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Valley Voice

A publication about water and environment ...lorado and the West

Inside this issue:

Hydrogeology 101

By Christine Canaly

The San Luis Valley is relatively young, in the geologic sense. Somewhere in the neighborhood of 25-30 million years old. At that time, and continuing to the present, there are tremendous tensional (pulling apart) forces, acting on this side of the earth, creating fractures and faults and a *Graben* (valley bounded by faults) was formed.

Over the next few million years, quick in geologic terms, mountains were rising from the shifts that were occurring below. On the west side of the valley, there were volcanos, where the San Juan mountains stand today. On the east side, the mountains formed differently, because of the faulting and shifting of the earth below and the Sangre De Cristo mountains were carved. Two very different mountain ranges, one smoother and thicker, the other taller and rigidly narrow, creating a valley in-between. Over the millennia, by filling it with material deposits and sediment toward the lower places, forming alluvial fans and creating layers of subsurfaces, we see the valley floor of today.

Water carving ancent stone in Hovenweep.

Weather

Why is the San Luis Valley a water rich desert? Mountains. The prevailing winds are from the northwest and monsoons come from the southwest. Warm wet winds are from the west and when it hits the wall of the San Juan mountains the warm air rises and cools. Cool air drops the moisture, in the form of precipitation and that is why the San Juans, on the west side of the range, (Wolf Creek for example), may get 40-50 inches/yr.

We get dry winds in the San Luis Valley because the winds have dropped their load before they get to the valley floor so it receives only about 7 inches/yr of precipitation.

Because the mountains surround the valley and are collecting precipitation, usually in the form of snowpack, and spring comes and snow melts into surface water which then feeds the groundwater beneath the valley floor, there is then a renewable source of groundwater, providing nature is cooperative.

Hydrology

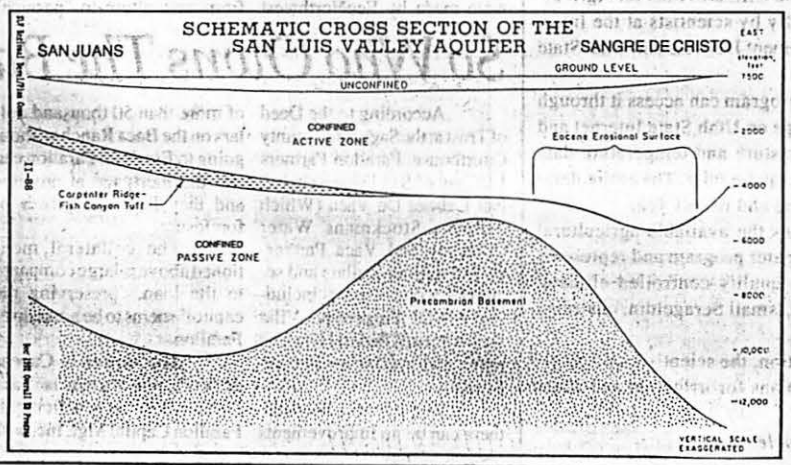
An aquifer is a basin of rock or sediment which is saturated and sufficiently permeable to conduct groundwater. Just below the surface of the valley floor we have the *unconfined aquifer*, which is anywhere from the surface of the valley to hundred's of feet deep.

There exists a series of clay and silt layers below the unconfined aquifer and it is referred to as the series of *blue clay layers*. It isn't actually one continuous layer but rather a series of layers on top of one another, like how our fingers fold together, and sands are separating the uppermost from the lower layers. These layers leak, there is communication between them, some waters are moving upward and some are moving downward, depending on where you are in the valley . These layers begin to narrow and do not continue toward the center of the valley.

Beneath these layers and where they exist (about 1,500-2,000 ft below the surface) is what is called the *active confined aquifer*. This is where Stockman's Water Co. and the preceding owner of the Baca Ranch, AWDI, planned pumping. Water is recharging and discharging through it, that is why it is called active. There are a couple of different geologic formations that exist at this level. They are the Los Pinos (roughly on the west) and Santa Fe (roughly on the east) formations. These formations do intersect and are significant because they help to indicate the water quality found at these depths.

