AQUIFERS OF TEXAS

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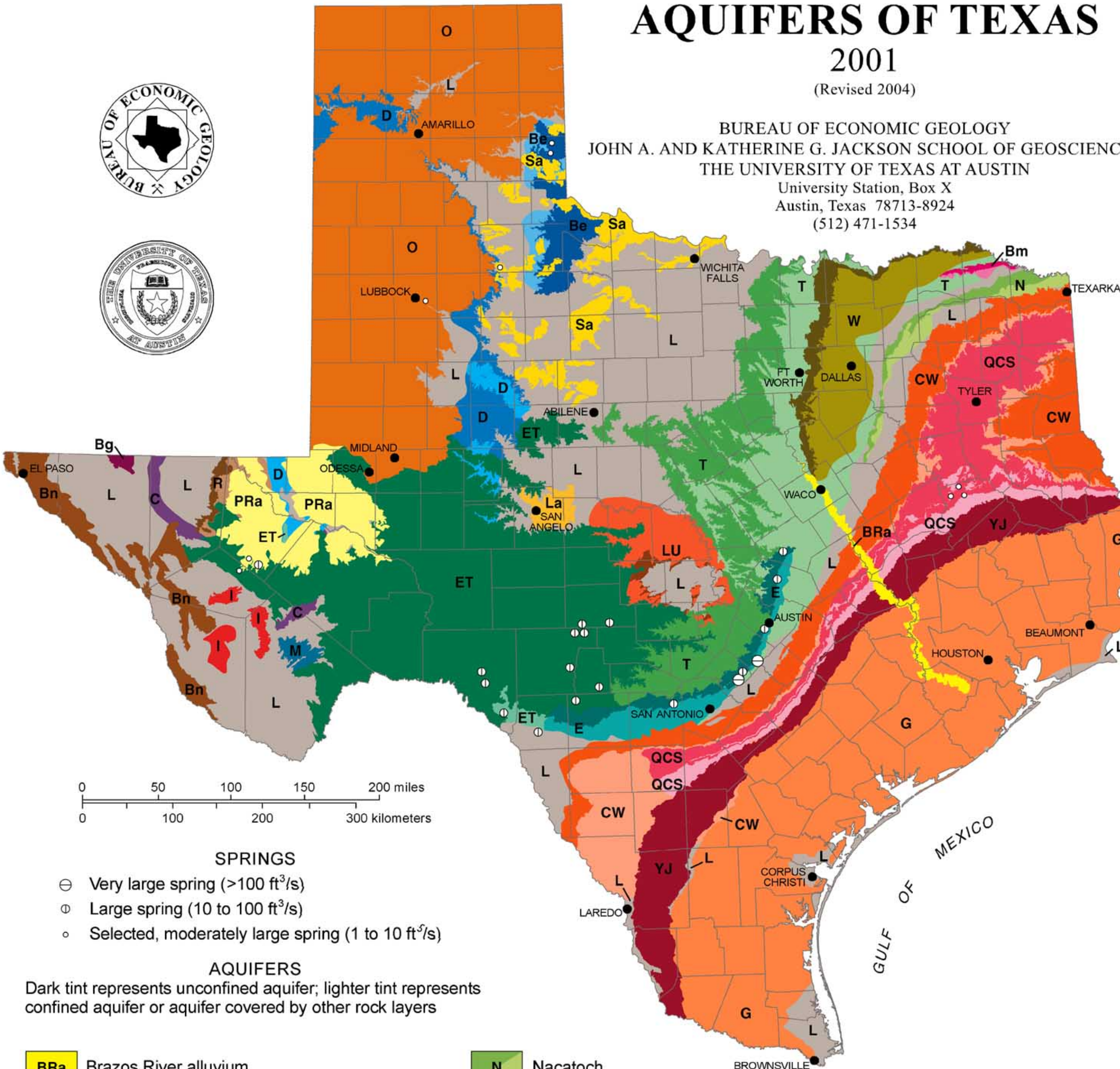

0 50 100 150 200 miles

0 100 200 300 kilometers

SPRINGS

- ⊖ Very large spring (>100 ft^3/s)
- ⦶ Large spring (10 to 100 ft^3/s)
- ∘ Selected, moderately large spring (1 to 10 ft^5/s)

