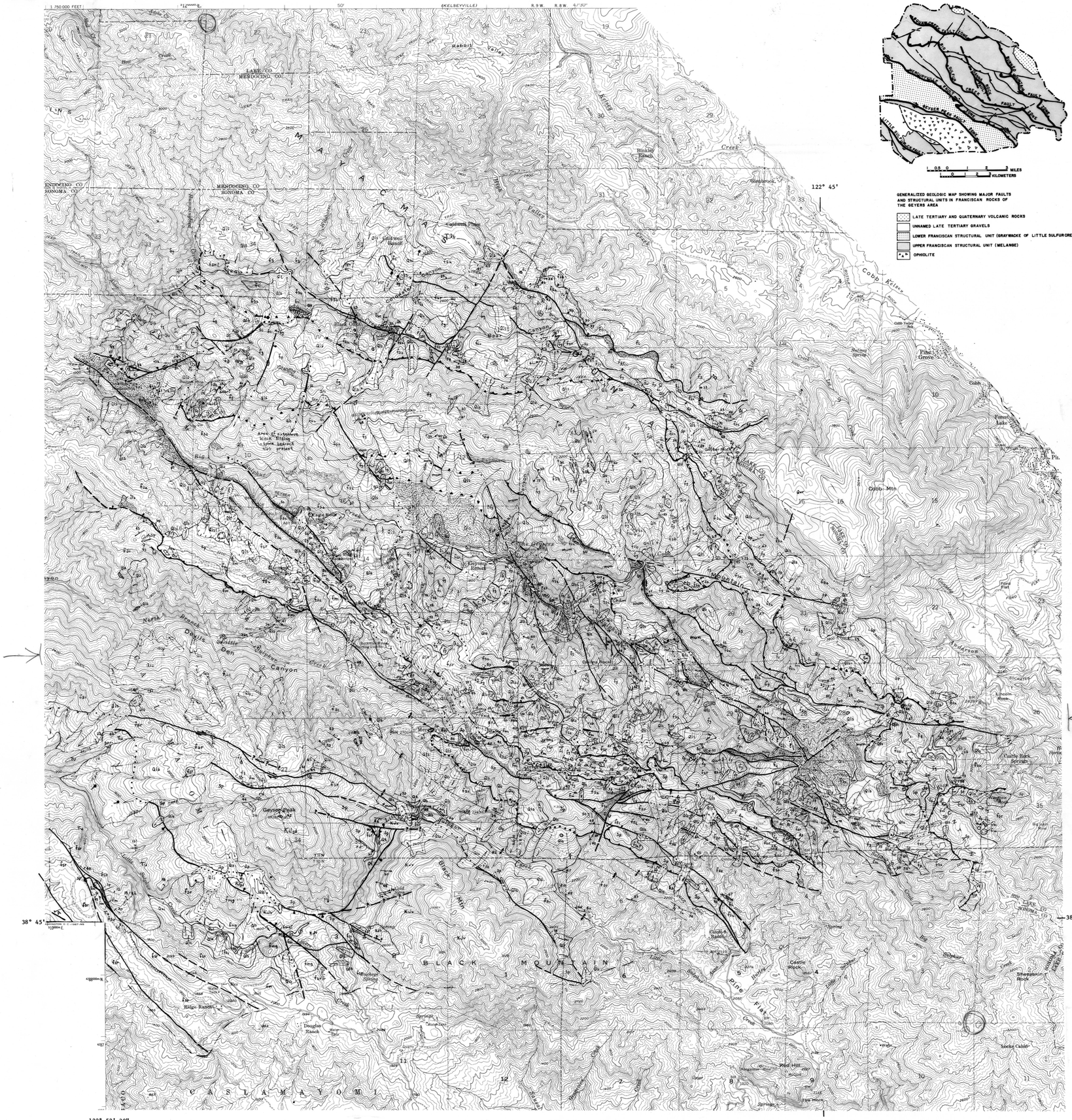
U.S. GEOLOGICAL SURVEY
OPEN FILE MAP
74 — 238

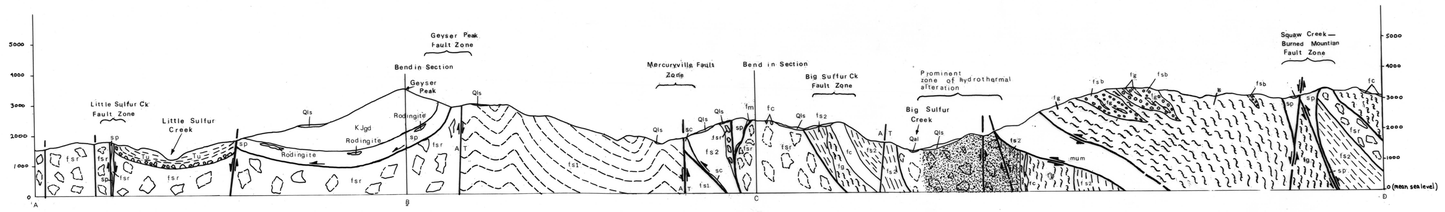


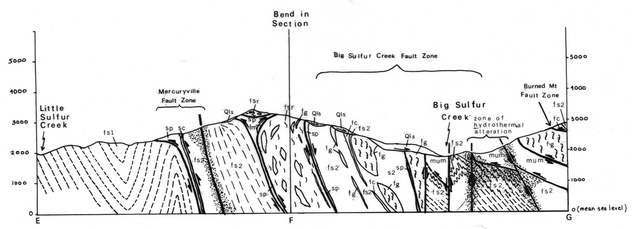
GENERALIZED GEOLOGIC MAP SHOWING MAJOR FAULTS AND STRUCTURAL UNITS IN FRANCISCAN ROCKS OF THE GEYSERS AREA

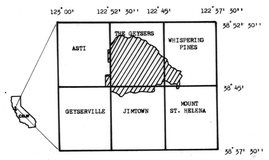
- LATE TERTIARY AND QUATERNARY VOLCANIC ROCKS
- UNNAMED LATE TERTIARY GRAVELS
- LOWER FRANCISCAN STRUCTURAL UNIT (GRAYWACKE OF LITTLE SULFUR CREEK)
- UPPER FRANCISCAN STRUCTURAL UNIT (MELANGE)
- OPHIOLITE

SCALE 1:24 000

1 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0 1 KILOMETER







INDEX TO PUBLISHED U.S. GEOLOGICAL SURVEY 7 1/2-MINUTE TOPOGRAPHIC QUADRANGLES, SHOWING LOCATION OF THE MAP AREA

APPROXIMATE MEAN DECLINATION, 1959

This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey standards and nomenclature.

PRELIMINARY GEOLOGIC MAP OF THE GEYSERS STEAM FIELD AND VICINITY, SONOMA COUNTY, CALIFORNIA

By

Robert J. McLaughlin

1974

EXPLANATION

CORRELATION OF MAP UNITS

Sc	Qal	Qls	Holocene	QUATERNARY
	Qt			
	UNCONFORMITY(?)			
	Qvr		Early Pleistocene	
	UNCONFORMITY(?)			
	TQb		Early Pleistocene or Late Pliocene ?	TERTIARY
	Tu		Late Tertiary	
	UNCONFORMITY			
Kjs	Early Cretaceous and Late Jurassic	fsr fsb fg fc fs1 fs2	Cretaceous and Late Jurassic ?	CRETACEOUS AND JURASSIC
