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U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 78-1079

CYCLIC LANDSLIDING AT WRIGHTWOOD, SOUTHERN CALIFORNIA—A PRELIMINARY REPORT

By

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November 1978

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Abstract.--Recurring landslide and mudflow events in the Wrightwood area of southern California are parts of a composite cycle of landslide activity that includes three recognizable stages. The three stages are interdependent, occur in sequence, and are of different duration. Deposits of the first stage--the largest in size--are removed to positions further downstream by the activity of second- and third-stage landslides.

First-stage landslides are represented by huge slumped masses derived from steep bedrock slopes in the canyon heads; the material moves down the principal stream drainage, which may be completely filled with debris. Second-stage activity develops as streams cut a network of branching channels into the massive first-stage deposit. The second-stage landslides are chiefly slumps from the older slide mass and from adjacent bedrock slopes. The movement of these slides generally is downslope toward actively eroding drainages. Third-stage activity includes mudflows that accompany the spring melting of snow-pack. The debris moves down the stream channels to depositional reaches on major fans. Removal of sufficient amounts of the first-stage landslide mass to the fan by second- and third-stage events resets the bedrock slope of the main drainage for another first-stage event.

The first-stage landslides in the Wrightwood area are of prehistoric origin, and their recurrence interval in any one canyon is probably several thousand years. The active duration of a first-stage landslide is one to several thousand years. Second-stage landslides last one to several years and are apparently preceded and triggered by a series of high-precipitation winters. The duration of observed third-stage (spring mudflow) sequences ranges from a few days to as much as six weeks; peak mudflow activity apparently results when a heavy spring snowmelt occurs during a period of second-stage landslide activity.

INTRODUCTION

The Wrightwood area of southern California is replete with a variety of recurring landslides. Spectacular spring mudflows (C. H. Gleason and R. E. Amidon, unpub. data, 1941; Sharp and Nobles, 1953; Morton and Campbell, 1974; Morton and others, 1978) have attracted widespread attention and have overshadowed other landslide activity in the area. We have been studying landslide processes in the area sporadically since 1966. Parts of the study were conducted while the senior author was associated with and funded by the California Division of Mines and Geology. Our work indicates that spring mudflows are part of an interesting composite landslide cycle. Not only are they the most exciting, they are even more impressive when their role in the composite cycle is understood.

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PHYSICAL SETTING

The community of Wrightwood (fig. 1) is built principally upon

Figure 1 near here

three coalesced alluvial fans, two of which, the Sheep Canyon and Heath Canyon fans, consist largely of mudflow deposits. The third fan, Acorn Canyon, appears to have been formed by roughly equal amounts of fluvial and mudflow deposits. The Sheep Canyon and Heath Canyon drainages contain the remains of major canyon-filling landslides, as do several other nearby canyons. Only the scar and a few small remnants can now be found to attest to the large landslide that once filled Sheep Canyon, whereas a very large landslide deposit remains in Heath Canyon.

Heath Canyon is a steep, north-flowing stream immediately south of Wrightwood (fig. 1). At the head of Heath Canyon is Wright Mountain, a topographic prominence on Blue Ridge (fig. 2), an elongate northwest-

Figure 2 near here

trending ridge. Blue Ridge is underlain by the Pelona Schist, a Mesozoic (?) fissile white-mica schist with local layers of quartzite, quartzite-marble, chlorite schist, and pods of actinolite and talc-actinolite rock. The schistosity dips consistently southward into the north flank of Blue Ridge. Much of the schist is fragmented and fails readily by landsliding.

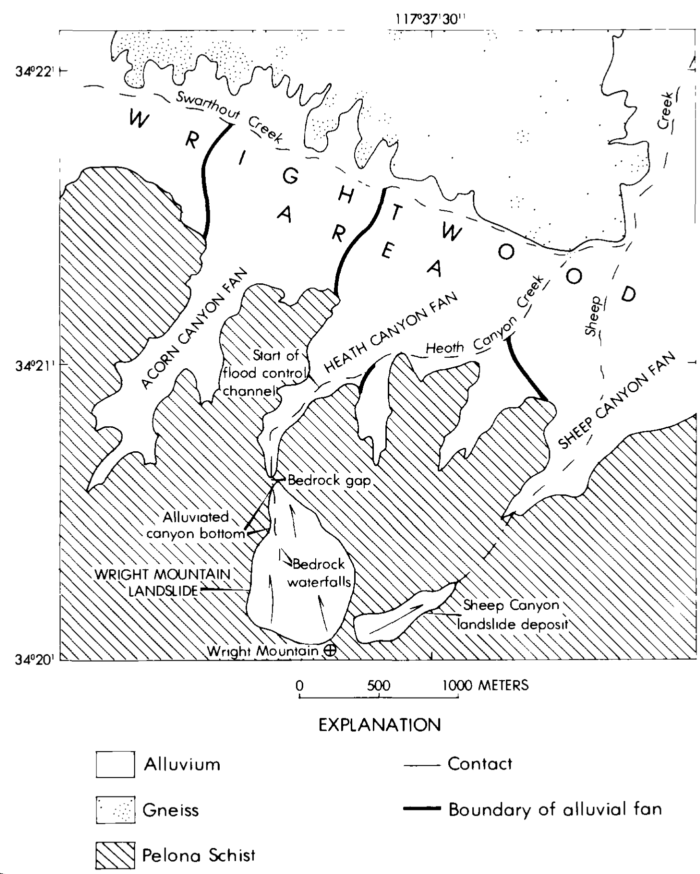

Figure 1.--General setting of landslide activity in Wrightwood area. Arrows indicate direction of movement of landslide.

