DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

MISCELLANEOUS FIELD STUDIES
MAP MF – 550

EXPLANATION

Landslides constitute a continuing natural and increasingly man-induced hazard to the urban and suburban development of the hillside areas of the San Francisco Bay region. Landslide deposits are being mapped throughout the nine Bay-area counties as part of the San Francisco Bay Region Environment and Resources Planning Study conducted by the U.S. Geological Survey and the U.S. Department of Housing and Urban Development. Most of the mapping has been done by photointerpretation using large-scale aerial photographs, and a number of maps have been published at a scale of 1:62,500. The extent and distribution of thousands of landslide deposits in the upland parts of the region are shown on the maps. The deposits have resulted from landslides during a long period of time, from perhaps several hundred thousand years ago to the time that the aerial photographs were taken. Thus the landslide deposits record a long history of natural slope failure, a process that continues today and may be accelerated locally by the activities of man.

Many recent landslides in the Bay region have involved renewed movement of old deposits. Maps of landslide deposits, which show where landslides have occurred in the past and are most likely to occur in the future, can be particularly useful for land-use planning. Although these maps present a great deal of data, they are sometimes difficult to evaluate and use on a regional scale or from a generalized perspective, especially in combination with other mapped data. For this reason, an isopleth map of the southern part of the San Francisco Bay region was prepared, using techniques and theory outlined in Schmid and MacCannel (1955).

This map generalizes and quantifies the distribution of landslide deposits, thereby enabling the user to consider these deposits in conjunction with other quantified map data and to take landslide hazards into account in regional planning. Zones and belts of abundant landslide deposits can be recognized at a glance and compared quantitatively. Trends and geographic orientations of belts of these deposits can be easily recognized. Confusing details shown on compiled maps of landslide deposits are clearly and distinctly summarized by the isopleths, and errors in those maps are smoothed.

The isopleth map can be easily superimposed on maps showing soils, bedrock geology, slopes, rainfall, vegetation, seismic zones, extent of urbanization, and other factors that affect landsliding to determine correlations between these factors and landslide deposits and derive a more refined map of slope stability. Where other geologic data are lacking, the isopleth map might serve as a generalized guide to landslide susceptibility.

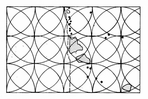
We constructed the isopleth map by systematically moving a 1-inch diameter plastic counting circle, enclosing an inscribed 20x20 per inch grid, over a 1:125,000-scale compilation map of landslide deposits compiled from various sources (Fig. 1). Circle centers were positioned at 0.5-inch intervals and at each position the number of grid squares within the circle covered by mapped landslide deposits was counted and recorded. Contour lines (isopleths) were then drawn through numbers equivalent to selected percentages of area covered by landslide deposits. The isopleth map thus shows the percentage of the area covered by landslide deposits within a 1-inch diameter circle centered at any point on the map. The steps used in the construction of this map are shown below.

The isopleth map is no better than the larger scale maps from which the base map was compiled, and may even be less accurate. The larger scale maps--the original sources--vary in reliability and accuracy, inasmuch as they were prepared by different geologists using different techniques and procedures. Many small landslide deposits, less than 200–300 feet long, were not shown on those maps. Furthermore, in preparing the isopleth map, we included deposits originally mapped as questionable and gave them the same value as all other deposits. For these reasons, users who are interested in specific locations should also consult the original sources.

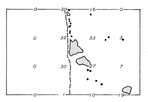
R.H. Campbell first applied the isopleth technique to landslide distribution at a larger scale (Campbell, 1973), and we wish to thank him for pointing out its potential uses and advantages. Edward Belfarts, Richard Greenwood, John Nakata, and Bruce Ross aided in the map preparation.

A – Compilation of mapped landslide deposits; dots represent deposits less than 500 feet in longest dimension; areas enclosed by contacts represent deposits more than 500 feet long.

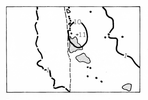
B – 1-inch diameter counting circle enclosing an inscribed 20x20 per inch grid. Circle contains a total of 350 500-foot² squares.



C – Overlapping counting circles centered at 0.5-in. intervals superimposed on landslide deposits; counting grid omitted for clarity.



D – Values, recorded at circle centers, representing the number of grid squares within the counting circles covered by mapped landslide deposits, each dot counted as one square.



E – Isopleth map with isopleths drawn at 1% and 10% and a maximum (peak) counted value. Note that the isopleths are drawn on the distribution of the numerical values of the last step and do not simply enclose areas having the percentage landslide deposits cover shown by the isopleth label.

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_____1972b, Preliminary photointerpretation map of landslide and other surficial deposits of parts of the Altamont and Carbona 15-minute quadrangles, Alameda County, California: U.S. Geol. Survey Misc. Field Studies Map MF-321, scale 1:62,500.

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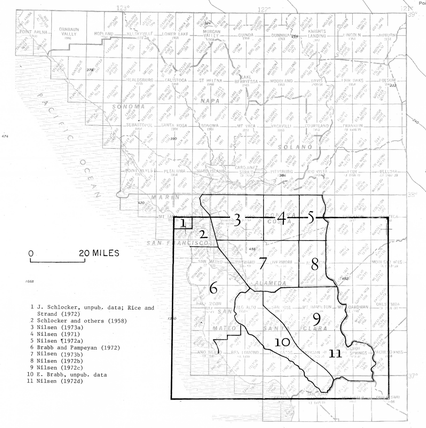

Figure 1. Index map to isopleth map of Sheet 3 of 3, San Francisco Bay Region Study area, showing sources of landslide deposits data. Data are incomplete in Santa Clara County west of the Santa Clara Valley (10), so that area was not contoured on the isopleth map.

MAP SYMBOLS

>500ft in longest dimension — <500ft in longest dimension

Landslide deposits

10 — Isopleth, showing percent (Isopleths drawn at 1, 10, 20, 30, 40, 50, 60, 70, 80, and 90 percent; hachures indicate closed isopleth depression)

+5% Maximum or minimum determined percent within closed isopleth

Base by U.S. Geological Survey, 1970

SCALE 1:125 000

CONTOUR INTERVAL 200 FEET
DOTTED LINES REPRESENT 40-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WATER
SHORELINE SHOWN REPRESENTS THE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 6 TO 7 FEET

ISOPLETH MAP OF LANDSLIDE DEPOSITS, SOUTHERN SAN FRANCISCO BAY REGION, CALIFORNIA

By

ROBERT H. WRIGHT AND TOR H. NILSEN

1974

SHEET DIAGRAM

COUNTY KEY
A. MARIN
B. SONOMA
C. NAPA
D. SOLANO
E. CONTRA COSTA
F. ALAMEDA
G. SANTA CLARA
H. SANTA CRUZ
I. SAN MATEO
J. SAN FRANCISCO

DECLINATION AT CENTER OF SHEET

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