LATE-PLEISTOCENE DEFORMATION IN THE LIME-KILN CANYON AREA, SANTA SUSANA MOUNTAINS

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Introduction

The Santa Susana Mountains, located in the western portion of the Transverse Range, are a part of the regional east-west structural trend along the southern side of the Ventura Basin. This basin is a highly folded and faulted synclinorium extending westward from the San Gabriel Mountains to beyond the Santa Barbara Channel Islands which contains a thick section of sediments ranging from Cretaceous to Recent in age.

Along the southern flank of the mountains, two large canyons, Limekiln and Aliso, reflect recent movements along the Santa Susana fault.

Previous investigators reported that Late-Pleistocene movements of the Santa Susana fault are reflected in the distribution, altitudes, and relationships of the terraces formed in this area during Late Pleistocene.

This study was undertaken to distinguish the phases of movements of the Santa Susana fault and discern the stratigraphic relationships associated with these phases. Movement times must be considered relative because material is lacking for determination of absolute dates.

Geologic History

Sediments encountered in this area range from Miocene to Late Pleistocene-Recent in age and include the Topanga, Modelo, Towsley, Pico, and Saugus formations. Nearly all beds are separated by unconformities which reflect a marginal oscillating environment in the old Miocene-Pliocene depositional basin. The strata of Pleistocene age suggest brackish water, minor encroachments of the marginal seas in areas receiving terrestrial deposits, or minor depressions near an old shoreline (Jennings, 1957). In Upper Pleistocene times the seas completely withdrew and only terrestrial deposits were laid down. The San Gabriel Mountains have been proposed as a possible source for some of these Pleistocene beds (Jennings, 1957).

Overlying the Saugus formation are two Pleistocene terraces, the oldest being best exposed in Horse Flats and the youngest best seen

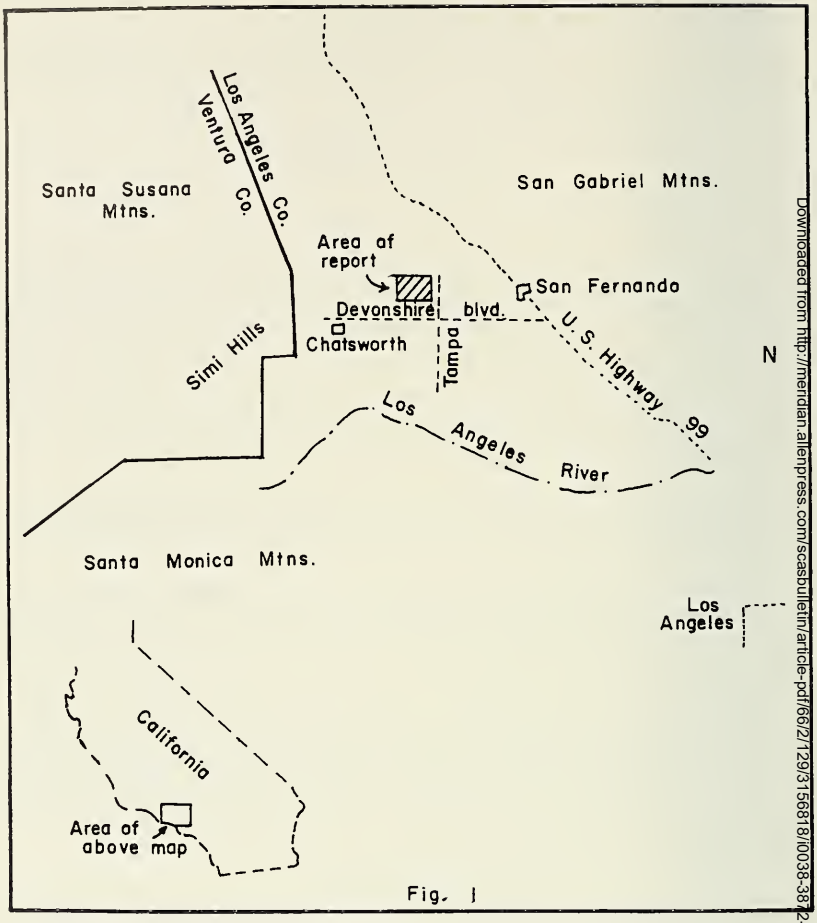

Figure 1. Regional map of southern California showing the location of Limekiln Canyon area.

in Aliso Canyon. The older terrace (Terrace I) is composed of sand, silt and gravel, with the gravel being white, angular, siliceous fragments of the Modelo formation. The younger terrace (Terrace II) is almost entirely of shale fragments in a matrix of reddish brown sand, silt and clay. Jennings (1957) believes that these represent a flood plain deposit, loosely cemented with calcium carbonate.

