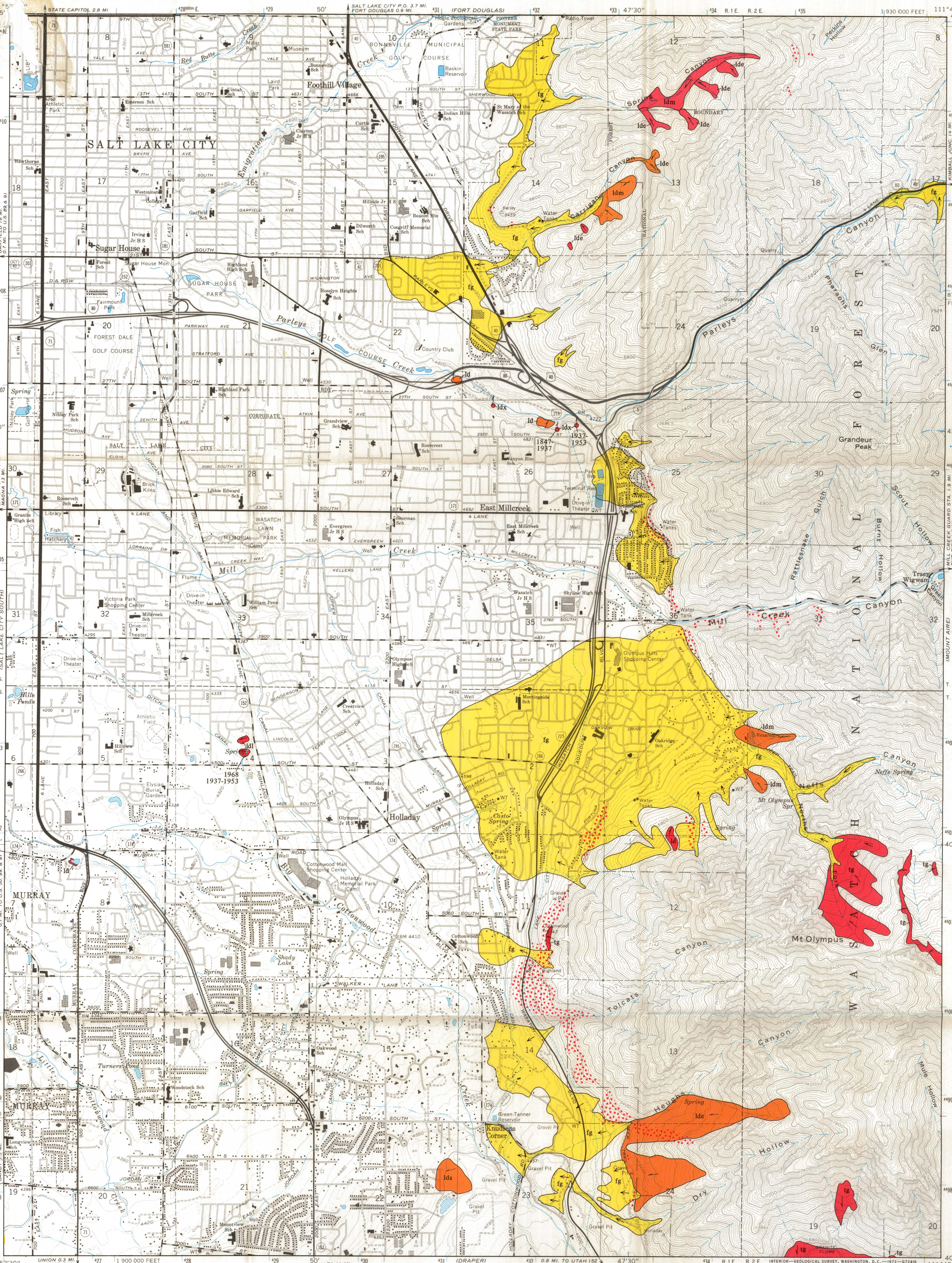
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY



Base from U.S. Geological Survey, 1963
Photorevised in 1969
10,000-foot grid based on Utah coordinate system, central zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

UTAH
QUADRANGLE LOCATION

Deposits mapped in 1963-65 and 1971

LANDSLIDE AND ASSOCIATED DEPOSITS MAP OF THE SUGAR HOUSE QUADRANGLE, SALT LAKE COUNTY, UTAH

By
Richard Van Horn
1972

EXPLANATION

LANDSLIDE DEPOSITS IN WHICH SOME MOVEMENT PROBABLY HAS OCCURRED WITHIN THE LAST 5,000 YEARS

- ld — LANDSLIDE UNDIFFERENTIATED
- lde — EARTHFLOW
- ldl — FAILURE BY LATERAL SPREADING
- ldm — MUDFLOW
- tg — TALUS
- ldx — SAND RUN

