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Geologic map of the Arvada quadrangle, Colorado

Engineering properties of geologic map units

by

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1. Seismic activity in the Sunnyside mining district, Carbon and Emery Counties, Utah, during 1968, by C. Richard Dunrud, John O. Maberry, and Jerome Hernandez. 27 p. (including 14 tabular pages), 4 pl. (scale 1:24,000), 1 fig. 1012 Federal Bldg., Denver, Colo. 80202; 8102 Federal Office Bldg., Salt Lake City, Utah 84111.

2. Geologic map of the Arvada quadrangle, Colorado, by Robert M. Lindvall. 1 map, 2 cross-sections (3 sheets), scale 1:24,000. 1012 Federal Bldg., Denver, Colo. 80202; 8102 Federal Office Bldg., Salt Lake City, Utah 84111. [Material from which copy can be made at private expense is available at 1012 Federal Bldg., Denver.]

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4. Geologic map of the Oreana tungsten mine, Pershing County, Nevada, by R. E. Wallace and D. B. Tatlock. 2 sheets. 8102 Federal Office Bldg., Salt Lake City, Utah 84111; 504 Custom House, San Francisco, Calif. 94111; 7638 Federal Bldg., Los Angeles, Calif. 90012; Library, Mackay School of Mines, University of Nevada, Reno, Nev. 89507. [Material from which copy can be made at private expense is available in the Reno office.]

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5. Geologic map of the Central La Plata quadrangle, Puerto Rico, by D. H. McIntyre. 1 sheet, scale 1:20,000.

6. Geologic map of the San Sebastian quadrangle, Puerto Rico, by Othmar T. Tobisch and Mort D. Turner. 1 sheet, scale 1:20,000.

Engineering properties of geologic map units

by

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Introduction

Many of the engineering-geologic problems in the Arvada quadrangle are related to the unconsolidated surficial deposits, which mantle the bedrock to depths of as much as 40 or 50 feet. In this report most of the emphasis is placed on the map distribution of these materials and on a description of their physical properties. Much of the information presented on the geologic map in the form of abbreviated columnar sections is from water-well and exploration drill holes; the remainder is from foundation excavations and natural rock outcrops. A brief description of the composition and thickness of each map unit is given in the Explanation.

The generalized statements that follow, regarding the engineering properties of the map units, are based on field observations and on general performance information obtained from local engineers, contractors, builders, and property owners. It is hoped that this information, used in conjunction with the geologic map and cross sections, will be helpful to land-use planners and developers, engineers, public officials, and others in making preliminary plans and designs. It is obvious that such information cannot and should not take the place of detailed field and laboratory investigations that are required in the design of specific engineering structures.

Artificial fill

Permeability of artificial-fill deposits is variable; it is generally low in dams and highway fills, probably high in trash dumps, and probably high laterally in sanitary landfills. The water table is generally low in highway and railway embankments, variable in dams and canal embankments, and generally high in dumps and sanitary landfills in the valley of Clear Creek. Dams and highway embankments are generally well compacted; trash dumps and sanitary landfills are generally very poorly compacted. Trash deposits are generally interlayered with and covered by earth materials which may be moderately compacted. Excavation, using power equipment, varies from easy to difficult. Foundation stability conditions are generally poor in landfill areas; piers to suitable underlying material or bedrock are probably necessary for heavy structures; stability of dams and highway embankments is generally good. Earthquake stability conditions are probably very poor for structures founded on landfill deposits, and are probably poor for dams and embankments underlain by thick alluvium or other poorly consolidated materials. Slope stability conditions are generally good where fill is compacted and generally poor in uncompacted fill. Resistance to erosion by running water is moderate on compacted fills covered by vegetation, but very poor where slopes are unprotected.

Landslide deposit

This deposit is limited to a small area in the western part of the quadrangle. (Sec. 16, R. 69 W., T. 3 S.). However, landslides may possibly develop in other areas of steep slopes, particularly when cuts are made in hillsides, when the area is overloaded by construction of road fills or buildings, or when excess moisture is introduced into the subsurface.

