THE SAN GABRIEL MOUNTAINS

THE SAN GABRIEL mountains form a beautiful but potentially dangerous backrop for the city of Los Angeles and its many suburbs along the foothills.

As the population increases in the foothill area, residences are continually being built farther and farther up the slopes and the notches cut to form level spots for homes resemble a giant stairway, as man attempts to scale and conquer the 5,000-10,000-foot peaks.

The higher man goes in the mountains the more problems he faces. Fire, flood, erosion, and earthquake are ever-present threats. The way he deals with such threats will determine whether man is really going to win this conflict with the mountains – or whether nature will win out in the end.

The San Gabriel mountains were formed when they were literally squeezed upward due to great lateral pressures between the Pacific Basin and the North American continent. The mountain range has an east-west orientation as compared to the north-south axis of most mountains on the continent. The San Andreas fault, which extends from the Salton Sea into the Pacific Ocean north of San Francisco, forms the northern boundary of the range. While this fault is the best known, it is only one of many in the San Gabriels; the mountains have been fractured by so many earthquakes that all the fault lines have never been mapped. The rocks of the entire range are literally shattered due to earthquake activity.

Back in the Pleistocene age, some of the pressure on the faults was relieved by either the valley dropping or the mountains being raised. (Evidence of such an event can be seen in the huge debris cone at the mouth of the Arroyo Seco which today forms the hill behind the Jet Propulsion Laboratory.) This action started a new wave of geological erosion which is still progressing up the mountains.

In the San Gabriels even the streams are steep and the water is rapidly cutting deeper into the underlying rock. This deepening of the stream beds causes a further steepening of the side slopes. Consequently, in the Los Angeles River drainage, one of the largest in the mountains, over half of the slopes are at the angle of repose (which is 70 percent) or even steeper. On these steep slopes everything that isn't mechanically held in place will fall into the canyon bottom. The mountains are extremely sensitive to activities and noises around them. One can actually sit quietly and hear the mountains falling apart. A bird scratching on the face of a slope, or a plane flying by with its motors out of synchronization, can start stones rolling and debris sliding. The only reason that the exceedingly steep stream banks are standing is that rock outcrops and vegetation are holding them in place – or because they have not had sufficient time to erode away.

The steepness of the slopes and the fractured rock in the San Gabriels result in the most dangerous mountain-climbing conditions in the country. Practically every week the newspapers testify to this fact by reporting the heroic efforts of the mountain rescue teams in retrieving stranded hikers. In fact, the ruggedness of the terrain has practically prevented any detailed geological study of these mountains.

A tremendous amount of debris has come out of these mountains over the years. Much of the Los Angeles metropolitan area, including Pasadena, is set on a deep layer of this debris. The debris-filled basin on which Pasadena stands is rimmed by a mountain range, of which only the top can now be seen. It extends past the Huntington Hotel, the Huntington Library, and through the Arboretum. The low hills in the Arboretum are actually the tops of buried mountains. There are more than 20 of these debris-filled basins between the San Gabriel mountains and the ocean.

In addition to sharing the cool wet winters and the warm dry summers of southern California, the San Gabriels have a weather pattern of extremes. The average annual rainfall increases with elevation. Pasadena, at the foot of the mountains, has an average rainfall of approximately 20 inches, while the top of Mt. Wilson – 6 miles away and 4,500 ft. higher – receives an average of 35 inches of rain. The rain often comes in high-intensity storms and two world records have been recorded at different points in the range. At Opid's Camp 0.65 inches of rain fell in one minute

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MAN AND NATURE IN CONFLICT

by Henry Hellmers

In the San Gabriels even the streams are steep and the water is rapidly cutting deeper into the underlying rock, making the side slopes steeper.

The San Gabriel Mountains . . . *continued*

in April 1926, and in January 1943 a rainfall of over 26 inches in a period of 24 hours was recorded at Hoegee's Camp.

Dry thunderstorms develop in the summer in contrast to the wet cloudbursts that can occur in winter. As their name implies, there is no rain in these dry storms. This is because the precipitation evaporates before it reaches the ground. Unfortunately, the lightning is not dissipated and many forest fires result from lightning strikes during the dry season.

Other unique meteorological phenomena of the mountains include high velocity Santa Ana winds that frequently sweep over the peaks and down the canyons from the desert. These warm dry air masses greatly increase the fire danger in the area.

