

U.S. Mexico Water Resources: The Rio Grande/Rio Bravo example





12 Great Rivers of North America: The Rio Grande is the fourth-longest river in North America (1,885 miles, 3,034 km). It begins in the San Juan Mountains of southern Colorado, then flows south through New Mexico. It forms the natural border between Texas and Mexico as it flows southeast to the Gulf of Mexico.

In Mexico it is known as Rio Bravo del Norte.

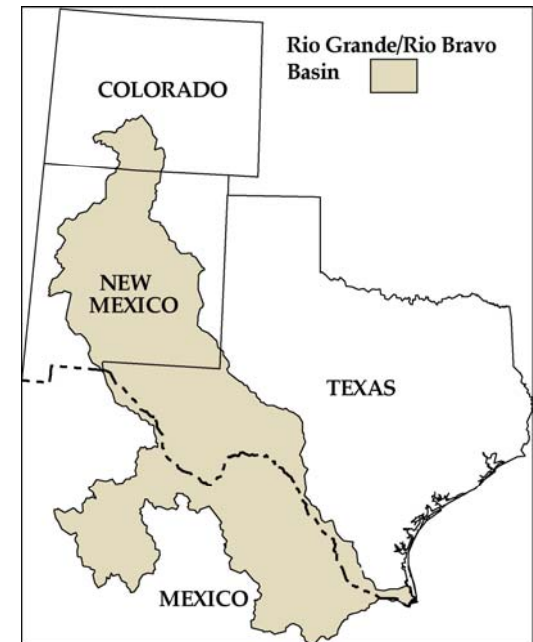
<http://www.worldatlas.com/webimage/countrys/nariv.htm>

Rio Grande: One river or two?

- Shared between two nations
- Has two names
- Basin did not become integrated (the entire river system did not connect) until recently (a few hundred thousand years ago)
- Today the river again does not flow uninterrupted to the sea
- Upper Rio Grande and Lower Rio Grande/Rio Bravo
- Should be renamed Rio POCO or Rio Importante?

Topics to be discussed

- Human History
- Geologic Evolution and Hydrology of the Upper Rio Grande
- Water Resources in the 21st Century: The Challenges facing the Lower Rio Grande



History to 1850 A.D.



World Heritage Sites in the U.S.

<http://whc.unesco.org/heritage.htm>

***Mesa Verde** (SW Colorado; 6th to 12th Century
Anasazi ruins)

Yellowstone

Grand Canyon National Park

Everglades National Park

Independence Hall

Redwood National Park

Mammoth Cave National Park

Olympic National Park

***Cahokia Mounds State Historic Site** (NE of St.
Louis; 9th-15th century)

Great Smoky Mountains National Park

La Fortaleza & San Juan Historic Site Puerto Rico

Statue of Liberty

Yosemite National Park

Monticello and University of Virginia in Charlottesville

***Chaco Culture National Historic Park** (NW New
Mexico; 850-1250 A.D.)

Hawaii Volcanoes National Park

***Pueblo de Taos**

Carlsbad Caverns National Park (N. New Mexico)

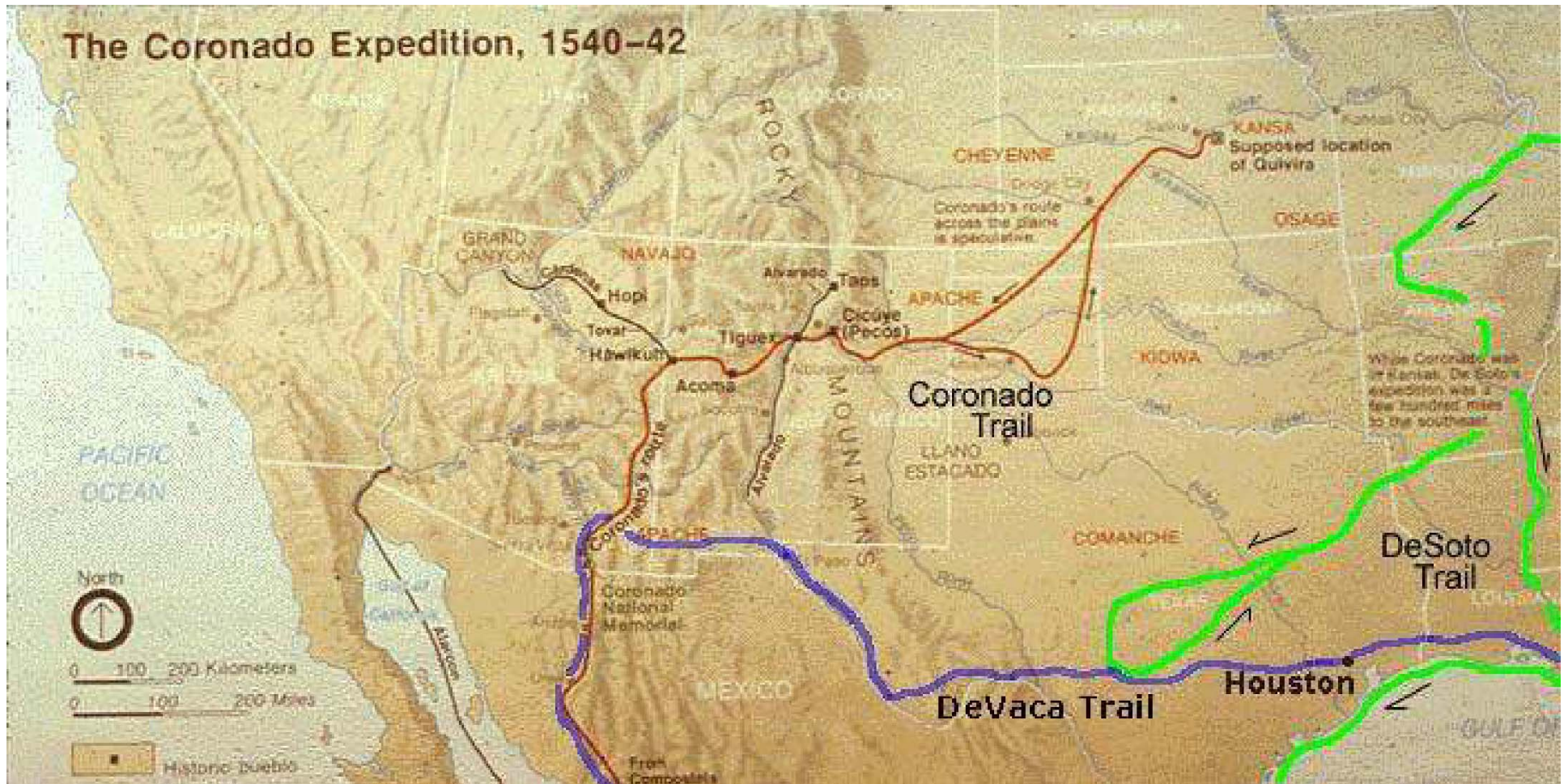
* Native American sites



Alonso Alvarez at the mouth of the Rio Grande -1519

When Spanish explorer Alonso Alvarez discovered the Rio Grande in 1519, the river's mouth was more than 30 feet deep and Alvarez sailed nearly 20 miles up the river without running out of room to tack his four ships. As late as 1907, steamships carried passengers and cargo 100 miles up the river, while river cities like Brownsville and Matamoros were thriving ports. But now all that's left at the mouth of the 1,885-mile Rio Grande is a still and shallow lagoon of algae-green water that stops several hundred yards from the ocean.

Cabeza de Vaca: First European to Cross the Rio Grande upstream



Cabeza de Vaca (1528 Tampa Bay FL to 1536 Sinaloa, Mexico). His tales of the Zuñi and their villages, the legendary Seven Cities of Cíbola, encouraged other expeditions to the north, particularly those of the explorers Hernando de Soto and Francisco Vázquez de Coronado. <http://www.vaca.com/coronados-trail.html>

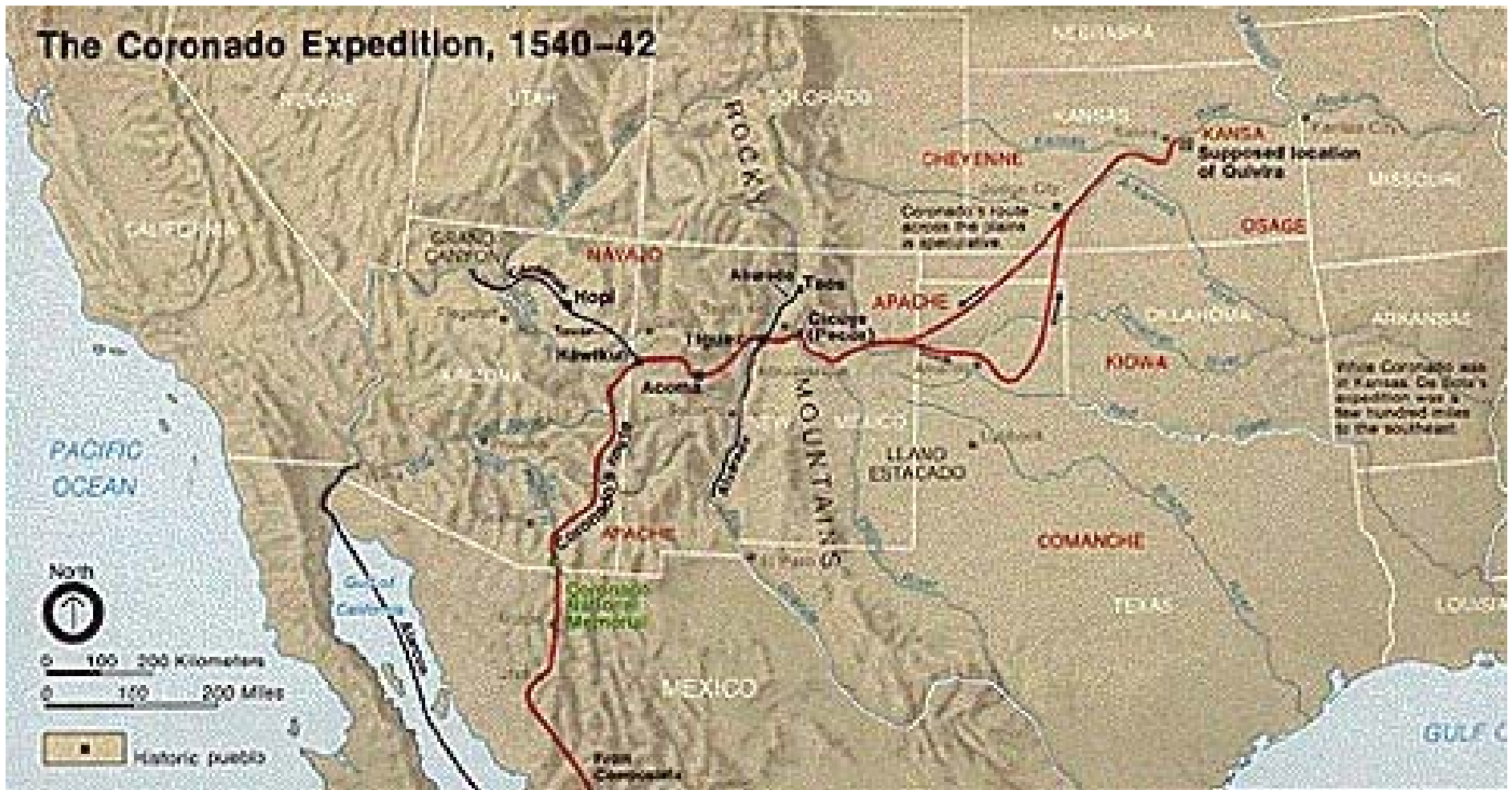
Cabeza de Vaca & Coronado

1536 Cabeza de Vaca and three other men return to Mexico after 8 years of wandering from Florida to the Pacific. He is the first European to see bison and the first to cross the Rio Grande.

1538 Fray Marcos de Niza, a Franciscan friar, is sent to explore the lands to the north of Mexico, guided by Esteban, the African who had accompanied Cabeza de Vaca. Within a year, Marcos returns with news of a great city called Cibola, which from a distance appeared to him "bigger than the city of Mexico."

1540 Francisco Vasquez de Coronado leads 300 conquistadors and more than one thousand Indian allies to conquer Cibola. This is the Zuni Pueblo of Hawikuh (in western New Mexico).

1540 Lopez de Cardenas, an officer in Coronado's army, sets off to investigate Hopi reports of a great river to the west. After a 20-day trek, Cardenas becomes the first European to see the Grand Canyon.



1540 Coronado moves his camp to the upper Rio Grande. In August some of his party reach Taos pueblo.

1542 Coronado returns to Mexico City in July, where he dies in 1544.

Don Juan de Oñate, Colonizer of the Rio Grande Valley 1598

In 1595, Don Juan de Oñate was awarded a contract by King Philip II of Spain to settle New Mexico. After many delays Oñate headed north in early 1598. He forded the Rio Grande at the famous crossing point of El Paso del Norte in May 1598. Oñate is also infamous for cutting off the feet of 24 Acoma Indians to punish them for rebelling.