Permeability of the deposit is generally low, but when saturated, the material may flow and slide. Compaction of materials in the landslide deposit is generally moderately easy. Excavation is generally easy with power equipment. Foundation stability conditions vary from very poor to fair depending chiefly on thickness of the deposit, moisture conditions, slope of the surface, and load imposed on the deposit. Earthquake stability conditions are probably very poor, particularly if the moisture content of the deposit is high. Slope stability is generally poor and may be hazardous in areas of steep terrain. Resistance to erosion by running water is poor where the deposit is not covered by vegetation, and is probably fair where protected.

Colluvium

Permeability of deposits of colluvium is variable, but is generally low. Compaction is generally moderately easy with the use of rubber-tired equipment. Excavation is easy with power equipment. Foundation stability conditions vary from poor to fair. Deposits with high clay content may be subject to moderate to high swelling when wetted. Earthquake stability conditions are probably poor to fair, depending on the moisture content of the material. Cut slopes in colluvium commonly stand vertically when dry, but may collapse or flow when saturated. Deposits on steep slopes may be subject to landsliding if overloaded by construction or an increase in moisture content. Resistance to erosion by running water is generally poor on slopes not protected by vegetation but is fair to good where vegetative cover is heavy.

Post-Piney Creek alluvium

Permeability of the alluvium is generally low, particularly in clay and bog clay. The water table may be high in the valley of Clear Creek, particularly in spring and summer. Compaction of the material with sheepsfoot or rubber-tired rollers is generally easy. Excavation is easy with power equipment. Foundation stability conditions are generally fair, but are extremely poor on bog clays. Earthquake stability conditions are probably fair to poor. Cut slopes may stand vertically for short periods of time after excavation but will eventually slump to slopes of about 2 1/2:1 (2 1/2 horizontal distance to 1 vertical). The alluvium is moderately resistant to erosion.

Piney Creek Alluvium

Permeability is generally low, but may be somewhat higher in the sandy portions of the deposit. The water table is generally 5-10 feet below ground surface, but may be locally absent, especially during fall and winter. Compaction is generally easy with a sheepsfoot roller. Excavation is easy with power equipment. Foundation stability conditions are fair to poor for heavy structures, and clayey portions of this unit may have medium to high swelling properties when wetted. Earthquake stability conditions are probably poor to fair. Cut slopes may stand vertically for extended periods if dry, but will eventually tend to slump to stable slopes of about 3:1 to 6:1. The deposits are subject to moderate erosion, particularly along stream banks, and to gully erosion on terrace surfaces.

Eolian sand

Deposits are highly permeable, and surface drainage is generally good. The water table is generally low and may be locally absent. Use of vibratory equipment is needed for compaction. Sand deposits are easily excavated with hand tools. Eolian sand may stand in vertical walls as much as 10 feet high for short periods after excavation when moisture content is moderately high. Walls of trenches and ditches may be subject to collapse if not supported by shoring. Foundation stability conditions are generally good under static loads, but heavy loads or vibrations may cause settlement. The material is not subject to swelling when wet. Earthquake stability is probably low. Natural slopes of as much as about 3:1 are generally stable. Resistance to erosion is low on steep slopes and cut banks, and is moderate to high on flat areas where permeability is high.

Broadway Alluvium

Permeability of the alluvium is moderate to high. The water table is generally 10 feet or more below ground surface. Compaction is easy in clayey and sandy silt using sheepsfoot or rubber-tired rollers, but vibratory methods may be necessary for the sandy portions. Excavation is generally easy using light power equipment. Foundation stability conditions are generally good. Earthquake stability conditions are probably moderately good. Slope stability is moderately good; cut slopes about 5-10 feet high may stand vertically for short periods after excavation, but shoring is generally required in construction operations. Natural slopes of as much as about 2:1 are generally stable and are moderately resistant to erosion, particularly when protected by vegetation.

Loess

The vertical permeability of loess is moderate; lateral permeability is very low. The water table is generally absent. Loess generally compacts easily with sheepsfoot or rubber-tired rollers into a hard dense state. It is easily excavated with hand or power tools. Foundation stability is variable; shear strength is moderate when the loess is dry, but decreases rapidly as the moisture content increases. Loess has low density in the original depositional state but may "shrink" markedly when excess water is applied. Differential settlement may occur and cause problems to foundations where uncontrolled irrigation or puddling of backfill is allowed. Swell pressure is minor in undisturbed loess but increases with density in reworked material. Earthquake stability conditions are probably poor to fair. Cuts in loess will stand in nearly vertical walls as high as 10 feet for periods of several years when dry but will eventually slump to stable slopes of about 2:1 to 4:1. Deposits are moderately resistant to erosion by running water on slopes protected by vegetation.