LANDSLIDE DEPOSITS THAT PROBABLY HAVE NOT BEEN ACTIVE WITHIN THE LAST 5,000 YEARS

- ld — LANDSLIDE UNDIFFERENTIATED
- lde — EARTHFLOW
- ldm — MUDFLOW
- lds — SLUMP

DEPOSITS THAT MAY CONTAIN MUDFLOW DEBRIS – SOME OF THESE AREAS MAY NOT HAVE BEEN AFFECTED BY MUDFLOWS WITHIN THE LAST 5,000 YEARS

- fg — AREAS SUBJECT TO POSSIBLE MUDFLOWS DURING FLASH FLOODS – Arrow shows direction of stream flow

FALLEN BOULDER ACCUMULATION

1968 — APPROXIMATE DATE (OR LIMITING DATES) OF HISTORIC MOVEMENT

INFERRED DIRECTION OF LANDSLIDE MOVEMENT

INTRODUCTION

As urban growth continues in Salt Lake County, Utah, construction on landslide deposits should be avoided unless suitable detailed slope stability investigations are conducted to determine appropriate engineering safeguards. In addition, areas of rocks or surficial deposits similar to those involved in landslides, and that have slopes or indications of springs similar to the ones found at landslides, should be analyzed by engineers or geologists to determine if these areas are potentially unstable.

Landslides result from unstable slope conditions; renewed movement of some landslide deposits that seem to be stable now may be caused by earthquake disturbance, an increased water content, excavation of the lower part, or loading of the top. Knowledge of landslide deposit locations, therefore, should help those people who are concerned with using and developing land, as well as people who are responsible for planning both for future urbanization and for disasters such as major earthquakes and floods. The map shows the location of known landslide deposits, areas of alluvial fan deposits that have been subject to mudflows during flash floods, and places where rocks have come to rest after falling from a position higher on a slope.

The recency of movement of a landslide can be determined by observation of surrounding features; the latest movement will, of course, postdate the age of the youngest feature that has been disturbed by the landslide. In addition, the degree of preservation of the original form of the landslide deposit and the freshness of cracks and scarps suggest the age of the landslide relative to surrounding deposits. The ages of some surficial geologic formations, which are younger than the bedrock of the area, have been determined by the radiocarbon dating method, and others by the amount of weathering they have undergone since they were formed. Limiting dates of very recent landslides can be determined from aerial photographs taken at different times. Other features such as faults, shorelines, and valleys, which have displaced or eroded into the geologic formations, are also useful in establishing the time of movement of the landslide deposits. Aerial photographs of the Sugar House quadrangle that were used for this investigation were taken in 1937, 1953, 1962, and 1970.

LANDSLIDE DEPOSITS

Landslide deposits are formed by the movement of rocks or earth downward and outward to a lower position on a slope. Movement may be very rapid, as, for example, a rock falling from a cliff, or it may be as slow as a fraction of an inch per day. The composition of a landslide deposit is similar to that of the material upslope from the deposit. Most landslide deposits in the Sugar House quadrangle are 15-30 feet thick.

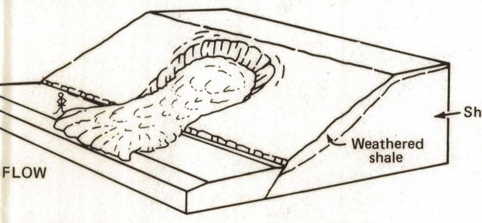
Landslides generally can be recognized by:

1. a short steep cliff or scarp (main scarp) or a zone of cracks, at the top, immediately above the flatter landslide deposit;
2. a less steeply sloping middle area with small hillocks and depressions (landslide deposit);
3. a zone of springs or seeps commonly issuing from the lower end (toe) of the landslide deposit; but they may also issue from the main scarp or from within the landslide deposit.

A potentially unstable hillslope is like a balanced teeter-totter – either will move if its balance is disturbed. The movement of the hillslope is called a landslide. Most of the landslides in Salt Lake County are not active now. The inactive landslides in the Sugar House quadrangle, however, are like geologic booby-traps that are just waiting for some natural or man-created disturbance to upset their balance and start them moving again. Four ways in which their balance could be disturbed are by:

1. removing support from the lower part;
2. adding weight to the upper part;
3. increasing the water content;
4. shaking of the earth.

