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Environmental Science Institute

Hot Science - Cool Talks # 20

***The Edwards Aquifer:
Will There Be Water for Texas?***

**Dr. John M. Sharp
October 18, 2002**

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The Edwards Aquifer: Will There be Water for Texas?

Dr. John M. Sharp, Jr.
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In Texas

Whiskey is for drinkin'
and water is for fightin'
and if you don't know water
you don't know **JACK**



The Edwards Aquifer

- What is an aquifer?
- Geologic History
- How does water enter the aquifer?
- How does water leave the aquifer?
- Who uses water from the aquifer?
- Issues facing the aquifer



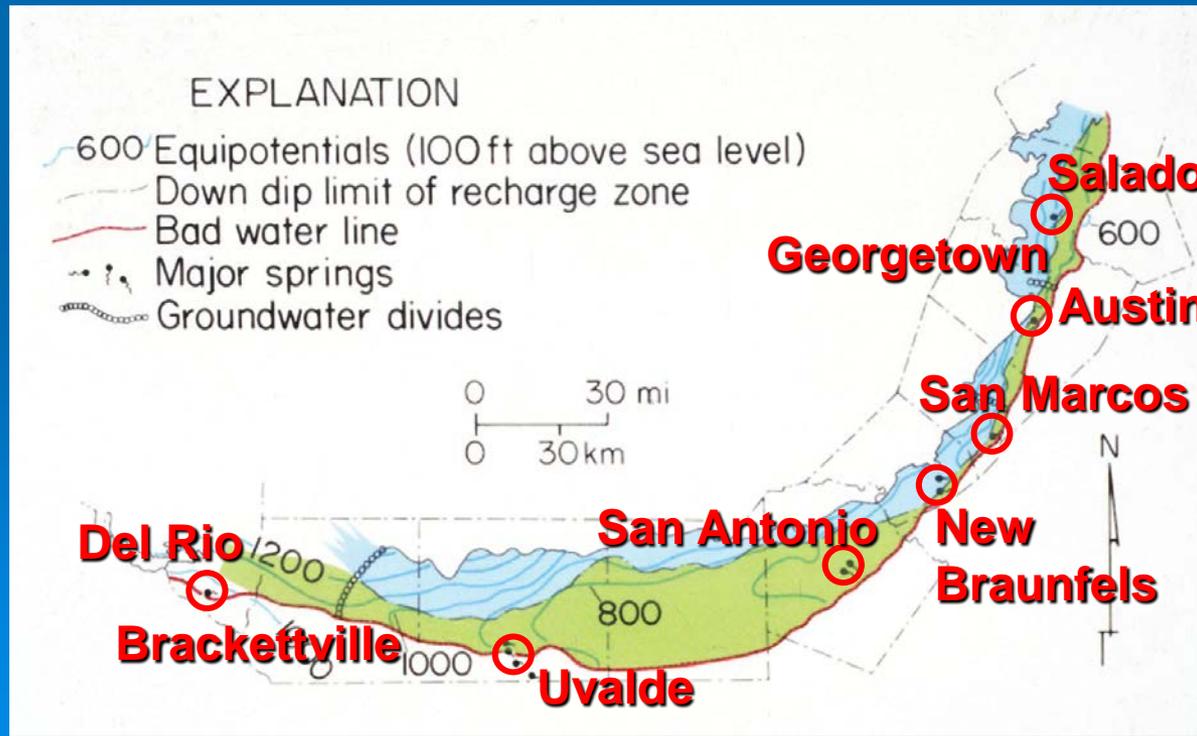
Headline News

Water is always making headlines in Texas. Locally, the Edwards aquifer always seems to be in the news. This is because water is vital to our society.



It's Where We Live

- These springs led to the development of major towns along the aquifer: Salado, Georgetown, Austin, San Marcos, New Braunfels, San Antonio, Uvalde, Brackettville, and Del Rio. All of these towns are sited where major springs discharge from the Edwards aquifer.

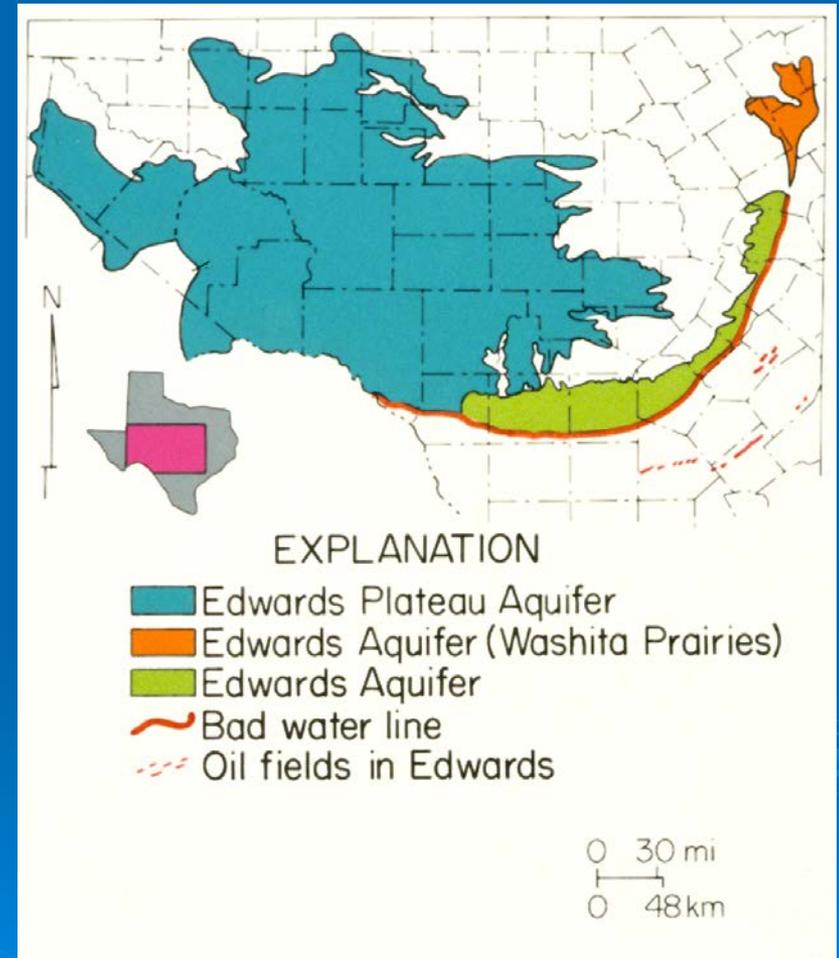


From Barton Springs to the Gulf



What is an aquifer?

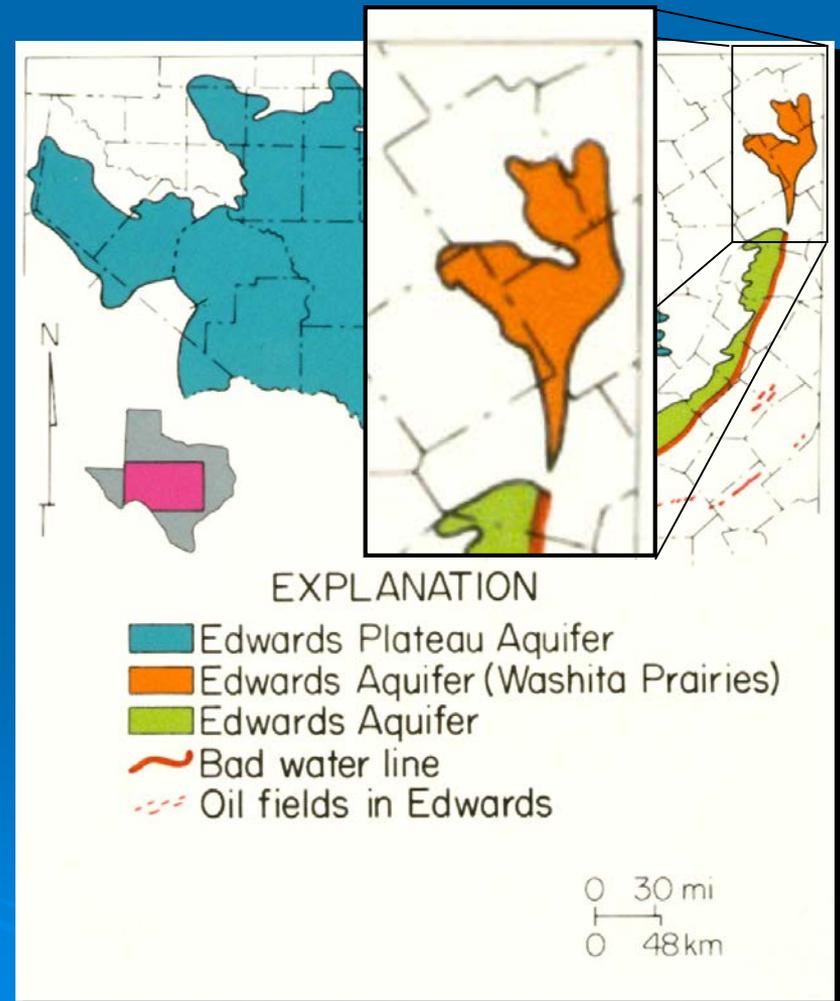
A body of rock, sediment, or soil that contains drinkable water and can transmit this water to wells or springs in economically usable quantities



Related Aquifers in Central and West Texas

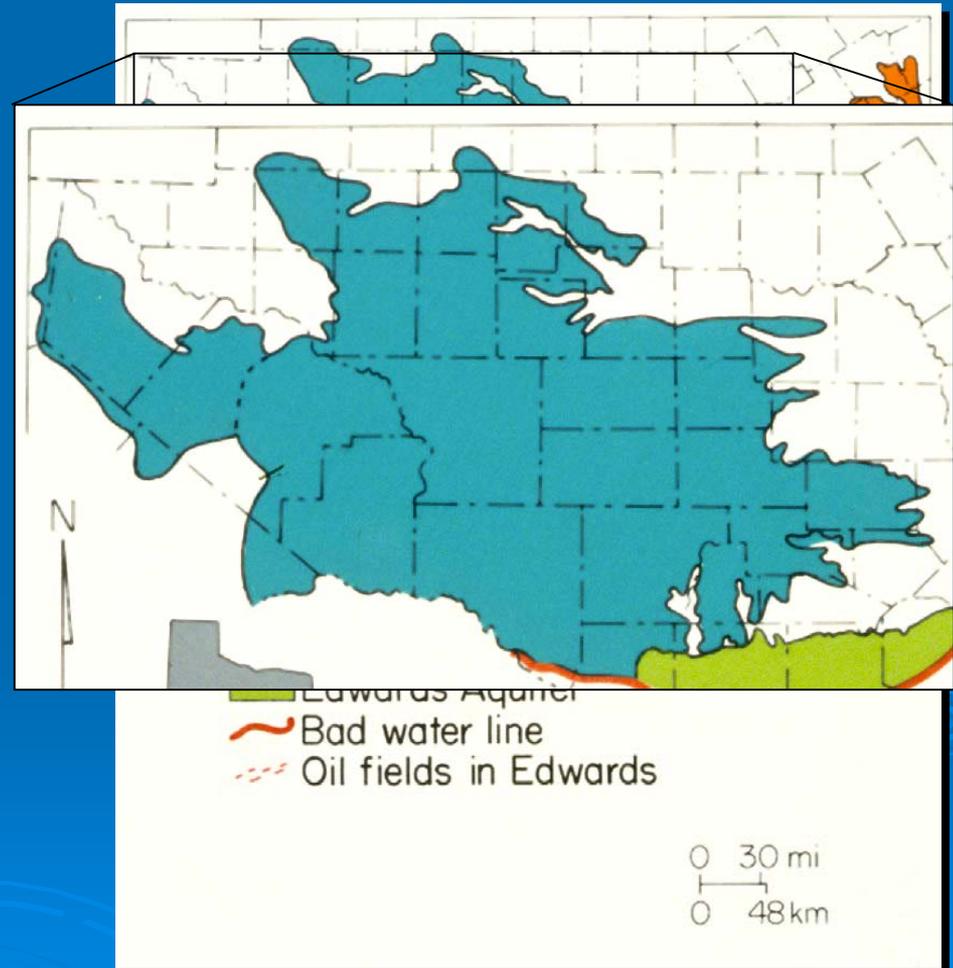
The carbonate rocks that hold the waters form several aquifers:

- The Washita Prairies aquifer near Waco



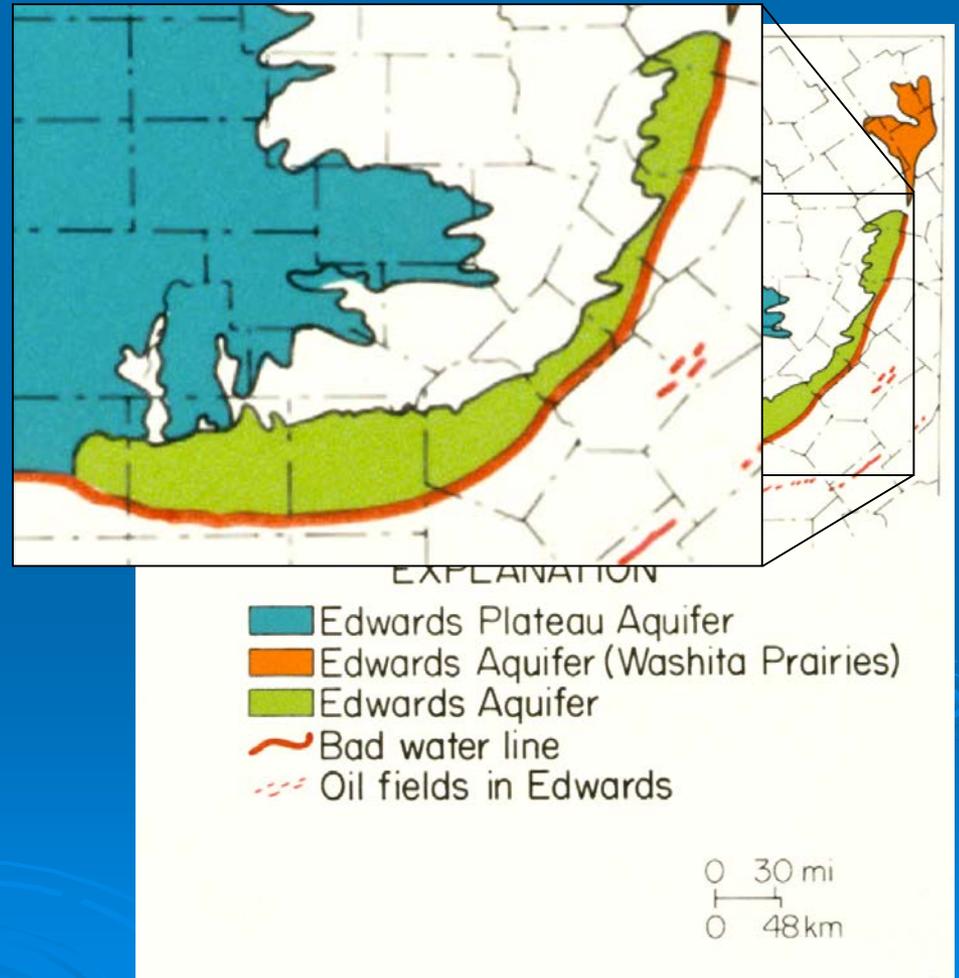
Related Aquifers in Central and West Texas

- The Edwards-Trinity Plateau aquifer (that long, flat stretch between Junction and Fort Stockton along I-10)



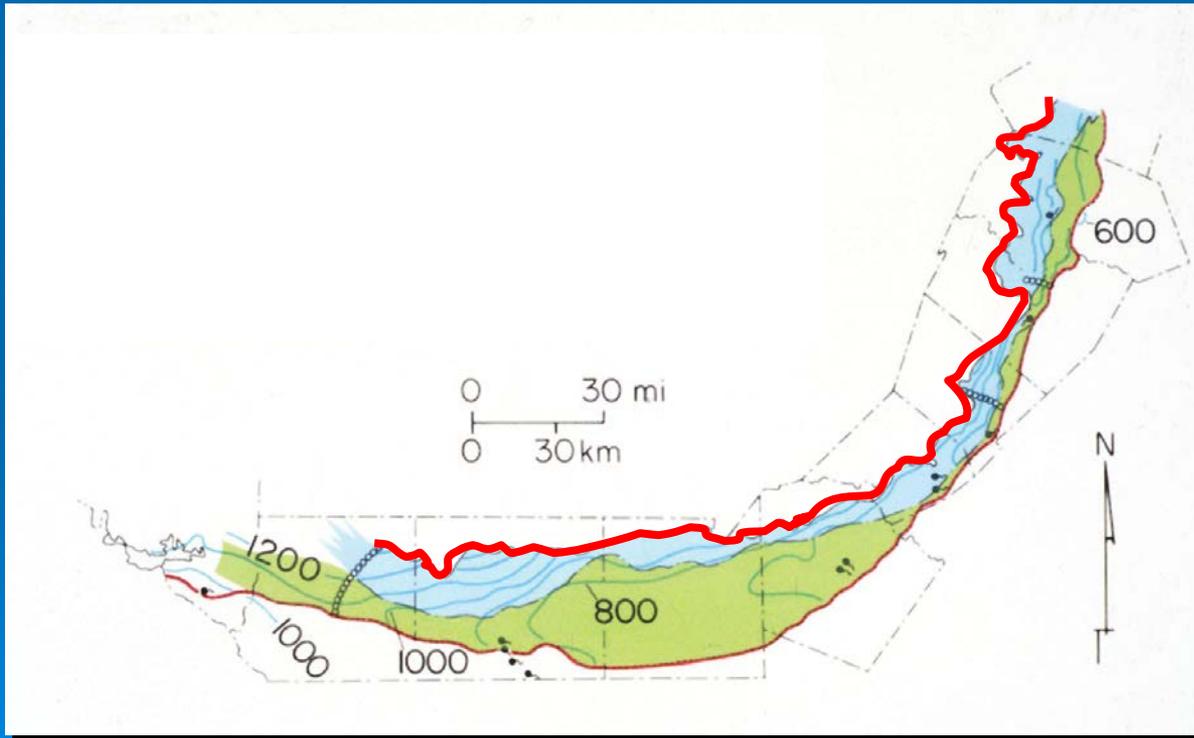
Related Aquifers in Central and West Texas

- The (Balcones Fault Zone) Edwards aquifer, what we refer to as the Edwards aquifer



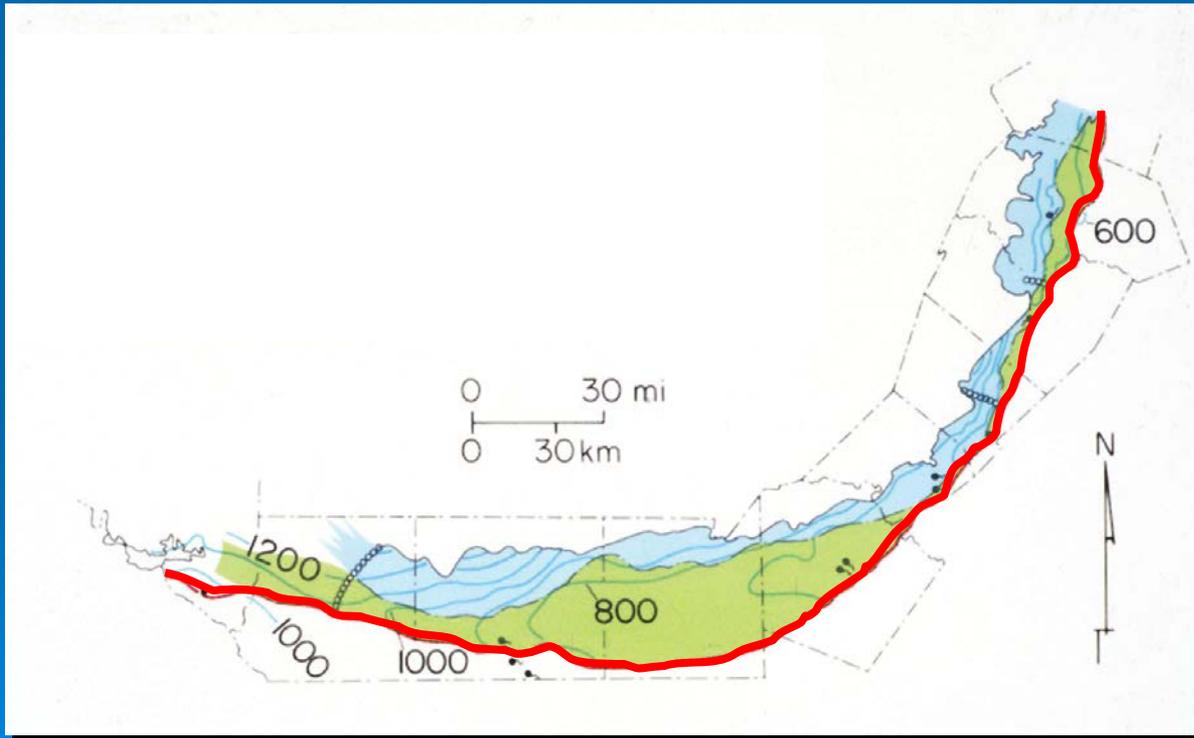
The Edwards aquifer

This narrow band of carbonate rocks extends from Del Rio to Salado, Texas. The boundary along the north and west is where the rocks have been eroded.



The Edwards aquifer

The boundary along the south and east is the badwater line. Waters pumped beyond this boundary are too salty for human consumption.



The Edwards Aquifer

- What is an aquifer?
- Geologic History
- How does water enter the aquifer?
- How does water leave the aquifer?
- Who uses water from the aquifer?
- Issues facing the aquifer



The Rocks

Edwards aquifer rocks formed during the days of the dinosaurs (the Cretaceous Period or between 62 million and 130 million years ago) in a series of reefs and lagoonal deposits.