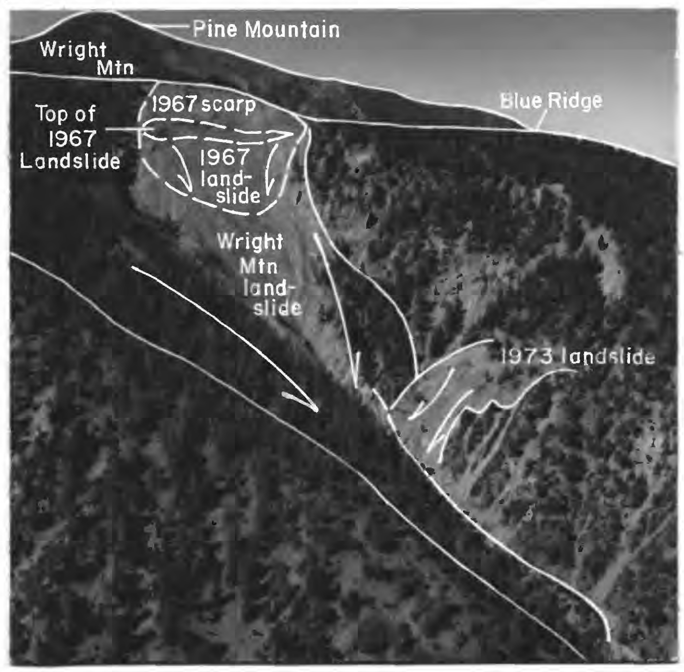

Figure 2.--Wright Mountain landslide in 1975.

The Pelona Schist is the most landslide-prone basement rock in the eastern San Gabriel Mountains. Major landslides of the schist that fill the headward parts of canyons are bedrock slumps; the deposits of these slumps consist of debris as highly fragmented as some composed of other bedrock units that have moved much greater distances from their sources. Of the several hundred landslides we examined in the Pelona Schist, none showed evidence of having moved rapidly, whereas landslides in adjacent different basement rocks commonly moved rapidly and over considerable distance as rock slides. Many landslides in the Pelona Schist are marked by ridge-top trenches and side-hill trenches and lack easily recognized lateral and distal margins.

COMPOSITE LANDSLIDE CYCLE

The three principal stages of the composite landslide cycle are distinguished from one another by size of the associated deposits, mechanism of displacement, and proximate causes. The stages occur in sequence, the deposits of the first cycle being removed to positions further down-canyon by the activity of the second- and third-stage landslides. There are major differences in duration of each of the component stages.

First Stage

The first stage of the composite cycle is the formation of a large-scale bedrock slump, the deposit of which occupies the headward part of a canyon. The head of Heath Canyon is filled with a partly dissected first-stage landslide, the Wright Mountain landslide (fig. 2), covering an area of 400,000 m^2 with an estimated volume of 14,000,000 m^3 (Morton and Kennedy, 1978). Wright Mountain landslide formed by large-scale slumping of bedrock with the principal downslope movement to the north-northwest. The landslide is at last 500 years old, as determined by the age of jeffery pine trees now living on parts of the landslide deposit; they could not have survived had they traveled downslope with the landslide, even as young saplings.

Major canyons having smooth concave longitudinal profiles (such as Acorn Canyon, fig. 3) apparently formed without first-stage landsliding.

Figure 3 near here

Completely dissected landslides (Sheep Canyon, fig. 3) or partly dissected landslides with a reestablished canyon (Heath Canyon, fig. 3) have profiles that show marked deviation from smooth concavity. Profiles of largely undissected or undissected parts of landslides (undissected part of Wright Mountain landslide, fig 3) have clearly convex profile segments.

(TOP)

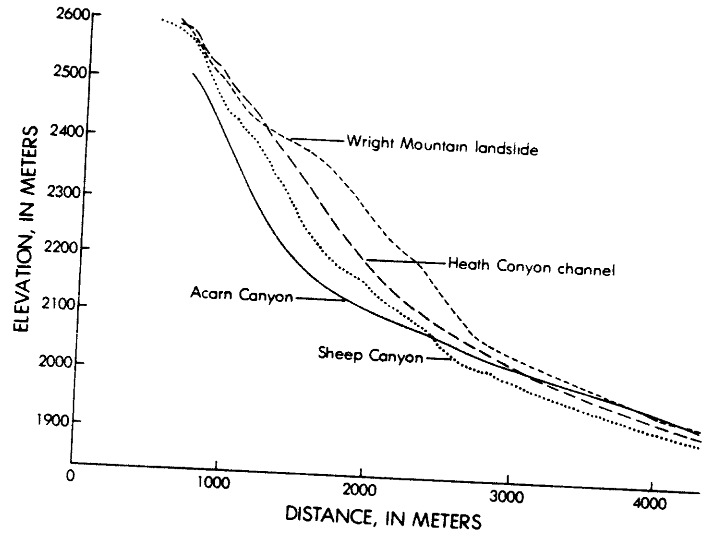

Figure 3.--Longitudinal profiles of Sheep, Heath, and Acorn Canyons.

Upper Sheep Canyon was filled by a first-stage landslide deposit similar to that filling Heath Canyon, but it is now completely dissected leaving only a few remnants of landslide debris. The completely dissected nature of this landslide indicates it is considerably older than the Wright Mountain landslide.

Second Stage

Most of our studies were done in Heath Canyon, and the second- and third-stage landslides described originated there. Geographic points referred to in the text for Heath Canyon are indicated on figure 1.