Structurally apparent in this region is the Santa Susana fault which has moved in a southerly direction as two imbricate thrust plates, as a result of Pleistocene folding in the eastern Ventura Basin.

Gouge along the thrust plate and brecciation of the Modelo shale indicates the movements of these plates at extremely shallow depths north of this area. Several high angle and reverse faults occur at angles to and near the front of the thrust. Two well-developed anticlines, two synclines, and a minor anticline strike northwest-southeast across Aliso and Limekiln canyons.

The Santa Susana thrust is exposed as two separate plates: the upper and lower plates. The movement has been directed slightly west of south in several independent pulses, sometimes at slightly different angles. The upper plate which comes to the surface about one-half to three-fourths mile to the north of the lower plate is about 700 feet thick at this point. This plate has Topanga, Modelo, Towsley, and Pico formations thrust southward over Miocene and Pliocene Modelo and Saugus of Plio-Pleistocene age. North of the area near the head of Aliso Canyon, the fault plane is folded along the Aliso anticline. About one-half mile north of the anticline, the upper plate dips north and is truncated by younger movement of the lower thrust plate (Jennings, 1957).

In this area, the lower plate has a thickness of about 1,500 feet, with Modelo through Saugus formations thrust over Pleistocene Saugus formation and post-Saugus terrace deposits. Displacement of the lower plate of 8,000 feet toward the south has been cited by Hazzard (1944), with combined displacement of the two faults have been reported to be 15,000 feet (Jennings, 1957). Both plates intersect the surface at angles between 21° and 35° but steepen to about 60° in depth. They intersect in depth north of this area and east of Limekiln Canyon; only the lower plate continues into this area.

Deformation of Terraces

The post-Saugus Pleistocene terraces in this area have been in places intensely deformed by the movements of the Santa Susana thrust. The oldest terrace (Terrace I), which is upper Pleistocene, is best exposed in Horse Flats and along the southwest edge of the lower thrust. This terrace represents the flood-plain deposits which were being shed by the rising upper plate north of this area. The relief created by this upper plate was the greatest of the two plates. Thrusting movement ceased temporarily and the terrace became well indurated, being cemented with calcium carbonate. This cementation by ground water was augmented by abundant tufa-forming waters which were being transported to surface along bur-

