

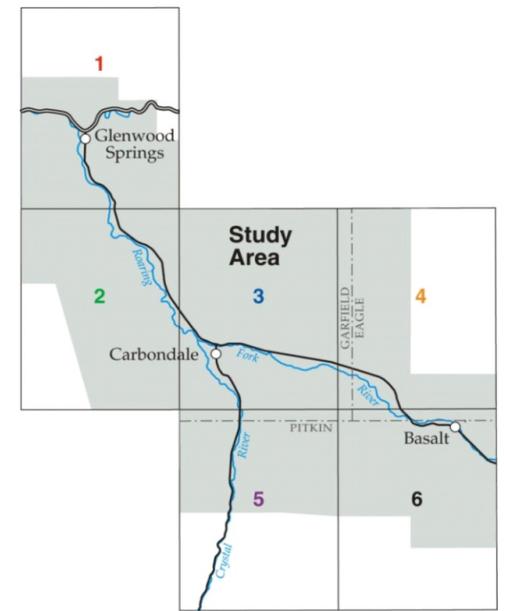
# COLLAPSIBLE SOIL AND EVAPORITE KARST HAZARD DELINEATION ON USING RECENT GEOLOGIC MAPPING

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**The Problem:** The Roaring Fork River Corridor is a popular and increasingly developed valley from the resort areas of Aspen and Snowmass Village downstream to Glenwood Springs at the confluence with the Colorado River. For years local citizens, county officials, and land use planners have asked, “Why is the soil settling here, but the land next to it is OK?” Or, “Why do sinkholes occur here when land in other parts of the valley have never had any? Providing the answers to these questions is one of the fundamental roles of the engineering geologist. One of their major professional duties is to detect potential geologic hazards and inform owners or policy makers the risks such hazards may impose.

**The Geologic Map:** This corridor was the first STATEMAP location in Colorado. Six 1:24,000 quadrangles were mapped, beginning with the Glenwood Springs Quadrangle in 1994. Because land development for residential uses was important in the valley, the mapping geologists placed an emphasis on surficial deposits and carefully delineated separate and geomorphologically distinct units. Concurrent with the STATEMAP program, the Colorado Geological Survey (CGS) had two other programs, a statewide collapsible soil study and a statewide evaporite karst hazard study. Collapsible soils are generally Recent, dry, low-density, high void-space soils that have the property where the meta-stable soil fabric collapses in the presence of moisture and the soil mass densifies.