The canyon winds on occasion are affected by a phenomenon known as the Catalina eddy. The presence of such offshore islands as Catalina at times affects the winds that occur in the San Gabriel mountains. The air mass moving down the coast sweeps around the island, forming an eddy that brings ocean air into the mountain canyons, such as the Arroyo Seco.

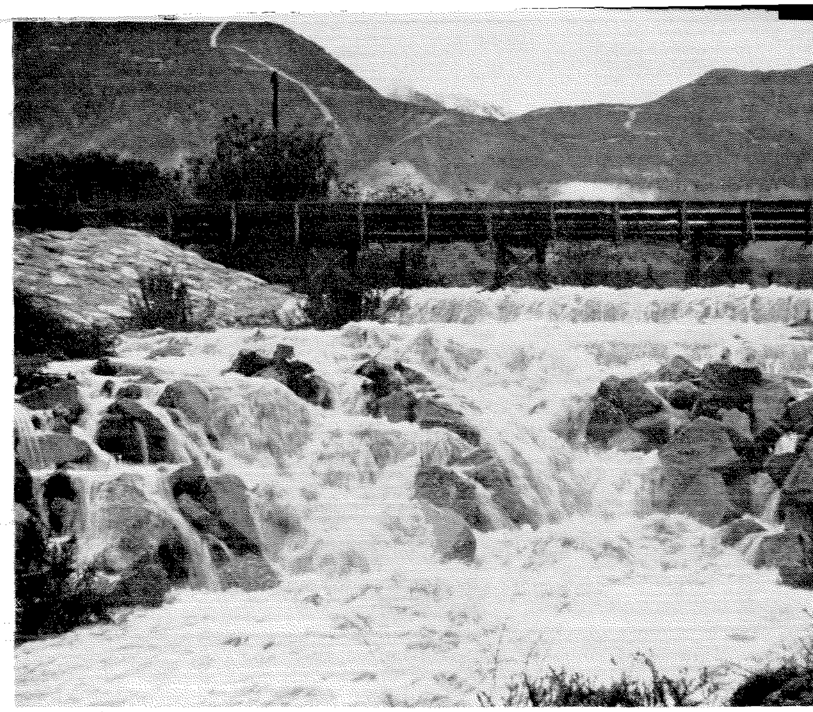
The vegetation attests to the prehistoric role of fire in the San Gabriels. The slopes are clothed in a vegetation that is defined as a "fire type"— a type that develops from or follows fire. The brush cover, or chaparral, is composed of species that readily sprout after fire or have seed that require a heat treatment before they will germinate. Many brush species which cause the fires to burn rapidly and with high intensity contain volatile oils.

The trees that occur on the tops and north-facing slopes have characteristics that protect them from destruction by fire. The pines, with their thick bark, occur in open park-like areas such as Messenger and Browns Flats and the heat from the low vegetation, usually grasses, can do little damage. Oaks and even big-cone Douglas fir have the ability to sprout along the main stem and branches after all the foliage has been completely burned.

In the recent past most of the slopes have been swept by fire on the average of every 30 to 50 years. There are some areas that haven't been burned that frequently but such areas are small. For instance, the 1960 fire that burned in the Arroyo Seco consumed the brush in at least one canyon that had not been burned in over 80 years. The fire history of the local mountains is closely correlated with the weather. The recent dry years have left their mark in the form of extensive fire scars, which serve as reminders of the magnitude of the problem if man is to change the fire pattern.

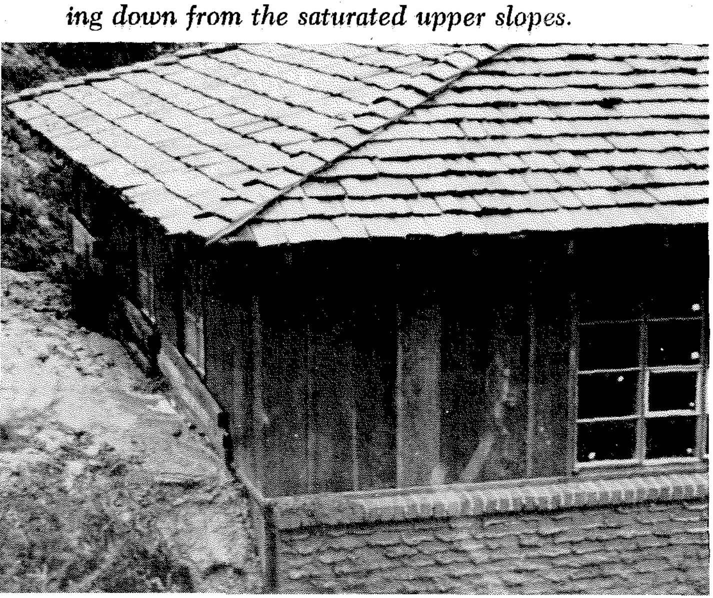
Some new and very powerful means, not yet discovered or invented, are needed to completely control fire in the San Gabriel mountains. The brush, with its volatile oils and thicket-type growth, produces fires of high intensity and with rapid burning rates.

