U. S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Preliminary geologic map of Santa Maria 30' x 60' quadrangle, California

by

Marilyn E. Tennyson (compiler)[1]

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

[1] U. S. Geological Survey
Lakewood, Colorado

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EXPLANATORY NOTES

INTRODUCTION

The geology of this 30' x 60' quadrangle has been compiled (Plates 1 and 2) from maps made by a number of different workers over the last 50 years. The original mapping was done on a variety of basemaps, including standard 7.5' quadrangles, 1:24,000 aerial photographs, and smaller scale topographic bases of uncertain projection. Apart from state geologic maps published by the California Division of Mines and Geology (Jennings, 1959, 1977) at 1:250,000 and 1:750,000, the detailed geology of the region has never been integrated from these various mapping sources. The 1:100,000 scale used here requires little generalization from the source maps to successfully show individual formations and local structures, yet encompasses a large enough area to show regional structure and stratigraphic variation. In some cases where areas mapped by different geologists overlap, there are significant differences in interpretation. Many of these differences have not been resolved on this preliminary map, but the map provides a basis for recognizing and evaluating them. A final digital version is planned.

SOURCES AND METHODS OF COMPILATION

The index map (see "Sources for Compilation" on Plate 2) shows the main sources from which various parts of the map were compiled.

Dibblee's (1950) 1:62,500-scale maps of southwestern Santa Barbara County were used for the Santa Ynez Mountains in the southern part of the quadrangle. Minor modifications were made in a few spots based on Dibblee's more recently published 1:24,000-scale maps of this area. Two of Dibblee's recently published maps, of the Casmalia and Orcutt and the Point Sal and Guadalupe quadrangles (Dibblee, 1989a, 1989b) were used as the basis for the northwestern part of the map. Unpublished mapping by T.W. Dibblee, Jr., was used in several spots in the east central part of the area where there were gaps between mapping of Woodring and Bramlette (1950) and Hall (1981).

In order for the geology mapped by Woodring and Bramlette (1950) in the north-central part of the quadrangle to be compiled, contacts were transferred to 7.5' topographic quadrangles by hand tracing from the World War II-era 1:24,000 photomosaic on which they were published. This involved constant manual shifting of the topographic quadrangles over the photo-based maps, because of distortion in the old photomosaic.

In the area along the West Huasna and Little Pine faults in the eastern part of the map, 1:24,000-scale maps of Hall (1978, 1981), partly of reconnaissance quality, were the principal basis for the compilation. In the San Rafael Mountains in the northeastern part of the quadrangle where no published geologic maps have been available, recent mapping by Vedder and others was used, some of which has been issued as a U. S. Geological Survey Open-File Report (Vedder and others, 1991b), and some of which remains unpublished as compilation and field checking are completed. In cases where recent more detailed mapping of Vedder and others (1991b and unpublished) differs with reconnaissance mapping of Hall (1978, 1981), Vedder's mapping has been adopted for the purposes of this compilation.

This map was compiled by reducing the component maps on a reducing photocopier, coloring the reduced maps to make the contacts visible enough to see through drafting film, and tracing the contacts onto a blank drafting film basemap which consisted only of registration tics at the corners of the 7.5' quadrangles. The contacts were photographically superimposed on a greenline film version of the Santa Maria 30' x 60' quadrangle. Because of several problems inherent in the method used for compilation (mainly the lack of precision in photocopier reduction but also including the instability of the paper bases on which the component maps are printed, as well as possible differences in projection between the original maps and the compilation), there is considerable distortion and lack of precision in the location of some of the contacts, particularly in the southern third of the map. Some contacts may be mislocated by as much as 1mm, which is equivalent to 200 m or about 600 feet on the ground. Therefore, although the map is suitable for use in analyzing stratigraphic, structural, and tectonic problems, it should not be used for detailed land use planning applications.

No bedding attitudes are shown on this map. The reason for this is that it is very difficult to trace an accurate strike from a map that has been reduced from 1:24,000 to 1:100,000. Depiction of attitudes has been postponed to the digital stage of compilation; accurate strikes will be entered into the computer by digitization.