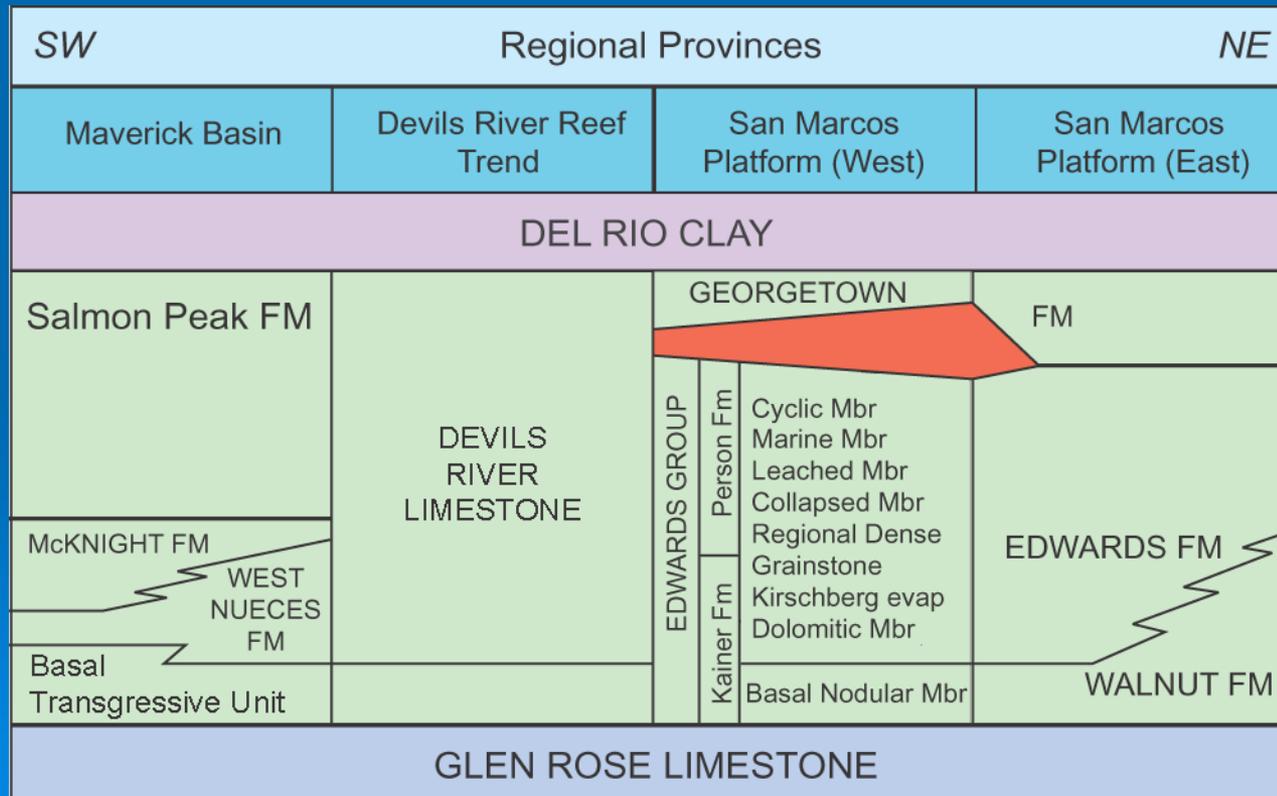
The Rocks

A rudistid clam, one of the chief reef-building organisms of Cretaceous time.



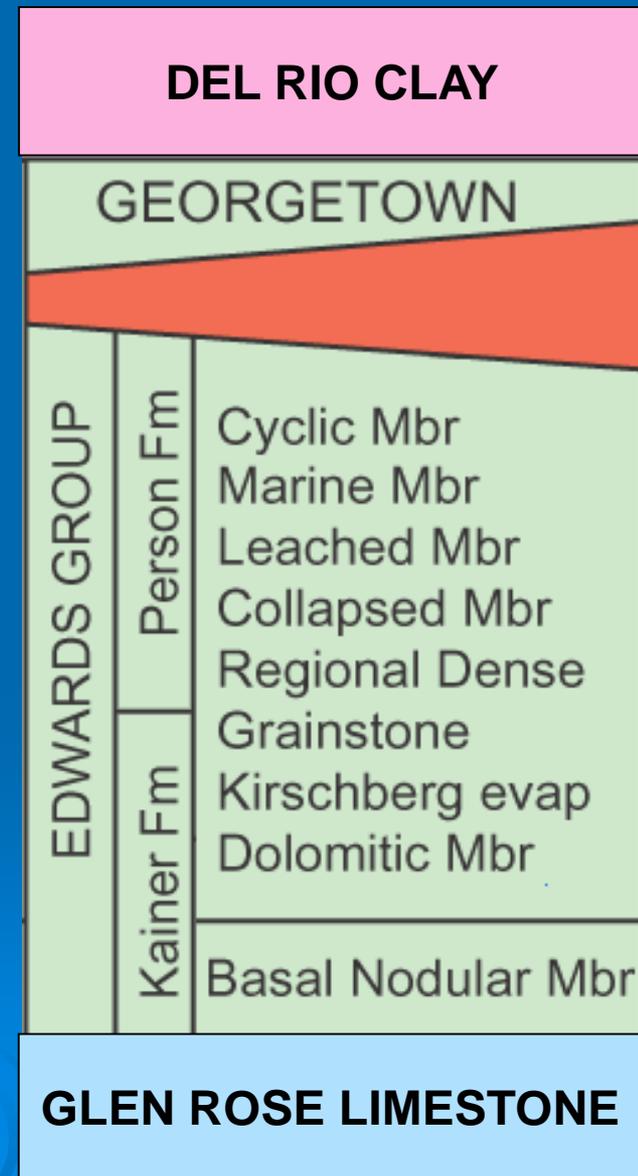
The Rocks

A number of different geological formations host the Edwards aquifer. In Austin, the aquifer rests in the Georgetown Formation and the Edwards Group.



Where's the water?

Water is held in rocks between the Glen Rose Limestone and the low permeability Del Rio Clay.



The Dolomitic Member

GEORGETOWN		
EDWARDS GROUP	Person Fm	Cyclic Mbr
		Marine Mbr
		Leached Mbr
		Collapsed Mbr
		Regional Dense Grainstone
	Kaine Fm	Kirschberg evap
		Dolomitic Mbr
		Basal Nodular Mbr



The Kirschberg Evaporite Member



GEORGETOWN		
[Red wedge-shaped layer]		
EDWARDS GROUP	Person Fm	Cyclic Mbr
		Marine Mbr
		Leached Mbr
		Collapsed Mbr
		Regional Dense Grainstone
	Kainer Fm	Kirschberg evap
Dolomitic Mbr		
		Basal Nodular Mbr

Regional Dense Member



GEORGETOWN		
EDWARDS GROUP	Person Fm	Cyclic Mbr
		Marine Mbr
		Leached Mbr
		Collapsed Mbr
		Regional Dense
	Kainer Fm	Grainstone
		Kirschberg evap
		Dolomitic Mbr
	Kainer Fm	Basal Nodular Mbr

Conduits in the Leached and Collapsed Member

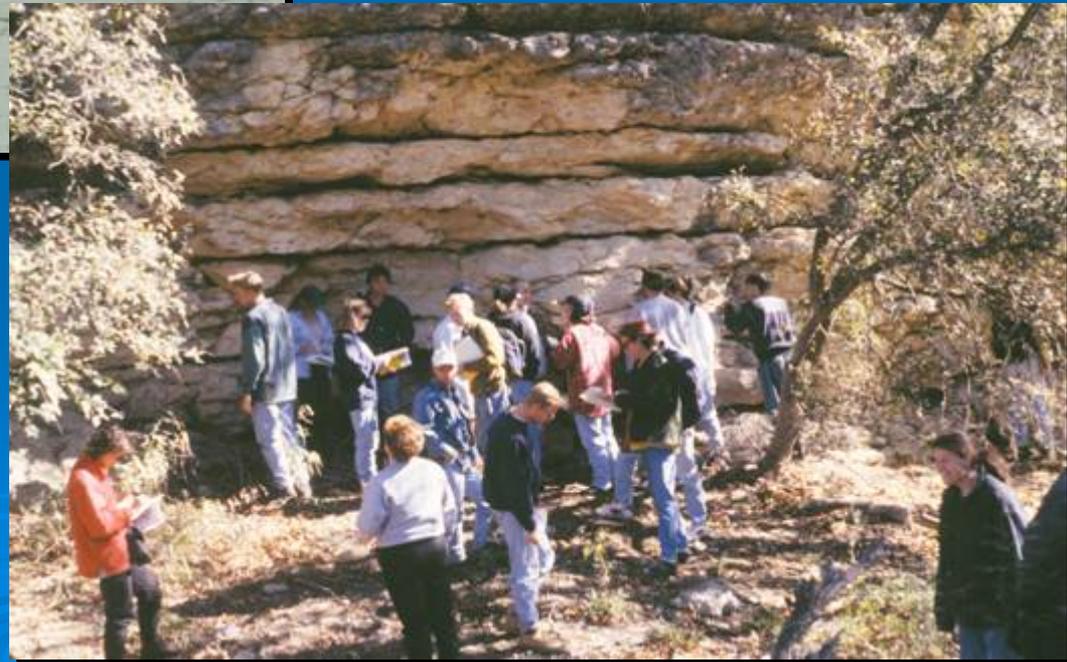
GEORGETOWN		
EDWARDS GROUP	Person Fm	Cyclic Mbr
		Marine Mbr
		Leached Mbr
		Collapsed Mbr
		Regional Dense Grainstone
	Kainer Fm	Kirschberg evap Dolomitic Mbr
		Basal Nodular Mbr



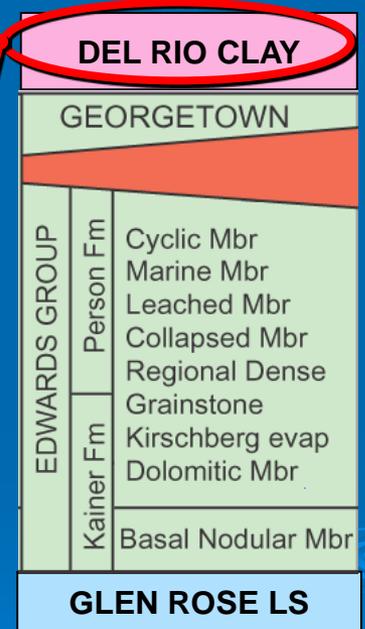
The Georgetown Formation



EDWARDS GROUP		Person Fm	Cyclic Mbr Marine Mbr Leached Mbr Collapsed Mbr Regional Dense Grainstone
EDWARDS GROUP		Kainer Fm	Kirschberg evap Dolomitic Mbr
EDWARDS GROUP			Basal Nodular Mbr



