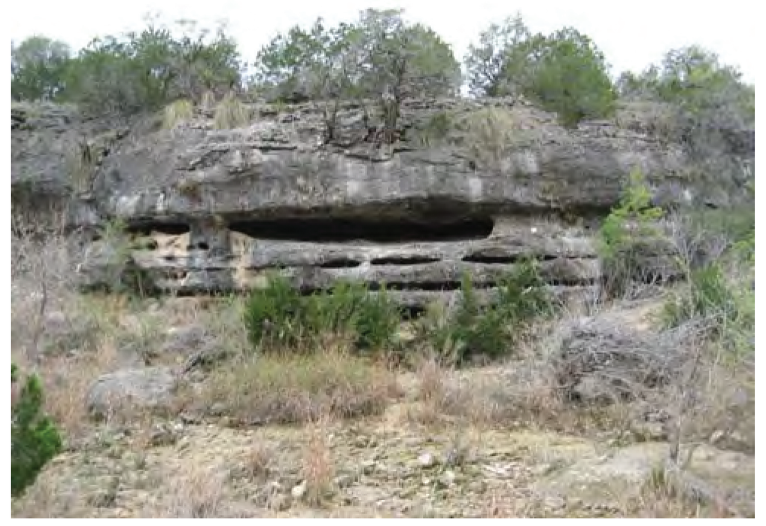
Occurrence of Karst and Springs

Douglas A. Wierman, P.G. and Brian B. Hunt, P.G.

Karst

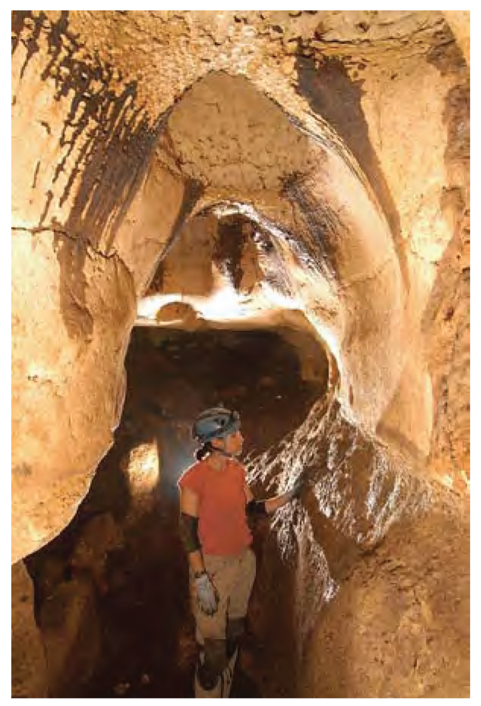
Karst landscapes develop where the bedrock is comprised of soluble rock such as limestones, evaporites, and dolomites. Karst features are formed when there is a chemical reaction between the groundwater and the carbonate bedrock. As rain, streams, and rivers flow over the earth's surface, the water mixes with the carbon dioxide that naturally exists in air and soil. The water and carbon dioxide react to form a weak carbonic acid. This acidic water seeps into bedding planes, fractures, crevices, and other depressions and dissolves the rock forming voids. Sinkholes can develop and bedding planes and fractures widen and lengthen. As the openings get larger, the amount of water that can enter increases, and thus more dissolution occurs (positive feedback). Eventually, an underground drainage system can develop. Karst features below the water table significantly increases the groundwater storage capacity of the aquifer and allow for the rapid movement of groundwater through the karst system. In the study area, there are many surficial karst features in exposed parts of the Lower Glen Rose in the Wimberley Valley and in the Edwards Aquifer (Figure 14-1). These surficial openings allow for rapid recharge of the Trinity and Edwards Aquifers (Figures 14-3 through 14-5). Rapid infiltration can allow pollutants to directly enter the aquifer without any treatment from surficial soils. Conversely, karst features can provide conduits for the rapid discharge of groundwater through springflow (Figure 13-4).

