR-1865)

SiO_2	63.62
Al_2O_3	16.61
Fe_2O_3	1.78
FeO	2.99
MgO	1.90
CaO	4.08
Na_2O	3.53
K_2O	2.50
H_2O^+	.92
H_2O^-	<.02
TiO_2	.97
P_2O_5	.25
MnO	.054
CO_2	.28
	99.48

Mode (DR-1865)

Plagioclase	51
K-feldspar	2
Quartz	24
Biotite	19
Hornblende	3
Sphene	1
	100



Directions for locality [5]: Continue for 1 mile on Cachagua Road to junction with Carmel Valley Road. Turn left on Carmel Valley Road and continue for 6.5 mi. thru Carmel Valley Village and turn right on Laureles Grade Road. After 5.9 mi. turn right onto Monterey Road (unmarked). Continue to Highway 101 at Salinas and take 101 north to San Juan Bautista turnoff. Follow Highway 156 for about 3 mi. to San Juan Bautista. Turn south (right) onto San Juan Canyon Road towards Fremont Peak State Park. Road forks after about 0.3 mi.; follow left fork. About 4.4 mi. from Highway 156 an old cement plant road crosses the Canyon Road. Park near the yellow gates. This locality is on private property.

Geologic feature emphasized: Quartz diorite of Vergeles.

Descriptive notes, analytical data, and locality map: Follow the old road south up Peak Canyon. Where the old black top road turns left, keep south on the "lesser" road up Canyon. It is about a 10-minute walk to an exposure of unusually fresh rock of the Vergeles mass. This is a relatively dark, hornblende-bearing granitic rock that may be correlative with the rocks of the Johnson Canyon mass. Marble and coarse quartz monzonite of Fremont Peak can be seen in the stream bed. Further up the canyon a pendant (screen) of marble separates these dark rocks from the quartz monzonite of Fremont Peak upstream, but contact relations are not seen. This fresh Vergeles outcrop presents nothing special, but it has been sampled for mode and chemical analysis--this would be a good place to collect a large sample.

Chemical Analysis (DR-1127A)

SiO_2	63.6
Al_2O_3	17.7
Fe_2O_3	1.2
FeO	3.2
MgO	1.7
CaO	5.2
Na_2O	3.5
K_2O	1.6
H_2O^+	1.2
H_2O^-	.09
TiO_2	.73
P_2O_5	.21
MnO	.09
CO_2	<.05
	100.02

