Gypsiferous-Soil-and Rock Susceptibility

Dixie Clean Stormwater Coalition

0 1.5 3 6

Miles

Source: Lund, W.R., T.R. Knudsen, G.S. Vice, L.M. Shaw, 2008, Shallow-Gypsiferous-Soil-and Rock-Susceptibility Map for the St. George-Hurricane Metropolitan Area

Ivins

Santa Clara

Washington

St. George

EXPLANATION

SOIL

GS_A Includes gypsiferous silt and clay and local gypsum, collectively referred to as *gypcrete*, that caps sloping irregular surfaces that cut across the Shinarump and upper red members of the Moenkopi Formation, and gypsiferous alluvial and eolian deposits that contain clay- to boulder-sized sediments that typically weather to a soft, white, powdery gypsiferous soil. These deposits crop out at the ground surface and typically are easily recognized.

GS_B Includes gypsum-bearing soils mapped by the Natural Resources Conservation Service (NRCS). The gypsum in the soils is largely pedogenic (formed by dissolution and re-precipitation at depth during the soil-forming process) and its presence may not be apparent at the ground surface.

Unconsolidated Units Known or Likely to Contain Abundant Gypsum

Unconsolidated Units[1]	Map Symbols	Data Source	Gypsiferous Soil Category
Gypcrete	Qhg	UGS	GS_A
Mixed Alluvial and Eolian Deposits	Qaep	UGS	GS_A
Flood Plain and Alluvial-Fan Deposits	SA, Sb, Sc, Sd, Se (St. George Series)	NRCS	GS_B
Alluvial-Fan Deposits	BH (Bohnsirz Loam)	NRCS	GS_B

[1] Refer to UGS 1:24,000 scale geologic maps (see SOURCES OF UNITS AND MAJOR LITHOLOGIES sections in accompanying text for unit descriptions.

ROCK

GR_A These bedrock units contain abundant gypsum, often in laterally continuous horizons up to several feet thick, and they and the alluvial deposits derived from them are commonly associated with dissolution and collapse features.

GR_B These bedrock units lack massive gypsum deposits, but contain thin to medium beds and veins of gypsum interspersed with other rock types. These units and the alluvial deposits derived from them, contain sufficient gypsum locally to cause foundation or other problems.

GR_C These bedrock units contain gypsum in greater or lesser amounts, but due to geologic or topographic complexities, individual rock unit subdivisions could not be recognized in the field at the scale of our mapping and therefore were mapped as undifferentiated. The extent to which these bedrock units, or the alluvial deposits derived from them, contain gypsum is not known, but areas where these rock units crop out should be carefully investigated for gypsum if development is planned.

Bedrock Units Known or Likely to Contain Abundant Gypsum

Bedrock Units[1]	Map Symbols	Data Sources	Gypsiferous Rock Category
Woods Ranch Member/Torrowap Formation; Harrisburg Member/Kaibab Formation; Shinarump Member/Moenkopi Formation; Temple Cap Formation	Pzv, Pkh, TRrna, Rc, Jhs	UGS	GR_A
Seligman Member/Torrowap Formation; Timpoweap, lower red, Virgin Limestone, middle red, and upper red members/ Moenkopi Formation; Moenkopi Formation undivided; lower member/Kayenta Formation; Co-op Creek Limestone and Crystal Creek Members/Carmel Formation	Pts,TRmt, TRmt, TRmv, TRmm, TRmu, TRm, Jkl, Jcco, Jcx	UGS	GR_B
Permian rocks undivided; Torrowap and Kaibab Formations undivided; Brady Canyon and Seligman Members/Torrowap Formation undivided; Triassic rocks undivided, Kayenta Formation undivided, Iron Springs, Carmel, and Temple Cap Formations undivided	Pu, Pkl, Ptbs, TRu, Kcu, Jk	UGS	GR_C

[1] Refer to UGS 1:24,000 scale geologic maps (see SOURCES OF UNITS AND MAJOR LITHOLOGIES sections in accompanying text for unit descriptions.