After the first-stage Wright Mountain landslide, Heath Canyon Creek was reestablished west of the pre-landslide canyon. Canyon cutting in both landslide debris and adjacent in-place Pelona Schist gave rise to oversteepened lateral and headward slopes, which subsequently failed by second-stage landsliding. Major modifications of the Wright Mountain landslide by second-stage landslides are shown in figure 4. Photographs

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Figure 4 near here

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and observations show that three major second-stage landslides have occurred since 1929. The first occurred sometime in the period 1938 to 1941, the second during 1967-69, and the third during 1969-73.

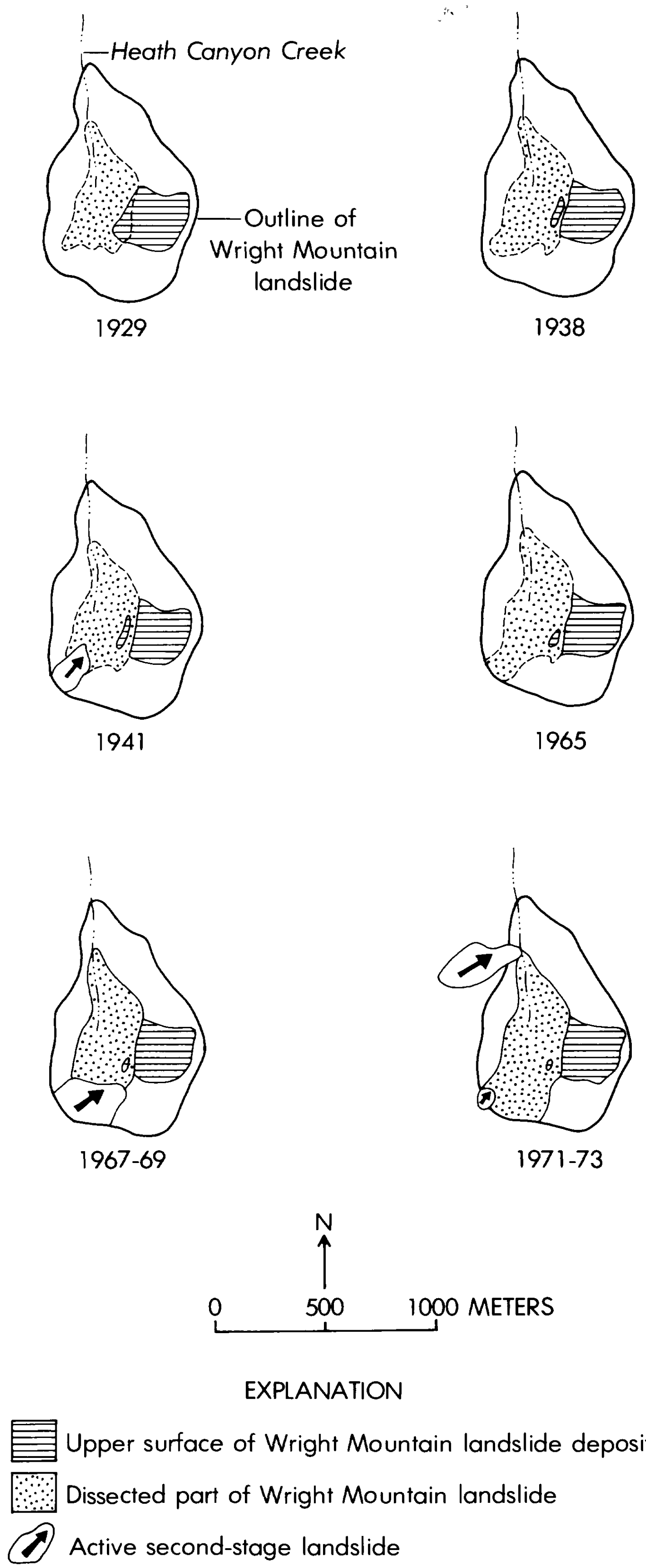

Figure 4.--Modification of the Wright Mountain landslide area by second-stage landsliding between 1929 and 1973.

The best-documented second-stage landslide occurred from 1967 to 1969 (Morton and Kennedy, 1978); we believe this landslide to be typical of second-stage landslides. This landslide began to move in the spring of 1967 and was studied in detail over the five-month period of most rapid movement, June through October 1967; however, the slide and underlying material continued to move throughout the spring of 1969. This landslide was a block 300 m by 200 m in plan and estimated to contain 760,000 m^3 of material (fig. 2).

When first visited on June 16, 1967, a new, largely linear scarp was 46 cm high and partly coincided with an old low scarp 25-40 cm high. The new scarp increased in height at rates ranging from 2.5 to 4 cm per day. The crown scarp dipped 65° to 75° northward. Slickensides were oriented downdip in the central part of the scarp, 10° to 15° west of the dip on the west side of the scarp, and a similar amount to the east on the east side, indicating that the moving mass was deforming laterally.

The toe and lower sides of the block became distinct by September 28, at which time the scarp had reached a height of 8 m. Until this time the landslide movement as expressed by the ever-increasing scarp height was taken up by distortion within the block. The rate of movement began to increase by 0.5 cm/day between September 30 and October 6. The mean increase in the height of the scarp from October 6 through 13 was 43 cm/day. The rate had increased to 60 cm/day by mid-October, the maximum recorded.

During the time of most rapid landslide movement the block slowly disaggregated, with the lowest parts slowly sloughing over a lower face as steep as 35°. The remaining part of the block, part of the sloughed debris, and underlying debris continued to move slowly, at least until the summer of 1969. The remaining part of the block moved more than 100 m downslope.