The Del Rio Clay and Overlying Sediments

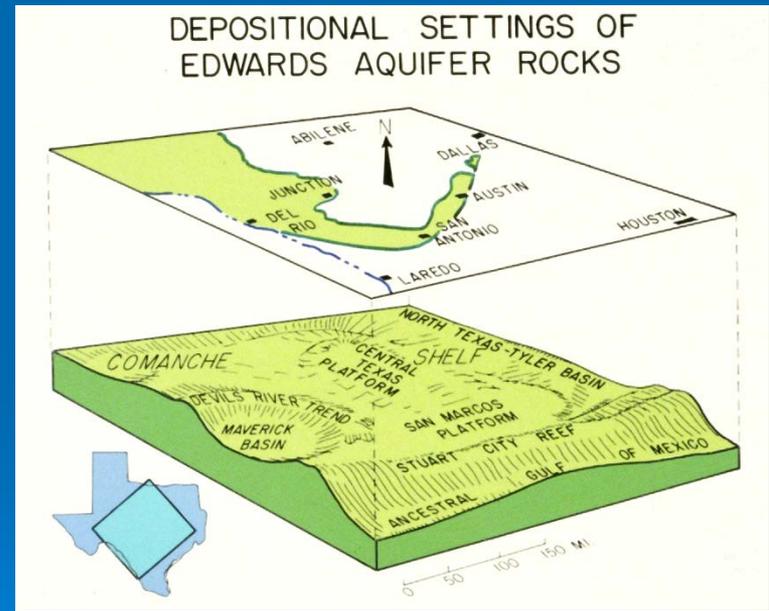


A Little Geologic History

The Edwards aquifer rocks formed on a broad carbonate shelf, flanked by deeper basins in a setting similar to the modern Bahamas.



*Crooked, Acklins Islands, Bahamas
Photo: NASA*



Geologic History

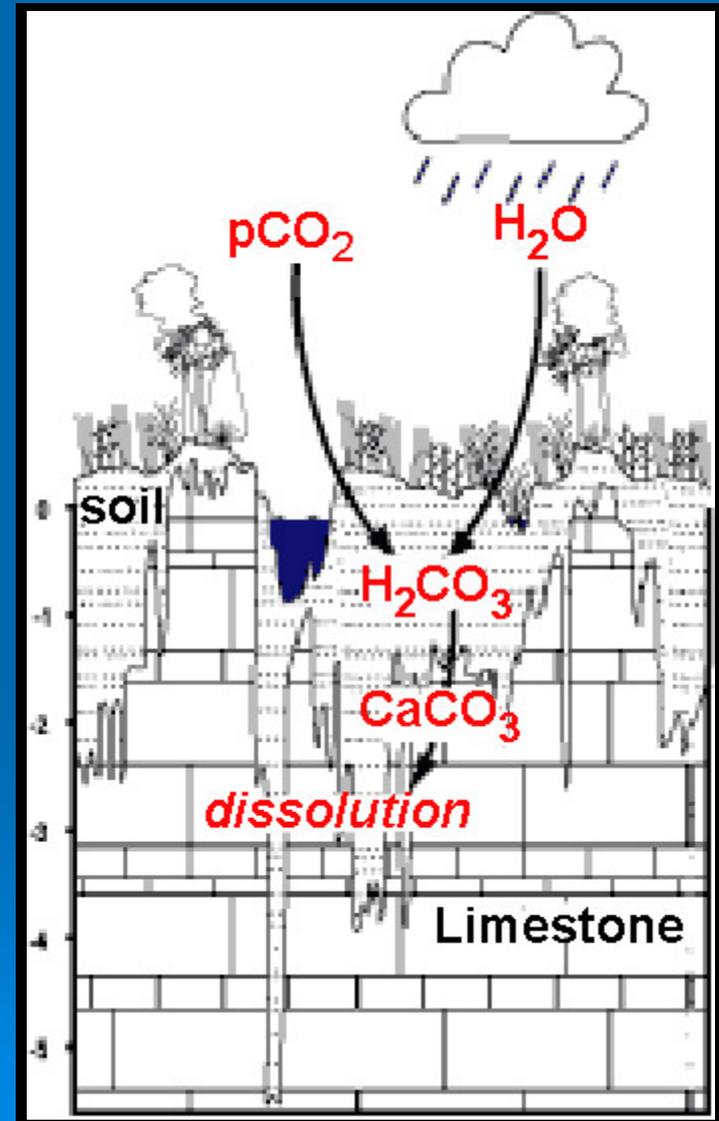
Dinosaurs living in the area left tracks in the emerged muddy tidal flats.



*Dinosaur Valley State Park, Glen Rose, TX
Photo courtesy Texas Parks & Wildlife © 2002*

Geologic History

Rainwater mixed with carbon dioxide in the air and soil, carving the landscape into caves and fissures.



Geologic History

The rocks sank again and more carbonates (the clayey Del Rio, and other rocks) were laid down above aquifer rocks. These include the Austin Chalk upon which much of Austin is built.



Geologic History

In the Miocene (about 17 million years ago), the aquifer rocks were uplifted and faulted (forming the Balcones Escarpment). They again became subject to erosion and dissolution.