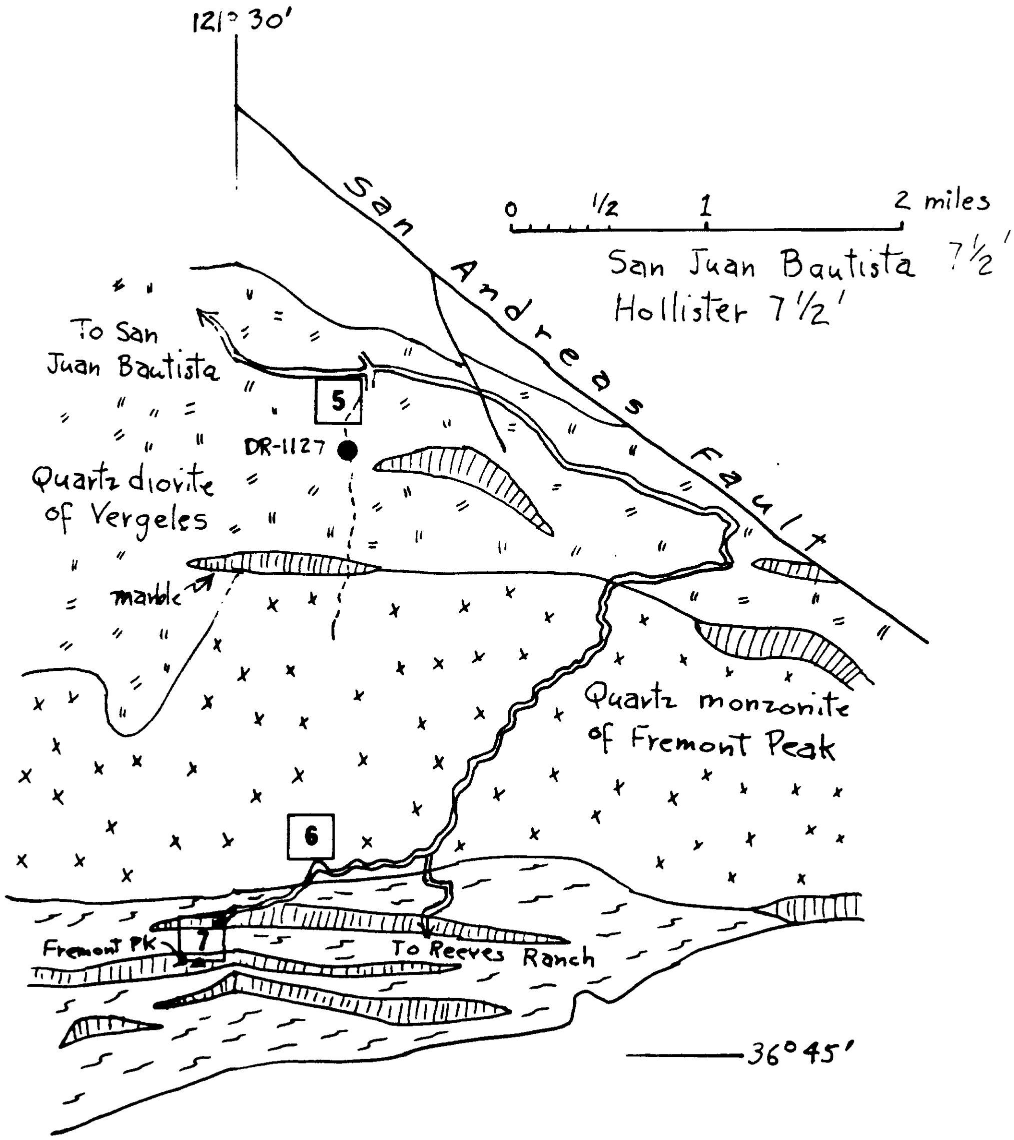
Mode

Plagioclase	61
K-feldspar	2
Quartz	21
Biotite	11
Hornblende	4
Sphene	1
	100

Directions to locality [6]: Continue up Fremont Peak State Park Road from parking spot of locality [5]. At 5.1 miles is a gravel road leading south to the Reeves Ranch (intersection un-marked). Continue 1 mile further and park to right of road beyond road cuts.

Geologic feature emphasized: Quartz monzonite of Fremont Peak.

Descriptive notes and locality map: Walk back 0.3 miles to relatively fresh road cuts in quartz monzonite. The grussy yellow-weathering slopes and road cuts you came through from the saddle above the big bend to the area of the Reeves Ranch turn-off were typical exposures of the Fremont Peak rock type. This quartz monzonite is a standard "low melting trough" rock with about equal amounts of sodic plagioclase, K-feldspar, and quartz with a few percent of biotite. This rock is of little value for correlation purposes by itself, because it is such a common lithology.



Directions to locality [7]: Continue to the end of the Fremont Peak State Park Road, which is the parking lot for the Trail up to Fremont Peak--about half a mile beyond the parking spot for locality [6].

Geologic feature emphasized: Metamorphic rock types in the large pendant on Rocky Ridge.

Descriptive notes and locality map: The climb to the summit is about 100 m in a distance of less than a kilometer (a leisurely climb up and back with stops can easily be accomplished in 45 minutes--if someone is on a schedule). The traverse up the trail begins in slope wash, but there is some biotite schist exposed beyond the first bend. This is followed by exposures of a belt of marble and then, at the big bend near the "radio facility", there is brown schist, sugary hornfels, and some sugary diorite. As you look over the grassy slopes from this point it is easy to see how the marble gets exaggerated in geologic mapping--it forms resistant exposures whereas the associated schist makes grassy covered slopes. Around the big bend is more marble and note the dark metamorphic rock (impure quartzite?) exposed in the swale between two marble prominences. From here looking west you can see small dumps--all that remains of modest mining that produced about $31,000 worth of barite during and shortly after World War I.

As you go through the marble belts it is possible to conjure up visions of crinoid columnals and coral cross-sections. Some of the marble banding undoubtedly reflects original bedding, but there is much shearing, brecciation, and truly "reconstituted" layering here also.

From the top of Fremont Peak you get a splendid view of the surrounding countryside (if you have good luck with the weather). You can also bask in a little history here, where John C. Fremont in April 1846 prepared himself for an imagined attack by "hordes of Californians." (A story board at the parking lot gives a version of this event.)

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