A pre-1969 rockslide, located on the west side of Heath Canyon, is not part of the Wright Mountain landslide but resulted from oversteepening on the west side of Heath Canyon as canyon cutting reestablished the canyon bottom west of the pre-Wright Mountain landslide canyon bottom. Movement of this second-stage landslide was renewed in the spring of 1969 and continued through the summer of 1973. Talus accumulations along Heath Canyon channel in the spring of 1969 were partly removed by the 1969 mudflows. Inspection during 1970 to 1973 indicated that this landslide continued to move intermittantly. Part of the material underlying the western scarp area of the 1967 slide began to move as a discrete mass during 1969 and continued moving through 1973.

In all observed second-stage landslides the style of movement was similar to that observed in the 1967 landslide: continued slow movement and considerable comminuation of bedrock. Photographs indicate that a rockslide occurred sometime after 1938 and before the mudflows in the Spring of 1941 in the headward part of Heath Canyon. Other parts of the Wright Mountain landslide not constituting discrete landslides have moved intermittantly for at least 40 years.

Third Stáge--Mudflows

The third stage includes sequences of major mudflow events accompanying the spring melting of snowpack. Indicidual small mudflows are annual spring phenomena in Heath Canyon, as they are in other areas underlain by the Pelona Schist in the eastern San Gabriel Mountains. However, only a few drainages have produced large mudflows and mudflow sequences in historic times. All of these drainages contain major first-stage landslides which are in part active, at least intermittently. Spring mudflows are known to have occurred in Heath Canyon in 1941, 1943, 1969, and 1973.

In addition to spring thaw, two other climatic conditions cause short-lived mudflow: (1) summer or fall "cloudburst" rains; and (2) exceptionally heavy fall rains. These mudflows produced by exceptionally heavy surface runoff and, though posing an important hazard to Wrightwood, they are quantitatively minor contributors to the fan deposits. Mudflows generated by these conditions are not considered further here.

THE SPRING MUDFLOW SEQUENCE

The best documented spring mudflow activity is that of 1969 (Morton and others, 1978), and it forms the basis of description of third-stage landsliding. About the first of May, 1969, a steady thaw of the snowpack was accompanied by 40 days of mudflow activity that was separable into three phases: waxing, climactic, and waning. This sequence is considered typical of spring mudflows in the area.

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Waxing phase.--The waxing phase consisted of short-lived mudflows that deposited debris downstream in the alluviated bottom of Heath Canyon (fig. 5a). For 16 days deposition progressed downstream, eventually reaching the apex of the Heath Canyon alluvial fan.

Figure 5a near here

The debris deposits were distributed in a braided fashion. While deposition prograded downstream, a flumelike channel began to incise in the upper reaches above a narrow bedrock gap (fig. 1), through the recently deposited debris.

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Climactic phase.--More prolonged mudflows began on May 17 and continued for six days. This phase produced the largest and longest lived mudflows. The mudflows originated at progressively higher elevations in Heath Canyon, and the narrow flume-like channel quickly extended downstream through the alluviated canyon bottom from the bedrock gap (fig. 5b) to the apex of the fan where the flows emptied into a flood-control channel (fig. 1). The deepest

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Figure 5b near here

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part of the channel, near the apex of the fan, was 8 m deep. Subsequent flows were transported through the alluviated canyon floor in this channel and the upper part of the fan in the flood-control channel without visible net deposition or erosion. Deposition took place chiefly on the middle and lower parts of Heath Canyon fan and was limited to the east side of the fan by flood-control levees. A few of the larger flows reached as far as the confluence of Heath and Swarthout Creeks, 6 km from their point of origin (fig. 1).

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Waning phase.—The amount of meltwater began to decrease about May 22 and the frequency and duration of mudflows decreased steadily. Smaller flows gradually backfilled the flume-like channel through the full length of the alluviated canyon. (fig. 5c). Subsequently some

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Figure-5c near here

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flows spilled over the backfilled channel and once again aggraded the canyon bottom in a braided fashion. By June 6, the snowpack had all but disappeared and spring mudflows had ceased.

MUDFLOW INCEPTION

Meltwater from the thawing snowpack was quickly absorbed by landslide debris with very little excess to form stream flow. Meltwater percolated through the active second-stage landslide mass toward steep faces above the drainage channel in the toe area of the landslide giving rise to small shallow slumps, slides, and flows in the saturated debris. This activity constantly replenished the supply of saturated debris in the channel.

In the first two weeks of mudflow activity, during the waxing phase, intervals of several minutes to hours separated events that placed debris in the channel. As the meltwater stream flow increased, so did the frequency of these events. During the climactic phase, sloughing and tributary mudflows continously placed debris in the channel, and the point at which mudflows were initiated migrated headward as the edge of the snowpack receded up the mountain side.