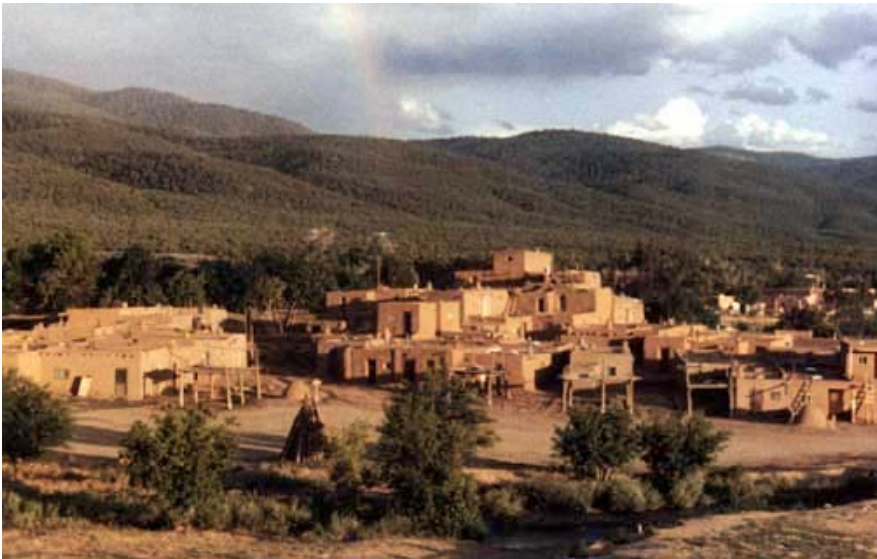
"Don Juan de Oñate, Pathfinder of the Southwest 1598", (over three stories high) will be the largest equestrian bronze in the nation - if it ever gets finished! Several Indian rights' groups have voiced their opposition to the statue. It has been renamed "The Equestrian".



U.S. sculptor John House stands next to a cast of what will be the largest bronze in the world, a three-story statue that represents conquistador Don Juan Oñate at House's studio outside Mexico City. The nearly \$3 million bronze artwork was commissioned by the city of El Paso, Texas.

Mecate de Palmilla: The Pueblo Revolt of 1680

Ancient ruins in the Taos Valley indicate that people lived here nearly 1000 years ago. The main part of the present Taos Pueblo were most likely constructed between 1000 and 1450 A.D.



Indian leader Po'pay organized the revolt in 1680. Churches were burned, 380 Spaniards (including 21 priests) and Mexican Indians also killed. The Spaniards were driven as far south as El Paso until don Diego de Vargas reconquered the territory in 1692.

Rivers and Rivals

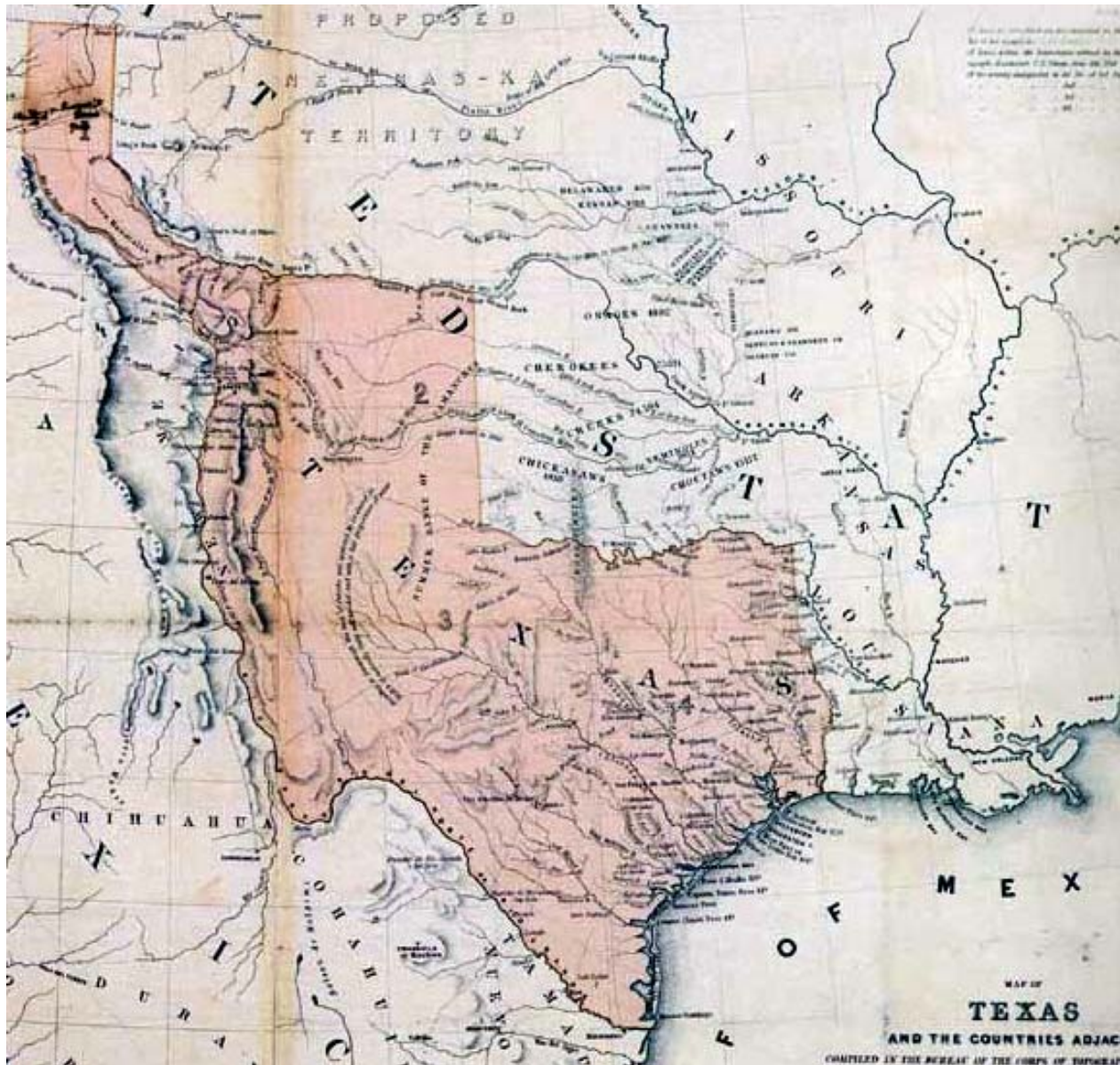
Natural obstructions to land transportation provide natural boundaries between national entities: rivers, mountain, deserts, lakes, and seas. The greater the obstacle, the greater the separation of the entities.

Among these, rivers provide the weakest separation.

Interestingly, the notion of "rival," derived from the Latin "*rivalis*," which described people living on opposite banks of a river.

Rivers in desert regions often break down boundaries because they represent a scarce resource, drawing people from both sides.

Of course, competition for scarce resources often leads to conflict.



Western and southern boundary of the Republic of Texas (1836-1845) was the Rio Grande (or so the Texans thought)

1841 map

Tensions between the U.S. and Mexico in the 1840's

One problem complicating relations between the republics of Texas and Mexico was the desire in Texas for annexation to the United States. This desire was not shared by many Americans, including Ralph Waldo Emerson, who bitterly opposed any move toward annexation. "The annexation of Texas looks like one of those events which retard or retrograde the civilization of ages," Emerson wrote.

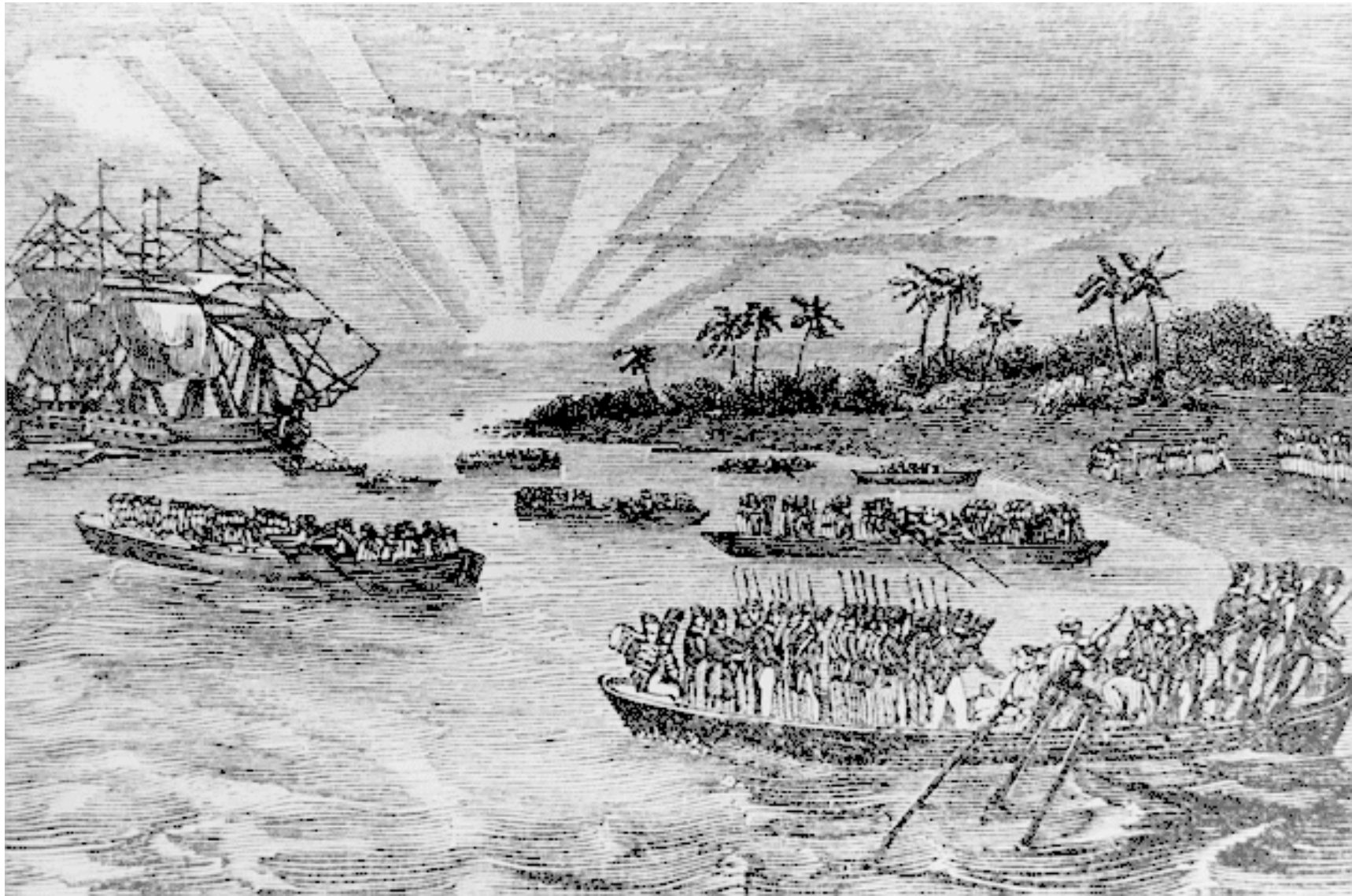
By 1844, the annexation of the Lone Star Republic had become a major political issue in the presidential campaign. The Democrat, James K. Polk of Tennessee, running on an expansionist platform calling for annexation, was swept into power. The lame-duck president, John Tyler, seeing the election as a clear mandate for annexation, maneuvered through Congress a joint resolution calling for Texas to become part of the Union.

On Dec. 29, 1845, the U.S. annexed Texas. Mexico, which had previously agreed to recognize Texas if the infant republic remained independent, then broke diplomatic relations with the United States. Both the United States and Mexico rushed to war. A reason for war was easy to find: The U.S. and Texas believed that its southern boundary was the Rio Grande. The Mexicans believed that it was the Nueces River to the north.

Mexican-American War

Fighting began in April 24, 1846 when Mexican cavalry entered an area claimed by both the US and Mexico, between the Rio Grande and Nueces, and surrounded a US scouting party under General Zachary Taylor; several were killed. After the border clash and battles at Palo Alto and Resaca de la Palma, the US Congress declared war on May 13, 1846.





U.S. troops landing north of the Rio Grande, March 1846



Mexico was invaded and Mexico City surrendered to U.S. forces in Sept. 1847. The Treaty of Guadalupe Hidalgo, signed on February 2, 1848, ended the war. Mexico agreed to give up about 55% of its territory in exchange for \$15 million. This territory is today occupied by California, Nevada, Utah, and parts of Arizona, New Mexico, Colorado, and Wyoming.

Water Treaties and Compacts

The modern conflict over Rio Grande water began with the modernization of agriculture and increasing use of irrigation.

US-Mexico Treaties: The 1906 and the 1944 treaties between US and Mexico and two interstate compacts define the respective shares of the waters of the Rio Grande.

Interstate (US) Compacts: The Rio Grande Compact of 1938 resolved conflicts between Colorado, New Mexico, and Texas. The Pecos River Compact of 1948 concerns the Pecos River, a tributary of Rio Grande in the lower basin, and rules the interstate use of its waters.

History of Water Conflict on the Rio Grande (late 1800's-early 1900's)

Irrigation in southern Colorado diminished flow of the river in New Mexico and soon caused water shortages in the lower basin. In some valleys of Southern Colorado in the period 1879-1890 irrigation increased by 600%. Shortages soon appeared in El Paso-Juárez region. Mexican farmers had insufficient water and many had to abandon their farms. The Mexicans accused the Texans of bringing on the shortage and the Texan pointed their fingers at the Mexicans. After changes and counter-changes came threats of violence. The official recognition that up-river diversions reduced the flow of the river led to the 1906 US-Mexico Treaty. This guaranteed Mexico at least 74 million m³ (60,000 acre-feet) per year.

Convention between the United States and Mexico Equitable Distribution of the Waters of the Rio Grande - 1906

Article I: United States shall deliver to Mexico a total of 60,000 acre-feet of water* annually in the bed of the Rio Grande at the point where the head works of the Acequia Madre, known as the Old Mexican Canal, now exist above the city of Juarez, Mexico

Article II: In case, however, of extraordinary drought or serious accident to the irrigation system in the United States, the amount delivered to the Mexican Canal shall be diminished in the same proportion as the water delivered to lands under said irrigation system in the United States.

*White Rock Lake contains 18,000 acre-feet of water.