Many wells drilled in northern Hays County lose circulation in the Glen Rose Formation. Water loss is the result of intrastratal karst (Klimchouk, 2000) caused by groundwater dissolution of limestone beds interbedded with shaley strata. With time and continued dissolution, these void spaces give rise to "shallow", local zones of relatively high porosity and permeability. This is particularly common in the Upper Glen Rose Member.

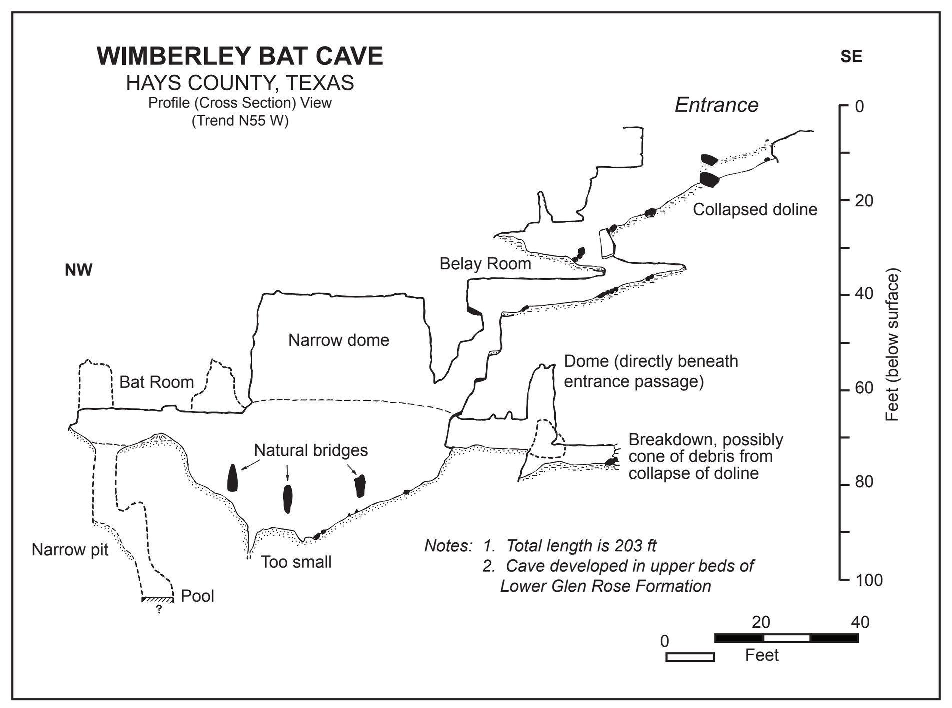


14-2 Bedding plane dissolution in the Cow Creek formation, Flat Creek, Blanco County. Photo by Brian B. Hunt.

14-3 Water pouring into Kiwi Sink and Cave, Hays County. Photo by Terry Raines.