AQUIFERS

Dark tint represents unconfined aquifer; lighter tint represents confined aquifer or aquifer covered by other rock layers

BRa	Brazos River alluvium
La	Lipan alluvium
Sa	Seymour alluvium*
PRa	Pecos River alluvium* (overlies Rustler)
O	Ogallala* (overlies Dockum, High Plains Edwards-Trinity, Rita Blanca)
Bn	Bolson (Hueco-Mesilla* and West Texas)
G	Gulf Coast* (Catahoula, Jasper, Evangeline, Chicot)
I	Igneous
YJ	Yegua-Jackson (overlies Queen City and Sparta)
QCS	Queen City and Sparta (overlie Carrizo-Wilcox)
CW	Carrizo-Wilcox*
N	Nacatoch
W	Woodbine (overlies Trinity)
Bm	Blossom
ET	Edwards-Trinity (Plateau)*
E	Edwards (Balcones Fault Zone)*
T	Trinity*
D	Dockum
Be	Blaine
R	Rustler
C	Capitan Reef Complex
Bg	Bone Spring–Victorio Peak
M	Marathon
LU	Llano Uplift (Hickory, Ellenburger–San Saba, Marble Falls)
L	Local aquifers of varying quantity and quality

*Major aquifer

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Aquifer units are generalized from the Texas Water Development Board digital database of major and minor aquifers of Texas.

Aquifers of Texas

Aquifers are a critical part of the water cycle. Rainwater that falls on land can (1) evaporate, (2) be taken up by plants, (3) run off into streams, or (4) seep underground through soil, sediment, and rocks. The fraction of the water that moves into the groundwater is called *recharge*. Rock or sediment that stores and transports water underground in amounts and quality sufficient to be useful to humans is called an *aquifer*.

Water is stored in spaces within the sediment or rock that are called *pores*. Pores range from microscopic spaces between mineral grains, to fractures, to caves. Below the water table, most pores in a rock are filled with water, so this rock is described as *saturated*. The aquifer property that lets water move through connected pores is known as *permeability*. Gravel, sand, and sandstone are sediment and rock types that are commonly very permeable. Clay and shale are examples of sediments and rocks having small or poorly connected pores through which water does not move easily. The permeability of limestone and igneous rocks depends on the geologic history of the rock.

Water in an aquifer is not stagnant but instead moves under pressure. It enters the aquifer at the surface in the *recharge zone*. Water leaves the aquifer at discharge areas. These can be springs or wells or areas along the bed of a river or along the coast. The flow path from the recharge area to the discharge area can be short and simple, or it can be hundreds of miles long and take fresh water to depths of several thousand feet before bringing it back to the surface. Some parts of the flow path have a low-permeability layer above the aquifer, which is called the *confined* part of the aquifer. When a well is drilled into a confined aquifer, pressure in the aquifer will make water rise in the well. If pressure in the confined aquifer makes the water in the well rise above the land surface, the well is a flowing *artesian* well. Water is pumped from wells for irrigation, city and home water supplies, manufacturing, and mining activities.

Groundwater dissolves or chemically interacts with minerals in the rock. What we call *fresh water* contains less than 1,000 milligrams of dissolved material in each liter of water. In a limestone aquifer, water dissolves some of the mineral calcite, which gives water the taste and poor lathering properties of hard water. At greater depths and in less-permeable rocks, water becomes increasingly salty. It also becomes saline where it comes in contact with salt deposits and where, in arid areas, evaporation of groundwater concentrates dissolved minerals.

People can alter the natural system. If water removed from the aquifer exceeds the water replaced by recharge, springs may dry up, salt water may move into an area that previously had fresh water, or the ground surface may subside, increasing the risk of flooding. Spilling or misuse of materials such as salt water, oil, chemicals, pesticide, or fertilizer can contaminate groundwater.

Texas gets more than half its water supply, more than 2.5 trillion gallons, from aquifers. Because each aquifer system in Texas is unique, this map captures only the general distribution of major and some minor aquifers. The nine major aquifers in Texas supply more than 90 percent of the state's groundwater.