STRATIGRAPHY

Stratigraphic units have been mostly transferred without renaming or reinterpretation from the component maps, although there will be selective revision on the final digital compilation. In cases where there is new radiometric or paleontologic age information for a given unit, it is mentioned in the "Description of Map Units." The following discussion addresses some of the stratigraphic issues that arose during compilation; it is not intended as a comprehensive review of the stratigraphy.

In the southwestern part of the map northeast of Point Arguello, the Honda and Espada Formations of Dibblee (1950) have been lumped together as the Espada Formation. In the northeastern corner of the map, Upper Cretaceous sedimentary rocks in the San Rafael Mountains have been designated by general descriptive names, following J. G. Vedder and others (1991b and unpubl.), rather than formation names proposed by earlier workers, which are unsatisfactory for reasons discussed by Vedder and others (1991b). Although these rocks are correlative with the Jalama Formation of Dibblee (1950) to the south in the Santa Ynez Mountains, the two units have not been combined, because they consist largely of different sedimentary facies.

Several somewhat different units are lumped as unit Tcg (Tertiary conglomerate). These include the Sespe Formation in the Santa Ynez Mountains, rocks in the San Rafael Mountains which are shown by Vedder and others (1991b) as the Simmler Formation, and rocks near the West Huasna fault which Hall (1978) designated as the Lospe Formation, but which are lithologically unlike and demonstrably older than the type Lospe Formation. Dibblee (1950) and Byrd (1983) reported that the Sespe south of the Santa Ynez River in the southeastern part of the map is lithologically unlike the Sespe south of the Santa Ynez fault. These various units will be separated on the planned digital compilation.

Unit Tss, marine sandstone of Miocene age, typically lies unconformably above Upper Cretaceous rocks and conformably beneath mudstone of the Monterey Formation in the San Rafael Mountains in the northeastern part of the quadrangle. It was mapped as the "so-called Temblor Formation of Dibblee (1966)" by Hall (1981) in the area along the Little Pine fault and the upper Sisquoc River drainage in the eastern part of the quadrangle, but since current stratigraphic usage disallows the use of the name "Temblor Formation" west of the San Andreas fault, that name is not used here. In some places, mollusks suggesting a late early or middle Miocene age ("Temblor" Stage fauna) have been found in this unit, but in other places it is more likely correlative with the older upper Oligocene and lower Miocene Vaqueros Formation of the Western Transverse Ranges. West of the West Huasna fault, rocks mapped as Vaqueros Formation by Hall (1978) have yielded latest early Miocene (upper CN2) calcareous nannofossils and upper bathyal Saucesian foraminifera (Tennyson and others, 1991), which suggests that designation as Vaqueros Formation may be inappropriate, as the Vaqueros in this part of California is typically a somewhat older nearshore deposit. Accordingly, these rocks will be designated as a separate unit on the final compilation.

On much of the map, the Monterey Formation is shown subdivided into lower and upper units as mapped by Dibblee (1950, 1966, 1989a, 1989b). Isaacs (1981) showed that the boundary between them has diagenetic rather than depositional significance in the Santa Ynez Mountains. Because no other maps show revised subdivisions of the Monterey in this area, Dibblee's members are maintained, although the digital compilation may show no such subdivisions of the Monterey. Hall (1981) mapped a lower siltstone member of the Monterey north of the Little Pine fault; this member was included with the lower Monterey on this compilation. Hall (1978) mapped the Point Sal Formation below the Monterey in the area near the West Huasna fault. Additional field and paleontologic data will be needed in order to determine whether to maintain these designations on the digital map.

Compilation revealed that some of the primarily Pliocene and Pleistocene units (Careaga Sandstone, Paso Robles Formation, Orcutt Sand, and terrace deposits) are mismatched across the boundaries of areas mapped by different workers, and in the area south of the Sisquoc River and east of Foxen Canyon where Hall (1981) and Woodring and Bramlette (1950) differ in their interpretations of stratigraphic and structural relations involving the Little Pine fault. The designation of these units in some of these areas will probably be revised on the final version, and the way they are rendered on this map is tentative.