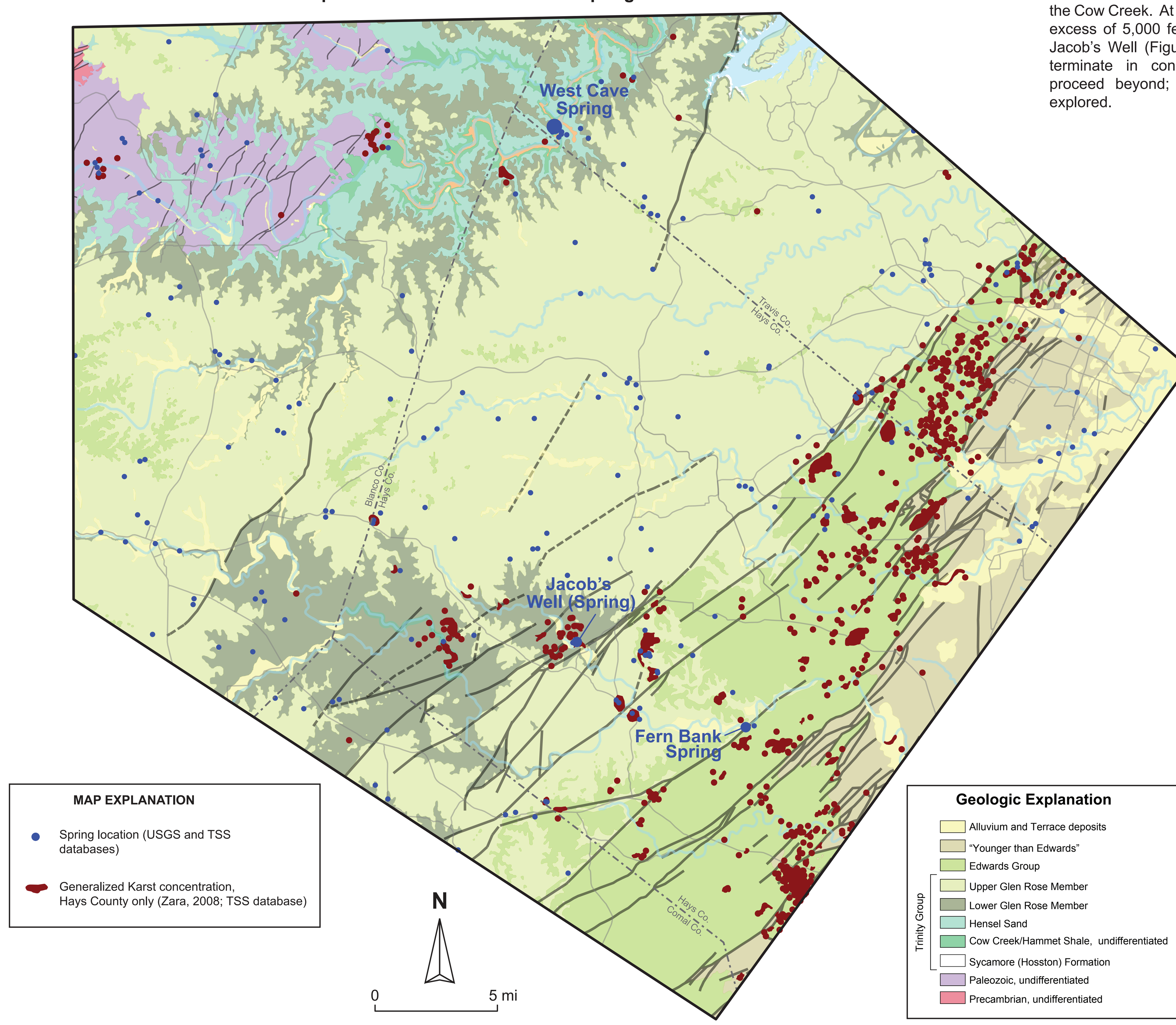


14-4 Wimberley Bat Cave, Hays County. Photo by Dr. Jean K. Krejca, Zara Environmental, LLC.



14-5 Profile view of Wimberley Bat Cave in Hays County. Brunton and tape survey 10 December 1972 by M. Burda, T. Jones, W. Russell, M. Warton, and D. Wymer. Redrafted 21 April 1983 by E. Kastning from original draft by W. Russell (TSS, 2007).