Earthflow deposits. – The earth begins to slowly flow downhill after weath-

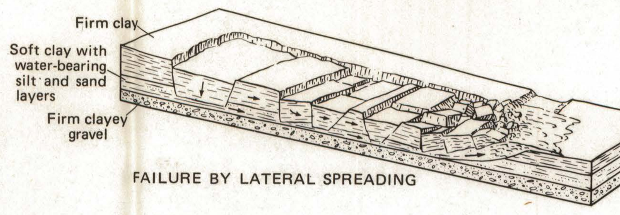


ered debris above the bedrock becomes saturated or nearly saturated with water. This generally happens after prolonged periods of rainfall. Most earthflows are small and do not move for great distances, although large areas may be involved in the movement. With increased water content some earthflows may become mudflows.

Earthflow deposits are found principally in areas of shaly bedrock. The eight small earthflows east of St. Mary of the Wasatch School are all in weathered shale of the Ankareh Formation. A landslide on the north side of Mill Creek 2 miles east of the Sugar House quadrangle is complex and consists of a block glide in the upper part, an earthflow in the middle part, and a mudflow in the lower part. The landslide is principally in soil and earth that overlie bedrock, although the upper part may have originated in weathered Woodside Shale. A large earthflow in the shale unit of the Big Cottonwood Formation is present east of 6400 S. Wasatch Boulevard, southeast of Salt Lake City. This earthflow has displaced the high shoreline of Lake Bonneville that was formed about 15,000 years ago.

Earthflows may be expected in areas of steep slopes where thick deposits of colluvium overlie shaly bedrock.

Deposits formed by failure by lateral spreading. – The two small landslides northwest of Holladay were caused by slope failures by lateral spreading of clay that was located along the upthrown side of a branch of the East Bench

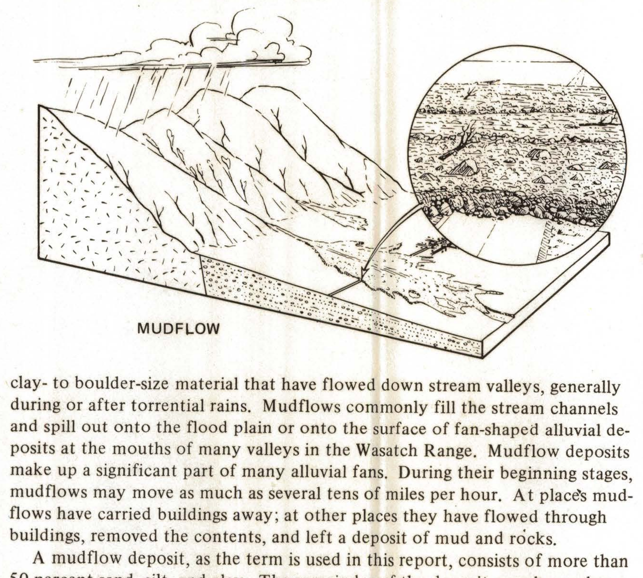


fault. There, lake clay had become saturated by water from an underlying gravelly sand and flowed out over the lower surface to the west of the fault scarp. Probably only one or two thin blocks of clay broke away from the bank and moved only a short distance before liquefying and flowing into the adjoining lake.

The deposits resulting from the two failures by lateral spreading consists of mud, a small amount of trash, and a few overturned trees. These deposits rest on the bottom of the lake.

Similar geologic and topographic settings are present at many places in Salt Lake County and are potentially hazardous. The potential slide areas are marked by nearly vertical clay slopes with springs near the bases of the slopes.

Mudflow deposits. – Mudflow deposits are formed by mixtures of water and

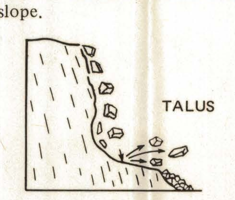


clay- to boulder-size material that have flowed down stream valleys, generally during or after torrential rains. Mudflows commonly fill the stream channels and spill out onto the flood plain or onto the surface of fan-shaped alluvial deposits at the mouths of many valleys in the Wasatch Range. Mudflow deposits make up a significant part of many alluvial fans. During their beginning stages, mudflows may move as much as several tens of miles per hour. At places mudflows have carried buildings away; at other places they have flowed through buildings, removed the contents, and left a deposit of mud and rocks.

A mudflow deposit, as the term is used in this report, consists of more than 50 percent sand, silt, and clay. The remainder of the deposit may be made up of pebbles, cobbles, and boulders. At places the deposit contains trees and other debris. Individual mudflow deposits range from 1 foot to 30 feet in thickness.

Mudflows are most common in the bottoms of short steeply sloping valleys heading in the Wasatch Range. As a mudflow leaves the mountains it slows down, and generally stops within a mile of the mountain front. Mudflows also may occur in the less steeply sloping valleys of Emigration, Parleys, Mill, and Big Cottonwood Creeks. In these valleys, however, they rapidly become diluted by excess water and the material is deposited as flood-plain alluvium during floods.