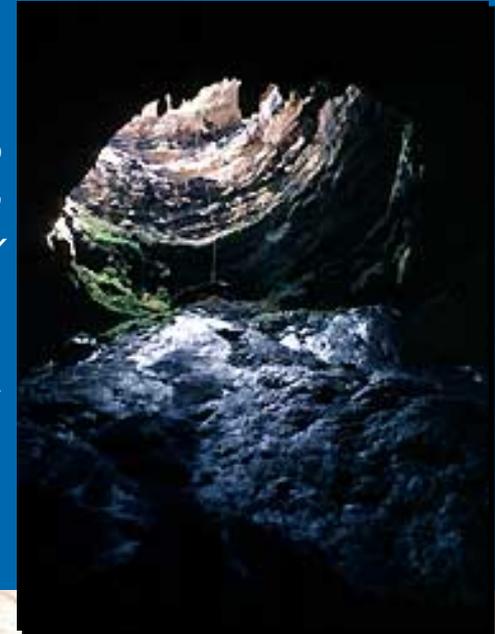


Caves Associated With the Edwards



*Inner Space Cavern
Austin, TX*

*Devil's Sinkhole
State Natural Area
Rocksprings, TX*



*Natural Bridge Caverns
Natural Bridge Caverns, TX*

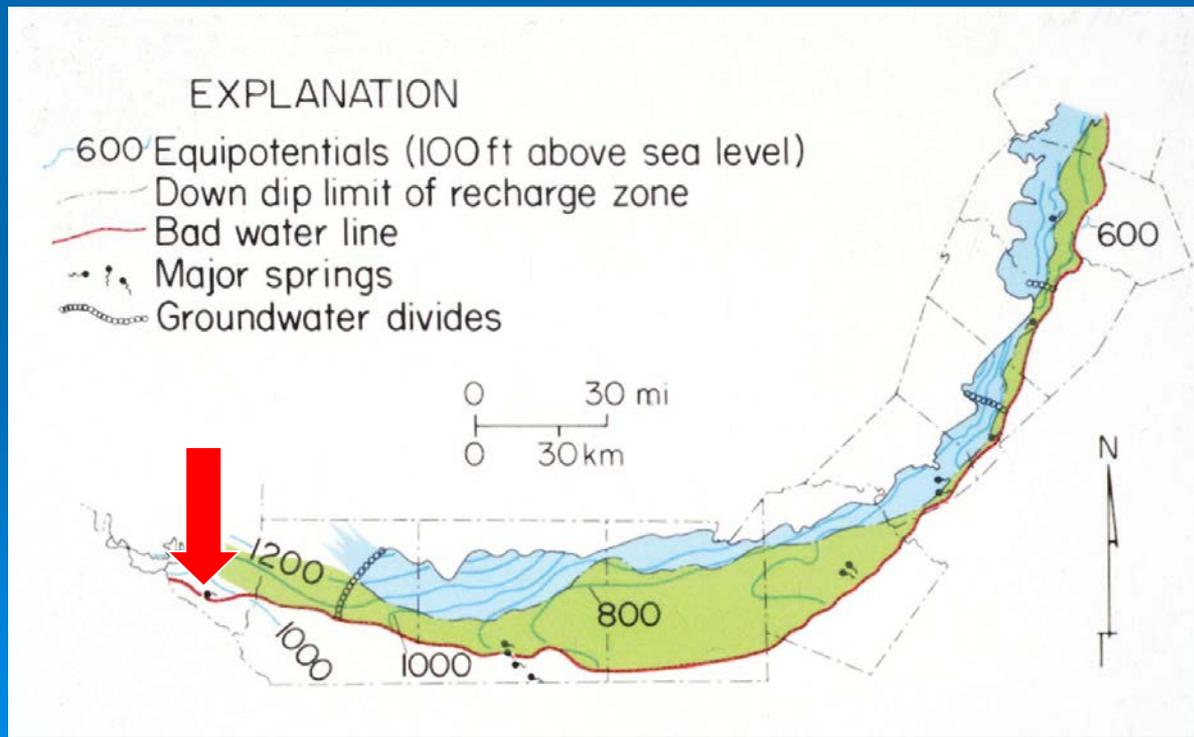


*Kickapoo
Caverns
State Park
Brackettville,
TX*



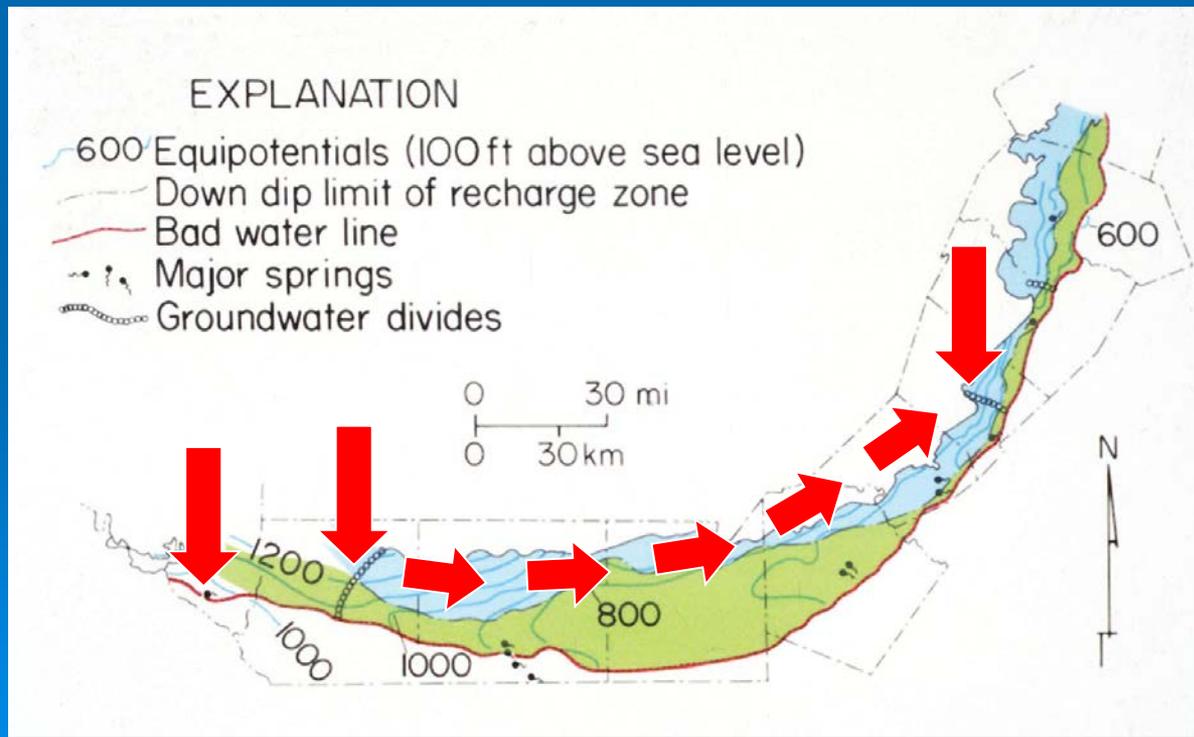
The Edwards Aquifer of Today

- The aquifer contains several flow systems – One occurs near Del Rio



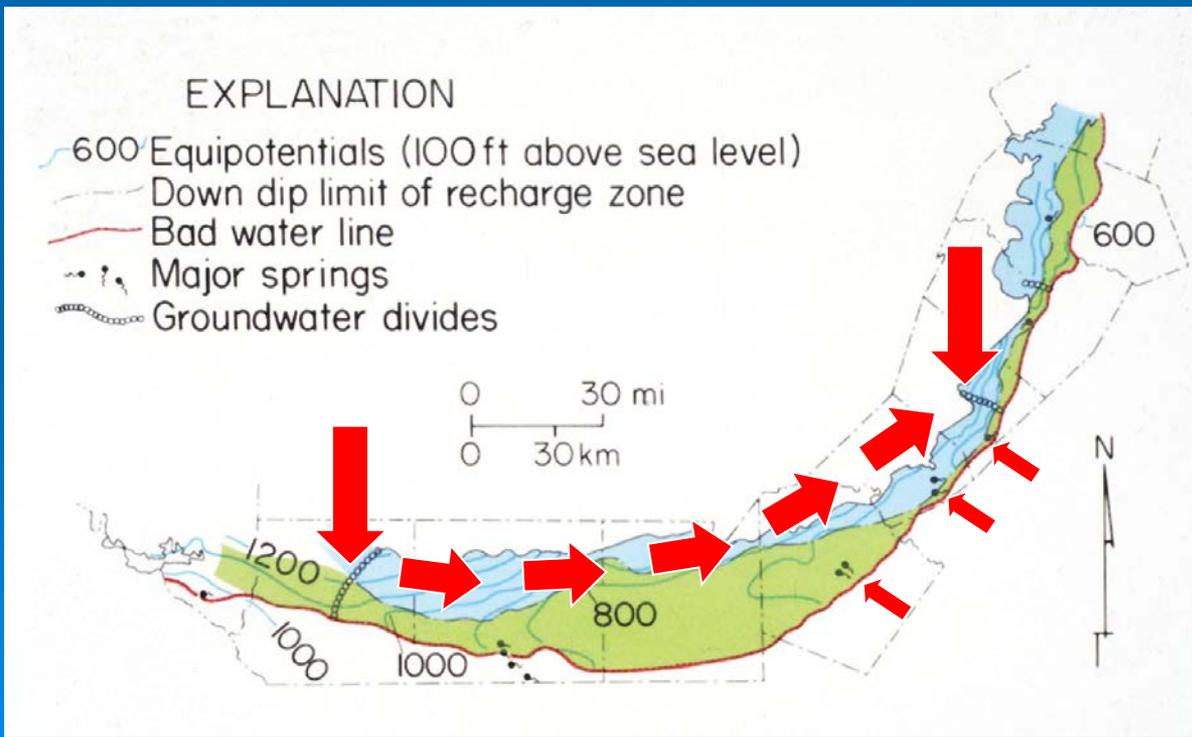
The Edwards Aquifer of Today

- The largest flow system runs from near Brackettville to near Kyle...



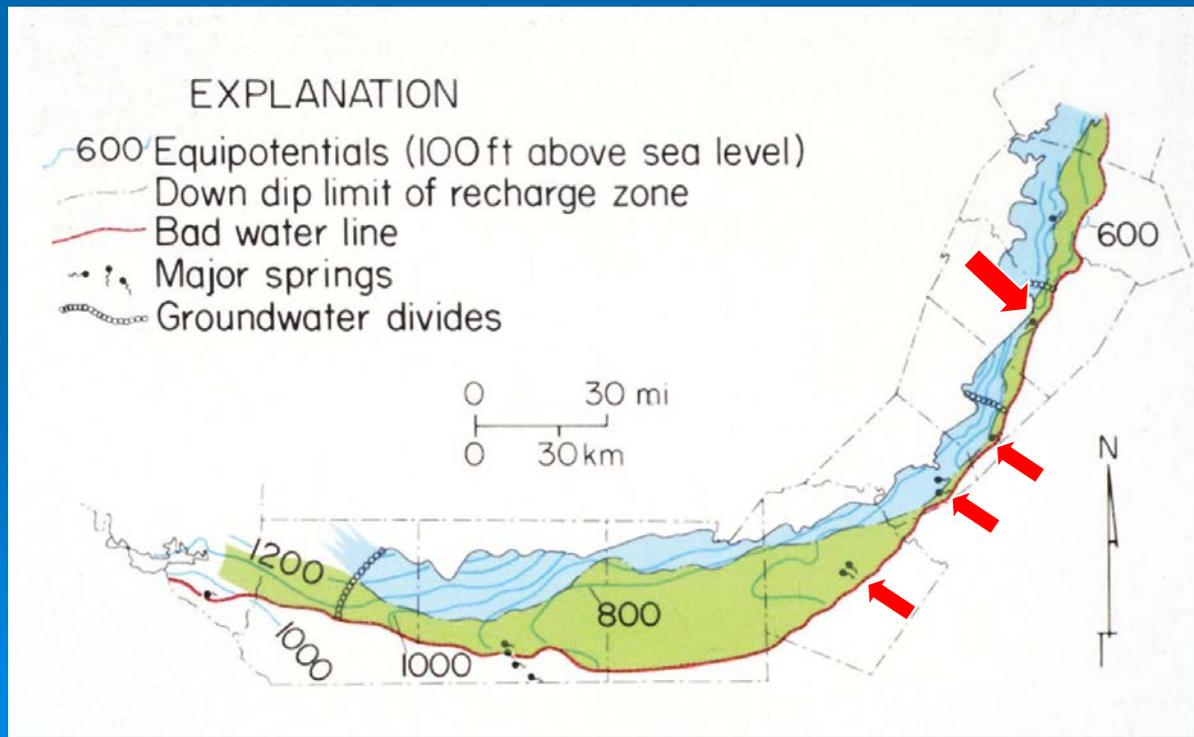
The Edwards Aquifer of Today

- ... and supplies the major springs at San Marcos, New Braunfels, and San Antonio.



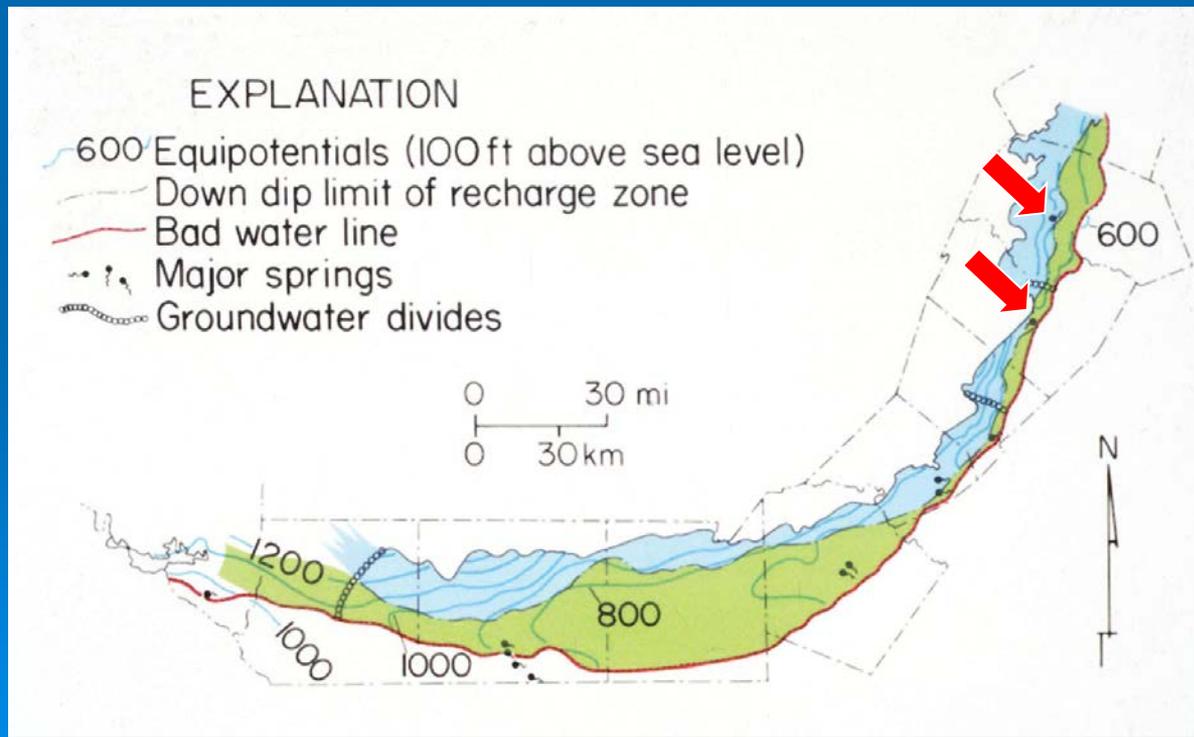
The Edwards Aquifer of Today

- Smaller flow systems include the Barton springs flow system...



The Edwards Aquifer of Today

- ...and areas north of the Colorado River .