1944 Treaty Between the United States of America and Mexico

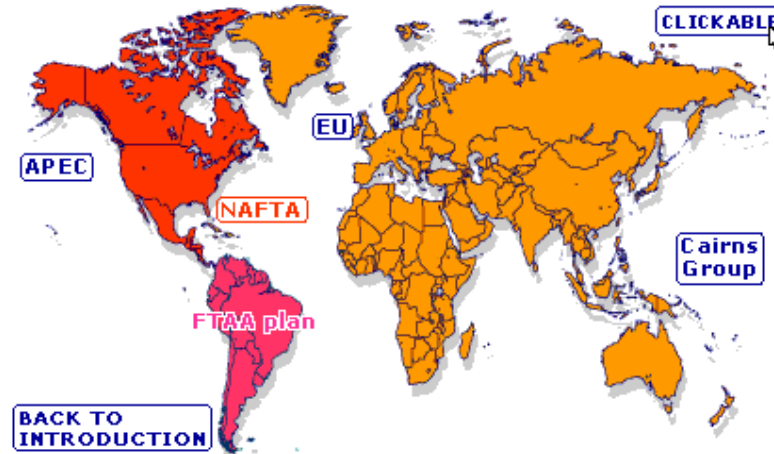
Article 4: B. To the United States: (c) One-third of the flow reaching the main channel of the Rio Grande (Rio Bravo) from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo, provided that this third shall not be less, as an average amount in cycles of five consecutive years, than 350,000 acre-feet (431,721,000 cubic meters) annually.

In the event of extraordinary drought or serious accident to the hydraulic systems on the measured Mexican tributaries, making it difficult for Mexico to make available the run-off of 350,000 acre-feet (431,721,000 cubic meters) annually, allotted in subparagraph (c) of paragraph B of this Article to the United States as the minimum contribution from the aforesaid Mexican tributaries, any deficiencies existing at the end of the aforesaid five-year cycle shall be made up in the following five-year cycle with water from the said measured tributaries. Whenever the conservation capacities assigned to the United States ...are filled with waters belonging to the United States, a cycle of five years shall be Considered as terminated and all debits fully paid, where upon a new five-year cycle shall commence.

Treaty also specified that the US should annually deliver 1,500,000,000 acre-feet of Colorado river water to Mexico.

NAFTA and the Rio Grande

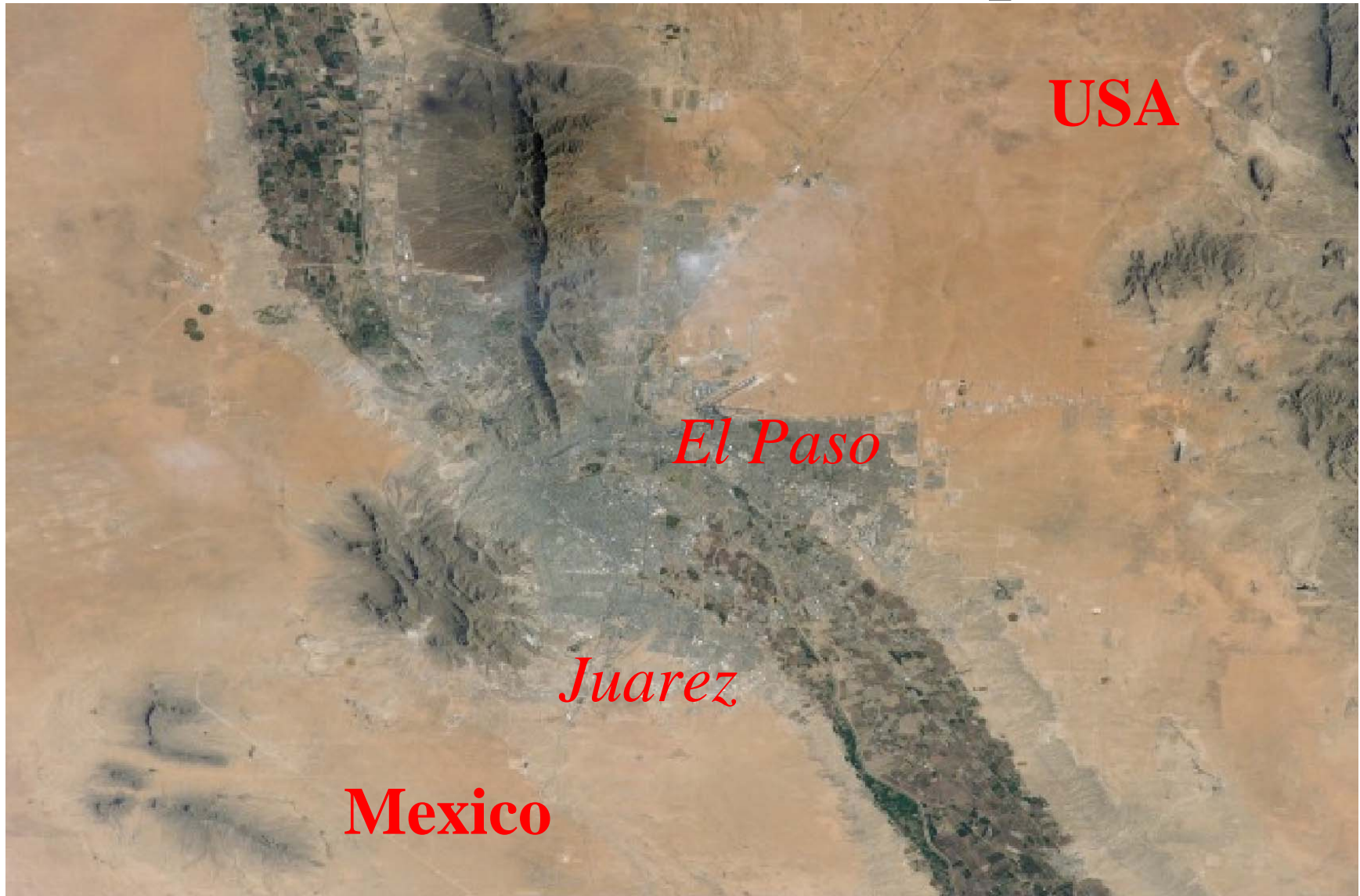
(One of 4 important free trade groups)



The United States, Canada, and Mexico agreed in 1994 to form a free trade zone, the North American Free Trade Agreement (NAFTA). The USA hopes to expand the area to the rest of Latin America creating a Free Trade Area of the Americas (FTAA) by 2005, but key countries like Brazil are skeptical of its benefits. The US is separately signing free trade agreements with Chile and the five central American countries of Honduras, Nicaragua, El Salvador, Panama, and Costa Rica.

Mexico is Texas' biggest trading partner: \$41.6 billion last year. NAFTA has led to rapid growth of *maquiladora* (assembly plants) along the border. There are over 300 *maquiladoras* in Juarez today, compared with 120 before NAFTA. This creates jobs, population growth, environmental problems, and demand for water. September 3, 2003 BBC News.

El Paso-Juarez “Borderplex”



ISS004E10716

ISS004-E-10716



El Paso, USA

North

Juarez, Mexico

Rio Grande

The El Paso- Juarez Borderplex

<u>Year</u>	<u>El Paso City</u>	<u>EP County</u>	<u>Cd. Juarez, MX</u>	<u>Combined</u>
1990	515,652	595,350	798,499	1,393,849
2000	563,662	681,898	1,218,817	1,900,715

The Borderplex grew 28% in the last 10 years!

Over the past 30 years, the Lower Rio Grande Valley has experienced explosive growth in just about everything: population, industry, commerce, tourism, and agriculture. It's the center of the NAFTA-driven border economy, the site of Mexico's largest concentration of export-oriented factories -- or *maquiladoras*.

Geologic Evolution and Hydrology of the Upper Rio Grande





Rio Grande/Rio Bravo Basin

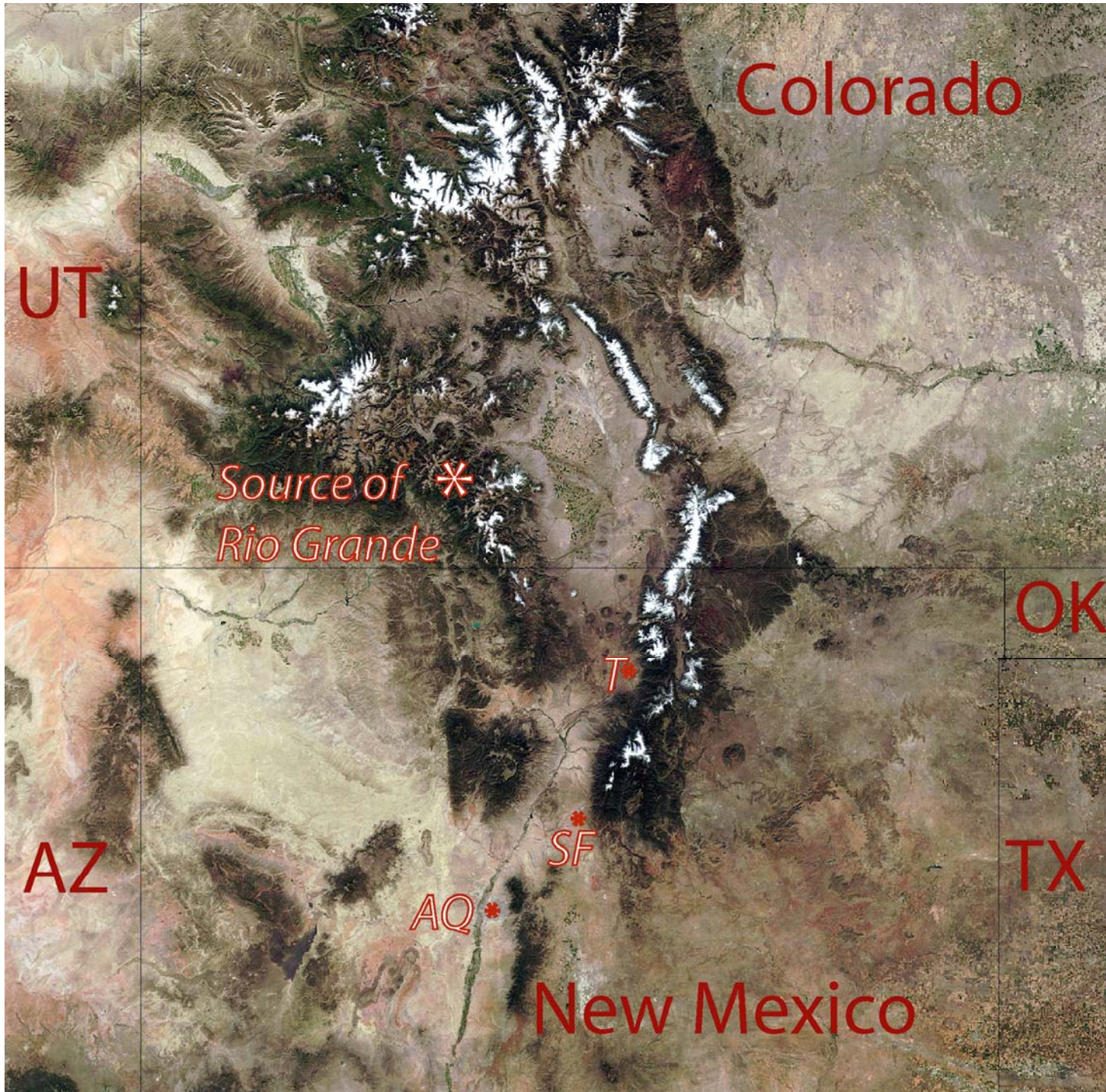
444,560 km²

U.S. 51.7%

Mexico 48.3%

Fort Quitman
separates the Upper
and Lower Rio
Grande basins.

Presently two rivers:
One stops at El Paso,
the other starts where
the Rio Conchos joins
the Rio Grande



MODIS
image
of upper
Rio
Grande
basin

T= Taos
SF = Santa Fe
AQ= Albuquerque



CO

NM

MODIS

3/2003

Melting snow produces the water of the Upper Rio Grande

Ways to measure water

Easiest is cubic km = 1×10^9 cubic meters

US most commonly refers to “acre-feet”: The volume of water in an area of 1 acre with a depth of 1 foot.

1 acre = 0.4 hectares (Ha=10000 m²)

1 acre foot = 325,851 gallons = 1,233 m³

(1 gallon = 0.00378 m³)

Texas reservoirs have a total capacity of ~35 million acre feet.

The biggest reservoir in Texas (Toledo Bend on the Sabine River) holds ~4.5 million acre-feet.

Lake Lewisville holds 550,000 acre-feet of water at capacity
~ 0.68 km³.

Domestic water use

According to the Texas Water Development Board, the average daily water use for Dallas residents in 2000 was 235 gallons (~0.9 m³) per person. San Antonio used 147 gallons per person, El Paso used 159, Albuquerque used 200. Dallas is the only big city in Texas whose per-capita usage is projected to rise in coming decades. (DMN July 2001)

Average daily water use for Mexicans in border communities is less than 100 gallon per day.

How many Dallas area residents
can be supported for how many
days by the water in Lake
Lewisville?

