REDUCING RISKS FROM GEOLOGIC HAZARDS IN UTAH

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Problem: Geologic hazards are natural geologic processes and conditions that pose a risk to humans and their structures. Catastrophic events such as earthquakes, landslides, rock falls (figures 1 and 2), and floods are the most familiar geologic hazards, but other less apparent hazards such as expansive and soluble soils may also cause considerable damage to buildings and roads. The frequency and severity of geologic hazards depend on local geologic conditions, which are clearly shown on geologic maps. Geologic maps are thus the basis for defining areas subject to geologic hazards. For example, geologic units and structures that pose hazards, including faults capable of causing earthquakes, active landslides, young alluvium subject to stream flooding, and clay-rich soil and rock units that may be damaging to foundations, are typically shown on geologic maps.

Figure 1: Rock-fall damage to railroad tracks on the west side of the Colorado River just west of the Portal.

The Geologic Map: In southeastern Utah, the city of Moab is in a rapidly growing recreational area due to its scenic beauty, sunny weather, and proximity to the Colorado River and Arches and Canyonlands National Parks (figure 3). Geologically, the area is complex because of underlying Pennsylvanian-age evaporite beds of the Paradox Formation. In most areas, these beds are deeply buried beneath the thick sequence of upper Paleozoic and Mesozoic sedimentary rocks that give the Arches and Canyonlands "red rock" country its distinctive beauty. Due to the weight of the accumulating sediments, the thick evaporite beds of the Paradox Formation formed salt-cored anticlines as the less dense salt rose and pierced the overlying rock layers (figures 4, 5, and 6). Erosion during the past few million years has brought the salt into the near-surface zone of fresh ground water. Resulting dissolution and collapse formed valleys along the crests of the salt-cored anticlines. The valleys are floored by a layer of residue, called "cap rock," left as the salt dissolved. Moab is in one such valley. The geologic map (figure 5) shows Mesozoic sedimentary rocks (Jn, Jk, T_Rc) exposed in cliffs in the southwestern part of the map area, and Paradox Formation (IPp) cap rock and Quaternary alluvial (Qa_1, Qa_2), alluvial-fan (Qafy), and talus (Qmt) units to the north at the base of the cliffs along the floor of Moab Valley.

Figure 2: Additional Rock-fall damage to railroad tracks on the west side of the Colorado River just west of the Portal

Using the Geologic Map: Each geologic unit has geologic-hazards implications as shown in the geologic-hazards map (figure 7), which is derived directly from the geologic map. For example, Mesozoic sandstone cliffs are a source of rock falls, and talus deposits are areas of rock-fall accumulation and hazard (labeled RF in figure 7). The Paradox Formation cap rock is an area of very poor soil conditions comprising intermixed, deformed, soluble gypsum and expansive clay (PS). Alluvial-fan deposits indicate areas where debris-laden flash floods run out from the cliffs (AF). Modern alluvial deposits along streams in the valley bottom denote flood plains and areas of possible stream flooding (SF).

Figure 3: View to the west of the geologic map area.

