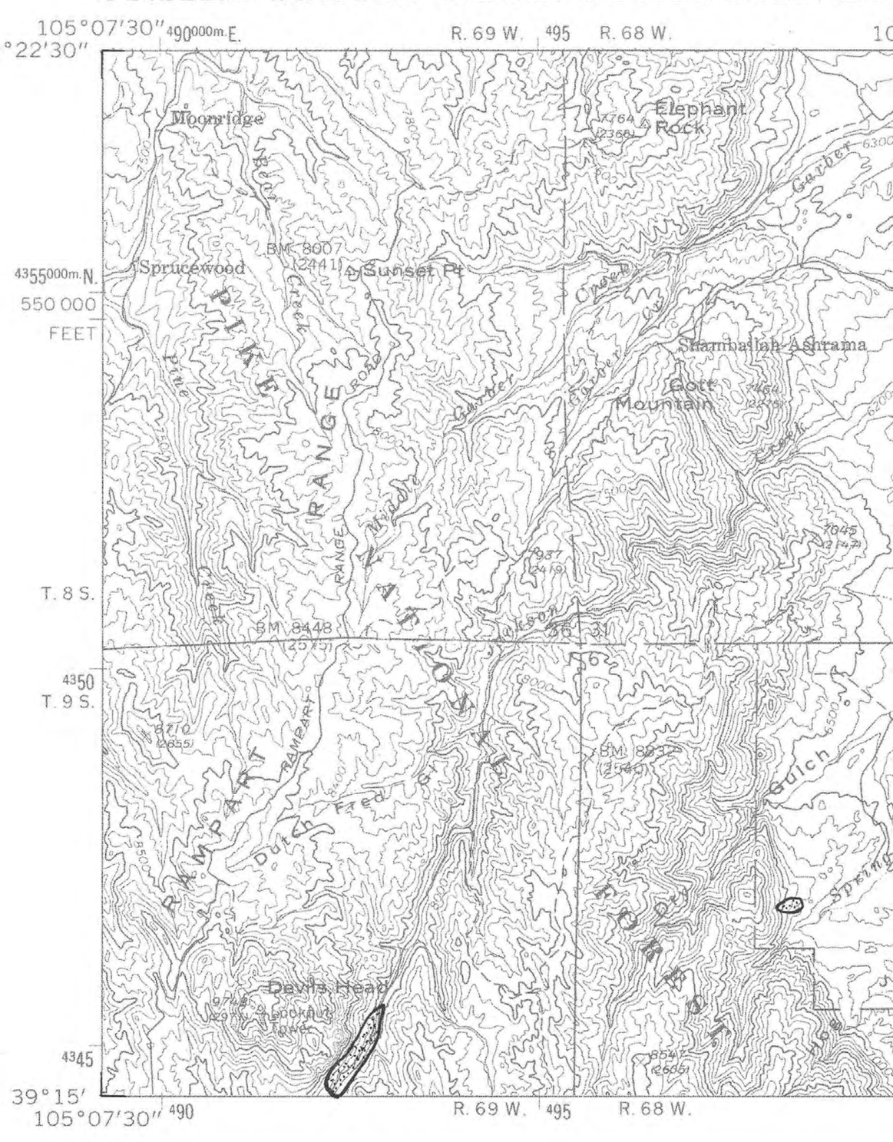
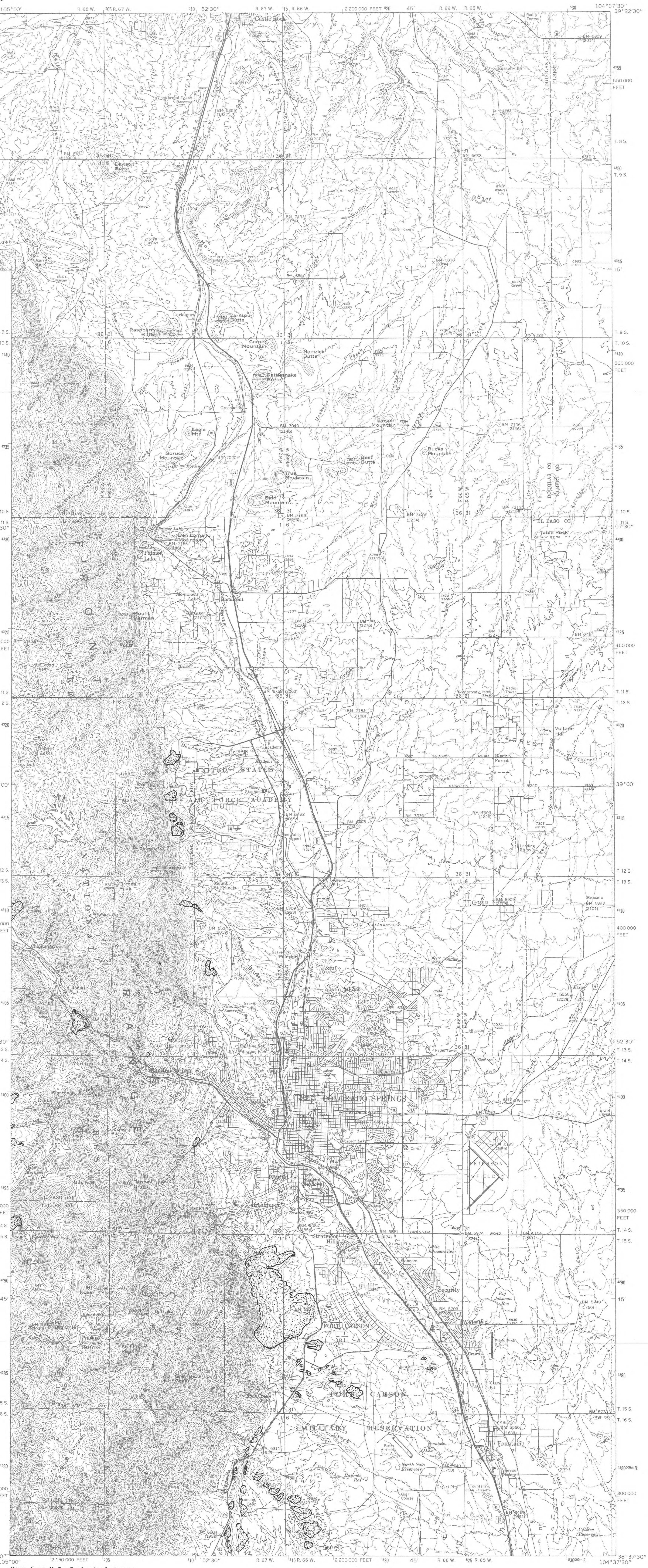
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