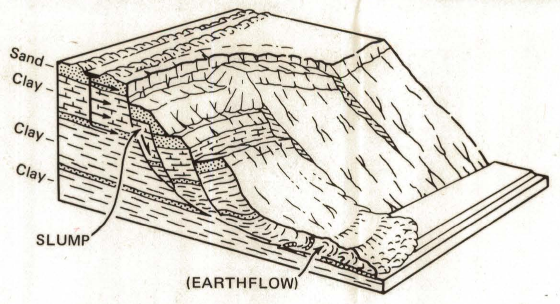
Talus. – Talus results from rocks falling from cliffs and accumulating as a thick pile at the foot of the slope.



Talus consists of loose angular rock fragments which are a few inches to many feet in longest dimension. Deposits range from 10 to more than 30 feet in thickness.

Talus accumulates at the angle of repose of the deposit and may slide downhill if disturbed. There is also danger from falling rocks in talus-covered areas.

Slump deposits. – Slump deposits are formed by the rotation of blocks of

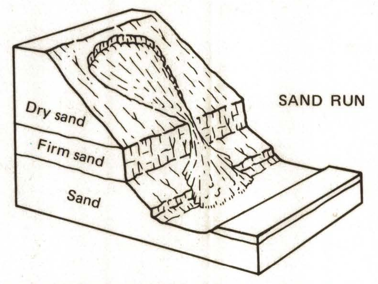


earth or rock about a horizontal axis that lies parallel to the slope. Undrained depressions that are formed in the upper parts of these landslide deposits commonly contain small lakes. Movement is generally slow and is accompanied and preceded by cracking of the ground surface.

Slump deposits are similar in composition to the in-place deposits from which they have been derived, although generally more broken up. The slump deposit south of 6200 South Street is relatively old and may have formed at the front of a delta in an ancient lake. The two undifferentiated landslides shown south of Parleys Creek may be slump deposits.

Slump deposits in the Salt Lake City area form along steep banks of lake silts and clays. The poorly consolidated fine-grained lake deposits are susceptible to slumping, particularly in the presence of water.

Sand-run deposits. – Sand runs form when oversteepened banks of nearly



dry, predominantly sand-size material can no longer support themselves and flow downward and outward. The sand flows through and, in part, erodes short steep-walled gullies which head in amphitheaters resulting from the removal of the sand.

A sand run generally forms a fan-shaped deposit at the base of a steep bank. The deposit is mainly sand, 5-15 feet thick. The walls of the amphitheater from which the sand run came are moderately steep and covered with sandy debris. Several sand-run deposits are present on the south side of Parleys Creek.

Sand-run movement is rapid and may be preceded by little or no warning. Steep banks of dry sandy material, such as those west of the mouth of Parleys Canyon, are susceptible to sand runs. Once an amphitheater is formed, erosion by recurrent sand runs or wind may continue indefinitely.

Deposits that may contain mudflow debris – Fan-shaped deposits that may contain mudflow debris extend westward from valleys cut into the Wasatch Range. The deposits themselves were formed mostly by flash floods at places where the carrying power of streams is decreased because of a lower slope (gradient) or because of loss of water. At places these deposits resulted from mudflows as well as from normal stream deposition.

The deposits that may contain mudflow debris consist of bouldery to sandy silt on the west and bouldery to silty gravel and sand on the east. They are as much as 20 feet thick.

Most of these deposits may be inundated by mudflows during violent flash floods that originate in the short steeply sloping valleys heading in the Wasatch Range. Flash floods may also occur in the valleys of Emigration, Parleys, Mill, and Big Cottonwood Creeks, but mudflows have not been recognized in these valleys.

Fallen boulder accumulations. – The boulder accumulations shown on the map result from rocks falling from the nearby steep slopes and have formed over a period of time of perhaps as much as 20,000 years. The accumulations consist of a few boulders per square yard.

The isolated boulders that have fallen from very steep slopes in mountain valleys and along the mountain front indicate a potential hazard from future rockfalls.

The landslide terminology and drawings used in this report are modified from Varnes (1958). The bedrock geology of the Sugar House quadrangle is described and shown by Crittenden (1965). The surficial geology of the Sugar House quadrangle is described and shown by Van Horn (1972).

REFERENCES

Crittenden, M. D., Jr., 1965: Geology of the Sugar House quadrangle, Salt Lake County, Utah: U.S. Geol. Survey Geol. Quad. Map GQ-380.

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Varnes, D. J., 1958, Landslide types and processes, Chap. 3 *in* Eckel, E. B. (ed.), Landslides in engineering practice: National Research Council, Highway Research Board Spec. Rept. 29, p. 20-47.

For sale by U.S. Geological Survey, price 75 cents