550,000 acre feet = $6.78 \times 10^8 \text{ m}^3$

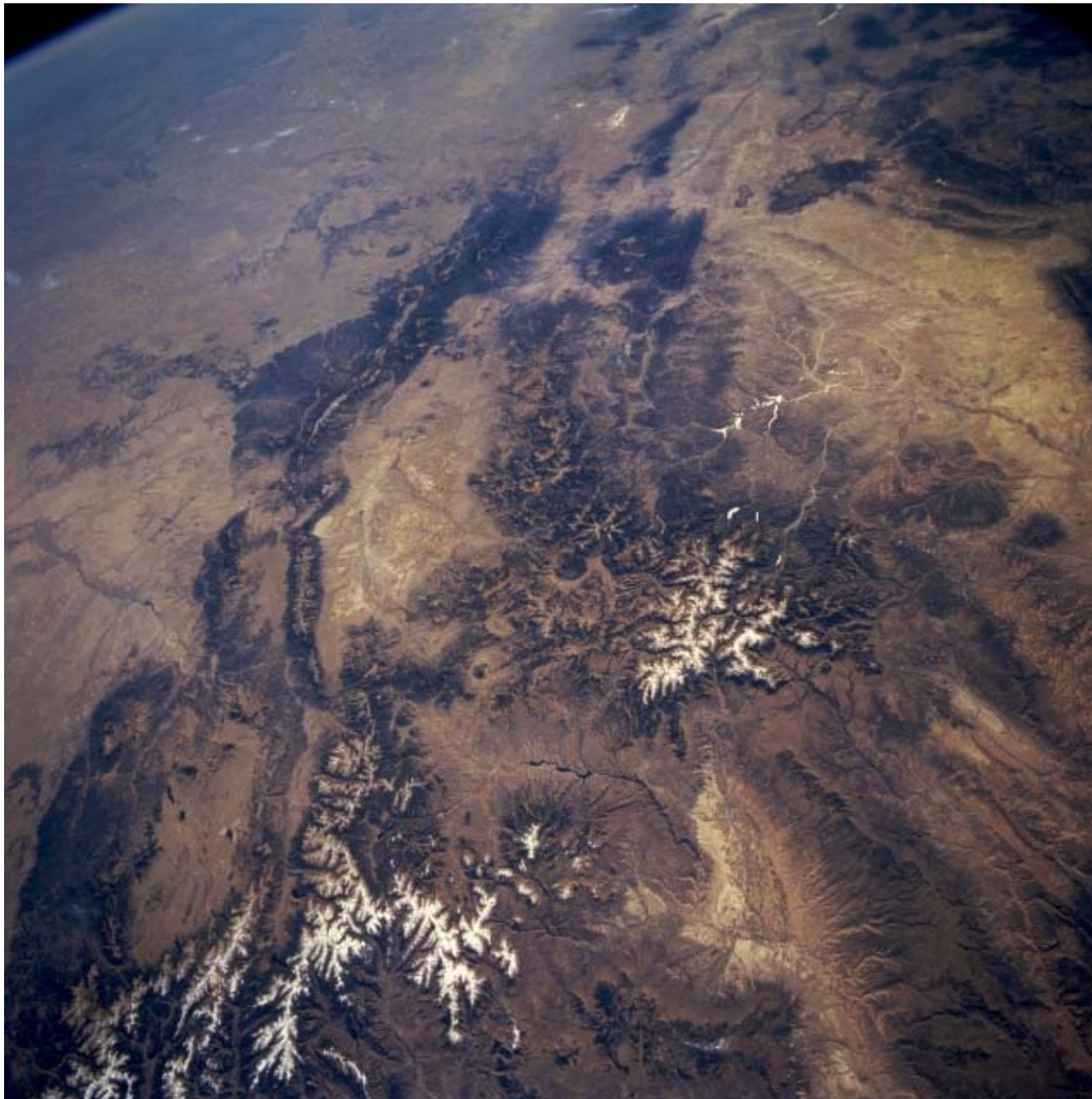
Each person uses 0.9 m^3 per day.

75,333,333 people-days of water

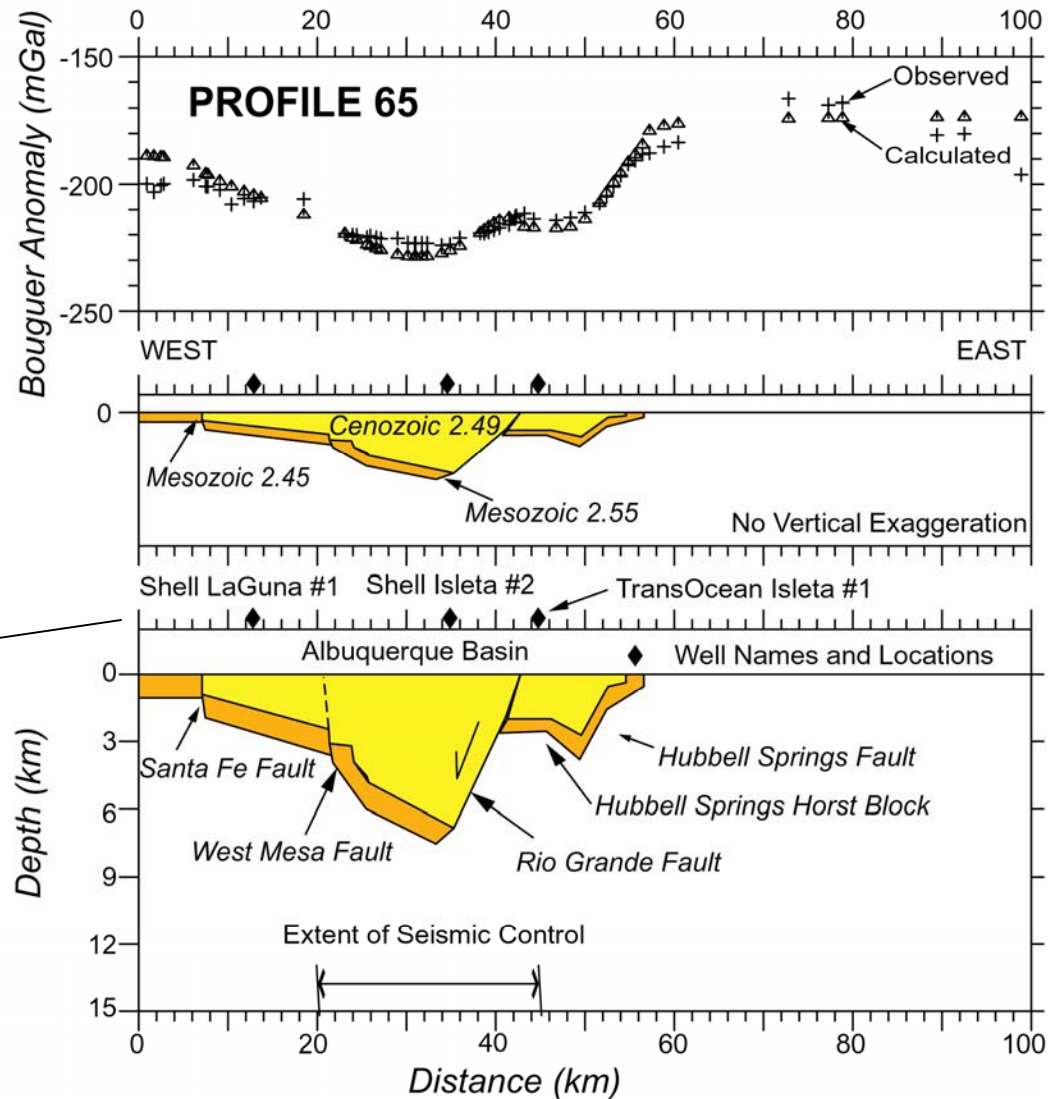
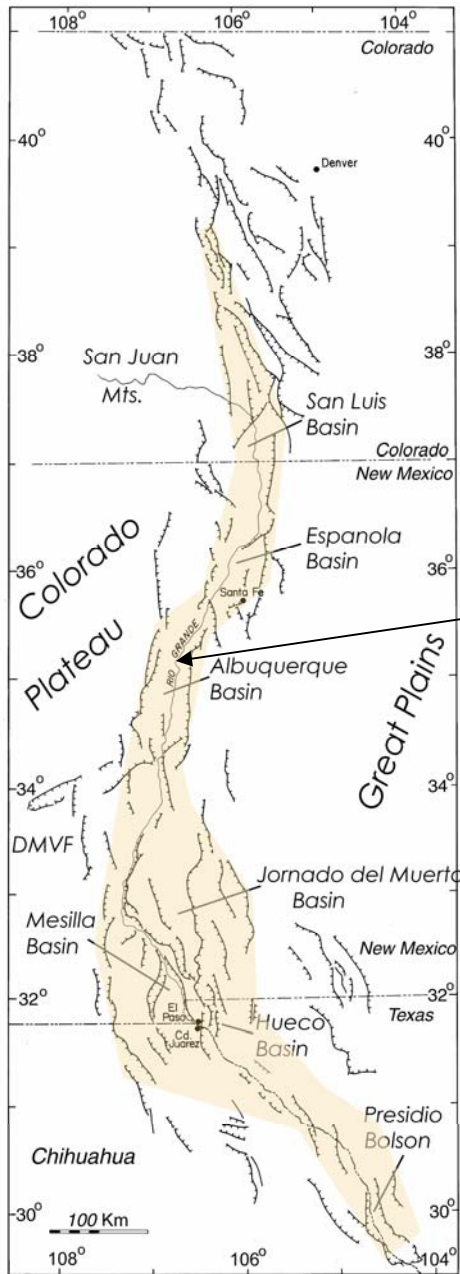
There is enough water in Lake Lewisville for 206,400 people for 1
year.

Water in the Upper Rio Grande Basin

The condition of the Rio Grande basin is described as "a state of drought, occasionally mitigated by periods of abundance". On an annual average, less than 2.5 million acre feet are produced by the river's headwaters (a little less than the water held in Lake Texoma). The upper Rio Grande produces about 20% of the water in the Colorado River. Diversions of water for irrigation claim nearly 95% of the average annual flow of river. Water rights claims exceed the actual supply. The basin's water supply picture would be even bleaker without the addition of 96,000 acre-feet imported from the San Juan river and 40,000 acre-feet salvaged by the Closed Basin Project in Colorado. Today, just 5 % of the water produced in the Upper Rio Grande basin reaches Ft. Quitman.

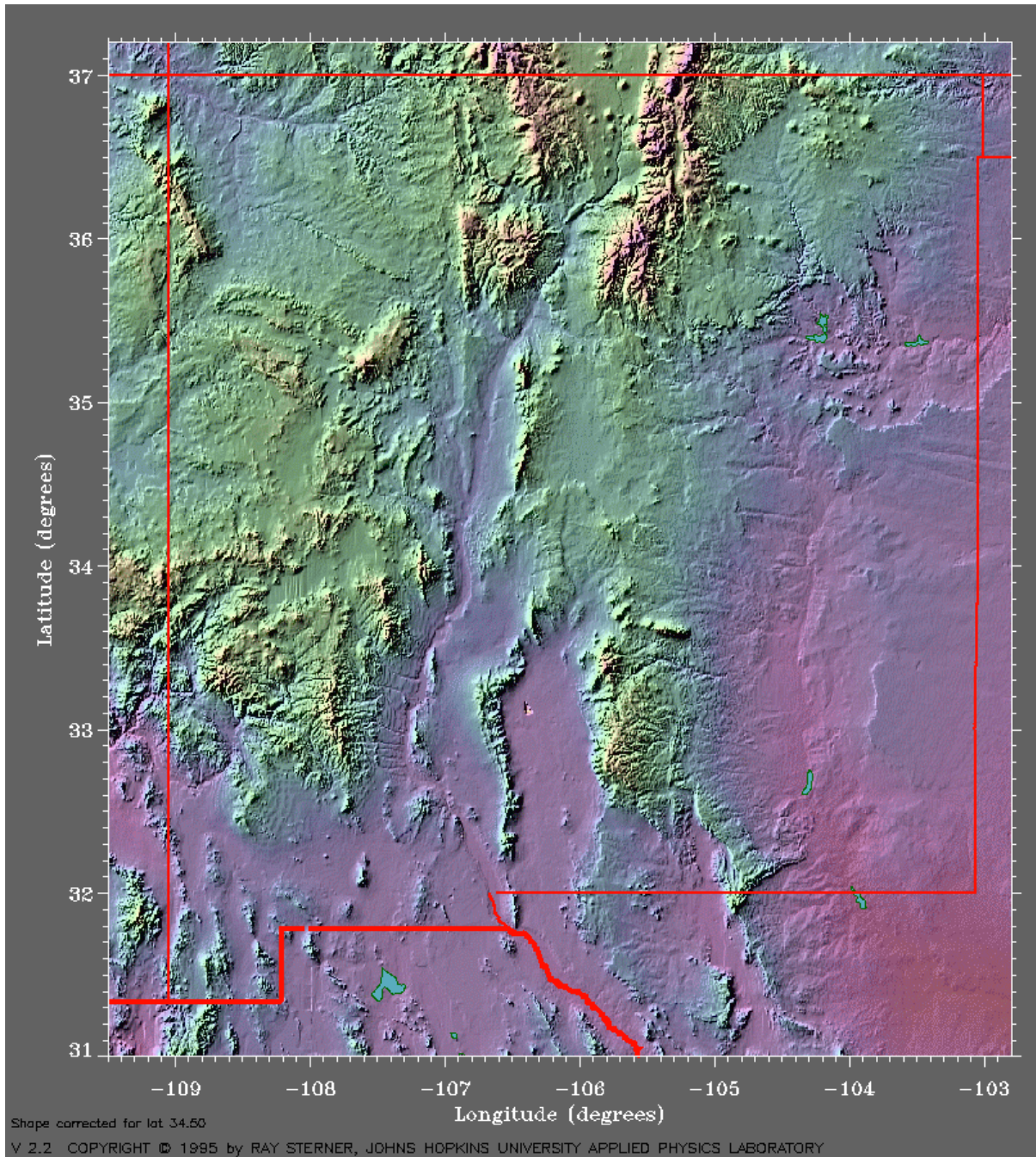


San Juan
Mountains, source
of the Rio Grande,
San Luis valley,
and Upper Rio
Grande (looking
south)