DISCUSSION

Gypsum-bearing soil and rock are subject to dissolution of the gypsum ($CaSO_4 \cdot 2H_2O$), which causes a loss of internal structure and volume. Where the percentage of gypsum is 10 percent or more, dissolution can result in localized land subsidence and sinkhole formation. Dissolution of gypsum may lead to foundation problems that affect roads, dikes, underground utilities, and other infrastructure. Another common gypsum-related foundation problem in the St. George – Hurricane metropolitan area is locally termed "water rock," which is a strongly indurated gypsum and calcium carbonate layer in the shallow subsurface in unconsolidated deposits. The layer commonly forms at the top of the water table and creates a local confining layer. Breaching the layer during construction may result in artesian ground-water flow that can flood excavations and require an extensive drainage system. Gypsum dissolution can be greatly accelerated by application of water, such as that provided by reservoirs, septic-tank drain fields, street, roof, or parking lot runoff, and irrigation. Gypcrete is also a weak material with low bearing strength and therefore is not well suited as a foundation material for heavy structures. Additionally, when gypsum weathers it forms dilute sulfuric acid and sulfates which can react with cement corroding and weakening unprotected concrete. Type V sulfate-resistant cement is typically required in high-gypsum areas. Because gypsum-bearing soil and rock rarely if ever cause rapid, catastrophic property damage or are a threat to life safety, for purposes of this study, gypsum-bearing soil and rock are considered adverse construction conditions and not geologic hazards.

For additional information about gypsum-bearing soil and rock in the St. George – Hurricane metropolitan area, refer to the Problem-Soil-and-Rock text document in this report.

USING THIS MAP

The Gypsiferous-Soil-and-Rock-Susceptibility Map shows the location of known and suspected gypsiferous soil and rock in the St. George – Hurricane metropolitan area. The map is intended for general planning purposes to indicate where gypsiferous soil and rock conditions may exist and special studies may be required. Regarding special studies, the UGS recommends performing a site-specific geotechnical foundation/geologic-hazards study for all development at all locations in the study area. Site-specific studies can resolve uncertainties inherent in generalized mapping and help ensure safety by identifying the need for special foundation designs or mitigation techniques. The presence and severity of gypsiferous soil and rock along with other geologic hazards and adverse construction conditions should be addressed in these investigations. If gypsiferous soil or rock is present at a site, appropriate design recommendations should be provided.

MAP LIMITATIONS

The Gypsiferous-Soil-and-Rock-Susceptibility Map is based on limited geologic and geotechnical data; site-specific studies are required to produce more detailed geotechnical information. The map also depends on the quality of those data, which varies throughout the study area. The mapped boundaries between hazard categories are approximate and subject to change with additional information. The susceptibility may be different than shown at any particular site because of geological variations within a map unit, gradational and approximate map-unit boundaries, and the small map scale. Additionally, gypsum-bearing bedrock units are locally covered by a thin veneer of unconsolidated deposits. Such areas may be susceptible to sinkhole development or collapse; however, because subsurface information is generally unavailable, those areas are not identified on this map. This map is not intended for use at scales other than the published scale, and is designed for use in general planning to indicate the need for site-specific studies.

MITIGATION

Although potentially costly when not recognized and properly accommodated in project design and construction, problems associated with gypsiferous soil and rock rarely are life threatening. As with most adverse construction conditions, early recognition and avoidance is the most effective way to mitigate potential problems. However, gypsiferous soil and rock are widespread in the St. George – Hurricane metropolitan area and avoidance is generally not a viable or cost-effective mitigation option.

In Utah, soil-test requirements are specified in the soil and foundations provisions of IBC Chapter 18 (p. 343) and the foundations provisions of IRC Chapter 4 (p. 42), which are adopted statewide. IBC Section 1802.2.1 (p. 343) contains requirements for soil investigations in areas where questionable soil (soil classification, strength, or compressibility is in doubt) is present. IRC Section R401.4 (p. 67) states that the building official shall determine whether to require a soil test to determine the soil's characteristics in areas likely to have expansive, compressible, shifting, or other unknown soil characteristics. Where the presence of gypsiferous soil or rock is confirmed, possible hazard-reduction techniques include use of Type V sulfate-resistant cement for making concrete; soil removal and replacement with noncohesive compacted backfill; use of special foundation designs such as drilled pier and beam foundations or stiffened slab-on-grade construction; careful site landscape and drainage design to keep moisture away from buildings and gypsum-bearing deposits; and the use of vinyleven beneath concrete slabs to form a vapor and sulfate barrier (Keller and Blodgett, 2006).