The distribution of landslide deposits varies considerably across the map. The smallest landslides mapped by all workers were not compiled because they were too difficult to show or obscured details of bedrock geology; no set minimum size was adopted. The density of landslides mapped by different workers varies considerably, and in cases where different component maps overlap, they typically do not agree on details of landslide boundaries. In general, landslides are mapped most thoroughly in the San Rafael Mountains, on the maps of Vedder and others (1991b and unpubl.).

MAJOR STRUCTURES

Folds

The Santa Maria basin which occupies most of the map area is a regional synclinal downwarp between major faulted anticlinoria in the San Rafael Mountains to the northeast and the Santa Ynez Mountains to the south. A large, Franciscan-cored structural high is present along the northeastern margin of the basin, interpreted by Namson and Davis (1990) as a regional anticline (Point San Luis anticline; not labeled) associated with a ramp in a south-verging blind thrust at depth, although Hall (1978; 1981; 1982) mapped a largely concealed system of faults along Namson and Davis' (1990) anticlinal trace. The Santa Maria Valley syncline in the northern part of the basin is a large, very open subsurface fold known from petroleum exploration. The trace shown is from Woodring and Bramlette (1950) with the western end deleted because it conflicts with structure evident in the map pattern in the Casmalia Hills east of Point Sal. Within the central basin, large, west-northwest-trending folds are clearly evident in the map pattern and the topography. A major anticlinal trend extends from the Point Sal area on the northwest, through the Solomon Hills, to the area south of the Sisquoc River in the eastern part of the map area. It consists of the Pezzoni, Casmalia, and Orcutt anticlines, bounded on the north by reverse faults, the en echelon Mount Solomon, Las Flores, and Gato Ridge anticlines in the eastern half of the map area, and several anticlines mapped by Dibblee (1950) in the easternmost part of the quadrangle. To the south is the San Antonio-Los Alamos Valley syncline, where a few thousand feet of upper Pliocene and Quaternary alluvial deposits were deposited, presumably in response to deformation, and then tilted to vertical or overturned on the south limb of the syncline. This syncline is the north limb of another large, north-verging, at least locally faulted structure, the Lompoc-Purisima anticline. The Santa Rita syncline of Dibblee (1950) lies along the south edge of the Santa Maria basin. To the south, complexly folded and faulted rocks of the Santa Ynez Mountains form another regional anticlinorium.

Faults

Faults are mapped with greater certainty in the San Rafael Mountains and Santa Ynez Mountains than they are within the basin. Although it is possible to show upthrown and downthrown blocks for many faults, not enough is known of most faults' subsurface somewhat less; his cross-sections show it cutting upper Pliocene and Pleistocene rocks. It is nearly coincident with the Point San Luis anticline of Namson and Davis (1990).

Santa Maria Mesa fault: Shown according to Hall (1978; 1981; 1982), on the basis of surface mapping south of the Sisquoc River. The fault is essentially vertical. Hall's cross-sections interpret ~2000 feet of up-to-the northeast post-Monterey offset.

Foxen Canyon-Little Pine fault: The Little Pine fault was originally mapped by Dibblee (1950) in the easternmost part of quadrangle as a thrust fault dipping 25-38°, thrusting rocks of the Franciscan Complex southwest over Paso Robles Formation. Woodring and Bramlette (1950) mapped an unnamed fault east of Foxen Canyon, shown on cross-sections as steeply southwest-dipping reverse fault, up on the southwest, overlapped to the north by the latest Miocene to middle Pliocene Tinaquaic sandstone member of the Sisquoc Formation. Hall's (1981) map shows the fault cutting the Tinaquaic as well as Pliocene to Quaternary units and connecting with his Santa Maria River fault. He interpreted it as nearly vertical, up on the northeast, cutting Quaternary Paso Robles Formation.

Garey fault: This fault is shown according to Hall (1981, 1982), who interpreted it from limited subsurface data as a steeply-dipping fault cutting units as young as Paso Robles Formation but mostly covered by alluvium. It dies out near the eastern edge of the map, where Hall interpreted it as having a steep northeast dip with a maximum of a few hundred feet of reverse separation. Farther northwest, in the area west of Figureroa Creek, Hall (1981) interpreted the fault as dipping steeply northeast with several hundred feet of normal separation.