Energy released by the Monrovia Peak fire in 1953 that burned 14,135 acres in 6 days was equivalent to about five of the atomic bombs that were dropped on Hiroshima. One fire, fanned by a Santa Ana wind, burned approximately 10,000 acres in the west fork of the San Gabriel drainage in 1957 in a couple of hours. A section of the canyon literally exploded. The intense heat on one side of the valley distilled the volatile oils from the brush on the facing slope and when the gas-filled air reached the ignition point the fire leaped across the valley with a roar. Lightning started the fire that destroyed the entire San Dimas Experimental Forest in 1960. Before anyone could do much about it, except get out of the way, the fire had wiped out the 17,000 acres of experimental forest, and had burned over the ridge into the San Gabriel River canyon.



After the ground is saturated, even a little rainfall brings a torrent of muddy water and debris out of the mountain canyons.

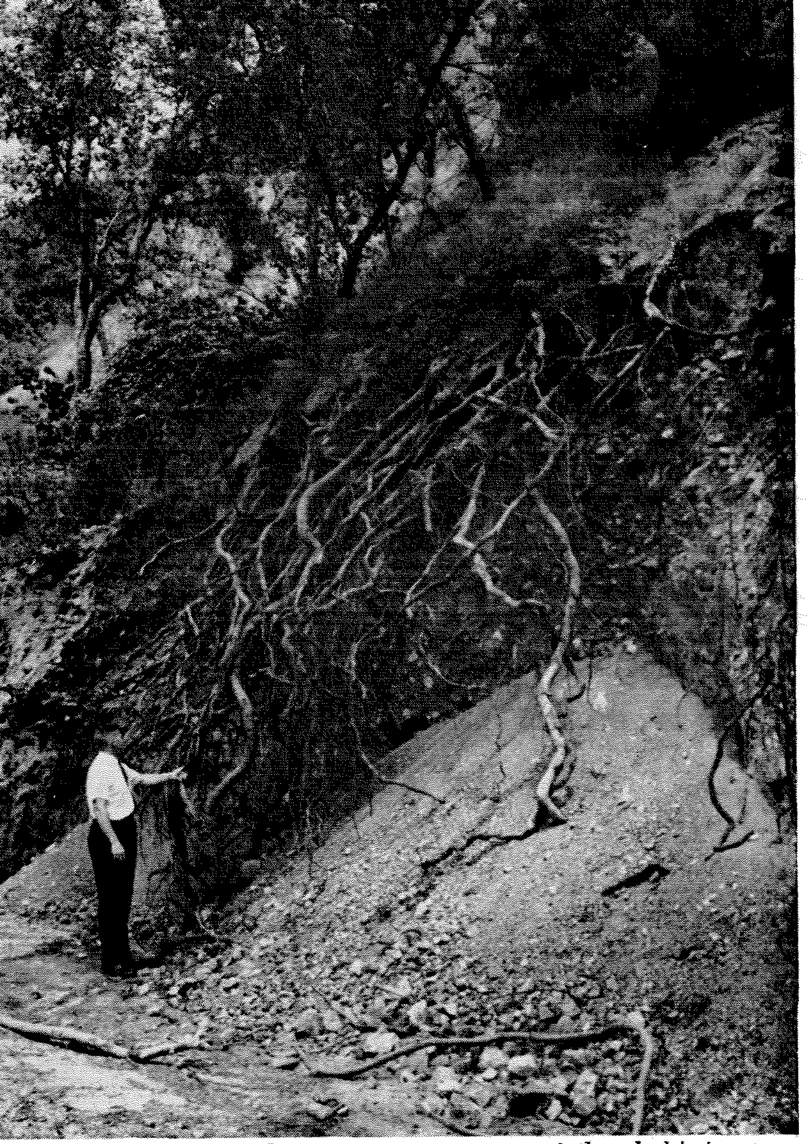
Canyon homes are frequently inundated by mud rolling down from the saturated upper slopes.



