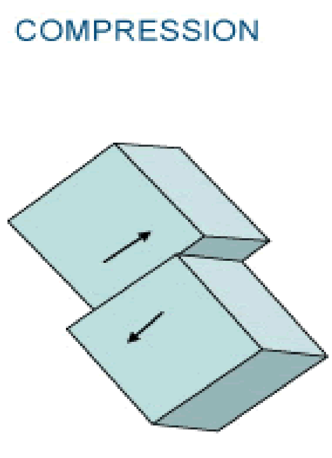
Chapter 18

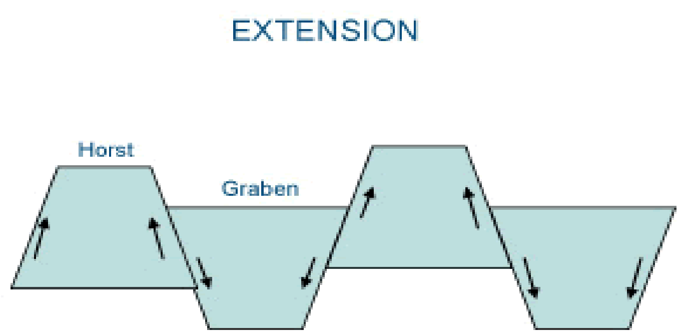
Geology of Eastern Nevada and the Occurrence of Ground Water in the Carbonate Aquifer System

It is difficult to summarize the geology of much of Nevada in a short chapter because it is quite complex. However, it is important to understand the geology because it is what controls the occurrence and movement of ground water in this region. Therefore, this chapter will take a broad view of regional geology in eastern Nevada, where extensive ground-water resources are the focus of much interest and study. Many of the concepts concerning eastern Nevada apply to other parts of Nevada.

Eastern Nevada is part of the Great Basin, which is a physiographic area that covers most of Nevada and western Utah, stretches from the Wasatch Range near Salt Lake City to the Sierra Nevada, and extends slightly into Oregon, Idaho, and California. This large area is comprised of hundreds of smaller basins, each surrounded by topographic high areas, or ranges, and is known as the Basin and Range Province. It is best described as a collection of north-northeast trending mountain ranges separated by broad alluvial desert basins.

A complex series of events created the Basin and Range topography (the physical surface features of a region). In the geologic past, a shallow sea covered much of the present Western U.S. Thick sequences of sediments were deposited offshore of the western margin of the ancestral North American coast, which was within present-day Utah. Later, this area became continental and different types of sediments were deposited across the region. Compression resulted in thrust faulting that pushed various masses of rock on top of one another in the western part of the present Basin and Range, resulting in complex stacks of different rock types. In eastern Nevada and western Utah, the rock types mainly remained marine sediments. The topography of the Basin and Range resulted from later uplift and extension (spreading) that pulled land apart. This extension resulted in some geologic blocks dropping relative to other geologic blocks. These dropped blocks form the basins, whereas, higher blocks form the ranges.





On the previous page, the image on the left shows thrust faulting, which can occur when two land masses are pushed together (compression). The image on the right shows features referred to as horst and grabens. These are German terms for ridges and trenches and these can occur when land is pulled apart (extension) and some blocks of land drop down relative to other blocks of land. The result is the basin and range topography of Nevada.

The geology of eastern Nevada consists of consolidated carbonate (such as limestone) or noncarbonate rocks, and basin fill. The carbonate rocks typically are fractured and jointed and these features have been widened by the solution of the rock by ground water (same process that forms caves and caverns). These rocks can be quite thick, with estimates ranging between 5,000 and 30,000 feet. This combination of high permeability due to fractures, joints, and solution features, in addition to the large thickness, is why the carbonate rocks make up an important aquifer in eastern Nevada. However, the connection of the carbonate aquifer from one basin to another basin is not well defined for many areas. Some geochemical evidence indicates that ground water moves more than 100 miles between basins in eastern Nevada.

The noncarbonate rocks in eastern Nevada include a wide range of rock types, including metamorphic (such as gneiss or schist) and igneous rocks (such as granite), fine-grained sedimentary rocks (such as shale and siltstone), and volcanic rocks (such as basalt). For the most part, these noncarbonate rocks tend to act as barriers to ground-water flow because of their low permeability. The exception would be some of the volcanic rocks, which can be aquifers if the conditions are right. In Fallon and in parts of southern Nevada, volcanic rocks serve as sources of water for users. The consolidated carbonate and noncarbonated rocks are the bedrock that forms the mountain ranges and underlies unconsolidated basin-fill sediments in the valleys.

The third type of geology is basin fill. The unconsolidated sediments (such as sand, gravel, and clay) that were eroded off the mountains were deposited in the basins by streams. The thickness of basin fill really depends on the local geology (how resistive the surrounding mountains are to erosion) and the depth of the basins between the ranges. The thickness of basin fill in eastern Nevada can range between thin deposits to greater than 10,000 feet. The basin fill also acts as an aquifer for much of the region and most ground water used in eastern Nevada is pumped from basin-fill aquifers. The degree of ground-water flow from basin fill in one basin to another depends on the topography (is the basin fill isolated or does it extend between basins where one basin is higher than another?) and bedrock geology of the ranges (can water move through the ranges or is it impermeable?). Just like the geology of the Basin and Range, the hydraulic connection between basins is highly variable.

An important aspect of the hydrogeology of the Basin and Range is the connection between the basin-fill aquifers and the carbonate aquifers that underlie some basins. This is important because it can affect recharge to the carbonate aquifers. Plus, it can mean that factors affecting one aquifer, such as pumping stresses, may affect other aquifers. This can go both ways, where pumping in the basin-fill aquifers may affect ground-water recharge to the underlying bedrock aquifer, and pumping from the bedrock aquifer may affect water levels in the overlying basin-fill aquifers. There is no simple answer to this because each basin is unique and different. Specific research on a particular basin or group of basins is needed to truly understand how the hydrology will be affected by different stresses.

Most recharge to aquifers in the Basin and Range originates from precipitation that falls in the higher mountains. Water in the form of rain and snowmelt can percolate into fractures in the bedrock or runoff to streams that lose their flow to aquifers in the valleys. Ground-water discharge from a basin typically occurs as ET, ground-water flow out of a basin, springs, or pumpage for irrigation, domestic, municipal, or mining/industrial needs. Pumping of ground water can affect surface-water supplies (either streams or springs) because declines in ground-water levels could increase stream losses and decrease spring flows.