UNCONFORMITY				
Kjv	Kjgd	Jurassic		
sp mum	FAULT			

STRATIGRAPHY

Qal ALLUVIUM (Quaternary) Largely unconsolidated gravel, sand and clay, but locally consists of blocks up to several tens of feet in diameter. Some deposits along faults are hydrothermally altered and cemented by iron oxide, opalline silica, sulfur, calcite, and other spring deposits.

Qls LANDSLIDE DEPOSITS (Quaternary) Unconsolidated rock and soil debris, that has moved downslope by such processes as surface creep, rotational slumping, or by flowage. Headwall zones of large landslides characteristically contain closed depressions.

Qt TERRACE DEPOSITS (Quaternary) Unconsolidated to semi-consolidated older dissected alluvium containing gravel, sand, and clay derived from local bedrock source areas.

Qvr COBB MOUNTAIN RHYOLITE (Early Pleistocene) Subaerial rhyolitic and dacitic volcanic flows, tuffaceous in lower part.

sc SILICA CARBONATE ROCK (Late Tertiary and Quaternary) Composed of a mixture of magnesium carbonate minerals, quartz, opal, and chalcedony; formed by hydrothermal alteration of serpentinite; extensively developed in ultramafic rocks associated with thermal springs along major fault zones; and in many areas is the host rock for mercury deposits.

TQb CALDWELL PINES BASALT (Early Pleistocene or Late Pliocene) Subaerial Olivine basalt flows.