The Edwards Aquifer

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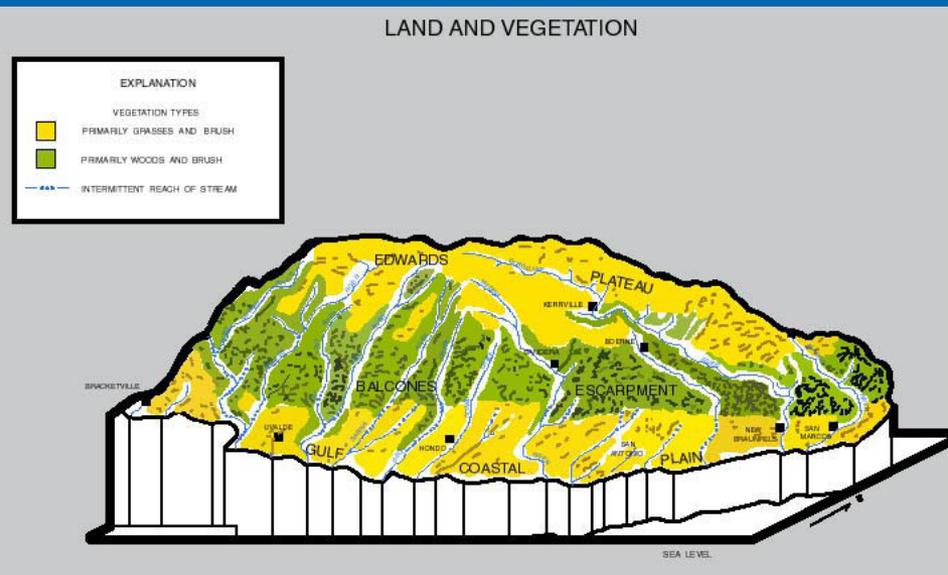


How does water get into the aquifer?

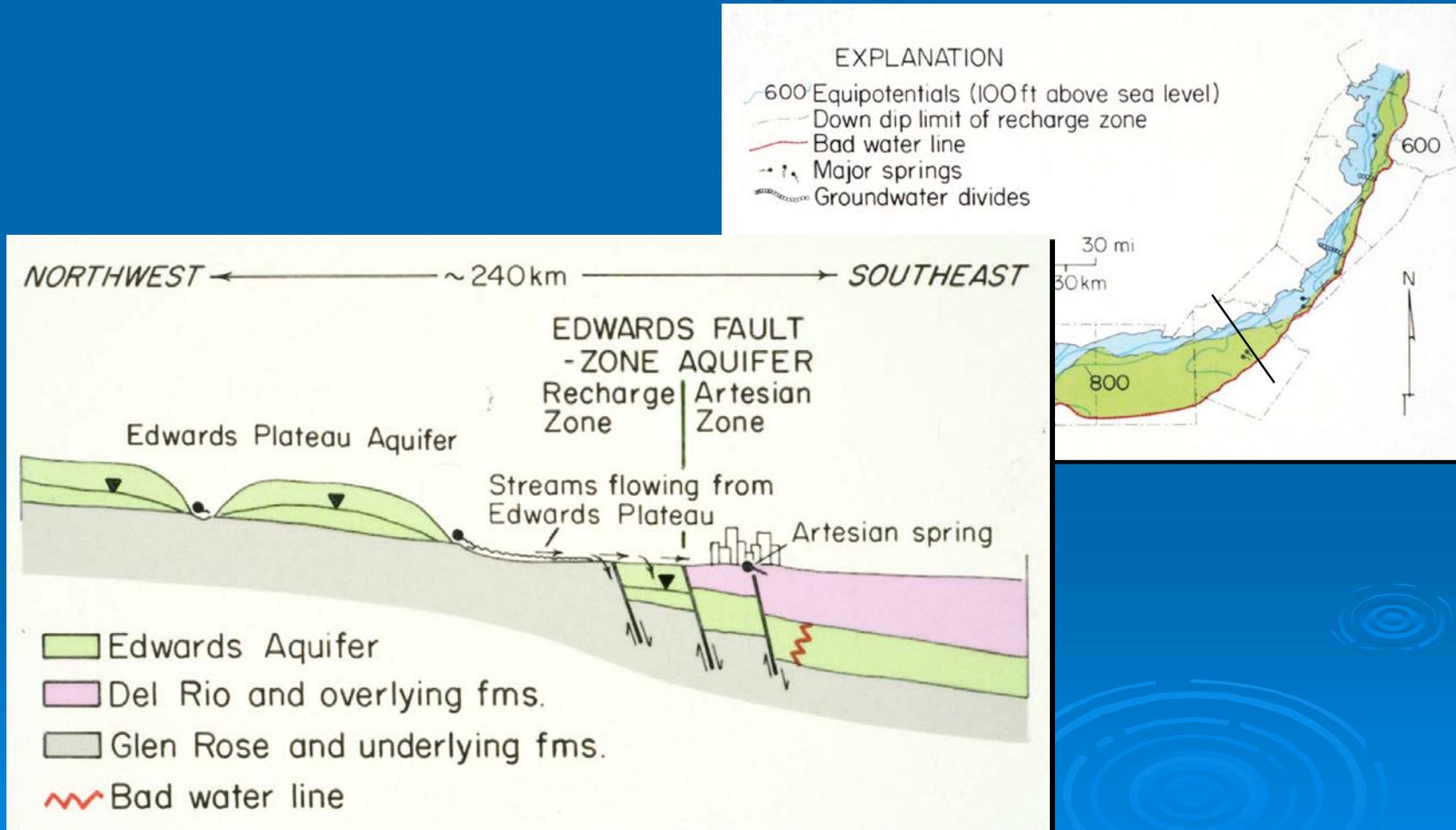
- Water enters the aquifer through faults, fractures, sinkholes, or percolation through the soil. This process is called *recharge*.



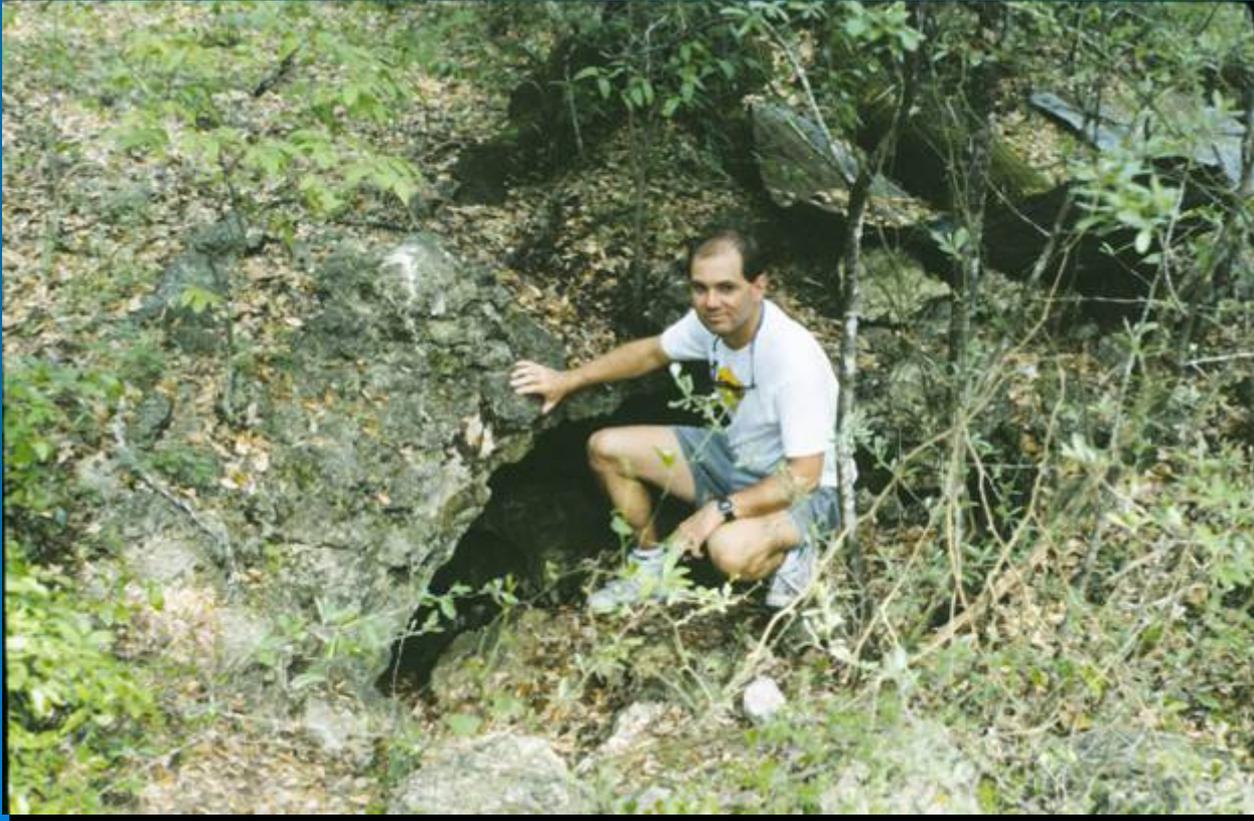
- The *recharge zone* is the area where water enters the aquifer.



Cross Section of the Edwards aquifer



Recharge Feature in South Austin



Antioch Cave



Marbridge Ranch





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- 

Big Boiling Springs Salado, TX

EXPLANATION



Barton (main) Spring Austin, TX

EXPLANATION



San Marcos Springs

San Marcos, TX

EXPLANATION



Comal Springs New Braunfels, TX

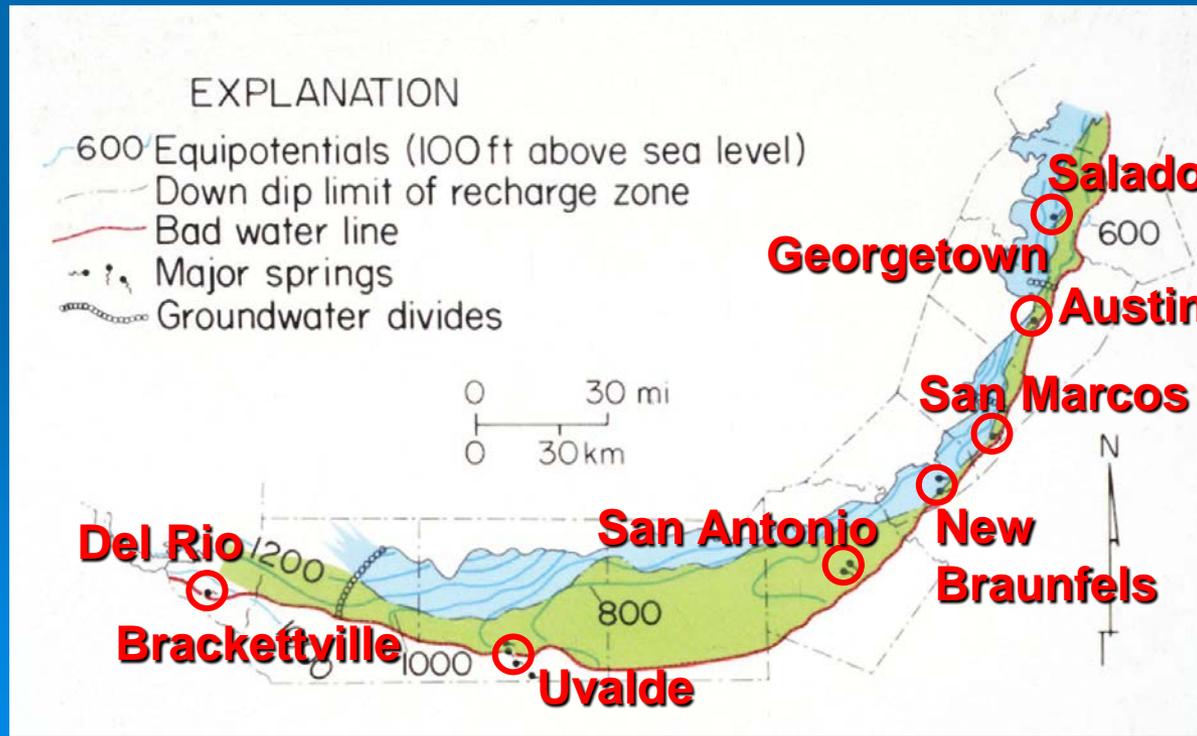


San Felipe Springs Del Rio, TX



It's Where We Live

- These springs led to the development of major towns along the aquifer: Salado, Georgetown, Austin, San Marcos, New Braunfels, San Antonio, Uvalde, Brackettville, and Del Rio. All of these towns are sited where major springs discharge from the Edwards aquifer.