Water Quality

See HYDROGEOLOGY on Page 12



HYDROGEOLOGY

Continued from Page 1

Water quality found around the edge of the valley is excellent. This is true for both the confined and unconfined aquifers. The quality of water found around the perimeter of the valley reflects the quality of the recharge water, coming from the surface water from the mountains.

In the *unconfined aquifer*, as water moves toward the center of the valley, picking up more material as it goes, eventually ends up with higher concentrations of salinity and alkali.

In the *confined aquifer*, as water slows and moves down gradient, picking up more material in the presence of clay beds, lava flows and minerals in the valley that exert their influence, both chemically and physically, changes the general composition of that water.

The history of deep well drilling (water, gas & oil) has shown us that *confined* aquifer wells have better water quality on the west side of the valley than the east. This is partially due to the formations mentioned above (Los Pinos and Santa Fe) and the materials they are made from. The finer the grain, the more soupy (dissolved materials) the water mixture contains. The Los Pinos formation is coarse grained compared to the Santa Fe. The more coarse the grain, the better flow of the well. Couple that with the deep faulting lines (like armor plates bonded together) that are beneath the east side of the valley floor and the circumstance is created for poor water quality.

Deep Passive Confined Aquifer

As far as is know, this level (3,000 feet and Below) is not hydrologically active. Water moves slowly, picks up a burden of materials. This water is a geothermal soup, creating poor (potable) water quality.

Deeper water is also warmer water, reflecting the earths temperature. We know this because of the geothermal waters (hot springs) that are enjoyed not only in this valley but downstream along the Rio Grande. What is significant about this deep geology is the tuffs and lava flows, or volcanic rock, that is brittle and has had the opportunity to fracture; creating an avenue for water to travel. It is thicker (perhaps 1,000's of ft) on the west side of the valley and narrows to disappearing toward the center. This is important hydrologically for the *active confined aquifer* system because water can be recharged through this material. This means there is a mode of groundwater movement that is feeding the layer above it.

Groundwater Movement

The San Juan Mountains posesses the ideal combination for recharge because of more water volume, the volcanic rock and the continuity of permeable rock (like underground water slides) to feed the aquifer systems.

When compared to the Sangre De Cristo Mountains, which is a narrow ridge of rock and lacks geologic continuity because of the Sangre De Cristo fault, the recharge that does occur goes through the gravel in the alluvial fans and the flows have a tendency to disappear, above the surface. That is why the streams along the Sangre De Cristo's are considered *losing streams. (see graphic)* The water table exists below these streams (and supports them) and since the groundwater may go in deeper because of fault, acts to recharge the confined and unconfined systems deeper in the valley floor (hence poor water quality).

Water Budget

The majority of the recharge comes from the San Juan Mountains. (See Water Budget) There have been a number of water budgets that have been made for the San Luis Valley and though the outflow components may differ, all pretty much agree on the inflow portion. The Sangre De Cristo Mountains bring in 10-25% of inflow compared to the San Juans.

There are differences among the hydrogeology communities when it comes to outflow components, specifically the evaporation (soil), transpiration (plant) rates and groundwater outflow (beneath the Rio Grande). These questions will not be answered until further study is conducted.

Conclusion

When HRS Consultants was hired by the San Luis Valley Water Conservancy District to do the most extensive study to date on the confined aquifer in 1987 they produced the San Luis Valley Confined Aquifer Study Phase 1 Final Report.

The reason for this study was to research the development possibilities of the *confined* aquifer. They concluded that the *confined* aquifer was not worth developing for a number of reasons including: it's uneconomic, the water quality is poor and the affect it would have on other aquifer systems. They saw no sensible reason for a phase 2.