Tu UNNAMED GRAVELS (Late Tertiary) Non-marine pebble and cobble gravel and minor siltstone. Gravels moderately to poorly sorted, with subrounded to well-rounded clasts derived from underlying Franciscan and Great Valley sequence rocks; locally with a basal breccia composed of angular blocks up to several tens of feet in maximum dimension. Dark gray to black siltstone and mudstone in upper exposed beds locally contains ostracods, thin-shelled mollusks, and scattered fish remains. Absence of recognizable Late Cenozoic volcanic detritus suggests formation pre-dates Sonoma Group of Gealy (1951) and is perhaps Late Pliocene or older.

GREAT VALLEY SEQUENCE (Jurassic? (pre-Tithonian?) - Early Cretaceous?)

Kjs Knoxville Formation(?) (Late Jurassic (Tithonian) - Early Cretaceous (Valmginian)) Olive gray to black marine mudstone and thin alternating interbeds of hard dark green siltstone and graywacke sandstone, composed largely of basaltic volcanic detritus. Mudstone locally contains hard gray-weathering impure limestone concretions with rare, poorly preserved dinoflagellates of Lower Cretaceous(?) age (W. R. Evitt, written communication, 1974). Base of unit locally faulted over diabase, and coarse-grained sedimentary breccia composed chiefly of basaltic volcanic rocks is locally present at base.

Kjv Basalt and diabase (Jurassic? (pre-Tithonian?)) Undifferentiated altered basaltic rocks, consisting of pillow flows, pillow breccias, tuffs, and diabase; deeply weathered except in stream bottoms, contains prominent epidote, and locally contains lawsonite and prehnite.

Kjgd Diabase and gabbro of Geyser Peak (Jurassic? (pre-Tithonian?)) Largely fine- to medium-grained equigranular to porphyritic diabase and gabbro. Intrusive relations of diabase and gabbro undetermined; minor basalt and quartz keratophyre locally present at the top of Geyser Peak, associated with diabase and gabbro.

ULTRAMAFIC ROCKS

Sp Serpentinite (Jurassic? (pre-Tithonian?)) Harzburgite peridotite, partly to completely altered to chrysotile± clinochrysotile±orthochrysotile, and pervasively sheared with most extensively sheared rock concentrated along margins of serpentinite bodies. Serpentinite at base of diabase and gabbro of Geyser Peak may be part of Great Valley Sequence; elsewhere serpentinite is present in Franciscan Assemblage along major fault boundaries, shear zones, and in the cores of diapiric structures. Some evidence suggests that locally serpentinite has been re-mobilized plastically along faults of Tertiary and Quaternary age. In the Geyser Peak area, tectonic inclusions of gabbro and diabase present along serpentinite margins, are altered to rodingite mineral assemblages (rd).

mum Metamorphosed ultramafic rock (Jurassic? (pre-Tithonian?)) Foliated ultramafic rock completely metamorphosed to serpentine and calcium-magnesium amphibole mineral assemblages (antigorite±chlorite±talc-actinolite±tremolite± cummingtonite). Large ultramafic rock slab north of Big Sulfur Creek is almost completely metamorphosed to these mineral assemblages; but elsewhere metamorphosed ultramafic rock is present only locally as isolated tectonic blocks within pervasively sheared mélange units of the Franciscan Assemblage.

FRANCISCAN ASSEMBLAGE

fs1 GRAYWACKE OF LITTLE SULFUR CREEK (Lower Structural Unit) Largely fine- to medium-grained, massive to well bedded, relatively impervious, fractured graywacke and minor interbedded black shale with slight metamorphic fabric (textural zone 1 of Blake and others, 1967); locally graywacke contains prominent grit-sized grains of shale, chert, and quartz and in places displays graded beds, sole marks, crossbedding, and rip-up structures; shale locally contains hard oblate impure chert and limestone concretions with black shaly rinds; the graywacke contains pumpellyite, and is veined with calcite and quartz.

fsr SEDIMENTARY AND TECTONIC MELANGE (Upper Structural Unit) Mostly graywacke, shale, and conglomerate, with lesser amounts of chert, basaltic rocks, and minor blueschist, occuring chiefly as tectonic blocks and imbricated slabs from less than a foot up to several miles in length, enclosed in a pervasively sheared matrix of black shale and gouged rock. Shale matrix locally is unsheared and well bedded, and may enclose oblate limestone concretions or angular to well-rounded water worn clasts, suggesting that mélange is in part a sedimentary breccia. Components of mélange are differentiated on map as follows:

fsr Sedimentary and tectonic mélange, undifferentiated; chiefly pervasively sheared shale and gouged rock, enclosing tectonically emplaced blocks and resistant masses of rocks too small to be individually shown at map scale.