14-1 Map of Surficial Karst Zones and Springs



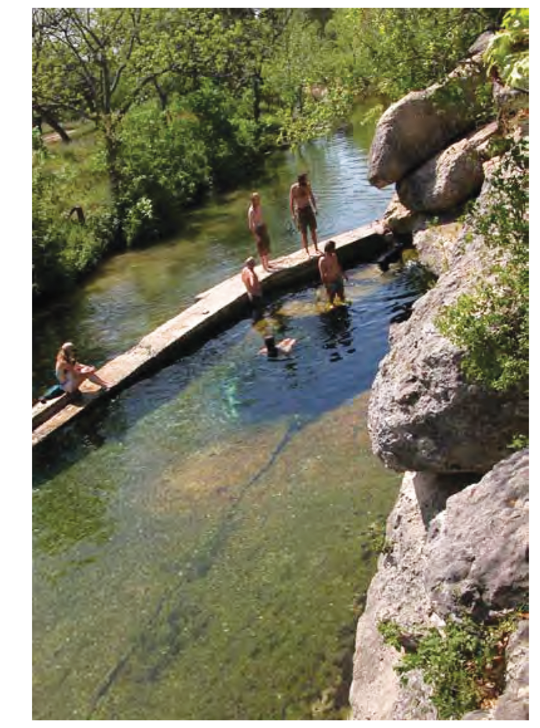
Jacob's Well

Jacob's Well is an excellent example of a perennial, base flow, karst spring (Gunn, 2004), and provides a unique habitat for aquatic species (14-11). The opening of Jacob's Well in the bed of Cypress Creek (Figure 14-9) occurs in the Lower Glen Rose Member of the Middle Trinity Aquifer. The nearly vertical shaft of Jacob's Well (Figures 14-13 and 14-14) probably follows a former fracture or joint set that has been enlarged by solution activity. Approximately 70 feet below the mouth of the spring is the contact between the Lower Glen Rose and the Hensel formation. There are two large caverns at the contact. The contact between the Hensel and Cow Creek occurs 100 feet below the ground surface. The cave passageway becomes roughly parallel to the horizontal bedding and continues laterally several thousand feet of the Cow Creek. At present, divers have mapped in excess of 5,000 feet of cave passages linked to Jacob's Well (Figures 14-10). Several passages terminate in constrictions that divers cannot proceed beyond; others are continuing to be explored.

Springflow from Jacob's Well consists of artesian flow from the Cow Creek formation up through the confining Hensel and Lower Glen Rose. The major source of recharge to the Cow Creek occurs west of the Cypress Creek watershed from the downward leakage of water from the Upper and Lower Glen Rose and Hensel where these formations are exposed at the surface and receptive to the infiltration of precipitation. Water moves downward into the Cow Creek and down dip (southeastward) towards the BFZ (Figure 12-5). As the overlying Hensel formation transitions from a predominantly sand facies to a shale/dolomite facies, it tends to act as a confining layer creating artesian conditions in the Cow Creek. The faults of the BFZ (Tom Creek Fault Zone) tend to restrict the horizontal movement of groundwater forcing groundwater upward with surface discharge via Jacob's Well. Groundwater under artesian pressure in the Cow Creek provides the majority, if not all, of the base flow to Cypress Creek.

The flow from Jacob's Well varies significantly with major precipitation periods and events as evident on Figure 14-12. Artesian flow from the Cow Creek generally maintains a discharge of 3-7 cfs. During major precipitation events, peak discharge has been measured at over 70 cfs, indicating a pressure surge in the Cow Creek or other potential sources of water such as direct recharge from the open karst features observed locally in the Lower Glen Rose. Gunn (2004) describes large changes in spring discharge that may be due to rapidly filling open karst features becoming full and then exerting rapid increases in head in the aquifer and thus spring discharge.

Karst springs such as Jacob's Well are excellent indicators of the health of the aquifer. As stated by Gunn (2004) "Karst springs are now regarded as valuable integrators of the aquifer, and, compared to monitoring wells, provide comprehensive monitoring sites for assessment of contamination and supply". Pumping of nearby commercial wells drawing water from the same karst conduits influence discharge from Jacob's Well. The combination of periodic drought and increased groundwater pumping is tending to make Jacob's Well more of an intermittent spring than perennial spring.