Keller, UTEP

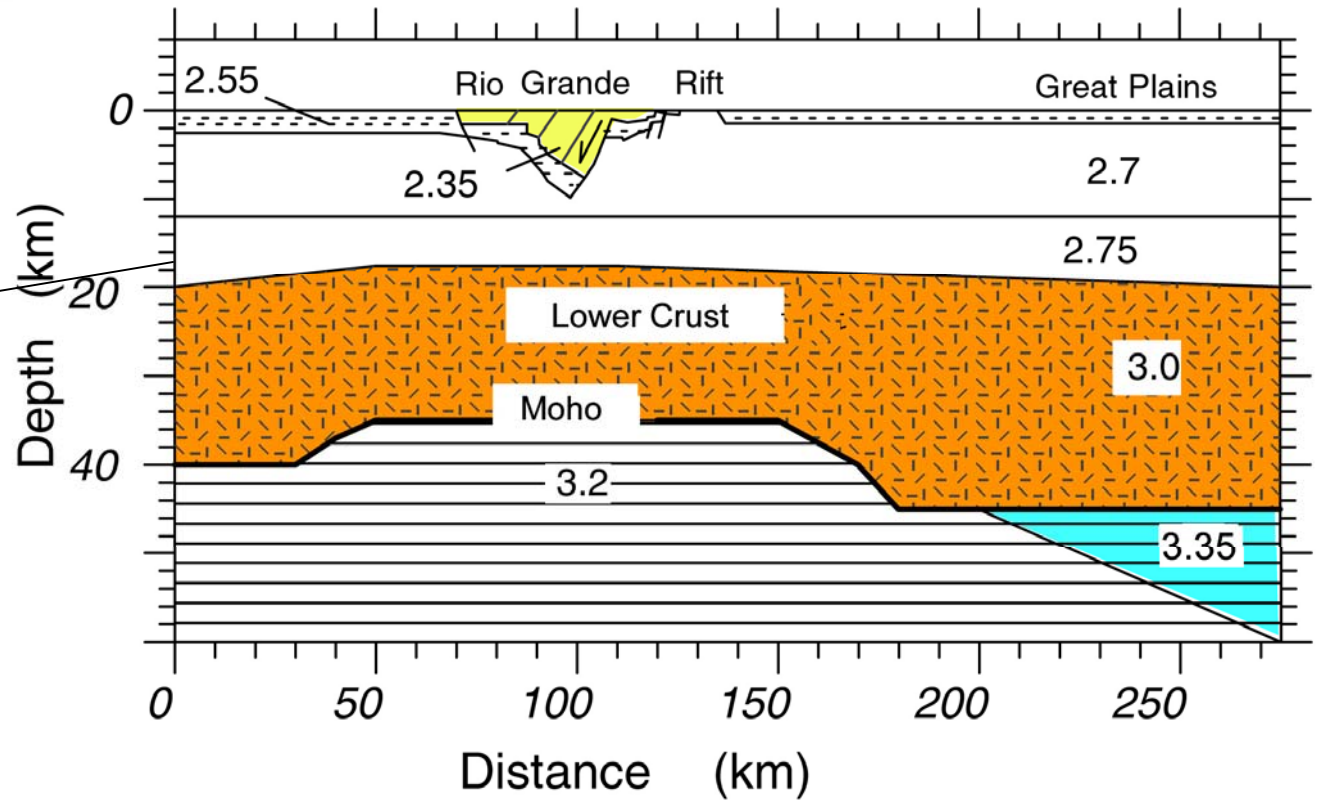
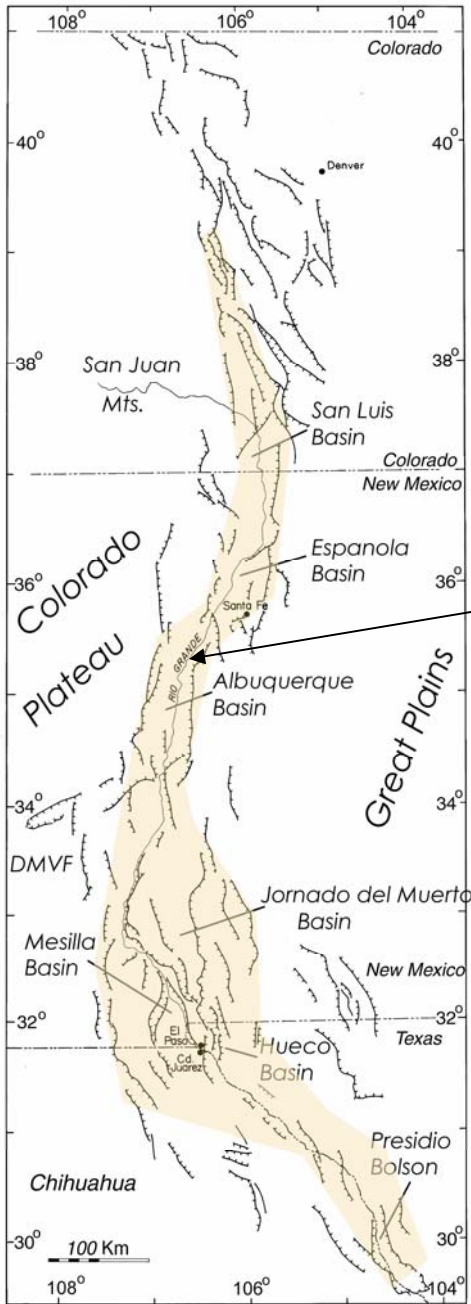
Rio Grande Rift formed by stretching of the lithosphere over the past 30 million years. Rifting has formed deep sedimentary basins, up to 7 km deep. The Rio Grande flows south along the axis of the rift.



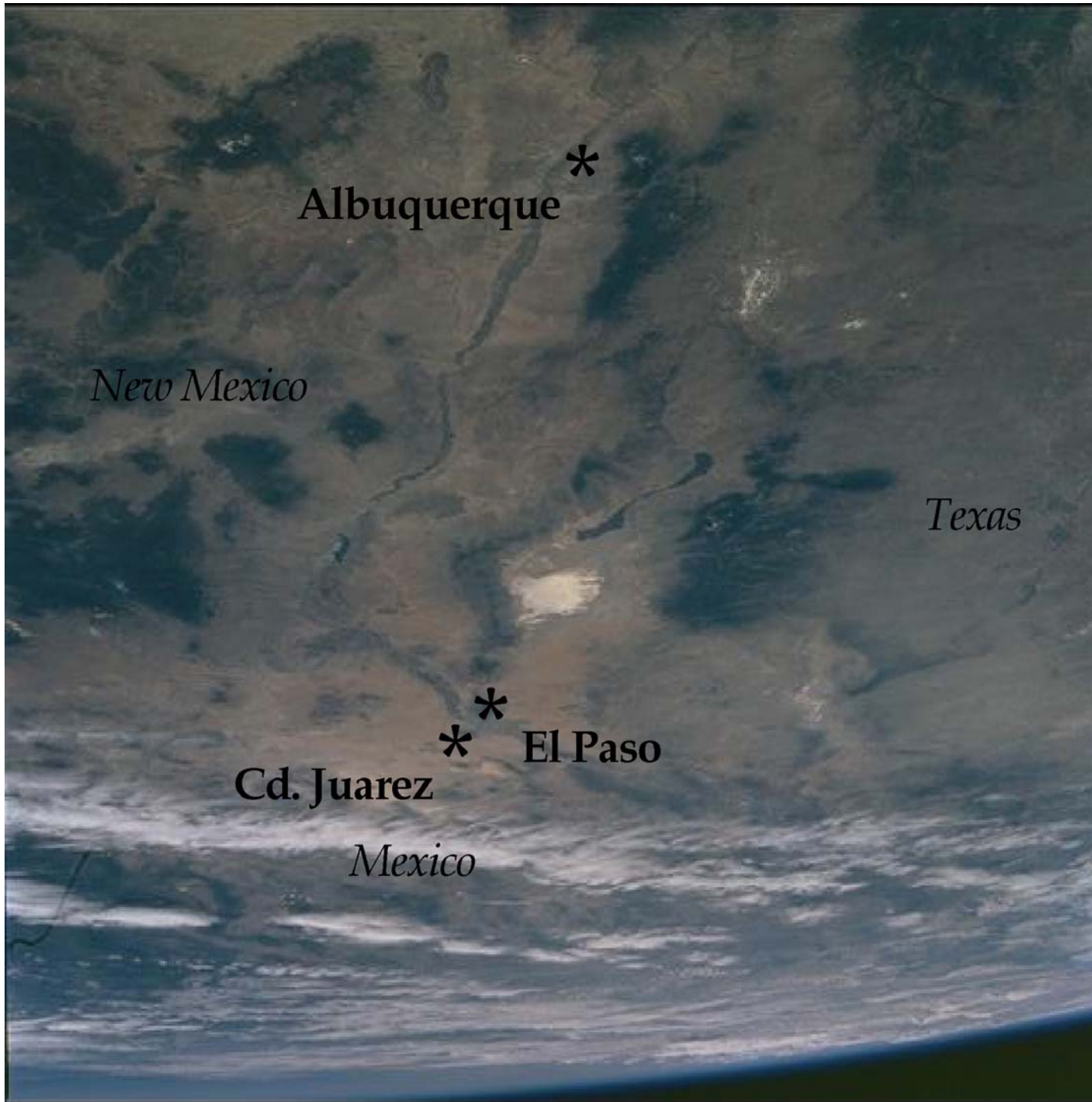
Shaded relief
map of New
Mexico

http://fermi.jhuapl.edu/states/nm_0.html

Crustal structure of Rio Grande Rift



Keller, UTEP



Albuquerque *

New Mexico

Texas

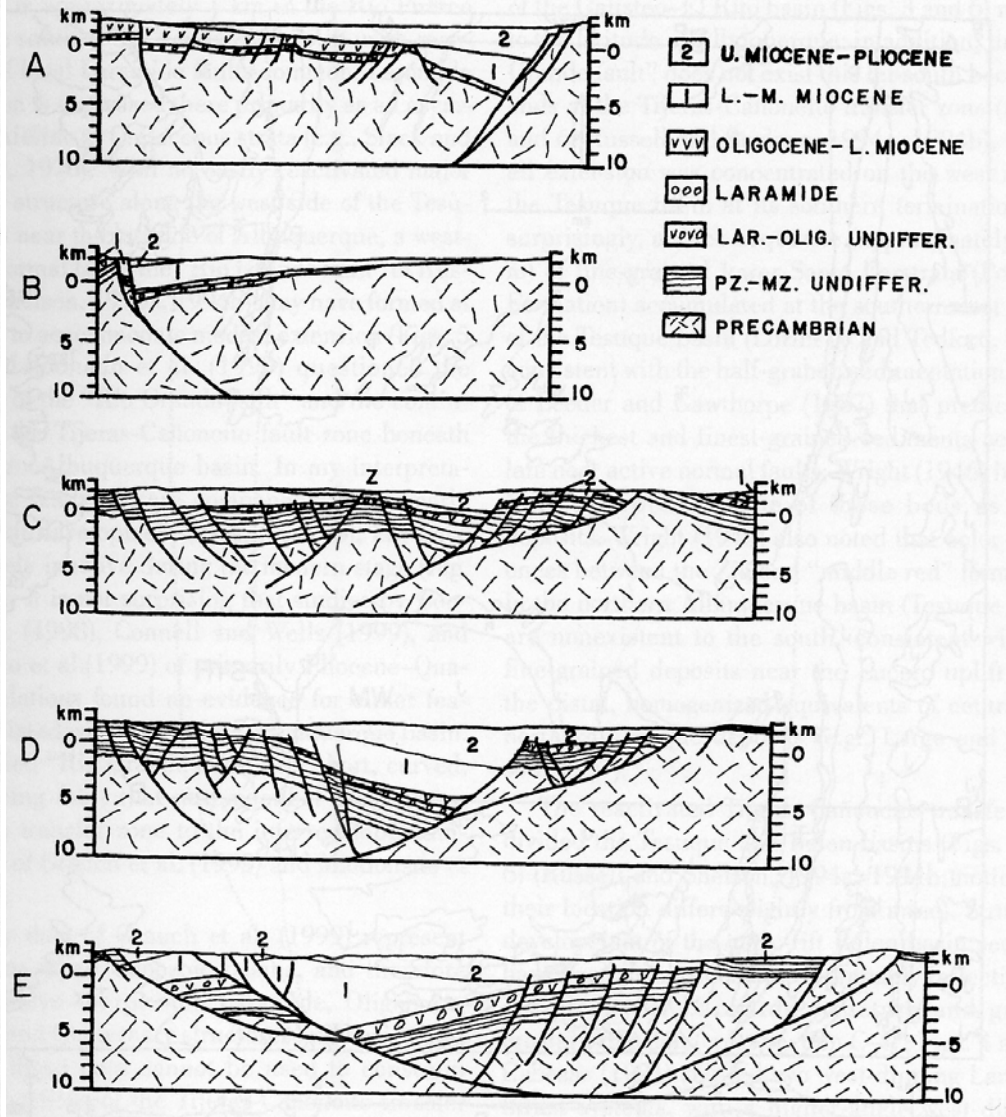
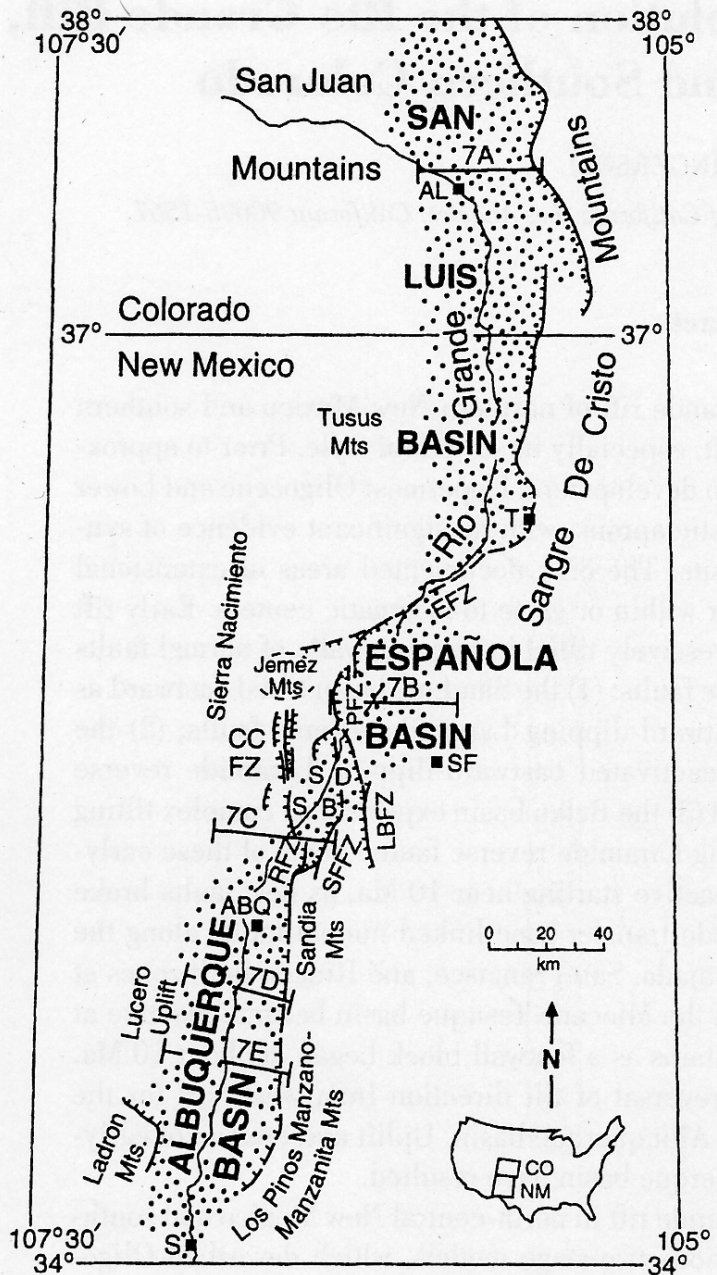
* *
Cd. Juarez El Paso

Mexico

Looking
south
down the
Rio
Grande
Rift

STS100-
704-152

Structure of the Rio Grande Rift



Ingersoll 2001 Int. Geo. Rev. 43, 867-891

Formation of the Upper Rio Grande

Rio Grande in Colorado and New Mexico must be younger than the Rio Grande Rift, which began to form ~30 million years ago.