fsb Sedimentary breccia, differentiated locally; contains detritus ranging in size and roundness from angular blocks up to several tens of feet in maximum length, to well rounded pebbles less than one inch in diameter, enclosed in a matrix of tuffaceous shale or mudstone. Angular clasts are chiefly composed of radiolarian chert, basaltic volcanic breccia, talc schist or graywacke; well rounded clasts are chiefly of pebble to boulder size, and are composed of mafic and silicic porphyritic volcanic and plutonic rock, dark chert, and vein quartz; matrix material generally is sheared, but original sedimentary stratification of unit is preserved.

fs2 Graywacke and minor interbedded shale and conglomerate with a slight to moderately strong metamorphic fabric (textural zone 1 to 2 of Blake and others, 1967). Graywacke is thin bedded to massive, relatively impervious, and fine- to medium-grained; it contains a high percentage of mafic volcanic detritus, and locally, concentrations of carbonized plant material are present along bedding planes. Interbedded conglomerate present in some areas has a graywacke matrix and contains abundant well rounded clasts of mafic and silicic porphyritic volcanic rock, diorite, dark chert, vein quartz, and quartzite, in addition to more angular clasts of basaltic volcanic rock, graywacke, and minor ultramafic rock; elsewhere conglomerate contains angular schist, radiolarian chert, and graywacke detritus identical to corresponding rock types in the Franciscan Assemblage. Graywacke of this unit contains pumpellyite±lawsonite; it is veined with quartz and calcite, and locally it is extensively hydrothermally altered.

fg Greenstone, slightly to moderately metamorphosed basaltic pillows, pillow breccias, tuffs, and diabase, slightly to extensively sheared and locally extensively hydrothermally altered.

fc Red, green, and white chert and minor interbedded siliceous tuff, thin bedded to massive, and locally hydrothermally altered; chert contains radiolaria that range in age from Late Jurassic (Tithonian) to mid-Early Cretaceous (Hauterivian)

fl Limestone; rare, foliated, and coarsely recrystallized limestone.

fm Blueschist grade metamorphic rocks; foliated, phyllitic to gneissose metamorphic rocks ranging in composition from Type II. to Type IV. of Coleman and Lee, 1963; containing fine to coarse grained sodic amphibole, jadeitic pyroxene, lawsonite, and other minerals formed by metamorphism at high pressures; locally, pre-metamorphic composition indicated by subscript (c) for chert, or (g) for greenstone.

MAP SYMBOLS

Contact
Certain to approximate location, dotted where concealed

Axis of Syncline
Dashed where approximate, dotted where concealed, arrow indicates direction of plunge

Axis of Anticline
Dashed where approximate, dotted where concealed, arrow indicates direction of plunge

Fault
Dashed where approximate, dotted where concealed, queried where uncertain; relative movement indicated by U (up) and D (down), by ball on downthrown side, or by arrows indicating relative lateral displacement; measured direction and amount of dip indicated by arrow and number

Thrust fault
Dashed where approximate, dotted where concealed, queried where uncertain; barbs on upper plate

Scarp line
May be either fault or landslide related; barbs on downslope side

Landslide deposit
Arrows indicate general direction of movement

Sag pond | Hot spring | Spring | Zone of hydrothermally altered rock

Attitude of planar structures

Flow structure | Bedding; tops of beds known from sedimentary structures | Bedding | Vertical beds | Overturned beds

Foliation | Strike and dip directions determined from aerial photograph | Plunge of linear features | Horizontal bedding

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REFERENCES CITED

Bailey, E. H., 1946, Quicksilver deposits of the western Mayacmas district, Sonoma County, California: Calif. Jour. Mines and Geology, v. 42, no. 3, p. 199-230.

Blake, M. C., Jr., Irwin, W. P., and Coleman, R. G., 1967, Upside-down metamorphic zonation, blueschist facies, along a regional thrust in California and Oregon: U. S. Geol. Survey Prof. Paper 575C, p. C1-C9.

Coleman, R. G., and Lee, D. E., 1963, Glaucophane-bearing metamorphic rock types of the Cazadero area, California: Jour. Petrology, v. 4, p. 260-301.

Gealy, W. K., 1951, Geology of the Healdsburg quadrangle, California: Calif. Div. Mines and Geology Bull. 161, 76 p.