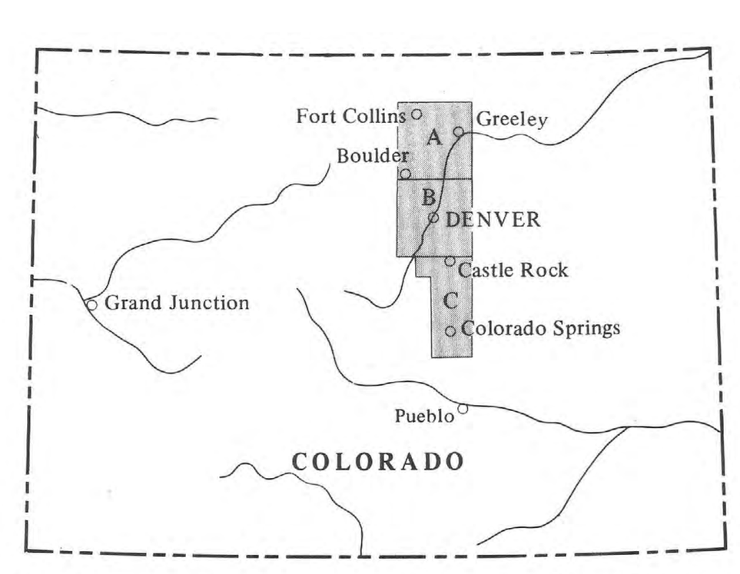



Base from U.S. Geological Survey
Front Range Urban Corridor,
Sheet 3, 1972

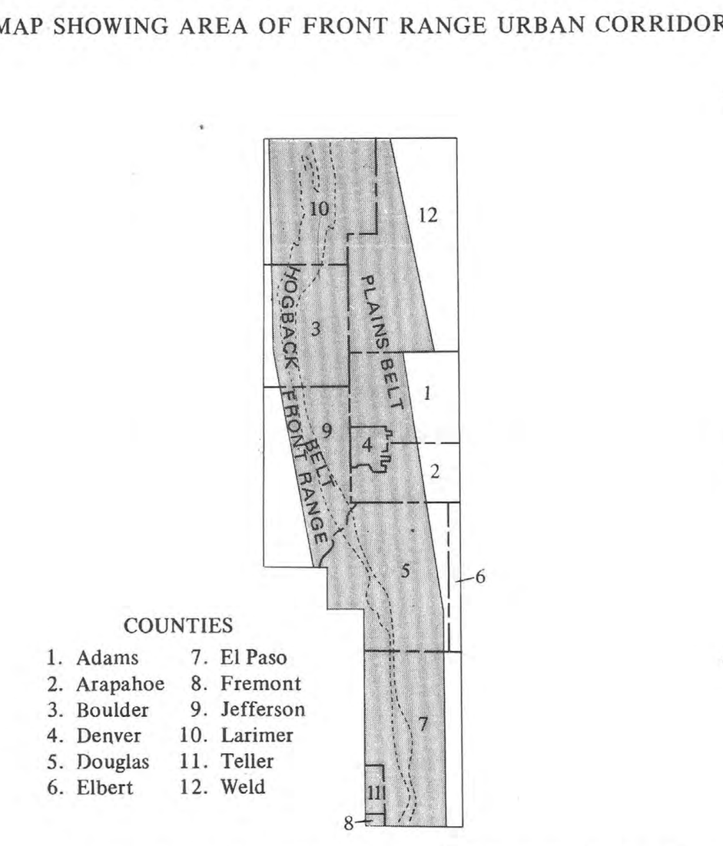
MAP C.-- LANDSLIDES IN THE COLORADO SPRINGS-CASTLE ROCK AREA, FRONT RANGE URBAN CORRIDOR, COLORADO