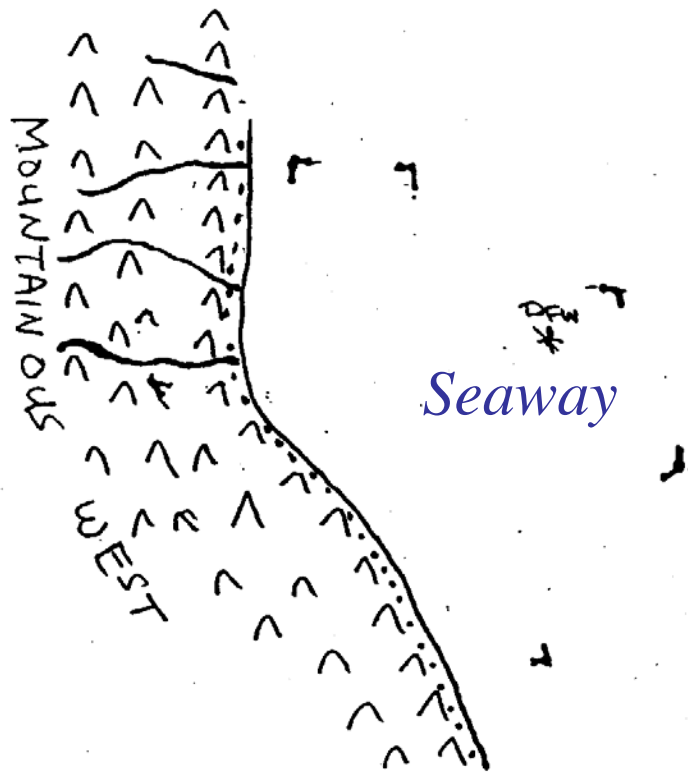
An older drainage system existed but was disrupted by rifting. Water that used to flow eastward via the Brazos and Colorado (TX) was diverted to flow south into the Rio Grande. The Pecos River is continuing this drainage reorganization.

Latest Cretaceous (Maastrichtian, ~75 Ma) Paleogeographic Map of Western North America

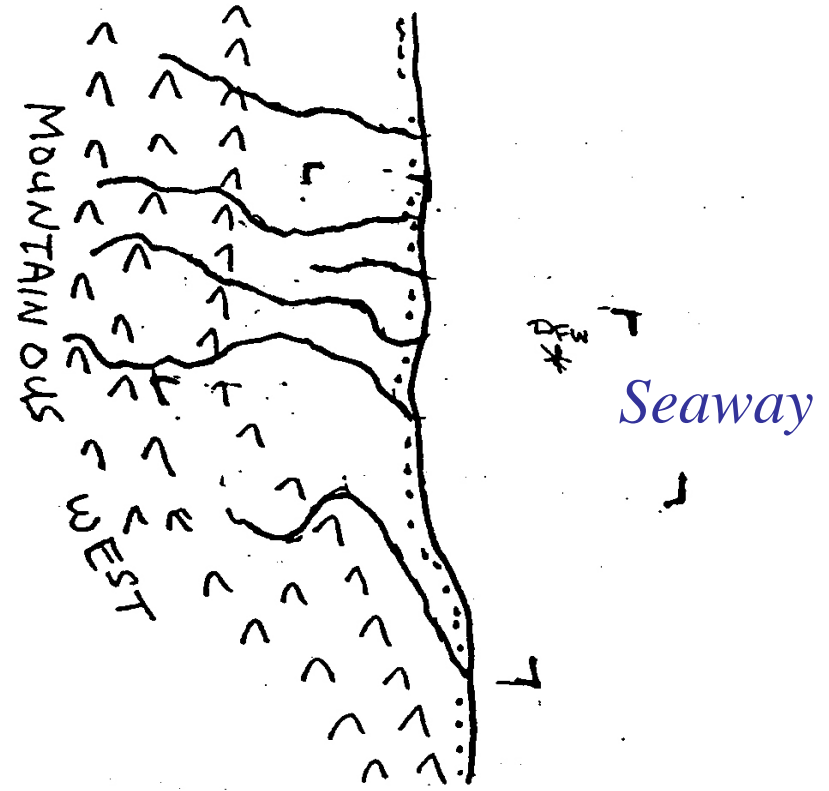


<http://jan.ucc.nau.edu/~rcb7/crepaleo.html>

Formation of the Rio Grande

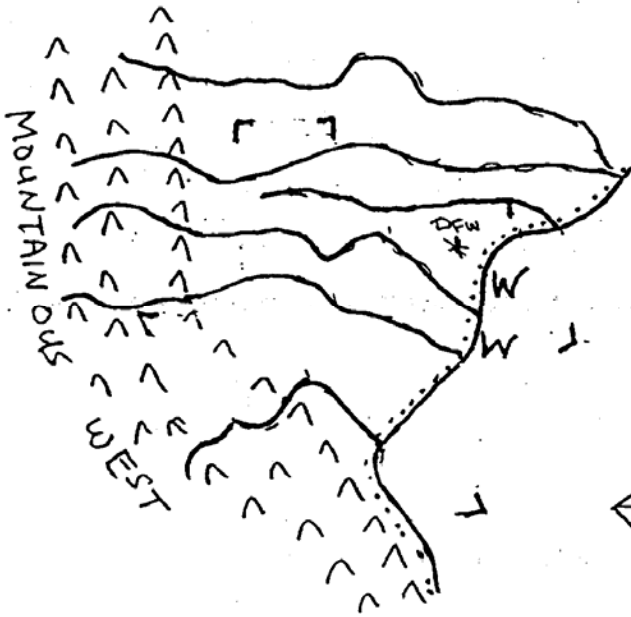


End of Cretaceous (~65 Ma):
Rivers of Rocky Mountains
flow east directly into the
Cretaceous Interior Seaway



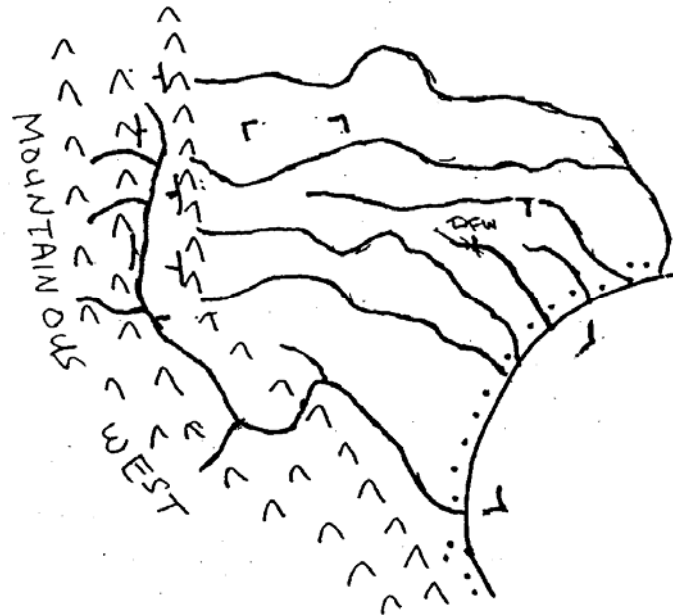
Paleocene (~60 Ma): Rivers
extend eastward as sealevel
drops and shoreline retreats.

Formation of the Rio Grande (cont'd.)

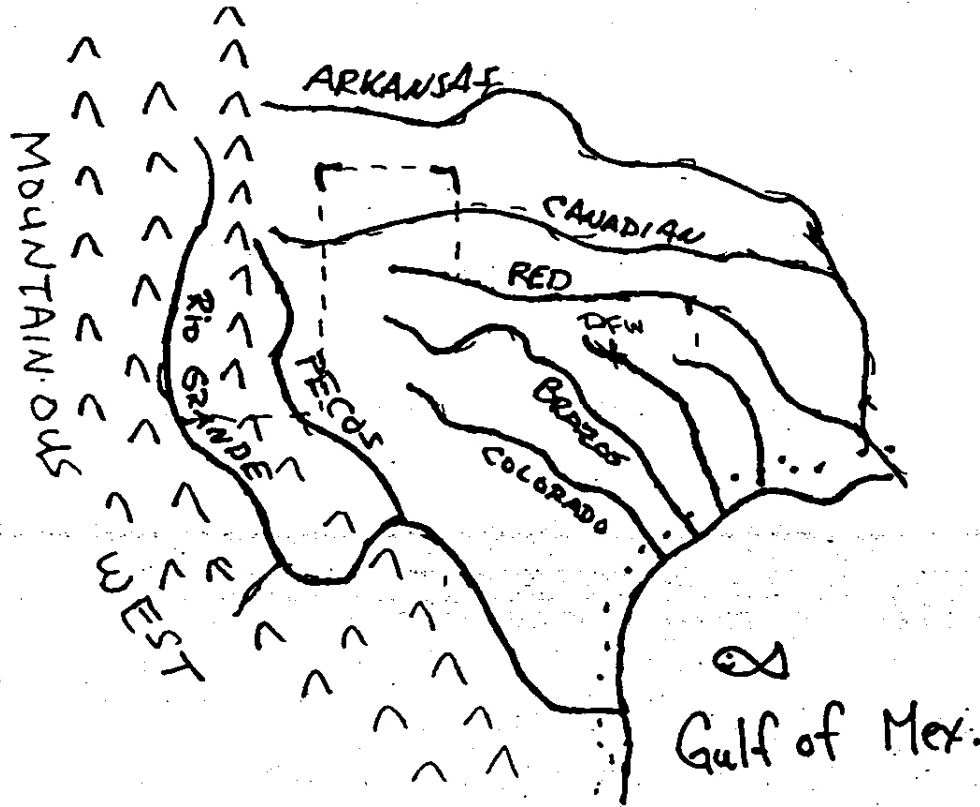


Middle Eocene (45 Ma) - East-draining rivers continue to lengthen as sealevel continues to fall and the shoreline retreats. Major deltas form at the mouths of the Brazos & Colorado Rivers (W = Wilcox Group).

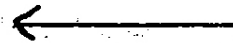
Oligocene (30 Ma) - Formation of the Rio Grande Rift forms the south-draining Rio Grande River and cuts off the headwaters of the early Tertiary rivers of Texas. The mouth of the Rio Grande becomes the major sedimentary depocenter in Texas. The Trinity River forms about this time.



Formation of the Rio Grande (cont'd.)

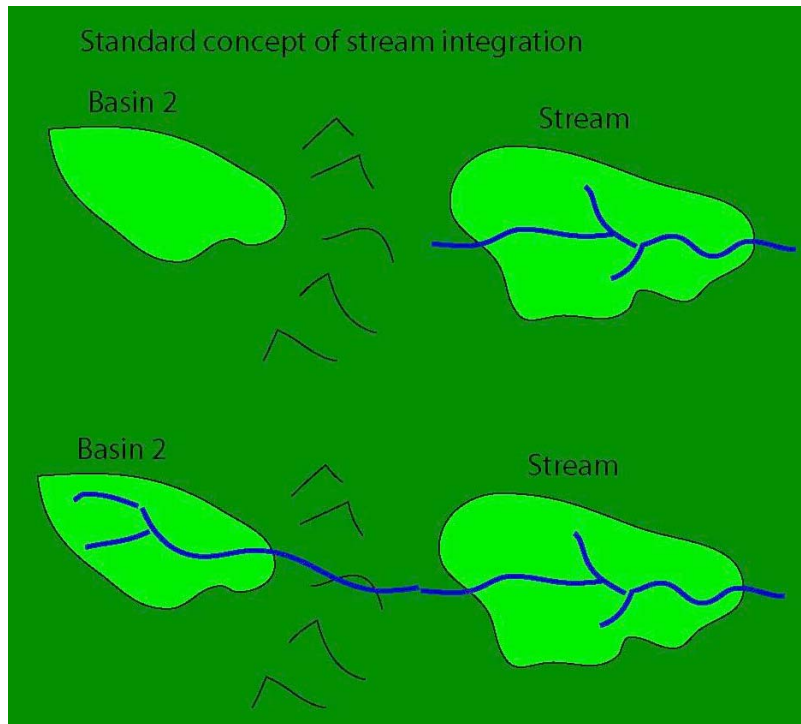


Late Cenozoic (10 Ma to present) - Development of the Pecos River by headwards erosion cuts off headwaters of Brazos and Colorado Rivers.