Pezzoni, Casmalia, Orcutt faults: The Pezzoni fault is shown as mapped by Woodring and Bramlette (1950), as a steeply southwest-dipping reverse fault with several thousand feet of offset, bounding the north side of the Pezzoni anticline in the Casmalia Hills; to the south it curves around to a southwest trend, with normal separation. Woodring and Bramlette also showed a ~3000 ft long, steeply S-dipping fault with small reverse separation on the north flank of the Casmalia anticline. California Division of Oil and Gas (1974) showed a northwest-trending subsurface fault, up on the southwest, along the northeast flank of the anticline, but gave no indication of dip direction or magnitude of stratigraphic separation. Hall's (1982) subsurface compilation showed a subparallel fault about 2000 ft south of the fault shown by California Division of Oil and Gas (1974), across which offset of pre-Monterey subcrop reverses, from about 1000 ft up on the southwest along the Casmalia anticline, to 4000 ft down on the southwest near Los Alamos; data to demonstrate these relations are not shown. The Orcutt fault (unlabeled; southeast of the town of Orcutt) is best known from subsurface data (California Division of Oil and Gas, 1974); it dips steeply south with several thousand feet of reverse separation. These faults cut rocks as young as late Pliocene and Pleistocene.

Lions Head Fault: Shown by Woodring and Bramlette (1950) as a near-vertical fault with normal separation, dipping steeply south, up on the north. Sylvester and Darrow (1979) reported that the fault displaces Quaternary terrace deposits.

Los Alamos fault: Offset on this apparently very young fault is up on the southwest. It is almost coincident with the trace of the Los Alamos syncline as shown by Woodring and Bramlette (1950). Work by Guptill and others (1981), based on air photo and geomorphic analysis and trenching, suggests that it is a south-dipping reverse fault (causing a 70 ft high scarp) on the vertical to overturned south limb of the Los Alamos Valley syncline. Hall's (1982) subsurface compilation indicates a well 2 miles southwest of the fault, in which a fault at 4250 feet thrusts rocks of the Monterey Formation over rocks of the Sisquoc Formation.

Lompoc-Solvang fault (Santa Ynez River fault): This proposed fault is not shown on the map because its trace has not been mapped. It was hypothesized by Sylvester and Darrow (1979) as the most likely explanation for a major stratigraphic contrast between the Santa Maria basin and the Santa Ynez Mountains, namely, the absence, north of the presumed fault, of the thick Paleogene section present in the Santa Ynez Mountains, in combination with the essential continuity of Monterey Formation and younger rocks across its postulated trend. Its surface trace (if any) is uncertain, although Byrd (1983) suggested that steeply-dipping east-west trending faults along the Santa Ynez River near Solvang are part of the fault system, and Sylvester and Darrow (1979) pointed out several possible surface manifestations. Sylvester and Darrow (1979) did not suggest when the fault was active, other than mentioning that the base of the late Pleistocene Orcutt Sand is warped near the fault zone north of Lompoc. A period of activity in Oligocene or early Miocene time is required if this presumed fault is responsible for pre-Monterey stratigraphic contrasts.

Honda fault: The Honda fault was mapped by Dibblee (1950) as a steeply south-dipping reverse fault juxtaposing Mesozoic and Eocene rocks on the south with Monterey Formation on the north; maximum stratigraphic separation is 3000 ft. The youngest rocks cut by the fault are Miocene.

Pacifico fault: This fault was mapped by Dibblee (1950) as a geologically young, steeply south-dipping reverse fault with about 5000 ft of stratigraphic separation. Sylvester and Darrow (1979) suggested that the most recent movement was probably Pleistocene.

Santa Ynez fault: The Santa Ynez fault system was mapped by Dibblee (1950) as a geologically young, south-side-up, steeply- to gently-dipping reverse fault system with 5,000 to more than 10,000 ft of stratigraphic separation and a smaller component of left separation. The Santa Ynez Mountains have been uplifted relative to the Santa Maria basin along this fault system, with the youngest activity possibly as recent as Pleistocene (Sylvester and Darrow, 1979).

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