# Geologic Insight to Lucerne Valley Groundwater Basin

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The Lucerne Valley groundwater basin is considered a closed watershed basin in that no external surface water flows from the basin. It is typified by large mountain ranges surrounding the basin with protruding hills of basement rocks exposed throughout the region. Its borders are defined by the Ord, Rodman and Stoddard Mountains to the north, the Granite Mountains and crests of alluvial fans in the west, Fry and Cougar Buttes Mountains to the east, and the large San Bernardino Mountains to the south. Adjacent to the mountain fronts, large alluvial fans slope towards the center of the basin where ephemeral (seasonal) streams deposit alluvial materials. The Lucerne Valley groundwater basin has a topographic low of 2,848 feet (ft) (amsl) in Lucerne (dry) Lake and rises to 8,248 ft in the San Bernardino Mountains (Fig. 1).

Materials that comprise the basin are derived from the weathering and erosion of surrounding mountains and consist of igneous, metamorphic, sedimentary rocks, and alluvial deposits. Alluvial materials adjacent to mountain fronts and in the central valley consist of Tertiary formations, Quaternary stream alluvium, alluvial fan deposits, playa deposits, landslide deposits, and dune sand [Gardner, 1941; Hewett, 1954; Dibblee, 1964a and 1964b; DWR, 1967; and Sadler, 1982a]. The Tertiary formations and stream or alluvial fan deposits are permeable, consisting of varying porosities, with high specific yields, and comprise the aquifers in the basin. They are designated water-bearing units; typically composed of gravel and sand, with minor silt, clay, and occasional boulders that are unconsolidated to semiconsolidated. The total thickness of the water-bearing units is estimated to be approximately 1,000-1,400 ft throughout most of the Lucerne Valley groundwater basin.

The predominant structural features in the Lucerne Valley groundwater basin that affect the subsurface distribution of water-bearing materials include a set of northwest trending, right-lateral, strike-slip faults: the Helendale, Lenwood, Camp Rock, and Old Woman Springs faults. These faults comprise the younger expression (late Cenozoic to early Quaternary) of the Eastern California shear zone [Dokka and Travis, 1990a and 1990b]. The Helendale, Lenwood, and Camp Rock faults also intersect a zone of thrust faults parallel to the northern front of the San Bernardino Mountains. This zone is known as the North Frontal thrust system of the San Bernardino Mountains and acts as a boundary to the basin aquifer at the southern edge of Lucerne Valley.

In assessing the subsurface geology of the Lucerne Valley groundwater basin, the following methods were applied: (1) geologic maps of Lucerne Valley [Dibblee, 1964; Sadler, 1982a; and Miller and Matti, 2003] were used to construct preliminary cross-sections; (2) all available and applicable driller's water well logs, oil well logs, and USGS monitoring well data were reviewed with respect to well location, depth of well, and detail of well log; and (3) based on well information and location of wells, 14 wells were gamma logged using a MGX II Portable Logger with the MGX II Console (Fig. 2).

The Old Woman Sandstone, of Shreve [1968] is exposed sporadically by faulting along the northern base of the San Bernardino Mountains. The unit is unconformable on plutonic pre-

Tertiary rocks and is estimated to reach thicknesses between 600 to 1,000 ft underlying most of Lucerne Valley groundwater basin [Dibblee, 1964a]. Its age has been estimated by several workers to lie between the late Miocene and the Pliocene. Dibblee [1964a] estimates the age of Old Woman Sandstone to be late Miocene, based on the unit lying uncomfortably on pre-Tertiary rocks. May and Repenning [1982] suggest the age of the Old Woman Sandstone to be Pliocene in age, based on mammalian fossils (rodent and horse teeth) found 8 miles southeast of Lucerne Valley in sandy material. Shreve [1968] and Riley [1956] also suggest the unit might be middle to late Pliocene in age.

The lithology of the Old Woman Sandstone varies within the Lucerne Valley groundwater basin, but generally consists of a succession of interbedded units of arkosic sandstone, conglomerate, limestone, silt and clay, and scattered basalt [Dibblee, 1964a; Shreve, 1968; and Sadler, 1982b]. Conglomerate is composed of cobbles and pebbles of granitic rocks, quartzite, schist, gneiss, vein quartz, Tertiary andesite and basalt, and rarely Furnace limestone, in order of decreasing abundances, within a sandy matrix [Dibblee, 1964a and Shreve, 1968]. This rock unit is identified in well logs by driller comments such as: "cementation" or "black rock." These terms refer to compaction and cementation of material or volcanic rock and cobbles found in the Old Woman Sandstone.