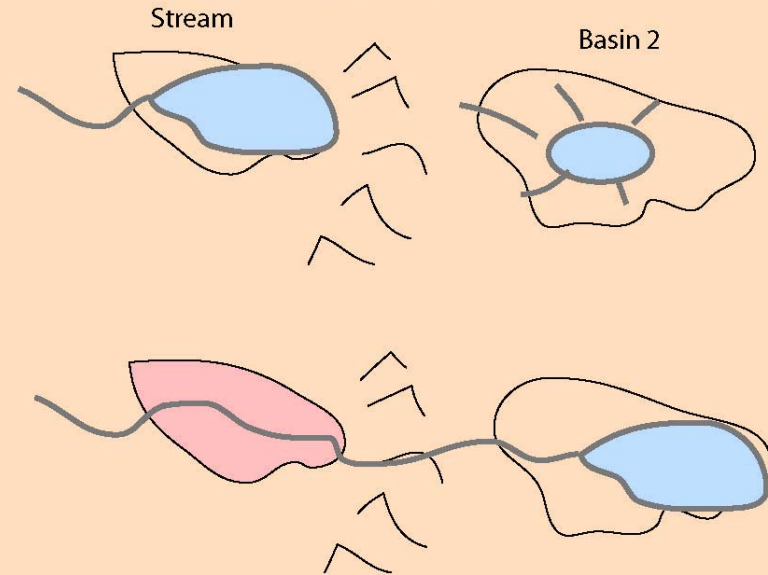
Late Cenozoic Evolution of Rio Grande

Standard model for basin integration: headward growth



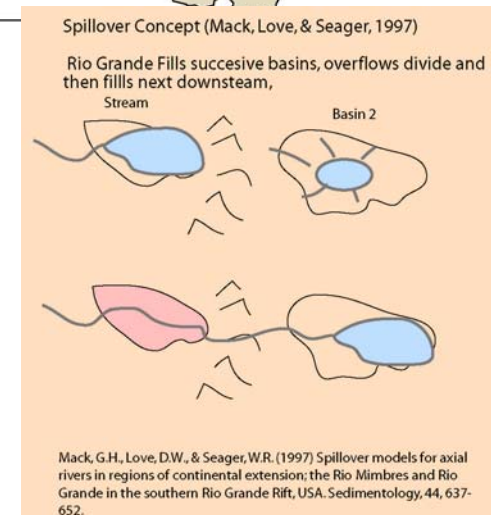
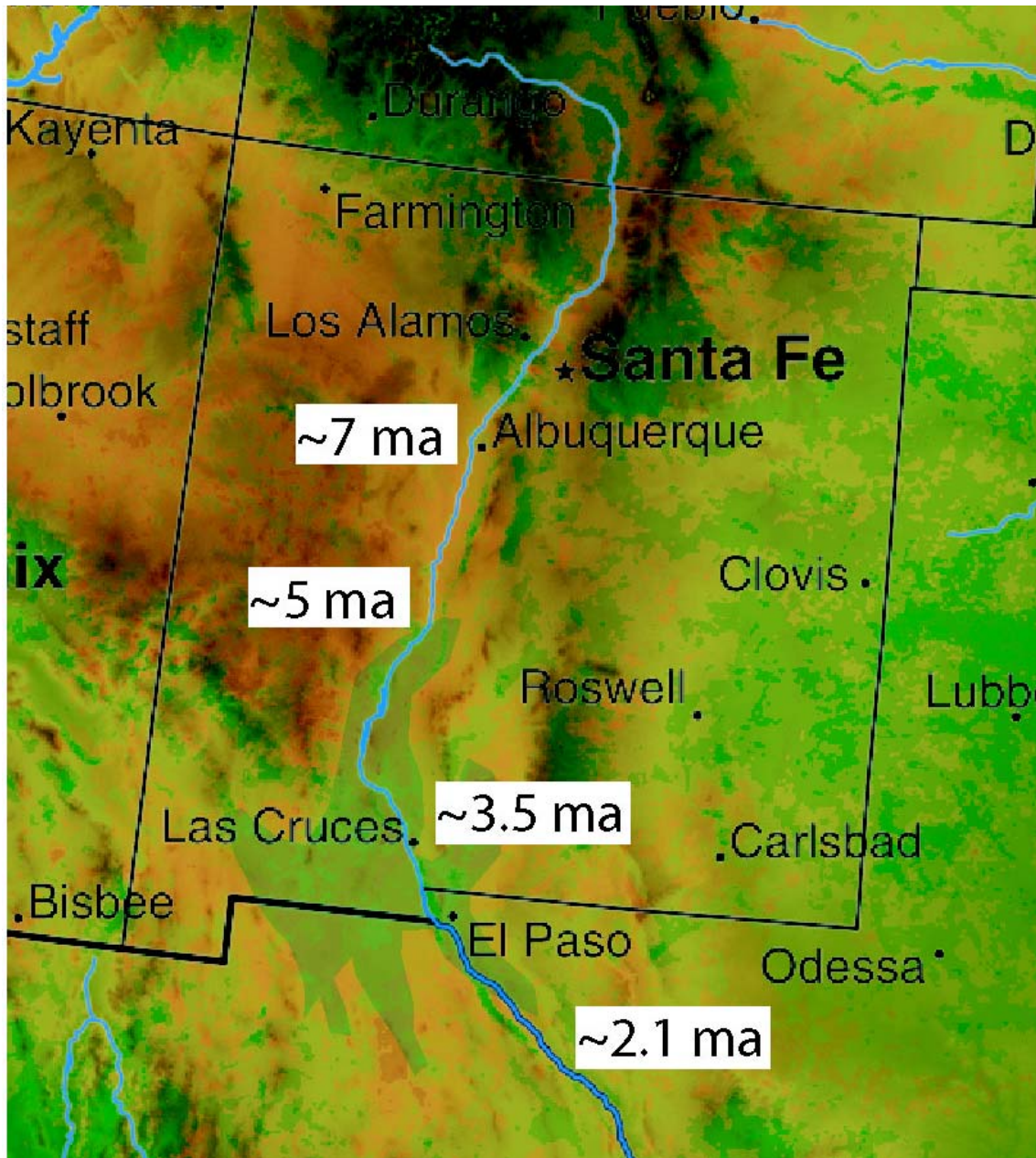
Spillover Concept (Mack, Love, & Seager, 1997)

Rio Grande Fills successive basins, overflows divide and then fills next downstream,

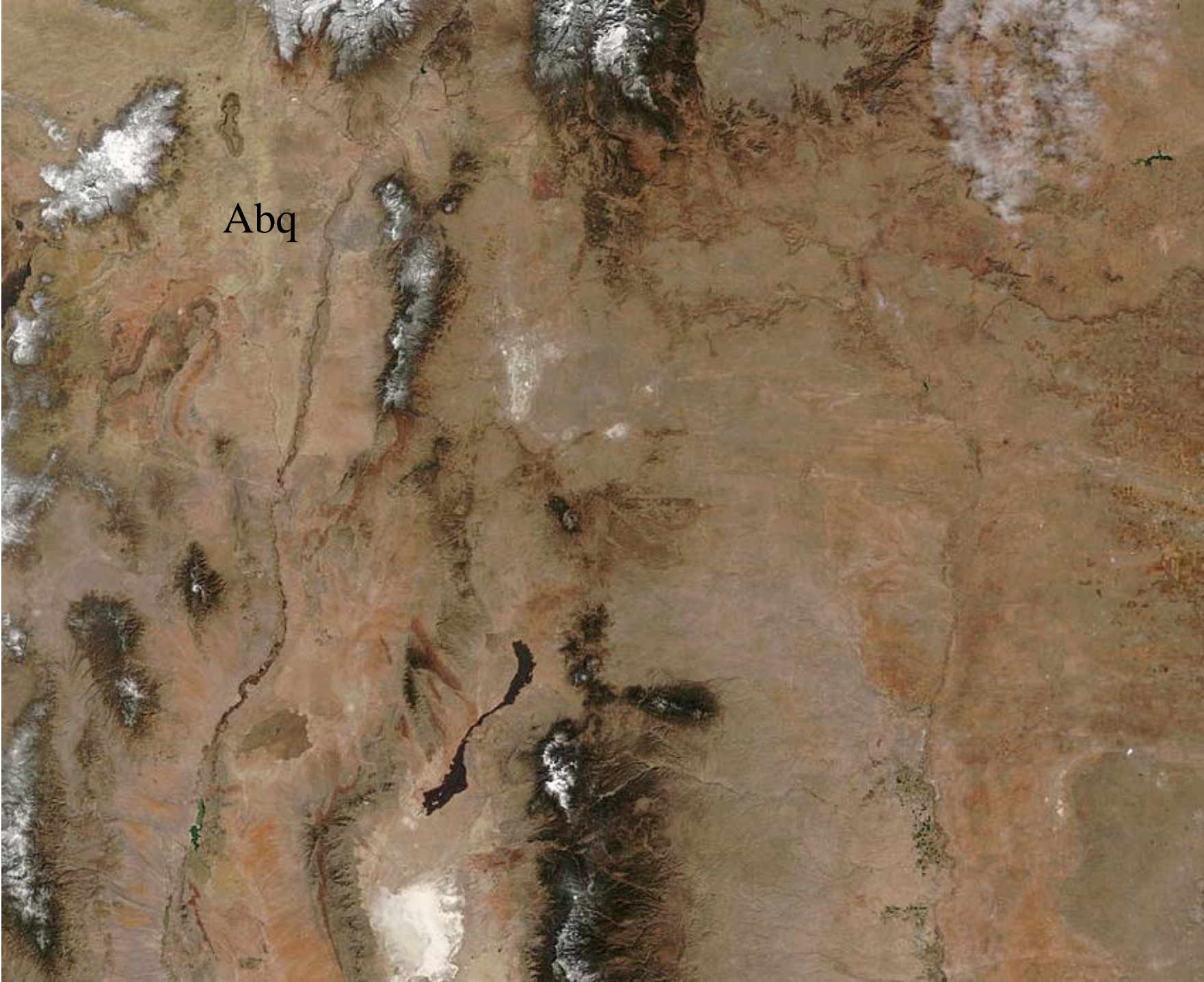


Mack, G.H., Love, D.W., & Seager, W.R. (1997) Spillover models for axial rivers in regions of continental extension; the Rio Mimbres and Rio Grande in the southern Rio Grande Rift, USA. *Sedimentology*, 44, 637-652.

Spillover concept seems to best explain integration of the Rio Grande in late Cenozoic time (Langford, pers. comm. 2003)



Integration of the Upper Rio Grande involved filling individual basins with sediments so that the river could grow southwards. R. Langford UTEP