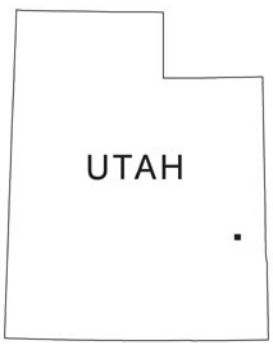


Figure 4. Location map

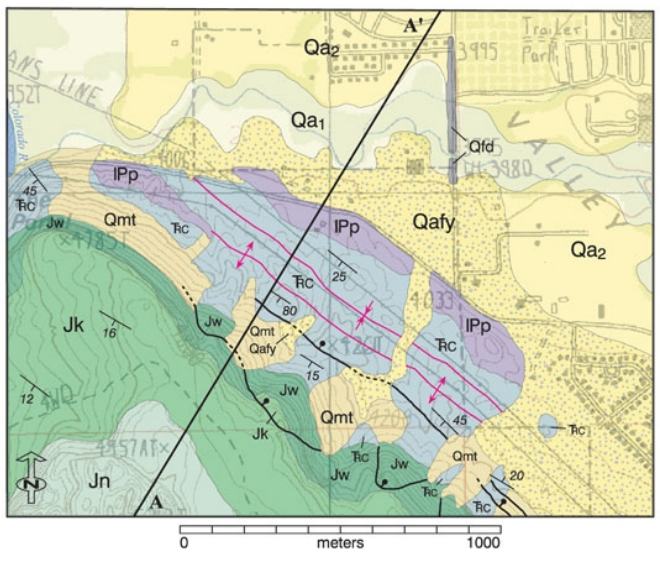


Figure 5. Geologic map

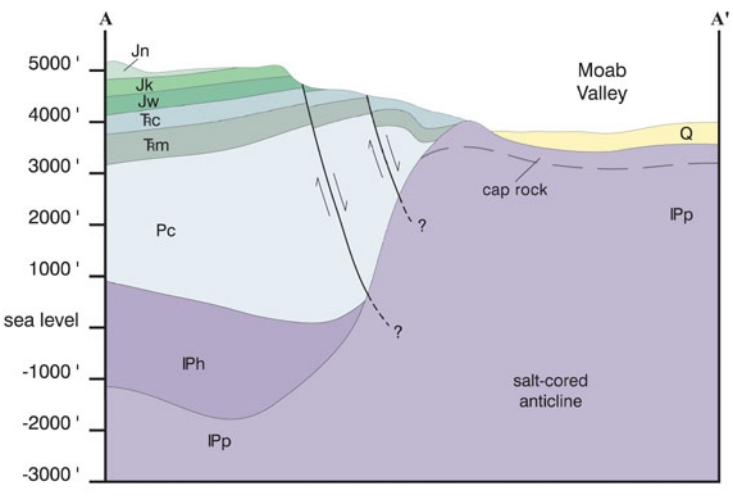
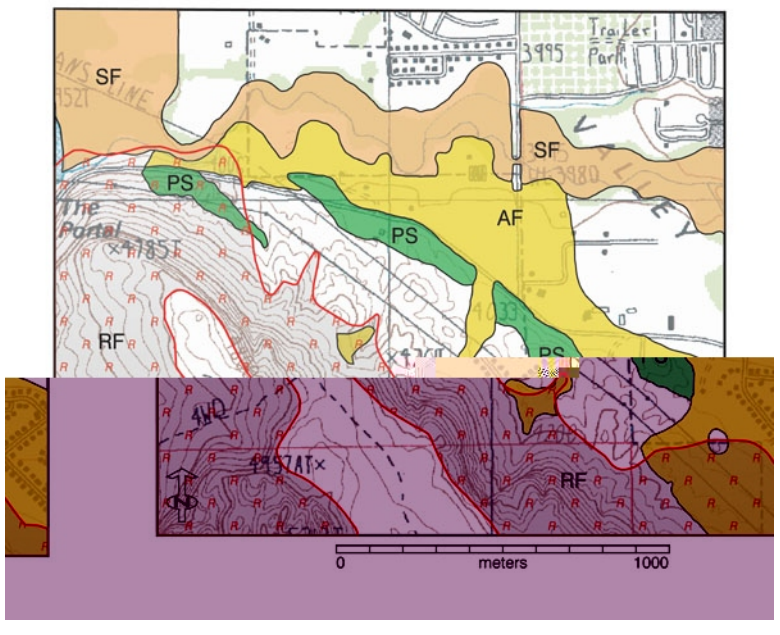


Figure 6. Schematic geologic cross section

Figure 7. (below) Simplified geologic-hazards map (AF-flash-flood/debris-flow hazard; PS-problem soil; RF-rock-fall hazard; SF-stream-flooding hazard)



Conclusion: Land developers, land-use regulators (usually city and county officials), and geological consultants use geologic-hazards maps to determine where studies are needed during the development process. Typically, a city or county will require detailed, site-specific geological studies in areas of potential hazard shown on the geologic-hazards map so that actual hazards at the site can be identified and risks reduced. Geologic maps are therefore of utmost importance because they provide the basis for deriving geologic-hazards maps that are then used by geologists and non-geologists (city planners, developers, government officials) to help reduce risks.