Fire and the steep terrain are potential dangers to the relatively few people who live or hike in the mountains, while floods are a threat to a much larger portion of the population. The flood of 1862 washed out the mining town of Eldoradoville in the east fork of San Gabriel Canyon; the 1934 New Year's Day flood killed 30 people and destroyed 483 homes in La Crescenta and Montrose. This flood was the result of the combination of fire followed by heavy rains. The brush on the slopes of Mt. Lukens had been burned in November and a month later nearly 600,000 cubic yards of debris rode out to the valley in the water from a 12-inch rainfall.

Erosion on the steep slopes of the mountains is a year-long process and does not require rainfall. The summer erosion or "dry creep" builds debris cones in the canyon bottoms as does erosion caused by small storms. Only infrequent and large storms produce sufficient water to flush out the channel bottoms, resulting in major catastrophes such as the flood of 1938 that did extensive damage and cut all lines of transportation out of the Los Angeles area.

Vegetation on the slopes tends to slow the rate of water movement out of the mountains and to reduce the rate of erosion. Storm flow from a completely burned area may be as large as 50 to 200 times that which would be expected had the vegetation not been burned. The great variation is due to the storm characteristics and the soil condition. Vegetation protects the soil from erosion by several processes. First, the vegetation absorbs the force of the falling raindrops, a force of approximately 100 horsepower per inch of rain per acre. On bare soil this energy is expended in splash erosion which destroys the porosity of the soil. Second, an average of ten percent of the annual



Deep and extensive root systems fail to hold the slope in place when the soil is washed away by an undercutting stream.

rain is used to wet the vegetation. This water returns to the air without ever touching the ground. Third, another ten percent of the rainwater flows down the stems of the plants into what is normally a very porous soil area. Fourth, the standing stems and the fallen litter form countless obstructions in the path of the small trickles of water flowing over the land surface, reducing their velocity and thus reducing the sediment-carrying capacity. These small dams are also a factor in helping to divert the water below the ground surface.

Fifth, the deep and extensive root systems tend to bind the soil mass together. Sixth, between storms the plants transpire, thus removing water from the soil mass and creating a reservoir to be filled by the following storms. It has been estimated that to saturate the soil mantle of the San Gabriel mountains after the dry summer requires nine inches of rain. The soils only become saturated during very large storms because much of the rain from small storms is removed by evaporation and transpiration between storms.

As the population increases and moves farther up the brush-covered mountains the need for protection increases. Fire prevention programs have greatly reduced the number of man-caused fires in relation to the number of people that are in the area. Efficient fire fighting organizations have controlled most of the fires early. Additional protection from fire and flood is continually being developed. However, in spite of active fire prevention campaigns and efficient fire suppression organizations, forest fire remains one of the very real potential dangers. The occurrence of exceptionally dry years and dry lightning storms are hazards yet to be conquered.

Once a mountain slope is swept by fire it is seeded with rapidly growing annual plants to obtain a protective vegetation cover for the soil as soon as possible. A mixture of black mustard and rye grass that was developed in the Earhart Laboratory here at Caltech is used almost exclusively. Plants of this combination of species were found to germinate and grow rapidly under the cool winter conditions. If weather conditions follow the average pattern, the gentle early season storms will furnish sufficient water and the foliage will then protect the soil surface from the larger storms that come in midwinter. Unfortunately, nature doesn't follow the average every year.

Flood prevention work that started with fire control efforts in the mountains at the turn of the century, followed by flood control dams on the main streams, has continued to expand. Straightened and concrete-lined channels to facilitate the moving of the flood waters from the mountains to the ocean have been built. Small channel barriers to maintain the level of the channel bottoms, and thus stablize the slopes, are being built in many of the mountain drainages.

How well man succeeds in conquering and controlling the mountains and their danger potential is dependent upon the sequence of natural events, many of which man has not yet learned to control.

The timing and violence of the next earthquake cannot be predicted. Whether it raises the mountains, thus making the slopes steeper, or just shakes the peaks down a little, the erosion potential will be increased.

Storm predictions are increasing in accuracy but little has been accomplished in altering the duration or intensity of a storm. Like the earthquake, the date of the so-called "hundred-year storm" — the big, big one that has a "once-in-a-hundred-years" frequency — is unknown. Maybe the storm of '38 was it and maybe it wasn't.

While the problems involving the San Gabriel mountains are unique to some extent, the Los Angeles area is not unique in having problems. All areas are exposed to the forces of nature, be it earthquake, tornado or whatever. Judging from the influx of population into the Los Angeles area and the ascent of the population area up the mountains, a lot of people agree that the benefits outweigh the potential dangers.