Wells

Catfish Farms Well is a Texas-sized well. It was the greatest flowing well in the world. Over time aquifer discharge by wells has increased and spring flows have decreased.



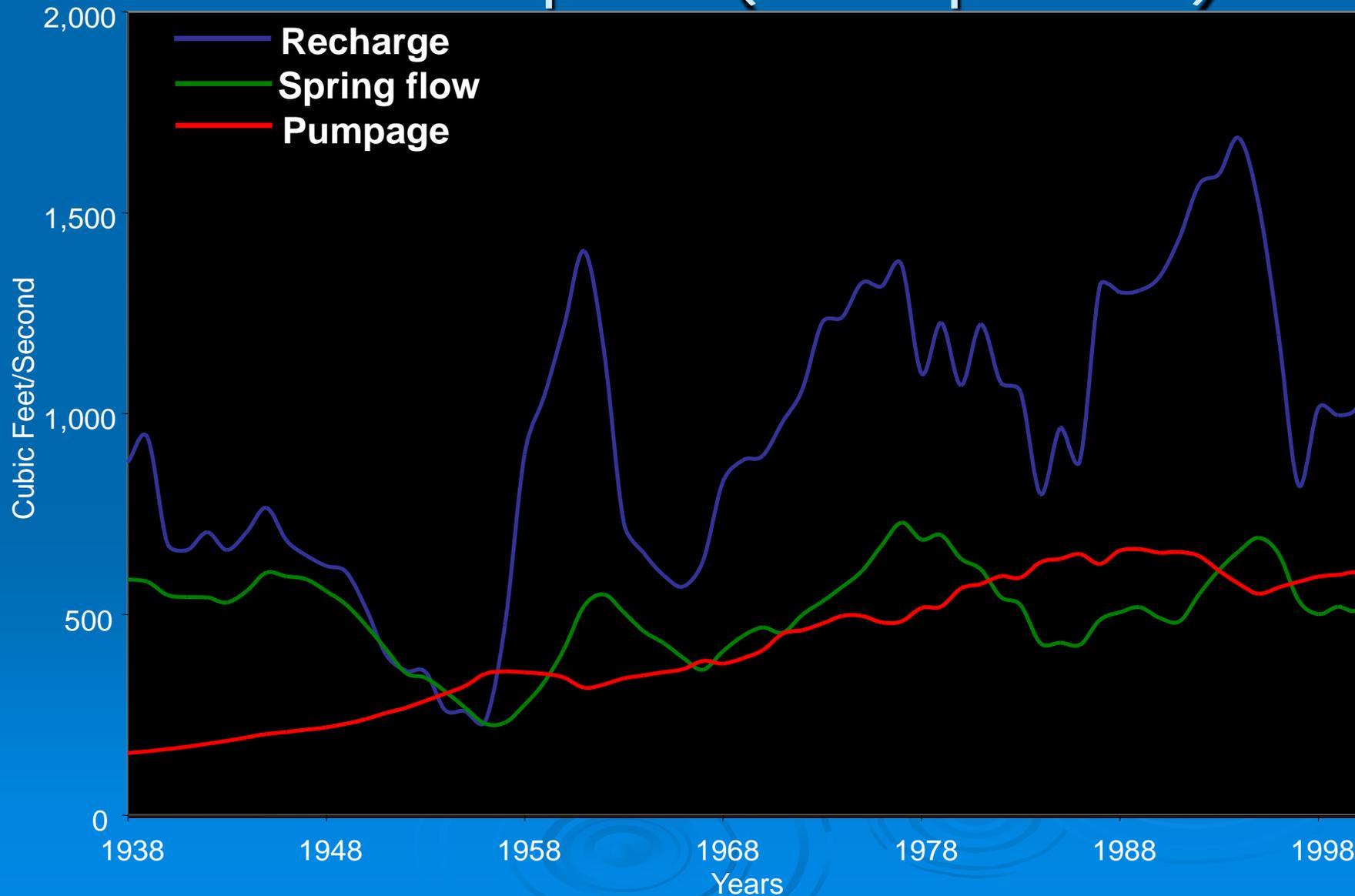
Photograph (C) 1995 by Gregg A. Eckhardt

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Historical Changes in the Edwards aquifer (1938-present)

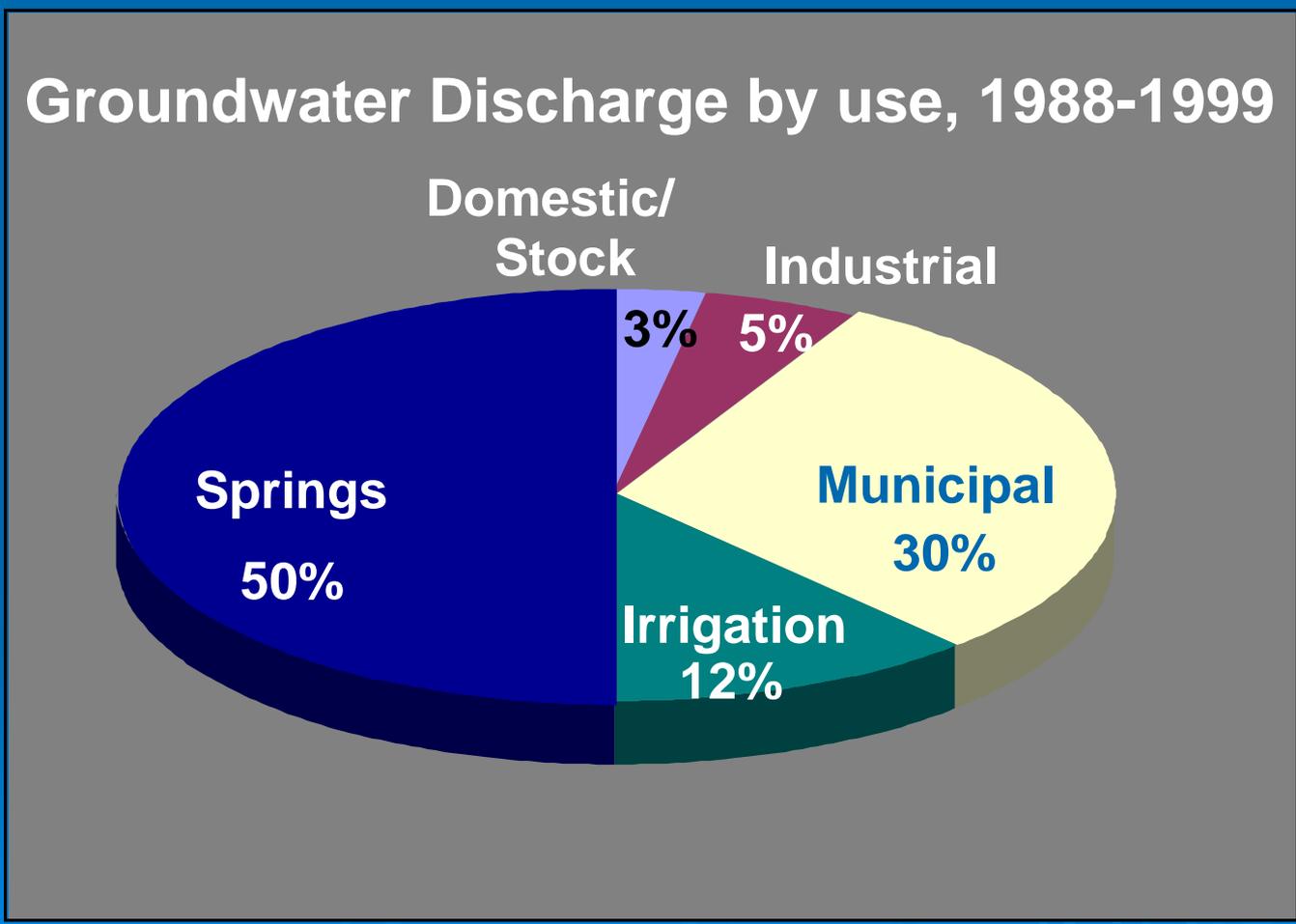




Who uses the aquifer's waters?

- Municipal Users (San Antonio, San Marcos, etc.)
 - Agriculture (irrigation)
 - Industrial
 - Recreational
 - Fish and Wildlife
 - Downstream Surface Water Users
 - Fisheries and flow to estuaries
 - Reservoirs for water supply
 - Irrigation
 - Recreation
- 

Who uses the aquifer's waters?



Source: The Edwards Aquifer Authority

Municipal and Industrial Users

- Population growth and economic development require water (e.g. the exploding population along the I-35 corridor in San Antonio, New Braunfels, San Marcos, and Austin)
- Few suitable, affordable reservoir sites exist
- Excess storage in the aquifer could be mined during dry years, then recover during wet years



A growing megalopolis stretches from Salado to beyond San Antonio

Both the industries and



the people dwelling here
now and in the future
need water.

Agricultural Users

- Have been farming the land for generations
- Have legal rights to aquifer ground water by either riparian or appropriative doctrines
- Don't want water metering!
- Dry land farming, stock raising less lucrative than irrigation farming



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Questions

- What is the best use of aquifer water?
- Is it possible to establish a market for water rights?
- Social costs?



Answers?

- Irrigated fields in Texas can be very productive.



- But heavy usage has reduced spring flows that are also important recreationally, esthetically, and for certain species native to the springs.