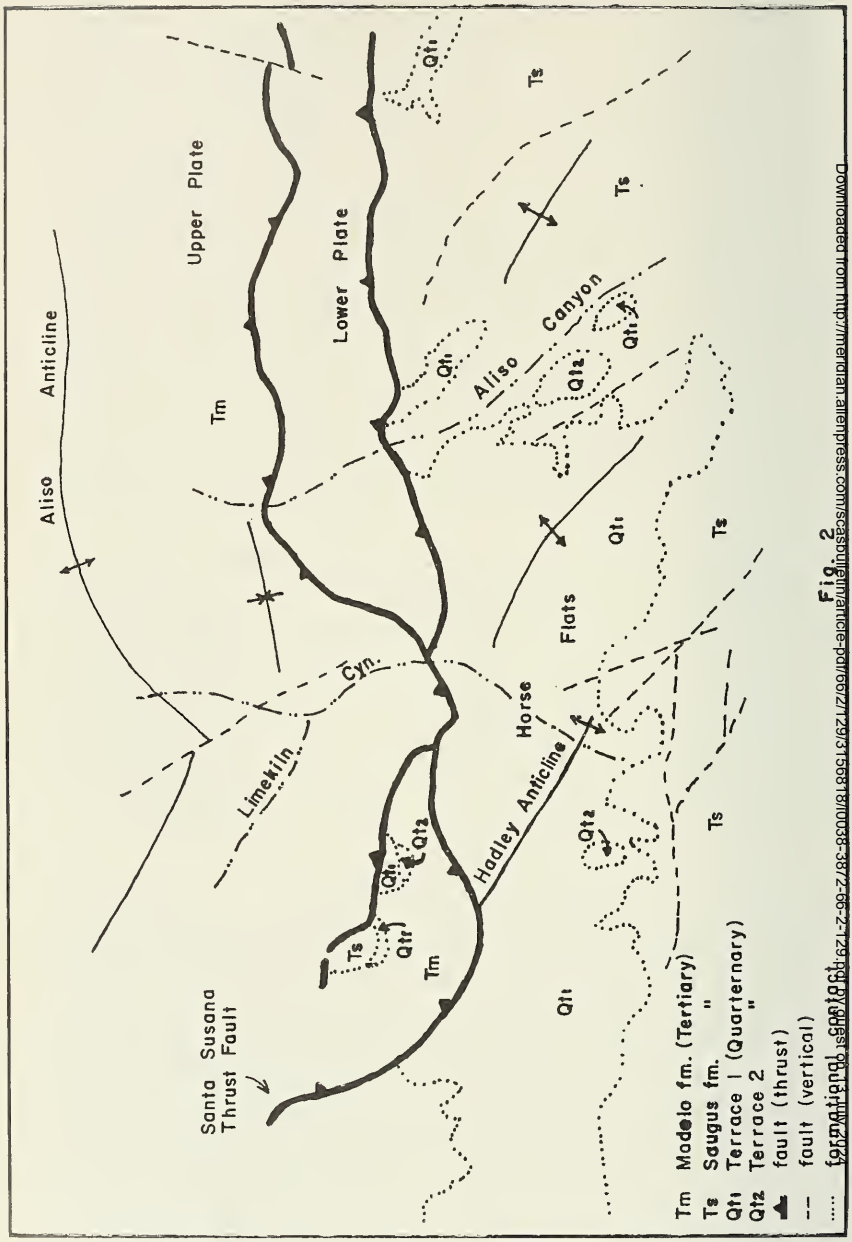

Fig. 2

ied faults. Many tufa deposits were formed just after the deposition of Terrace I as evidenced by implaced vent tubes still remaining in the tilted terraces. After a short interval, movement was again activated and the lower thrust broke through to the surface southerly from the upper plate. This plate involved only the Modelo, Towsley, and Pico formations with maximum movement being nearly horizontal. Erosion of this plate contributed Modelo detritus to its floodplain deposits with additional debris being derived from Terrace I. This thrusting period was short-lived as only 30 feet of material was deposited in the vicinity of Horse Flats and farther south. The area of deposition was considered to have been essentially flat in the region to Horse Flats as Terrace II, which still remains here, has only a slight southerly dip. Owing to the movement of the lower plate, the Modelo formation in the nose of the thrust displays dips of 75° to 80° and abruptly terminates against the Saugus formation.

About one mile west of Limekiln Canyon, a rotated block of Saugus formation and overlying Terrace I has been tilted vertically in front of the advancing thrust. Brecciation of the block lends difficulty to distinguishing whether it represents a single block or two blocks with Terrace I trapped in between.

The time that has lapsed since the deposition of Terrace II was somewhat shorter than the interval between Terraces I and II. Remnants of Terrace II still remain, and recent erosion has not extensively damaged the tilted block. It is proposed in this report that a third, very slight movement has occurred in which Terrace II has been tilted. West of Limekiln Canyon, Terrace I is topographically higher in places than Terrace II. A third pulse or continued movement during post-Terrace II age would be required to account for this.

Conclusions

The Limekiln Canyon area demonstrates Late Pleistocene, if not Recent, movements of the Santa Susana thrust along the southern flank of the Santa Susana Mountains. The thrusting here is accomplished in two plates which were not synchronous in time. Erosion of the older upper plate produced Terrace I and, subsequently, the exposure of the lower plate was reflected in deposition of Terrace II. The effects of the thrusting are apparent in brecciation and tilting of the affected strata.

The interval since the deposition of Terrace II is considered short since the terrace is thinner than Terrace I. There is indicated a post-

Terrace II younger or recurrent movement of the lower thrust which has deformed and tilted this terrace, possibly within the last 10,000 years.

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