EXPLANATION

Landslide or group of closely landslides



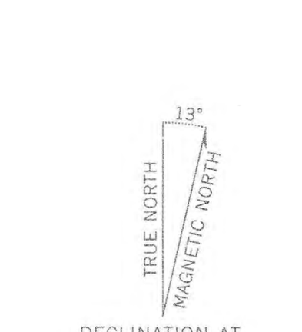
MAP SHOWING AREA OF FRONT RANGE URBAN CORRIDOR



COUNTIES

1. Adams	7. El Paso
2. Arapahoe	8. Fremont
3. Boulder	9. Jefferson
4. Denver	10. Larimer
5. Douglas	11. Teller
6. Elbert	12. Weld

MAP SHOWING AREA, PHYSIOGRAPHIC DIVISIONS, AND COUNTIES OF FRONT RANGE URBAN CORRIDOR



DECLINATION AT CENTER OF SHEET

SCALE 1:100,000

CONTOUR INTERVAL 100 FEET
DOTTED LINES REPRESENT 50-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

DISCUSSION

The term landslide is commonly used to designate many kinds of downslope movement of earth materials or the deposits resulting from those movements (Varnes, 1958). The processes range from falling, bounding, or rolling of rock loosened from steep or nearly vertical cliffs through gliding or slumping of large blocks or jumbled mixtures of rock and soil to flowing of water-saturated soil or rock debris.

Many landslides are recognized in the Front Range Urban Corridor by external form and, where evidence is available, by internal structure. Probably less than one percent of the landslides are recognized by actual movement. Landslides are most numerous along the front of the Rocky Mountains, on adjacent hogback ridges to the east, or on slopes of adjoining benches or mesas in the Colorado Piedmont Section of the Great Plains Province east of the mountains and ridges. Most of these deposits are ancient by human time standards and have been modified so much by later erosion that they have lost much of their characteristic landslide form. After half a million years the large rockfall at the east foot of Cheyenne Mountain near Colorado Springs retains a characteristic hummocky surface on the chaotic accumulation of boulders. Smaller landslides of comparable or lesser age may have gone unnoticed in the preparation of these maps because erosion has destroyed their original surface forms. Others are recognizable only with various degrees of uncertainty. Some landslides in the corridor have moved abruptly within the present decade, and a few are in slower, semicontinuous motion.

The mode of origin of the landslides is quite variable. Most landslides on the maps probably are in the intermediate category of gliding or slumping. Rockfalls and narrow water-saturated avalanches, readily apparent from the long light-colored scars that they form on steep slopes, are numerous below the caprocks of mesas and buttes in Douglas County, but many have not yet been mapped or are too small to show at a scale of 1:100,000. Rockfalls and block glides are present on many steep slopes in the mountains and on the scarp slopes (fig. 1) of hogback ridges. Small earthflows (not shown) in the soils of the Piedmont surface have been mapped near Parker in Douglas County (Maberry, 1972) and some of the landslide deposits in the Rocky Flats area of map B are attributed to earthflows (Colton and Holligan, 1977).

Every landslide is a response to the downward pull of gravity. Landsliding commonly is started by the introduction of water into rock and soil. Freezing and thawing of moisture in cracks may loosen and dislodge rock, setting it free to fall or slide. Saturation of earth materials by heavy or prolonged rain or melting snow may induce sliding or flowing of the saturated material, partly by reducing the shear resistance of the mass and partly by increasing the shear stress, through the added weight of the water. Many small slides followed the prolonged rains of May 5-6, 1973 in the Greater Denver area (Hansen, 1973, p. 11-17). Water in an inclined bed of clay or shale may create a lubricated surface on which an overlying mass of rock may slide. Earthquakes may cause instantaneous failure of earth material, wet or dry. The rockfall at Cheyenne Mountain may have been triggered by such an earthquake (Scott and Wobus, 1973). Landslides also may occur if lateral stream cutting removes support from a hill slope or from the outer edge of an existing landslide deposit. Man-made slides sometimes result from disturbance of slopes during construction activities, from leakage of irrigation ditches, or from overwatering of lawns and gardens.