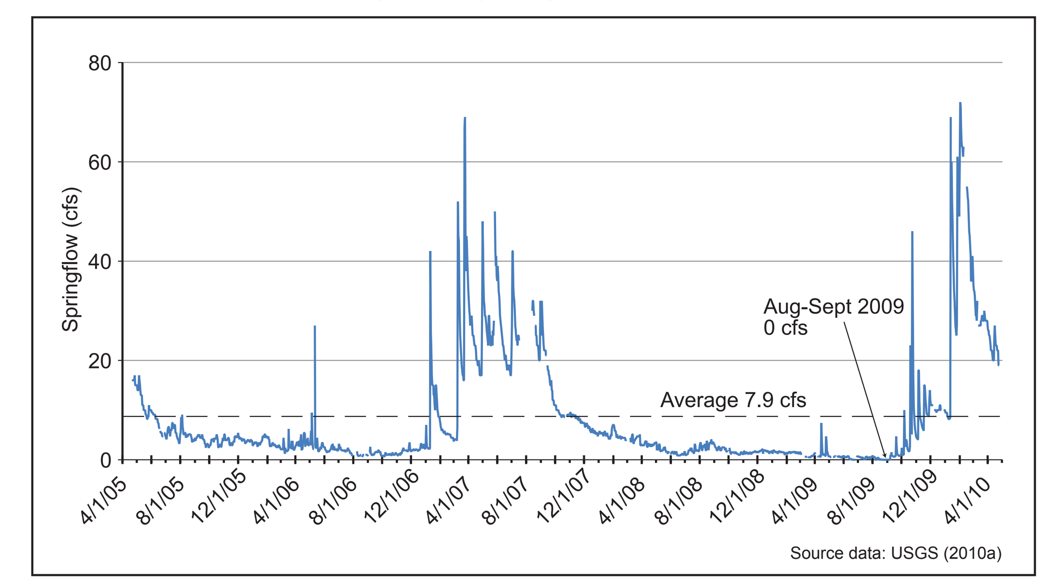


14-9 Jacob's Well. Photo by David Baker.

14-10 Diver in Jacob's Well

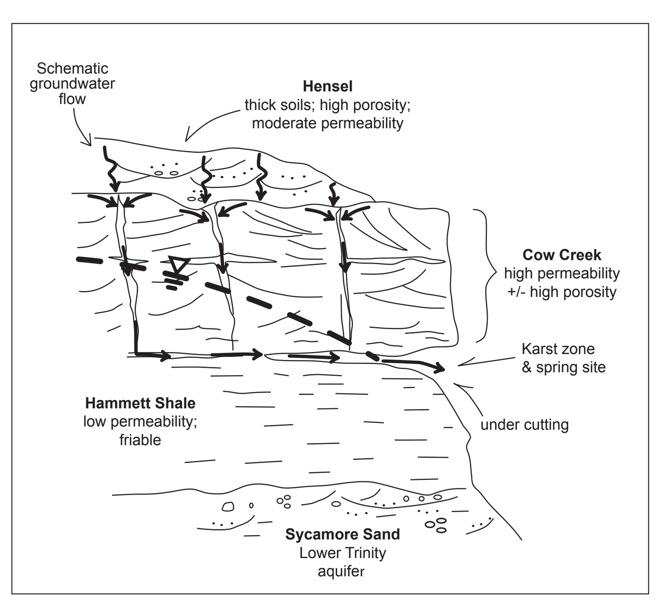
14-11 Jacob's Well salamander (*Eurycea pterophila*). Photo by Dr. Jean K. Krejca, Zara Environmental, LLC.

14-12 Springflow Hydrograph of Jacob's Well



Springs

Springs in the study area typically occur at the intersection of the water table and the land surface where groundwater discharges into streams under the force of gravity (gravity or contact springs). Recharge from precipitation migrates downward through the bedrock via fractures, karst, or the rock matrix, until it encounters a more impermeable rock layer that directs water laterally onto the surface or finds another vertical pathway. Springs are generally discrete points of discharge, often measured in cubic feet per second, while seeps are generally non-discrete zones of low flow or moist areas. West Cave Springs (14-6), Fern Bank Spring (14-7) and Grotto Spring (14-8) are examples of gravity springs. Gravity springs, and seeps, give rise to the many wet weather creeks in the area, though due to their shallow nature and dependence on local precipitation, they are typically intermittent. Artesian springs are formed when water in an aquifer discharges under pressure, through the overlying confining layer, onto the surface. Jacob's Well is the largest and best-known artesian spring in the study area. Flows from Jacob's well are documented to have exceeded 70 cfs during the last decade.