The older fanglomerate and older alluvium are unconformable above the Old Woman Sandstone and are exposed along the foot of the San Bernardino Mountains. The older alluvium deposits underlie most of Lucerne Valley, whereas the older fanglomerate unit pinches out to the north, grading into older and younger alluvium [Dibblee, 1964a]. The older fanglomerate is composed of poorly sorted, subrounded fragments of quartzite, granite, and Furnace Limestone approximately 500 ft in thickness [Dibblee, 1964a and Goodrich, 1978]. The older alluvium consists of gravels and sand fragments derived from surrounding hills. Dibblee [1964a] estimated the deposits to be of Pleistocene in age and reach thicknesses up to several hundred feet.

The unconsolidated surficial sediments consist of younger fanglomerates, younger alluvium, and playa deposits that are unconformable above older formations. The fanglomerates are exposed along the base of the San Bernardino Mountains and along other mountains as large fragments derived from surrounding hills which grade into younger alluvial deposits. The alluvium is composed of gravel, sand, and clay that is also derived from adjacent hills. Younger surficial deposits range in thickness from a few inches to approximately 100 ft [DWR, 1967]. The playa deposits, which are concentrated in the Lucerne (dry) Lake and Rabbit Springs (dry) Lake regions, consist predominantly of fine sand, clay, and silt approximately 100 to 150 ft thick [Brose, 1987].

Depth to basement, based on water-well logs and two oil-test holes, suggest bedrock is encountered approximately 1,200 ft below ground surface (bgs) in Lucerne Valley groundwater basin [Division of Oil and Gas, 1964]. Along the Helendale fault, the Division of Oil and Gas [1964] suggest basement rock is reached approximately 1,800 ft bgs.

**Conclusions:**

Old Woman Sandstone varies slightly in thickness throughout the groundwater basins, with an approximate thickness between 600 to 1,400 ft, where the deepest portion of the basin is through the center of Lucerne Valley. The estimated volume of the Old Woman Sandstone is $3.39 \times 10^{12}$ $ft^3$. Lucerne Valley groundwater basin appears to be dominated by a single aquifer system, but displays both unconfined and confined conditions. Towards the north and south edges of the basin the aquifer displays unconfined conditions with gravels and gravelly sand deposits. Towards Lucerne (dry) Lake, the aquifer displays semi-confined conditions with silty clay deposits incised by stream gravels and sand deposits.

Note: Funding was supported by a grant from the Mojave Water Agency.

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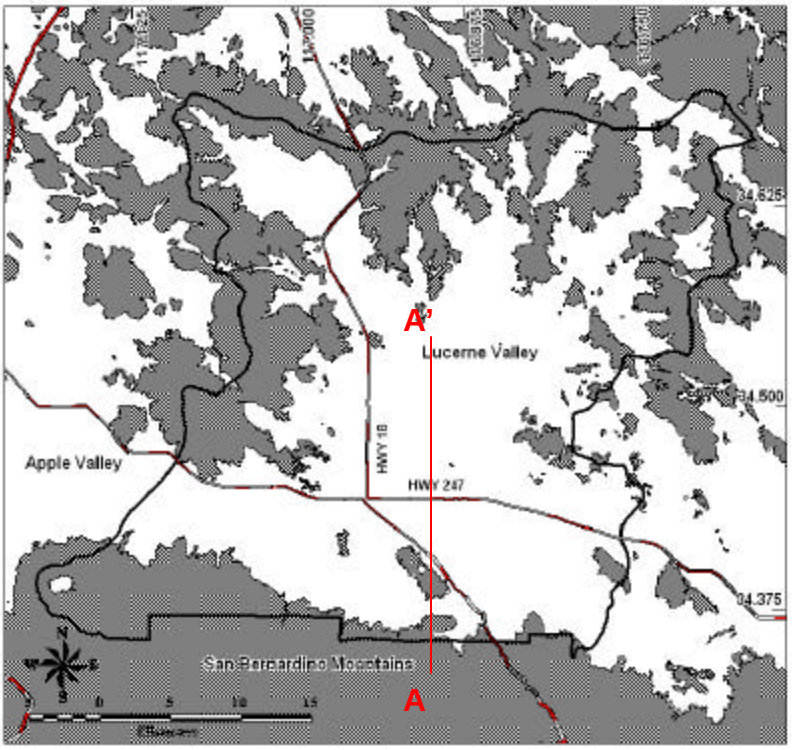


**Figure 1.** Location map of Lucerne Valley, San Bernardino County, California showing cross-section (A-A') profile.