These landslide maps are not intended to provide a firm basis for determining present stability or instability of slopes. For this purpose, a specific site evaluation by a soils engineer or geologist is needed. Some landslides are virtually stable after movement stops. Others are vulnerable to renewed movement. Although the probability of new landsliding may be greatest in areas of numerous known slides, the existence of isolated slides suggests that other slides may form in places where none is now recognized.

Most slides in the Front Range Urban Corridor have occurred in three geologic environments. These are (1) steep slopes on granitic or metamorphic rocks within or at the eastern front of the mountains, (2) benches, mesas, or buttes capped by resistant gravel or volcanic rock that protects and maintains steep slopes on weaker underlying sedimentary formations, and (3) hogback ridges or tilted sedimentary rocks along the mountain front (fig. 1).

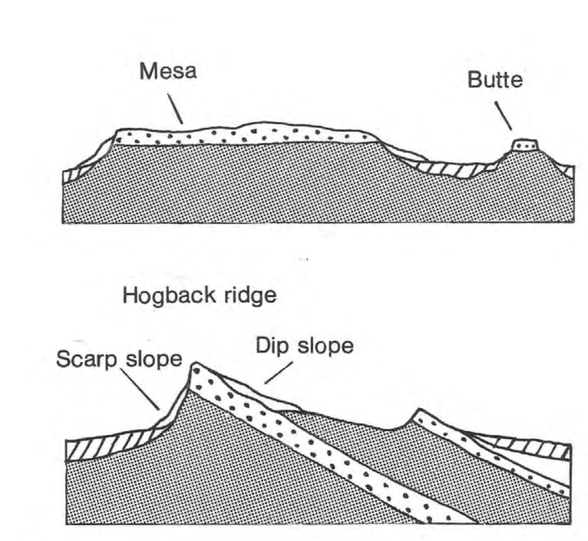


Figure 1.--A. Mesa and butte. B. Hogback ridge. Resistant cap rock, stippled; nonresistant slope rock, shaded; unconsolidated valley fill, line pattern; and landslide, white.

Nearly all the landslide deposits shown on map A are on the dip slopes of foothill ridges of sandstone and shale in the Dakota, Lyons, and Fountain Formations. Unmapped small rockfalls and rockslides are common on the scarp slopes of these ridges. On map B, landslides are most numerous in areas of the second environmental category, but slides also exist in categories 1 and 3. The resistant volcanic caprocks on North and South Table Mountains at Golden (map B) overlie weak shaly rocks of the Denver Formation. On Green Mountain south of Golden, the Green Mountain Conglomerate caps the Denver Formation. In the Rocky Flats area north of Golden and locally elsewhere on map B, weak rocks of the Pierre, Laramie, Arapahoe, Denver, and Dawson Formations are overlain by bench gravels of several ages and, therefore, are the source of slumps and earth flows at the bench margins and on the arroyo walls. In the area of map C, landslide deposits have been derived from granitic rocks within the mountains and along the mountain front; these include the exceptionally large rockfall deposit at Cheyenne Mountain. Landslide deposits are present on dip slopes and some scarp slopes of ridges of the Dakota and older sedimentary formations in the south half of map C. Landslide deposits are also common on slopes of Pierre Shale below gravel cappings in the Fort Carson Military Reservation near the south end of the mapped area.

Landslides shown on the accompanying maps have been compiled from published and unpublished sources supplemented by the inspection of aerial photographs. Published sources are listed under Selected References. Unpublished information was supplied mainly by R. B. Colton and M. N. Machette of the U.S. Geological Survey. The representation of landslides on the accompanying maps is approximate. In some parts of the map area, especially along the steep mountain front, what is or is not the remains of ancient landslide partly or largely obscured by erosion, vegetation, or both, is equivocal. Deposits old enough to be thus obscured probably have a long history of post-depositional stability. The mountains may contain small landslides overlooked because of forest cover. In Douglas County, within and east of the map area, slope stability is being studied by the Colorado Geological Survey (John Rold, oral commun., 1978). This study will provide additional information on landsliding and related processes in that important part of the Front Range Urban Corridor.

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LANDSLIDES IN THE FRONT RANGE URBAN CORRIDOR, COLORADO

By
E. J. Crosby
1978

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