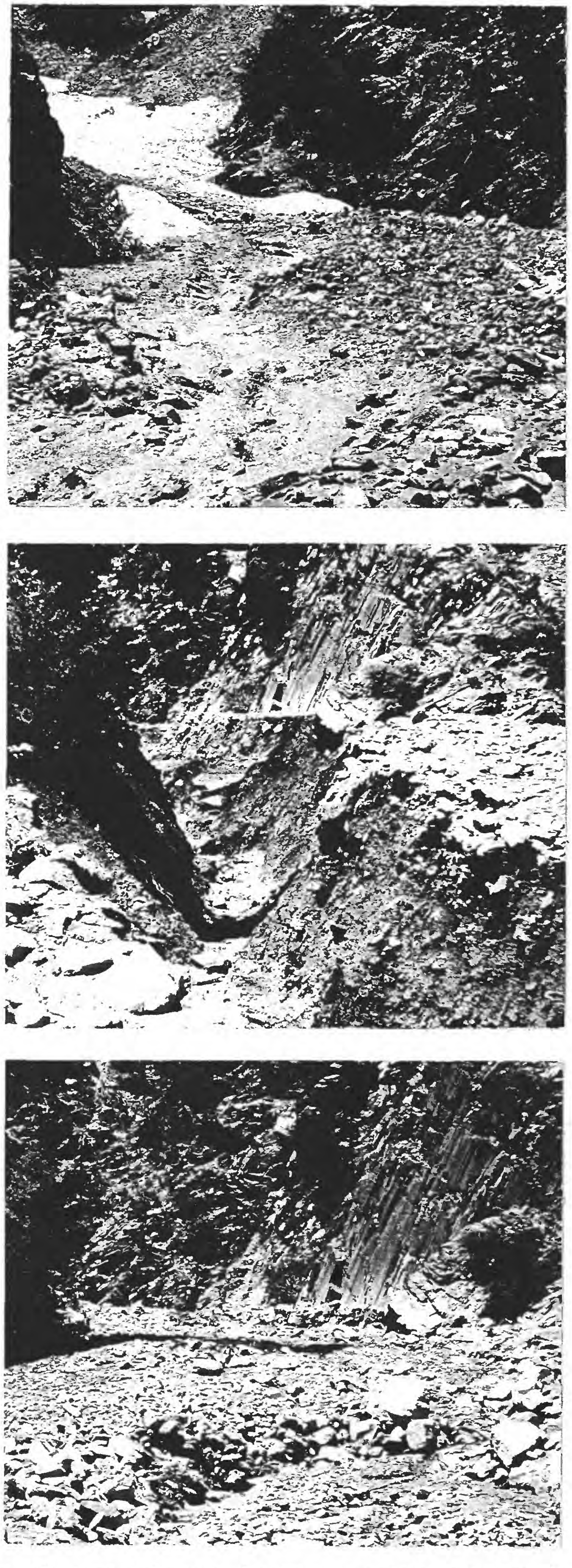

Figure 5.--Floor of Heath Canyon looking upstream through bedrock gap, spring 1969. A. Deposition of mudflow debris to a thickness of about 1 m during waxing phase. B. Channel cutting to depth of 5 m during climactic phase. C. Backfilled channel at end of waning phase.

During the waning phase, sloughing debris commonly accumulated faster than it could be removed by the decreasing amount of meltwater, and many mudflows moved only relatively short distances down channel. However, some downslope movement of debris continued after the final mudflows.

PHYSICAL APPEARANCE

Debris moved down the channel as individual mudflows, cascading over bedrock waterfalls before entering the alluviated canyon bottom (fig. 1). The mudflows on the alluviated canyon bottom had blunt rocky snouts generally 1 to 1.3 m high. These snouts consisted of relatively well sorted clasts, generally 15-60 cm in diameter with a few clasts as much as 1.3 m in diameter. Behind this coarse, bouldery front was an unsorted mixture of mud and rock, followed in turn by a mud slurry, which passed progressively into muddy water (fig. 6). The trailing

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Figure 6 near here

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muddy water tended to flush finer grained loose debris from the channel, leaving a rock-strewn bottom. Between the passage of mudflow surges, there was a small but nearly continuous flow of muddy water. At individual points of observation along the channel a temporary diminution or cessation of water flow frequently but not invariably heralded the approach of another mudflow; the diminishing water was a result of debris upchannel temporarily damming the channel.

Figure 6.--1969 mudflow during climactic phase showing characteristic blunt rocky snout and progressive decrease in clast size and degree of sorting upstream. Height of mudflow snout is 2 m.

Mudflows commonly spilled debris over the channel margins as they moved down channel, which developed a mudflow levee in a relatively short time (fig. 7a and 7b).

Figures 7a and 7b near here

Except when cascading over bedrock waterfalls, the mudflows moved in a laminar or nonturbulent fashion. Individual clasts tended to remain in the same relative position in a flow, sliding, slowly rotating and occasionally disappearing, or if on the snout, occasionally toppling down the front. As the viscosity of the flow decreased behind the rocky material and consisted of a slurry or debris-laden water, the flow became turbulent.

The velocity of an individual mudflow was variable from inception to deposition. Most mudflows, except during the climactic phase, completely halted at one or more points while in transit, only to be remobilized when overtaken and overridden by and combined with subsequent flows (fig. 8). Where flows halted without effective side con-

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finement, the debris became stabilized and deflected later flows. This process was particularly noticeable during the waxing and waning phases, when it caused a braided drainage pattern to form.