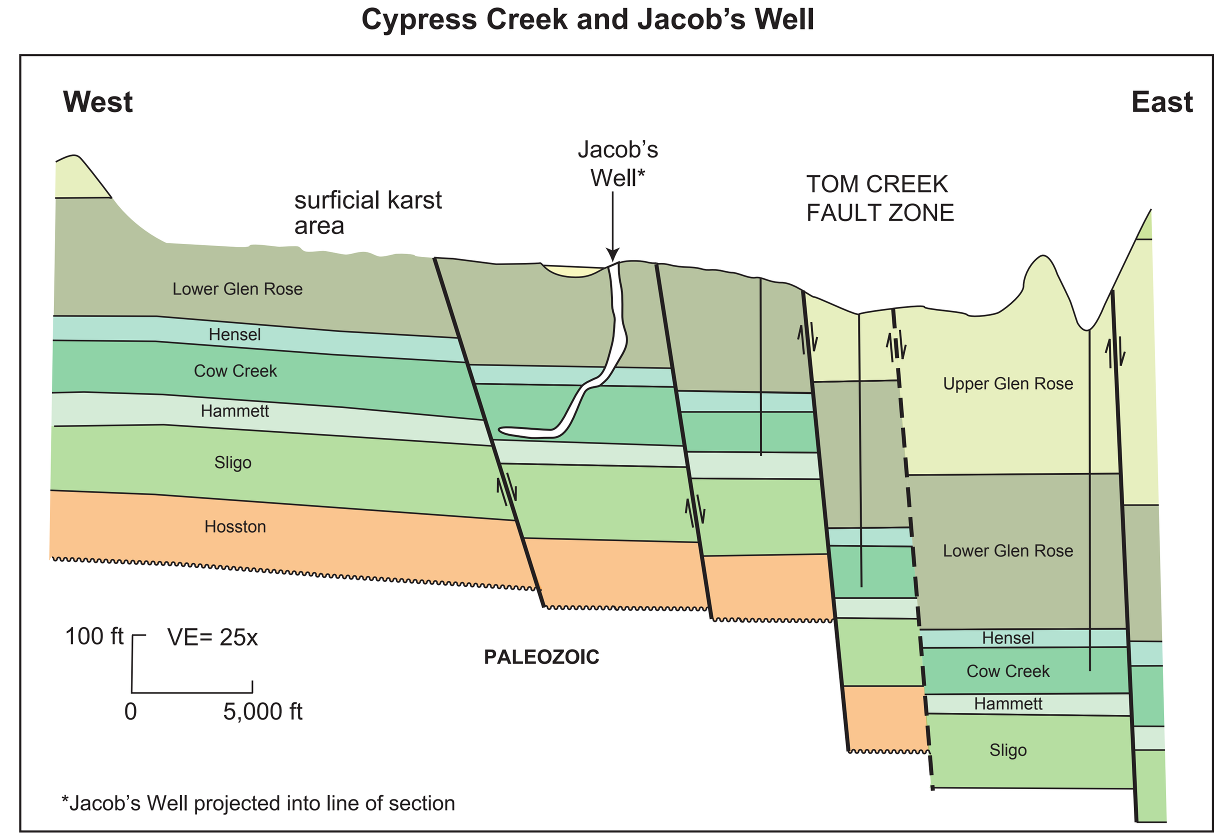


14-6 Schematic diagram of a gravity spring. Sketch based upon West Cave Spring in Travis County. Diagram from Woodruff (2007).

14-7 Fern Bank Spring along the Blanco River in Hays County. Photo by Dr. Jean K. Krejca, Zara Environmental, LLC.

14-8 Grotto Spring located on a ranch in Hays County, Onion Creek watershed. Spring area is a collection of seeps and springs issuing from the Upper Glen Rose. Photo by Brian B. Hunt.

14-13 Portion of Cross Section D - D' (Plate 10) Cypress Creek and Jacob's Well



14-14 Schematic Profile of Jacob's Well