Basic Geology of Aquifers of the Lower Cretaceous Trinity Group

History of Deposition

For over half the Early Cretaceous Period (145 to100 million years ago) this part of South-Central Texas was on the continent, inland from the shoreline of the northwestern Gulf of Mexico. About 120-125 million years ago, marine waters of the Gulf began to flood this area. Just north of what is now Kendall County, however, the Central Texas Platform ("Llano Uplift") remained a highland during most of the Early Cretaceous, with Precambrian igneous and metamorphic rocks and Paleozoic sedimentary rocks exposed to erosion.

The amount of sediment shed from this land area out onto the shallow sea floor varied through time. During times of higher rates of erosion and sediment influx, the sea floors were covered with mud and sand. During periods of little sediment influx, the sediments on the shallow-marine shelf were composed predominantly of calcium carbonate shells and skeletal parts of invertebrates and algae that proliferated in the warm, clear sea water.

Because of this alternation of major sediment type during the Early Cretaceous, the Lower Cretaceous rocks of this area are composed of units of sandstone and mudstone (derived from erosion of the mainland) as well as units of limestone and dolostone (derived from the carbonate sediment produced on the marine shelf). The Lower Cretaceous rocks, therefore, include both sandstone aquifers and limestone/dolostone aquifers. Over much of the area, the carbonate aquifers are of more importance to our water supply.

The basal Cretaceous rocks in South-Central Texas are conglomerate, sandstone, and shale of the Sycamore and Hosston Formations, deposited in non-marine environments over an irregular topography of Paleozoic rocks. In the more-seaward (southeastern) parts of this area, the upper part of this unit is shallow-marine limestone, the Sligo Formation.

Overlying this is the marginal-marine Hammett Formation (equivalent to the subsurface Pine Island Shale).

After deposition of the Hammett muds, approximately 115 million years ago, there was a period of probable subsidence of the highland and little influx of sediment off the land. During this time, the Cow Creek Limestone was deposited in the shallow sea.

Later there was uplift and sea-level fall, bringing an end to Cow Creek deposition and exposing the landward portions of the Cow Creek carbonate to weathering and erosion. After that, a major influx of sand and mud from the mainland covered the Cow Creek across the whole shallow-marine shelf in this area. This unit is the Hensel Sand. Farther away from the shoreline in what is now southern Kendall County, the uppermost layers of the Hensel are sandy dolostone. This unit passes gulfward into the Bexar Shale.

The northwestern margin of the Gulf Basin slowly subsided and the sea advanced onto the continent. Deposition of sands, muds, and gravels (Hensel) continued around the margin of the Central Texas Platform, but carbonate deposition (Glen Rose Formation) predominated across most of the South-Central Texas shelf. The Glen Rose Formation represents an extensive carbonate platform which developed around the entire northern Gulf from Florida to Mexico. Glen Rose rocks of South-Central Texas were deposited on the shallow-marine shelf from about 113-108 million years ago.

Frequently during deposition of the Glen Rose, fine material eroded off the land was carried far out onto the shallow-marine shelf. Consequently, the Glen Formation includes many marl and clayey limestone beds interlayered with pure carbonate rock. As the margin of the Gulf Basin subsided, the shoreline moved progressively landward, and sediment eroded from the land (Hensel) was reduced to an ever-narrowing belt adjacent to the Central Texas Platform

By about 108 million years ago, even the Llano-area island was being inundated by the rising sea level, cutting off influx of sediment eroded off the highland. This resulted in a period of deposition of carbonate sediments across South Central Texas. This carbonate unit overlying the Glen Rose is the Edwards Group.

Trinity Group

Geologists group all the Lower Cretaceous sedimentary rocks deposited before the Edwards limestone (i.e., all Lower Cretaceous Formations underlying the Edwards) into the Trinity Group.

Hydrogeologists divide the Trinity Aquifer System into:

Upper Trinity: Upper Glen Rose
Middle Trinity: Lower Glen Rose
Hensel Sand
Cow Creek Limestone
Lower Trinity: Sycamore, Hosston, Sligo

In this area the most productive aquifers are those of the Middle Trinity, but aquifer quality is variable from place to place, even in the same unit.

Edwards-Trinity Aquifer

In the northern part of Kendall County the aquifer systems include the basal Edward limestone, which immediately overlies the Glen Rose Formation.

Heterogeneity

Trinity Aquifer System is composed of many aquifers, which are characterized by

heterogeneity in thickness, porosity, permeability, and distribution. This makes them difficult to model.

Only some layers within each formation of the Trinity Aquifer System have enough pore space (holes) and connected pore space to be able to hold and transmit substantial amounts of ground water. The differences in porosity and permeability are the result of many factors, including the type and texture of the original sediment, changes during post-depositional burial and transformation of sediment into sedimentary rock, and later dissolution and fracturing,

Most of the rocks of the Trinity Aquifer System were deposited in coastal and shallow-marine settings. At any one stand of sea level, conditions that controlled sediment type and textured varied from place to place just as it does off the Texas coast today. During the Early Cretaceous, there were many minor oscillations in sea level. Raising and lower the sea level continually changed the whole depositional regimes of any one area. The sequence of rocks that results from deposition in shallow marine water with sea levels oscillating over time is characterized by both vertical and lateral heterogeneity. None of the Trinity Aquifer System formations is homogeneous, either in vertical or lateral dimensions. This means the characteristics of the various aquifer layers vary from place to place.

Carbonate rocks (limestones and dolostones) are susceptible to dissolution in fresh water, fresh ground water and surface water. This means that carbonate rocks in this area are characterized by holes that resulted from dissolution by fresh water. For example, ground water flowing along fractures in carbonate rocks will dissolve some of the rock, thereby widening the fractures. In time, the major pore system in that rock will reflect the amount and the trend of the fractures in the rock. The orientation of the fractures, then, controls the direction of flow. The number of solution-widened fractures controls how much water the aquifer holds and transmits. Without a good knowledge of the fracture systems in a given area, it is often difficult to predict amount and direction of groundwater flow.

In this area the recharge to and the flow within our carbonate rock aquifers (Cow Creek, Lower Glen Rose, and Upper Glen Rose) depends, in large extent, on the distribution and amount of holes dissolved in the rock, both at the surface and underground. This is controlled largely by the fracture systems and may vary from place to place.

Carbonate aquifers are especially difficult to model because of all these heterogeneities.