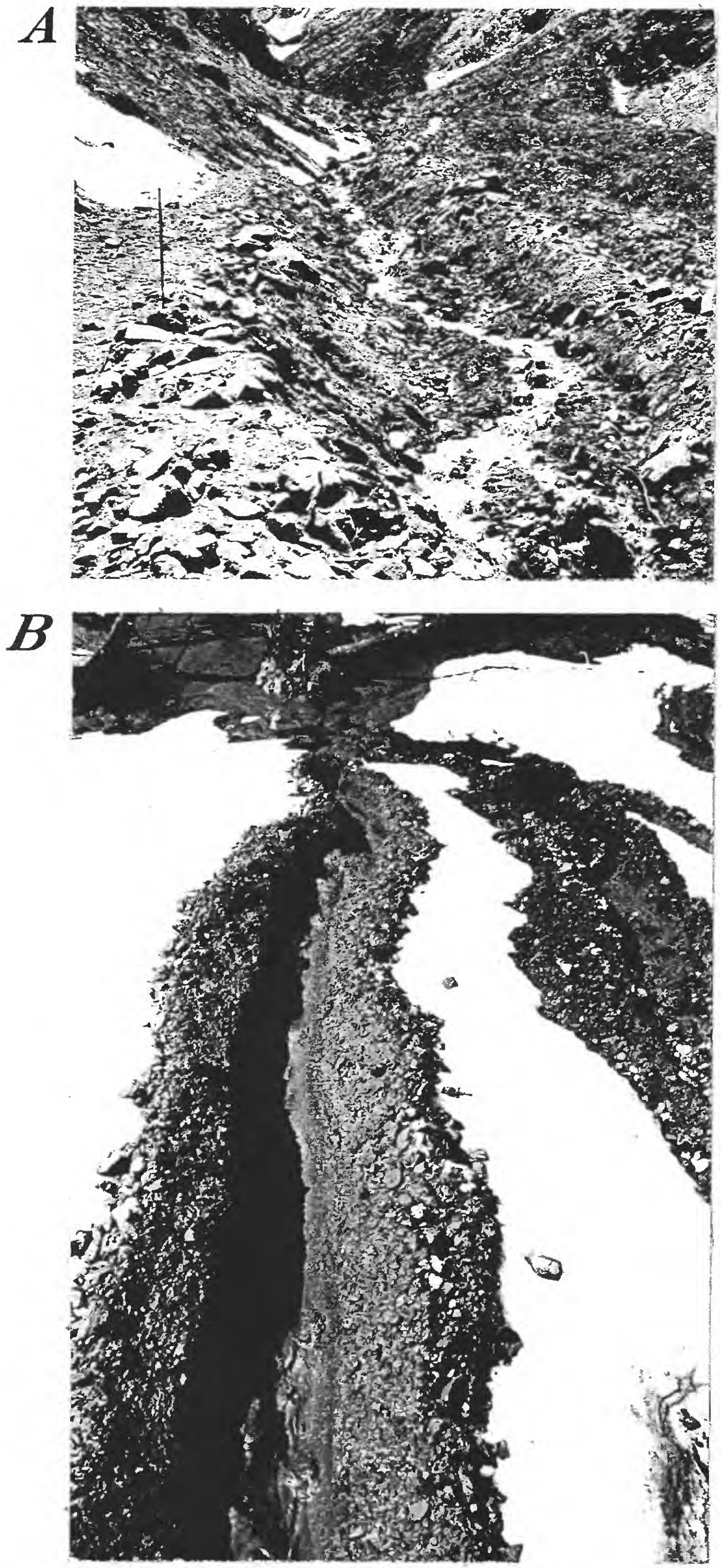

Figure 7.--Mudflow levees. a. View looking upstream above bedrock gap in alluviated canyon bottom; width of channel 3 m. b. View downslope of a 25-cm-wide 1973 mudflow channel.

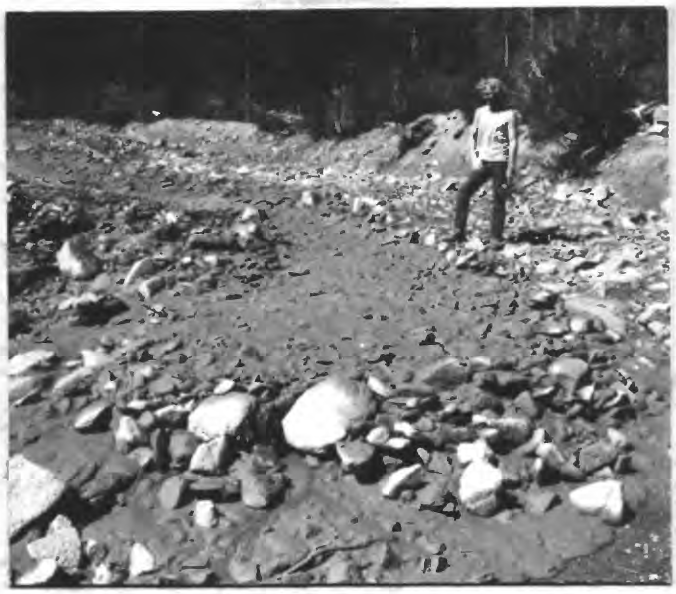

Figure 8.--Small stabilized mudflow at entrance to flood-control channel, 1973. Note blocky snout and fine mud that issued from coarser material.

During the climactic phase, mudflows on the gentler grades of Heath Canyon fan repeatedly merged to form continuous flows in which the rocky snouts of former individual flows were marked only by short segments containing concentrations of boulders. Velocities of moving mudflows varied between 0.6 and 4 m/second. Many flows in the flood-control channel had rounded snouts produced by a velocity difference of 0.3 to 0.6 m/second between the snout center and the more slowly moving margins. The mean velocity for one flow timed between the alluviated canyon bottom and 1.5 km downstream was 0.6 m/sec.

Most moving mudflows took 2 to 4 minutes for the entire body to pass a point, but during the climactic stage some large ones took 30 minutes. Continuously moving flows of 4 to 9 minutes duration were estimated to contain 150 to 700 m^3 of mud. The total debris transported as mudflows in 1969 is estimated at a minimum of 150,000 m^3. The volume of flows in 1941 was estimated as great as 918,000 m^3 (Gleason and Amidon, 1941). An estimated several thousand cubic meters of debris was involved in the 1973 flows.

In the flood-control channel, translatory waves 3 to 10 cm in amplitude formed during the climactic phase (fig. 9). These waves

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Figure 9 near here

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traveled at 6 to 8 m/second, twice the speed of the moving mud, and tended to remobilize temporarily halted boulder accumulations.

Figure 9.--Cresting translatory wave in fine-grained part of a 1969 mudflow. Width of flow is 3 m.