## GEOLOGIC INDEX MAP

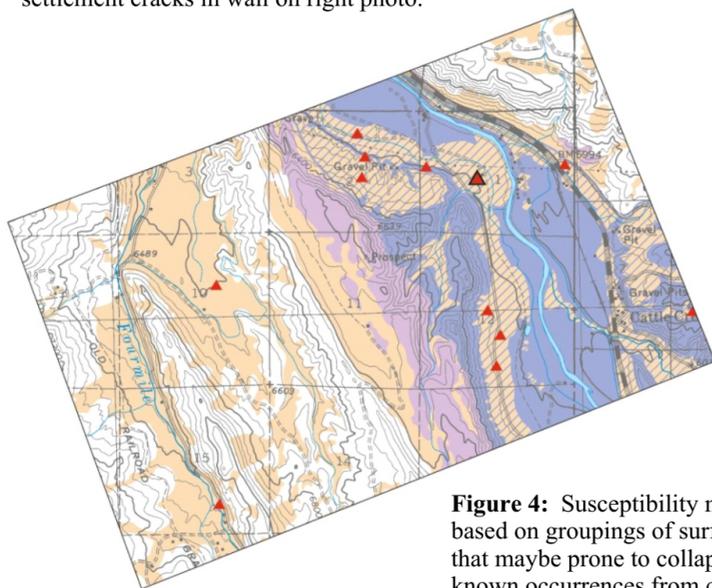


**Figure 1:** Location Map of STATEMAP Quadrangle Mapping along the Roaring Fork River Valley Corridor.

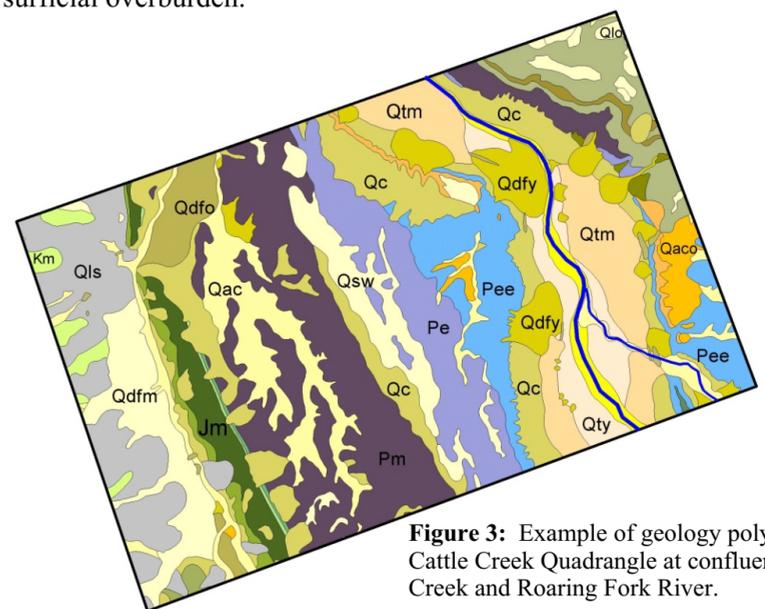


**Figure 2:** Damage from hydrocompactive soil. Note racked doorframe in left photo, downward deflection of beams from wall settlement on left in center photo, and settlement cracks in wall on right photo.

Commonly called hydrocompaction, the soil collapse manifests itself as ground settlement when soils are saturated. Evaporite karst hazards such as sinkholes commonly occur in west-central Colorado, in areas that are underlain by the Eagle Valley Evaporite. Both programs included the compilation of hundreds of case histories, many of which were located in the corridor. The formation of collapsible soil is unique to arid and semi-arid climates in which certain surficial deposits (e.g., Qdfy - alluvial fan, Qc - colluvium, Qsw sheetwash, Qac fine-grained alluvium and colluvium, and Qlo - loess) are derived from clay and silt-rich bedrock units. Sinkholes occur where evaporite (Pee, Pe) rocks lie beneath or are covered by thin mantles of surficial overburden.



**Figure 4:** Susceptibility map from figure 3 based on groupings of surficial deposit types that maybe prone to collapse. Red triangles are known occurrences from case history compilation. Blue and violet areas are underlain by evaporite and are susceptible to sinkhole occurrences. From White, 2002.



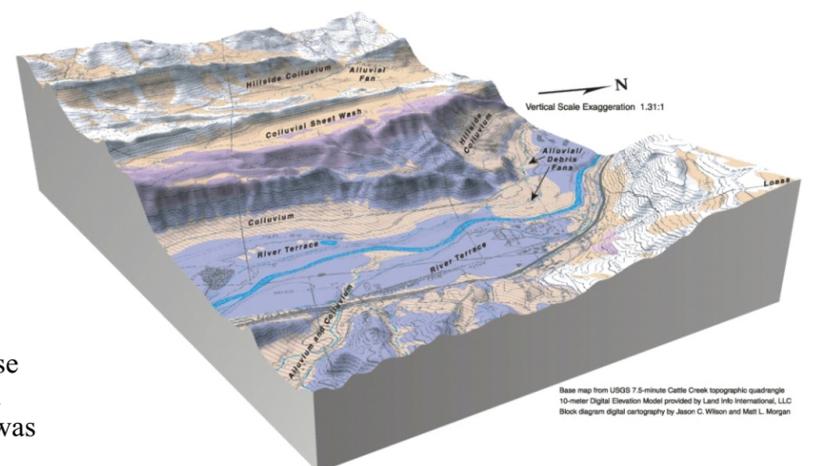
**Figure 3:** Example of geology polygons from Cattle Creek Quadrangle at confluence of Cattle Creek and Roaring Fork River.

**Using the Map:** Because of the heightened concern with these hazards in the fast-developing corridor, a derivative map of collapsible soil and evaporite karst hazards was completed. GIS polygons from the map coverages of the digitized STATEMAP quadrangles were grouped according to the common characteristics of deposition and source area that could result in collapse potential. These grouped areas corresponded extremely well with known locations that had been compiled from the Statewide Collapsible Soil Study (White and Greenman, in prep.). The same was done with mapped extents of evaporite rock and inventory of known sinkholes.

**Conclusion:** The resultant map series (White, 2002) is a geologic-hazards map that shows collapsible soil and evaporite karst hazard susceptibility in the Roaring Fork River Corridor. Few outside the geosciences understand the complexities of the many-colored polygons of a typical geologic map. But basic geologic maps are essential for use by trained engineering geologists as a basis for constructing hazard susceptibility overlay zones. The resulting derivative maps are targeted toward certain uses and are more easily understood by non-geologists. This creates a much more effective tool for policy makers and planning entities who direct local land use.

## References:

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- Streufert, R.K., Widmann, B.L., and Kirkham, R.M., 1998, Geologic map of the Basalt quadrangle, Eagle, Garfield, and Pitkin Counties, Colorado: Colorado Geological Survey Open-File Report 98-01, scale 1:24,000.



**Figure 5:** Same area shown in Figure 4 but rotated clockwise and shown as a block diagram draped on 10-m DEM. Such as labeled illustration better illustrated the morphology of those surficial deposits that may be collapse-prone. From White, 2002.



**Figure 6:** Swarm of sinkholes on Mid-Pleistocene terrace in the Roaring Fork River Valley.