Austin Blind Salamander (*Eurycea waterlooensis*)

Comal Springs



Barton Springs



Goals of Springflow Users

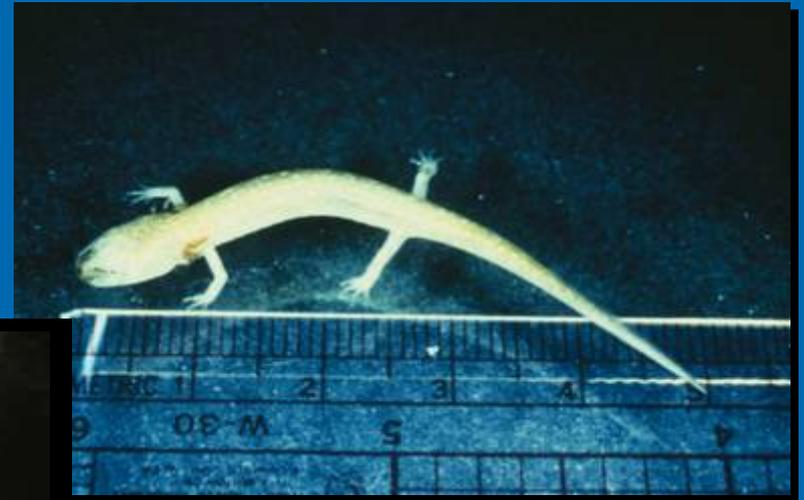
- Protect endangered species at the Springs.
- Preserve recreational/esthetic and environmental aspects.
- Suggest that new/other users shift to surface waters.
- Maintain springflow.



Concerns

- Are there alternative means of saving endangered species?
- Who pays?
- Can springflow augmentation or enhanced recharge prevent or reduce negative consequences? Who pays for this?

Barton Springs



Barton Springs salamander
(Eurycea sosorum)

San Marcos Springs Orifice

- How much water is required to preserve the species?



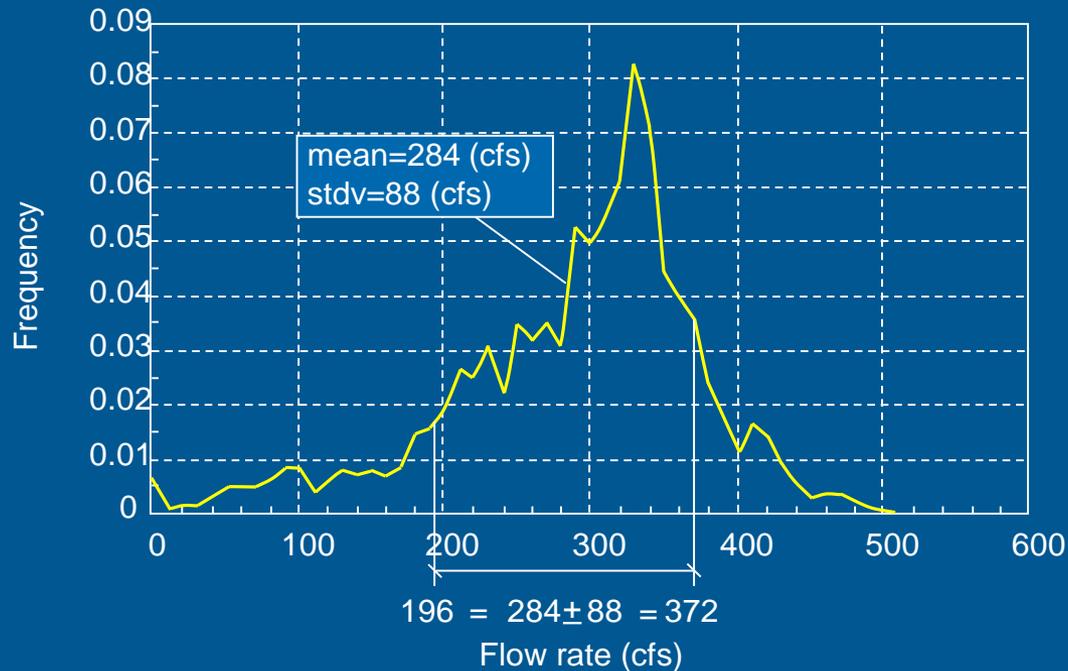


Take limit flows at San Marcos and Comal Springs

- San Marcos Springs
 - ◆ Fountain Darter – 100 cubic feet per second (cfs)
 - ◆ Texas Wild Rice – 100 cfs
 - ◆ San Marcos Salamander – 60 cfs (upwelling flow from orifices?)
 - Comal Springs
 - ◆ Fountain Darter
 - 200 cfs
 - 150 cfs if the Ramshorn Snail can be controlled
- 

Histogram of Comal Springs.

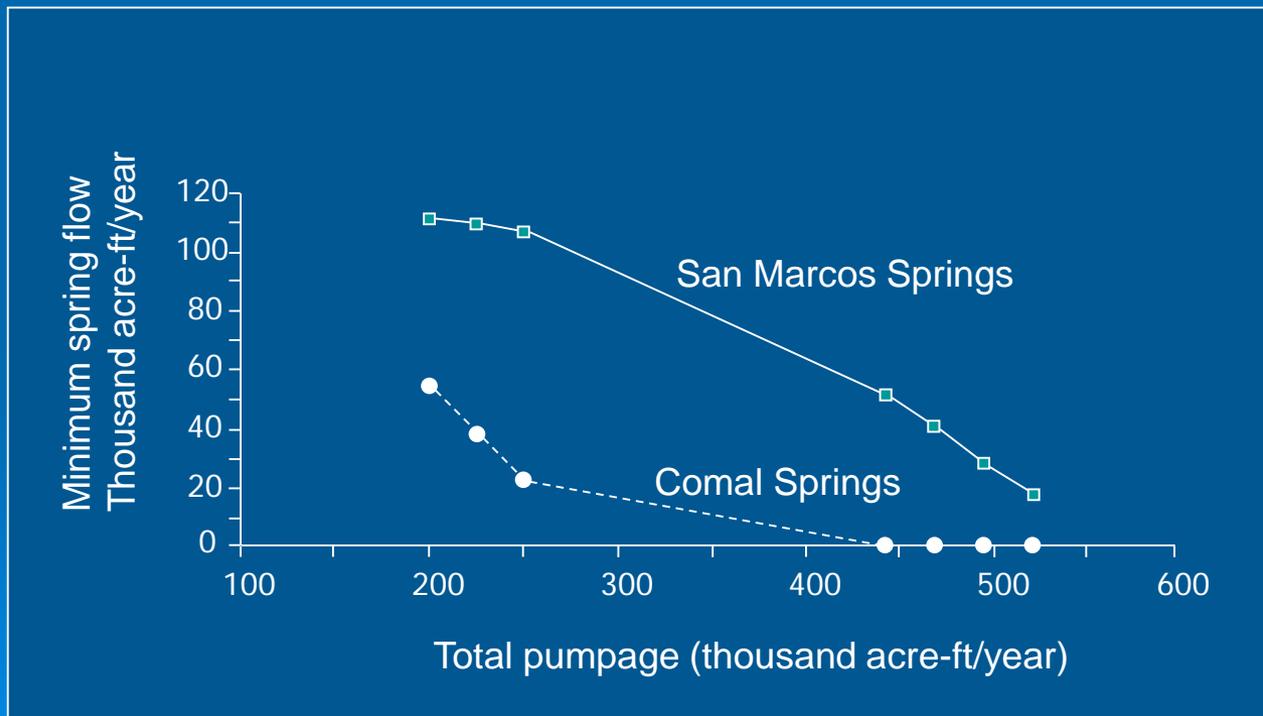
- We are already beneath the take limits for parts of the historical record.



Histogram of the historic daily flow at Comal Springs (1929 - 1992)

Springflow vs. Pumpage During Average Years.

- More pumpage for more people means lower springflows



Views of Downstream Users





Management of the Edwards aquifer is crucial to the development of Central and South Central Texas and is crucial to our environment. We don't have all the facts.





Hydrogeological Unknowns

- What are the actual flow paths and travel times?
 - How much cross-formational flow?
 - Where precisely does recharge occur?
 - What hydrogeological parameters must we ascertain for proper land use development?
 - Can we extract (pump) waters in a more optimal manner?
 - ◆ Use more in times of drought?
 - ◆ Pump equivalent amounts with fewer detrimental effects?
- 

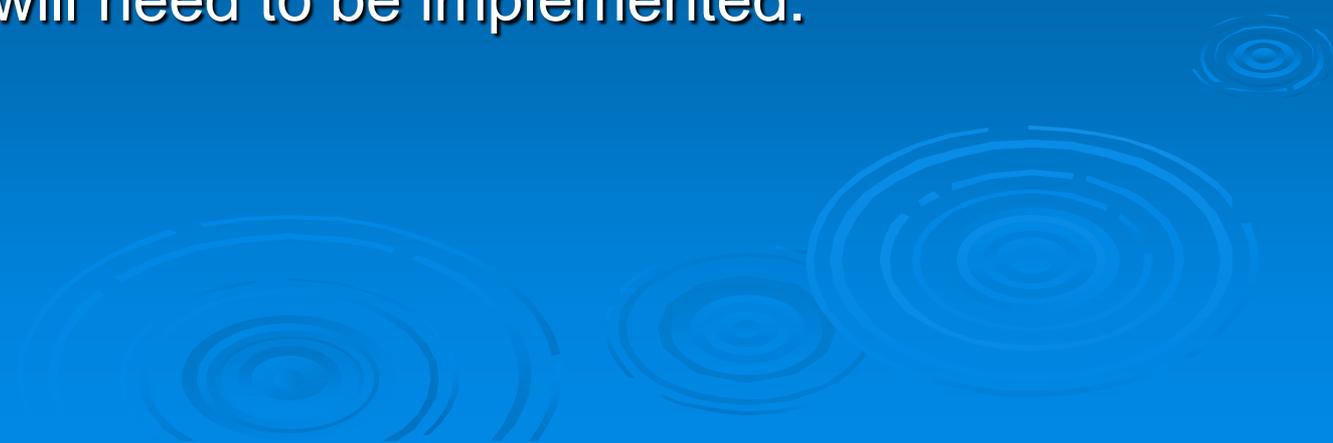


Political Unknowns

- Will we still subsidize growth in Austin and San Antonio over growth in Beaumont and Port Arthur?
 - Who will pay to provide water to Edwards users?
 - Will growth restrictions be imposed?
 - Will we market water rights (like Colorado)?
 - Will the endangered species law continue to be the “biggest gun” in this water battle?
 - Will the state (in its wisdom or lack thereof) allocate our waters?
- 
- 
- 



Conclusions

- The aquifer has a long term balance (1934-2002) between recharge and discharge
 - Periods of extended drought with present population or projected increases in use will create problems for aquifer users.
 - New management policies and new, probably expensive, technologies will need to be implemented.
- 

In other words...

We have to manage the Edwards aquifer and other Texas water resources to meet the needs of our society now and in the future.



TAP Statement

“...the greatest danger to the...aquifer would be a failure to effect prudent, conjunctive management while there is yet time to prevent a crisis from developing...because continued growth...increases the risk that effective [management] measures cannot be implemented rapidly enough in periods of drought to prevent...serious consequences. Regional management of the aquifer and associated river systems seems necessary if use and impacts are to be reconciled prudently.”

*Technical Advisory Panel Report
February 1990*

Barton Springs



Barton Springs



Barton Springs





Dr. John M. Sharp

Professor, Department of Geological Sciences

Dr. John M. Sharp is a professor and hydrogeologist at the University of Texas at Austin who is interested in the Trans-Pecos region of Texas.