Some of the most productive aquifers in the state are in relatively young (to 1.6 million years [m.y.]old) sediments deposited by streams and are known as *alluvial aquifers*. The Brazos River alluvium aquifer, for example, was formed when sand, gravel, silt, and clay were deposited in the floodplain and channel of the ancient Brazos River. Alluvial aquifers along many Texas rivers are used for domestic water supply and for irrigation. Because they are shallow and composed of permeable sediments, alluvial aquifers are susceptible to contamination. Natural and human sources of salinity have reduced the water quality in some alluvial aquifers, such as the Lipan aquifer.

Another group of aquifers are formed in deposits associated with rivers that flowed during the Cenozoic (as much as 65 mya). The Seymour aquifer is hosted by sand and gravel deposits of ancient east-flowing rivers. Its age is indicated by the valleys that modern rivers have cut into these deposits. Sand dunes as well as river sediment contributed to the Pecos River alluvium, and older rocks (Rustler) beneath the Pecos alluvium exchange water with it. The most prolific aquifer in Texas, the Ogallala aquifer of the Southern High Plains, is Cenozoic sands and gravels that were also deposited in a river-system complex. This aquifer is recharged from small playa lakes on the High Plains surface and is used heavily for irrigation. Water can flow between the Ogallala aquifer and underlying aquifers. Thousands of feet of sand, silt, and gravel deposits fill intermontane basins of West Texas known as *bolsons*. Each bolson has a distinct sequence of sedimentary fill and its own water balance. Because recharge and basin size are limited, water conservation is critical in these desert areas.

Also during the Cenozoic, rivers carried gravel, sand, and clay toward the Gulf of Mexico and deposited them in coastal-plain, beach, and marine environments. The Gulf Coast aquifer is a composite of several geologic formations composed of layers of sand and clay. In some areas, the water in the Gulf Coast aquifer can move easily from sand unit to sand unit; in others, the clay layers confine the water, and each sand unit acts as a separate aquifer. Names given to some of these partly separated aquifers are Catahoula, Jasper, Evangeline, and Chicot. In some areas heavy pumpage of the aquifer has had harmful effects, such as subsidence of the land surface and intrusion of saline water into the aquifer. Deep wells may tap several aquifers.

On the upper coastal plain an older Cenozoic sequence of coastal-plain sands, gravels, and clay hosts the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers. In most areas these aquifers are separated by clay-rich confining layers. Water enters these aquifers where sandstones crop out at the surface and moves down the aquifer into the subsurface, where it is pumped from wells. In some areas, water has reacted with low-grade coals (called *lignite*) or with iron-rich sediments and is of poor quality. The Carrizo-Wilcox aquifer is used heavily for irrigation in the southwest Texas Winter Garden area.

A band of rocks of Cretaceous age (140 to 65 m.y. old) hosts aquifers across the middle of the state. The fossiliferous Edwards limestone is one of the most dynamic aquifers in the country. Where Hill Country creeks and rivers cross the outcrops of the Edwards limestone, water is captured by caves and fractures, flows to depths as great as 3,000 feet through Edwards limestone layers, and discharges at some of the famous springs of Central Texas. But conflict between agricultural and urban pumpers and ecosystems dependent on springflow arises during drought. Cretaceous sandstone aquifers include the Trinity, Woodbine, Nacatoch, and Blossom. On the Edwards Plateau, limestones and sandstones are considered as one aquifer, the Edwards-Trinity, which is in hydrologic connection with over- and underlying Ogallala, Pecos River alluvium, and Dockum aquifers.

Small aquifers are important where water resources are scarce. The Capitan Reef Complex and Bone Spring–Victorio Peak of West Texas, for example, are limestone aquifers that are recharged in mountain areas. The Blaine aquifer, hosted by interbedded limestone, sandstone, and gypsum beds, is locally saline. The Hickory, Marble Falls, and Ellenburger–San Saba are minor aquifers around the Llano Uplift. These very old rocks (430 to 550 m.y.) lie on top of even older igneous and metamorphic rocks that are generally not porous or permeable enough to serve as aquifers. Fractured igneous rocks (for example, basalts and tuffs) and associated alluvial deposits are used for water resources in sparsely populated and arid areas of Trans-Pecos Texas. Similarly, fractured, folded, and slightly metamorphosed rocks and overlying alluvium are minor aquifers in the Marathon area.

Data from:

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Texas Natural Resources Information System, http://www.tnris.state.tx.us/

—Text by Susan D. Hovorka and Alan R. Dutton

Bureau of Economic Geology

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