Louviers Alluvium

Permeability of the alluvium is generally very high and the water table is generally within 10-15 feet of the surface in the valley of Clear Creek. Compaction is moderately easy using vibratory compactors or rubber-tired rollers. The alluvium is easily excavated with power equipment. Foundation stability conditions are generally good. Earthquake stability conditions are probably poor to fair. Cut slopes may stand vertically for short periods after excavation but will eventually slump to stable slopes of about 3:1 to 4:1. The alluvium is generally resistant to erosion on moderate slopes but is subject to undercutting of banks along Clear Creek. Deposits of Louviers Alluvium are a major source of sand and gravel in the valley of Clear Creek.

Slocum Alluvium

Permeability is high in sand and gravel but generally low in silty and clayey sand. The water table is generally at 5-10 feet below ground surface in gravels, but may be absent locally. Compaction is generally easy in the clayey portion using sheepsfoot or rubber-tired rollers, but is moderately difficult in gravels, probably requiring use of a vibratory compactor. Excavation is generally easy with power equipment. Foundation stability conditions are good to excellent; however, moderate swelling is possible in clayey upper part, which may crack concrete slabs, sidewalks, and driveways. Earthquake stability conditions are probably fair. Vertical cuts 8-10 feet high are generally stable for several months after excavation but subsequently may slump to slopes of from 2:1 to 4:1. Slocum Alluvium is generally resistant to erosion. It is a potential source of sand and gravel in the eastern part of quadrangle from terraces along Clear Creek.

Verdos Alluvium

Permeability is generally high in the sand and gravel, but very low in the clay and silt. The water table is 5-10 feet below ground surface, but may be absent locally. Compaction is generally easy with vibratory equipment in sand and gravel portions, and sheepsfoot and rubber-tired rollers perform satisfactorily in clayey materials. Excavation is easy with power equipment. Foundation stability conditions are fair to good in sand and gravel, but are poor to fair in clay. Moderate swelling is likely in weathered clays in the upper part of the alluvium. Earthquake stability conditions are probably fair. Vertical cuts as much as 10 feet high are generally stable for several months after excavation but usually slump to slopes of from 2:1 to 3:1. The alluvium is moderately resistant to erosion by running water.

Rocky Flats Alluvium

Permeability is high in the sand and gravel, but low in the clayey and sandy silt and in the calcium carbonate-cemented zone. The water table is 10-15 feet below ground surface, but may be absent locally. The alluvium is moderately easy to compact with vibratory equipment or rubber-tired rollers. Excavation is easy to moderately easy with light power equipment, but boulders and the calcium carbonate-cemented zone may require use of heavy equipment. Foundation stability conditions are generally good in the gravel parts of the unit, but clayey silts may swell moderately.

Earthquake stability conditions are probably fair. Slope stability is moderate to good; excavations as much as 10 feet deep generally stand in almost vertical walls for several months after excavation but eventually will slump to 2:1 to 4:1 slopes. The alluvium is moderately resistant to erosion.

Denver and Arapahoe Formations

Permeability is generally moderate in the fractured sandstone and conglomerate and is low to very low in the shale, siltstone, and claystone. The water table is variable, standing relatively high in the sandstone and conglomerate, and very low in the shale, siltstone, and claystone. The conglomerate at the base of the Arapahoe Formation is locally water bearing. Compaction is moderately difficult in the shale and in lightly cemented siltstone and claystone, and very difficult in the sandstone and conglomerate. Excavation is moderately difficult to difficult in the sandstone and conglomerate using power equipment, and locally may require use of explosives; it is moderately difficult in the shale, siltstone, and claystone. Foundation stability conditions are generally good in the sandstone and conglomerate, but groundwater seepage may be a problem locally; some of the shale, claystone, and siltstone units may have low to very high swelling properties. Earthquake stability conditions are probably good to very good. Slope stability is good to excellent; excavations in sandstone and conglomerate generally stand in vertical walls, but excavations in shale, siltstone, and claystone generally weather after a few months and slump to 1:1 to 2:1 slopes. Resistance to erosion by running water is moderate to excellent.

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