Physical Properties

Thirty 1-liter samples of relatively fine grained (<10 cm clast size) mud from moving flows were collected, as well as eight interflow water samples. Twenty-two samples, termed gravelly mud, were collected immediately behind the rocky front of flows, and eight samples, termed sandy mud, from the upstream terminal parts of flows. Specific gravity and the volume of rock of these samples are given in the following table. The rocky front of mudflows and clasts 10 cm and greater in size

	Percent rock by volume		Specific gravity	
	Range	Average	Range	Average
Gravelly mud	43.7-74.6	63.9	1.72-2.21	2.05
Sandy mud	13.0-58.0	41	1.22-1.96	1.67
Water	5.1-37.0	19	1.08-1.61	1.32

were not included in the sampling, biasing the values in the table on the low side. We estimate the rocky snouts to consist of up to 90 percent rock by volume.

Median grain size of indivdual samples from the gravelly mud were between 0.7 and 6 cm and from the sandy mud between 0.3 and 2 cm. Estimates of Bingham viscosity range from 4 x 10^2 poises for the sandy mud to 10^3 poises for the gravelly mud.

1973 mudflows

Smaller mudflows than those of 1969 occurred discontinuously over a 35-day period between April 11 and May 15, 1973. With the exception of those flows occurring on May 14 and 15, the flows did not extend below the bedrock gap. Mudflows during April originated from the active landslide on the west side of Heath Canyon (fig. 4); those during May originated from an active landslide at the head of the 1969 rockslide (fig. 4). These flows were similar in morphology to those occurring during the waxing and waning phases of the 1969 mudflow stage. However, mudflow phases developed on a small scale with progressive downslope deposition of debris, followed by progressive downslope channel cutting, followed in turn by channel filling or channel blocking and subsequent channel abandonment (fig. 10).

Figure 10 near here

Large flows during May 14 and 15, 1973 resulted when thaw was accelerated by a cloudburst on the afternoon of May 14. Except for these large flows, the 1973 mudflows were scaled-down versions of the 1969 mudflows. Most mudflows were 15-50 cm wide and 1-30 cm thick. Those originating on the west side of Heath Canyon originated on slopes of about 30° and emptied onto the alluviated canyon bottom where the gradient is 17°. Maximum clast size transported by the mudflows was 25 cm. Mudflow velocities on the 17° alluviated canyon bottom were 0.3-0.6 m per second.

Snouts of many mudflows or mudflow deposits are characterized by a concentration of the largest rock fragments in the flow (fig. 6), and speculation has centered on the mechanism repsonsible for their distribution. We observed the development of rocky snouts of the 1973 mudflows closely, as the relatively small size of the mudflows presented little physical hazard, which was not true of the 1969 mudflows.

A mudflow originating at the toe of an active landslide consists of well-mixed heterogeneous debris. As a mudflow passes through the upper part of its channel it leaves behind scattered detritus. Relatively fine grained detritus is flushed by stream flow between mudflows, leaving behind only the relatively well sorted largest rock fragments. As the mudflow continues down channel it accumulates at its snout the rocks left in the channel by the preceding mudflow.

Figure 10.--Series of small mudflow channels, 1973. Mudflow debris is relatively fine grained. Immediately right of the observer debris has blocked a channel causing later flows to be deflected to the left, at the observer's feet. Mudflow channel to right of photograph is dammed by debris at the lower right corner. View looking upslope.

1973 cloudburst

The cloudburst that occurred over the Heath Canyon area in the early afternoon of May 14, 1973 dropped intense rainfall on already saturated landslide debris in the upper reaches of Heath Canyon and caused several large mudflows the afternoon of May 14 and 15. These flows had a cross-sectional area of about 1 x 8 m where they entered the flood-control channel. The flows traveled as much as 3 km from their point of origin. Velocities were estimated at 6 m per second. At and above the bedrock gap the flows cut a 2.5- to 4-m-deep channel within two hours (fig 11). The first flows traveled in a turbulent

Figure 11 near here

flow in contrast to other mudflows observed in the Wrightwood area. These flows are probably the closest in kind to cloudburst-generated mudflows characteristic of the arid and semiarid parts of the southwest (Jahns, 1949). Thus, the normal spring mudflows should not be used as a model for cloudburst-generated mudflows.

CLIMATIC ASSOCIATIONS

As identified first-stage landslides are of prehistoric origin, nothing is known about the climatic conditions leading to their origin or whether present conditions are the same as those at the time they formed. Perhaps they resulted from some combination of abnormally wet years and high-intensity earthquake shaking.

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Conditions are known for several episodes of second- and third-stage landsliding. Once dissection of a first-stage landslide is underway, triggering of second- and third-stage landslides appear to be largely governed by weather. Precipitation records for 1925-26 through 1973-74 rainfall years (October through September) for Big Pines, 6 km west of Wrightwood, show two groups of relatively wet winters. One group is centered about 1940-41, the other clusters about 1968-69 (fig. 12). The two recorded periods of greatest mudflow activity

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Figure 12 near here

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coincide with the two wettest winters; other relatively wet winters (for example, 1937-38, 1957-58, 1966-67) were not periods of known spring mudflow activity. However, spring mudflow activity is reported for the 1942-43 winter (Sharp and Nobles, 1953, p. 553) and the 1972-73 winter (Morton and Campbell, 1974); both had less precipitation than 1937-38, 1957-58, or 1966-67. Both the 1941 and 1973 mudflow activity occurred at the latter part of a sequence of three or more successive wet winters.

Figure 11.--Mudflow channel cut by cloudburst-generated 1973 mudflows.