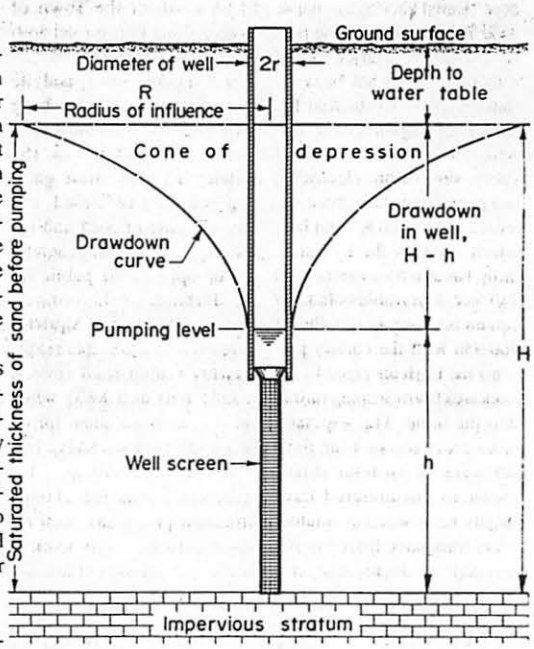
When the United State Geological Survey (USGS), including Philip Emery, did a study of the San Luis Valley aquifers in 1973, they drew some similar conclusions that need to be remembered today.

"It is estimated that the decline on flow of all artesian springs in the SLV has amounted to about 22,000 acre feet per year since 1951." USGS

"A potential water management problem that should be considered is land subsidence. Dewatering or lowering the confined aquifer appreciably could result in **irreversible compaction** of the aquifer and cause land subsidence. So far, no land subsidence has been detected in the SLV, but the potential exists. Land subsidence due to excessive groundwater withdrawal has occurred and is well-documented, in other similar alluvial basins." USGS

"Complex geology in the San Luis Valley determines a complex water system." Eric Harmon

References: Thanks to Eric Harmon, Hydrogeologist of HRS Consultants for his presentation to the SLV in 1991. USGS, Colorado Water Resources, Circular No. 18 1973 SLV Regional Development & Planning Commission-SLV Overall Economic Development Program, December 1992. Alan Davey-Davis Engineering.



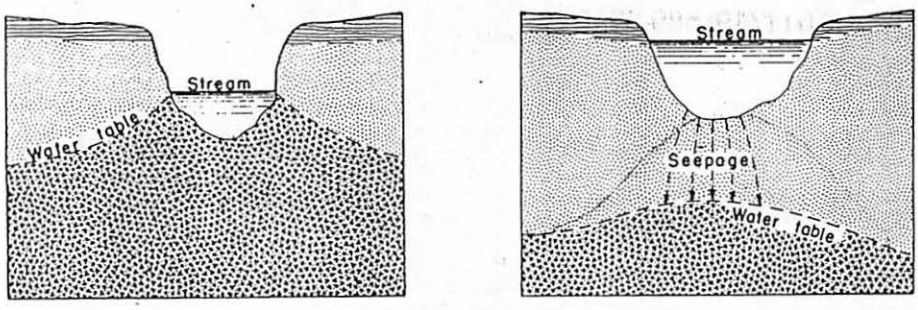
Cone of Depression

(see graphic)

A *cone of depression* is caused by water moving from an area of high concentration to an area of low concentration. Wells create cones of depression. How far away one well is from another will determines the *radius of influence* that well will have on its neighboring well. It is possible for wells to effect one another and interfere with each others cone of depression.

"The area of the cone of depression in the *confined* aquifer increases about 25 times as fast as it does in the *unconfined* aquifer. Recognition of the fact that widespread head changes are caused by withdrawal from the *confined* aquifer is important to the management of the Valley's water resources." USGS 1973

Losing Streams



Influent stream on the left loses water to the aquifer, stream on right flows only following periods of surface runoff, but is dry during droughts.