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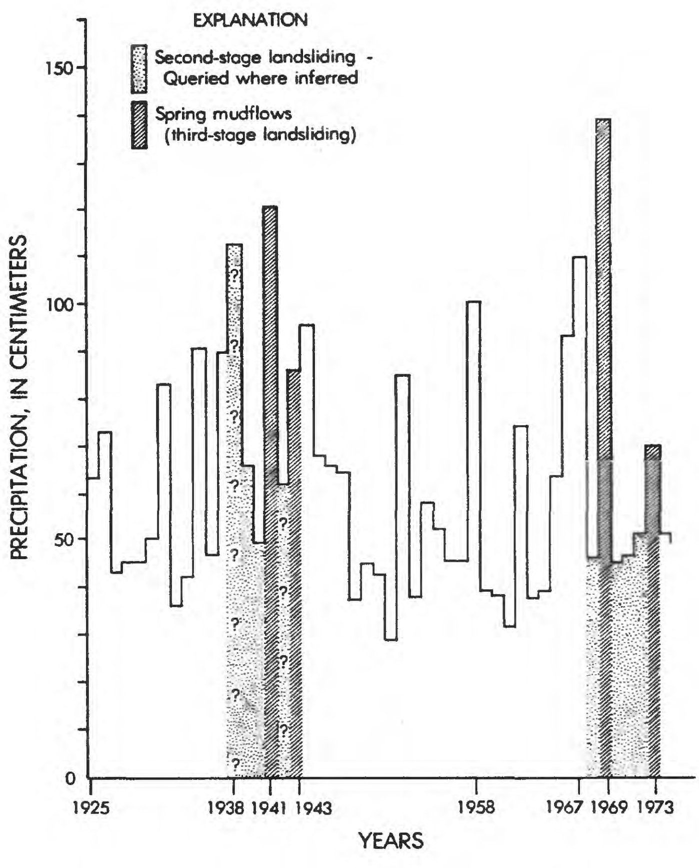

Figure 12.--Precipitation records for Big Pines area from 1925-26 through 1973-74.

A sequence of several relatively wet winters had a twofold effect. First, second-stage landslides appear to follow a period of consecutive wet years (1936-38 and 1965-67) or closely grouped wet years (1965-67 and 1968-69). Once triggered, second-stage landslides are capable of moving, at least discontinously, for a minimum of two to three years. Second, if a wet winter coincides with second-stage landslide movement, a third-stage landslide event--a sequence of spring mudflows--results.

In this model, the 1969 mudflows are considered to be a product of a combination of active second-stage landsliding resulting from the wet 1965-67 period and the melting of a deep 1969 snowpack. The combined 1965-67 and 1968-69 wet years triggered a new second-stage landslide at the head of Wright Mountain landslide and renewed movement in a pre-existing second-stage landslide on the west side of Heath Canyon. Movement of these two second-stage landslides continued, at least discontinuously, until the spring of 1973, when sloughing saturated debris once again formed mudflows.

Similarly, we consider the 1941 spring mudflows to be a result of active second-stage landsliding, triggered by the 1936-38 wet period, continuing through the spring of 1941. The 1943 mudflows could have resulted either from continued movement of the second-stage landslide that produced the 1941 mudflows, or more likely, based on the relatively small size of the 1943 flows, a smaller size of the 1943 flows, a smaller active second-stage landslide similar to those of 1969.

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POTENTIAL LANDSLIDE AND MUDFLOW HAZARD

Mudflows pose a recurring threat to parts of Wrightwood. Available data indicate that climatic conditions can be used to predict the occurrence of spring mudflows. A sequence of wet winters should again produce second-stage landsliding and subsequent overlap of continued second-stage landsliding, and a relatively wet winter in the sequence would likewise produce third-stage landsliding--mudflows. Understanding mudflows within the context of the composite landslide cycle and their relation to climatic conditions could lead to the prediction of spring mudflows a year or more before their occurrence.

It must be expected that severe earthquake shaking of the area would cause significant temporary increases in landslide activity, the character and extent of which should depend upon what stage of the landslide cycle was most active at the time of the earthquake. The community of Wrightwood lies in a valley eroded along the main trace of the San Andreas fault and the area has been severely shaken during historic earthquakes; however, the present data permit no more than speculation about possible correlations of seismicity and landslide activity. The first-stage landslide in Heath Canyon clearly predates the great Fort Tejon earthquake in 1857, and the second-cycle landslides of 1939-42 (?), 1967-69, and 1969-73 do not appear to correlate with known seismic events.

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887-100

REFERENCES CITED

Gleason, C. H., and Amidon, R. E., 1941, Landslide and mudflow, Wrightwood, California: California Forest and Range Experiment Station umpub. rept., 7, p.

Jahns, R. H., 1949, Desert Floods: Eng. and Sci. Jour., v. 12, p. 10-14.

Morton, D. M., and Campbell, R. H., 1974, Spring mudflows at Wrightwood, southern California: Quart. Jour. Eng. Geology, v. 7, no. 4, p. 377-384.

Morton, D. M., Campbell, R. H., Barrows, A. G., Jr., Kahle, J. E., and Yerkes, R. F., 1978, Part II: Wright Mountain mudflows: Spring 1969, in Landsliding and mudflows at Wrightwood, San Bernardino County, California: Calif. Div. Mines and Geology, Spec. Rept. 136 (in press).

Morton, D. M., and Kennedy, M. P., 1978, Part I: Wright Mountain landslide, in Landsliding and mudflows at Wrightwood, San Bernardino County, California: Calif. Div. Mines and Geology, Spec. Rept. 136 (in press).

Sharp, R. P., and Nobles, L. H., 1953, Mudflow of 1941 at Wrightwood, southern California: Geol. Soc. America Bull., v. 64, p. 547-560.