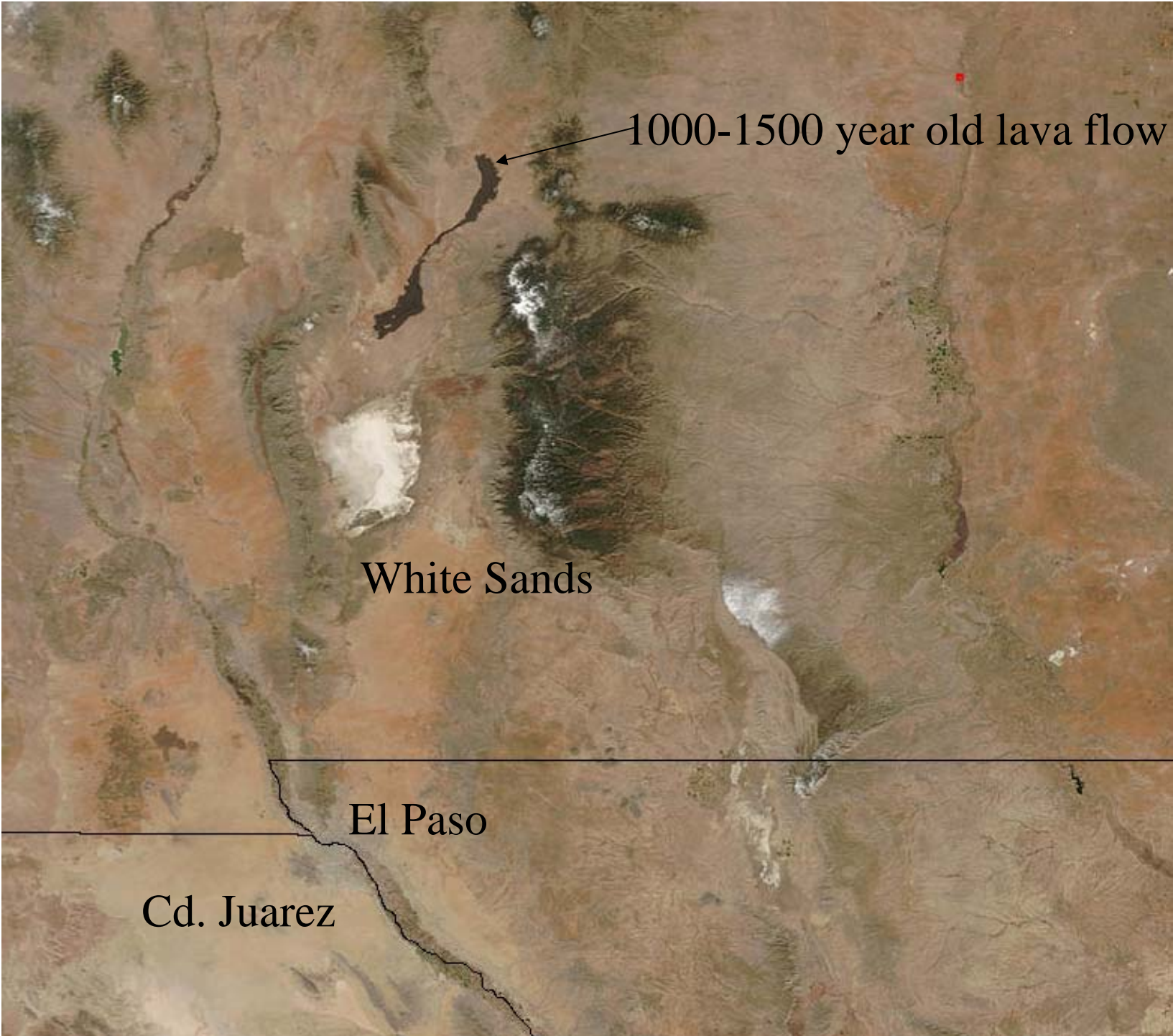
Abq

Albuquerque, New Mexico, Population 450,000



ISS004E11594

ISS004-E-11594



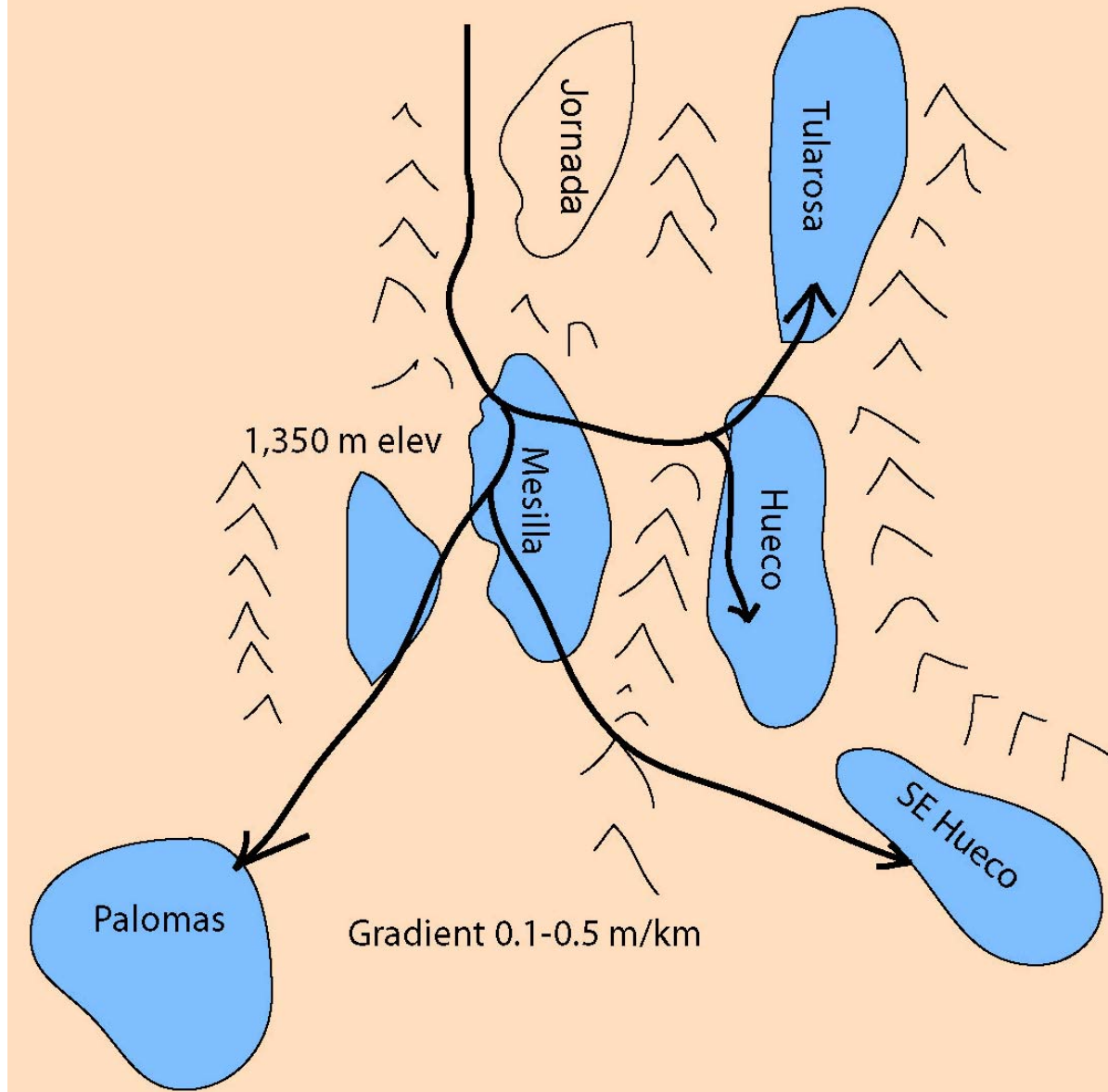
1000-1500 year old lava flow

White Sands

El Paso

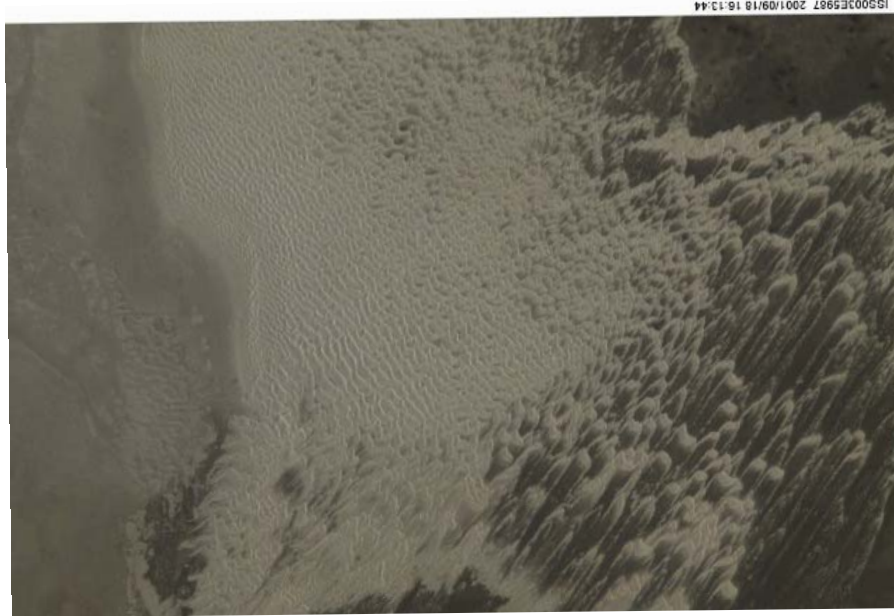
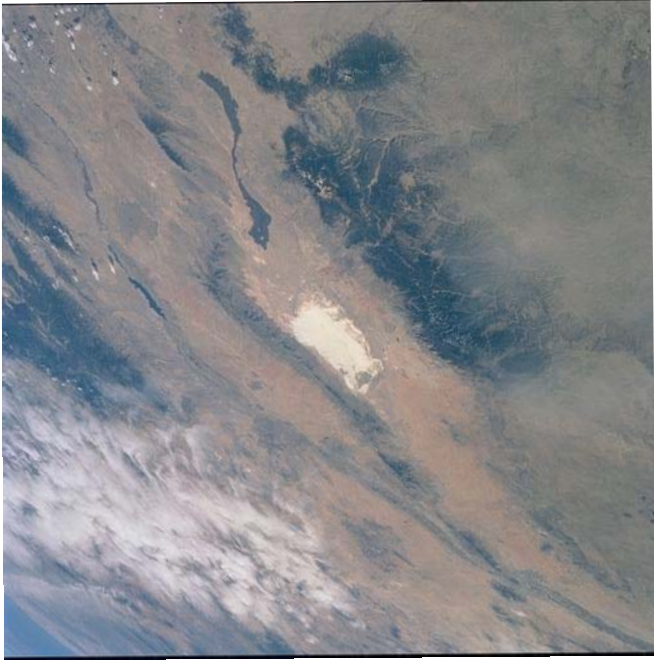
Cd. Juarez

Concept for El Paso Area



Pleistocene
(10,000-
1,000,000
year old)
lakes around
El Paso:
Dry lake beds
are *playas*

The most famous playa in the world: Tularosa Playa



275 square miles; the world's largest sand dune field created from gypsum (CaSO_4) eroded by wind from playa lake deposit.



Trinity Site at White Sands (Tularosa Playa)

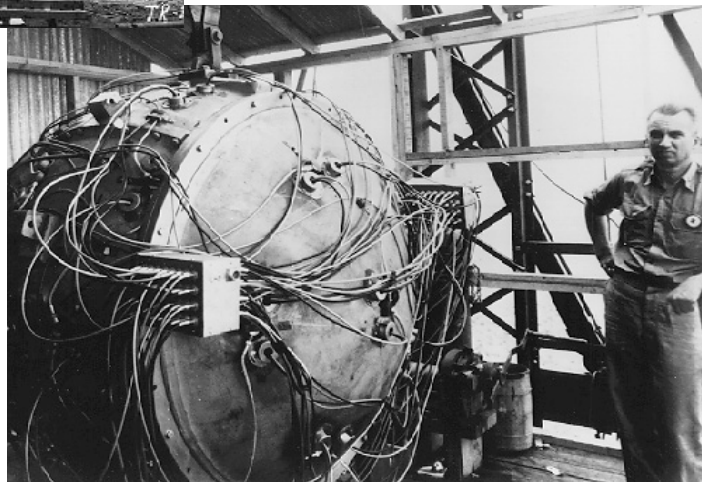
Trinity Site is where the first atomic bomb was tested at 5:29:45 a.m. on July 16, 1945

The tower



Bomb being hoisted into tower

The bomb in the tower



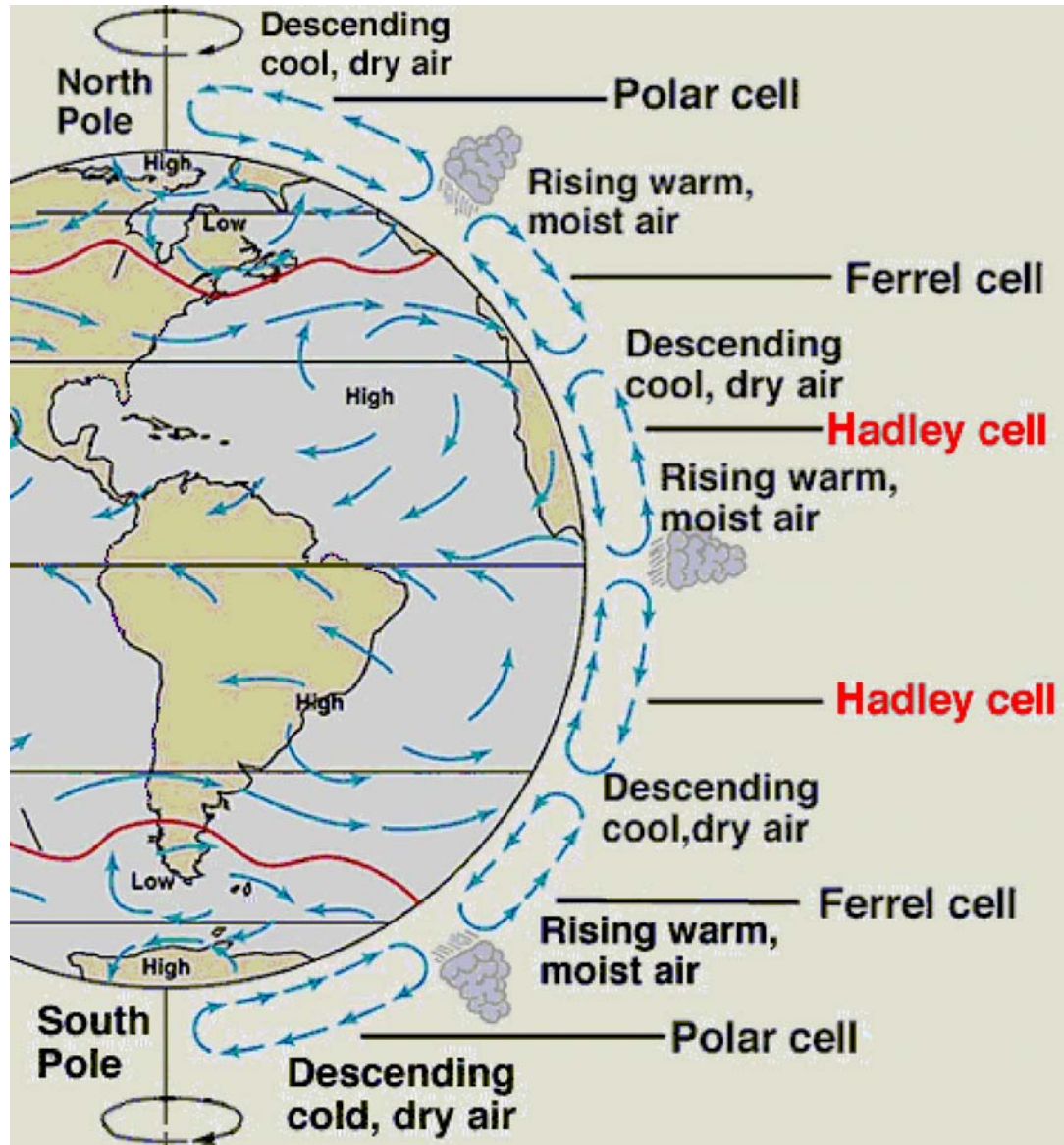
15 seconds after detonation

<http://www.wsmr.army.mil/paopage/Pages/Tpixind.htm>

Why is water scarce in the Rio Grande?

- Hadley Cell
- Ferrel Cell
- 30° N zone of atmospheric downwelling
- Chihuahuan Desert

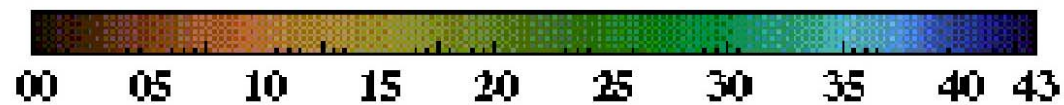
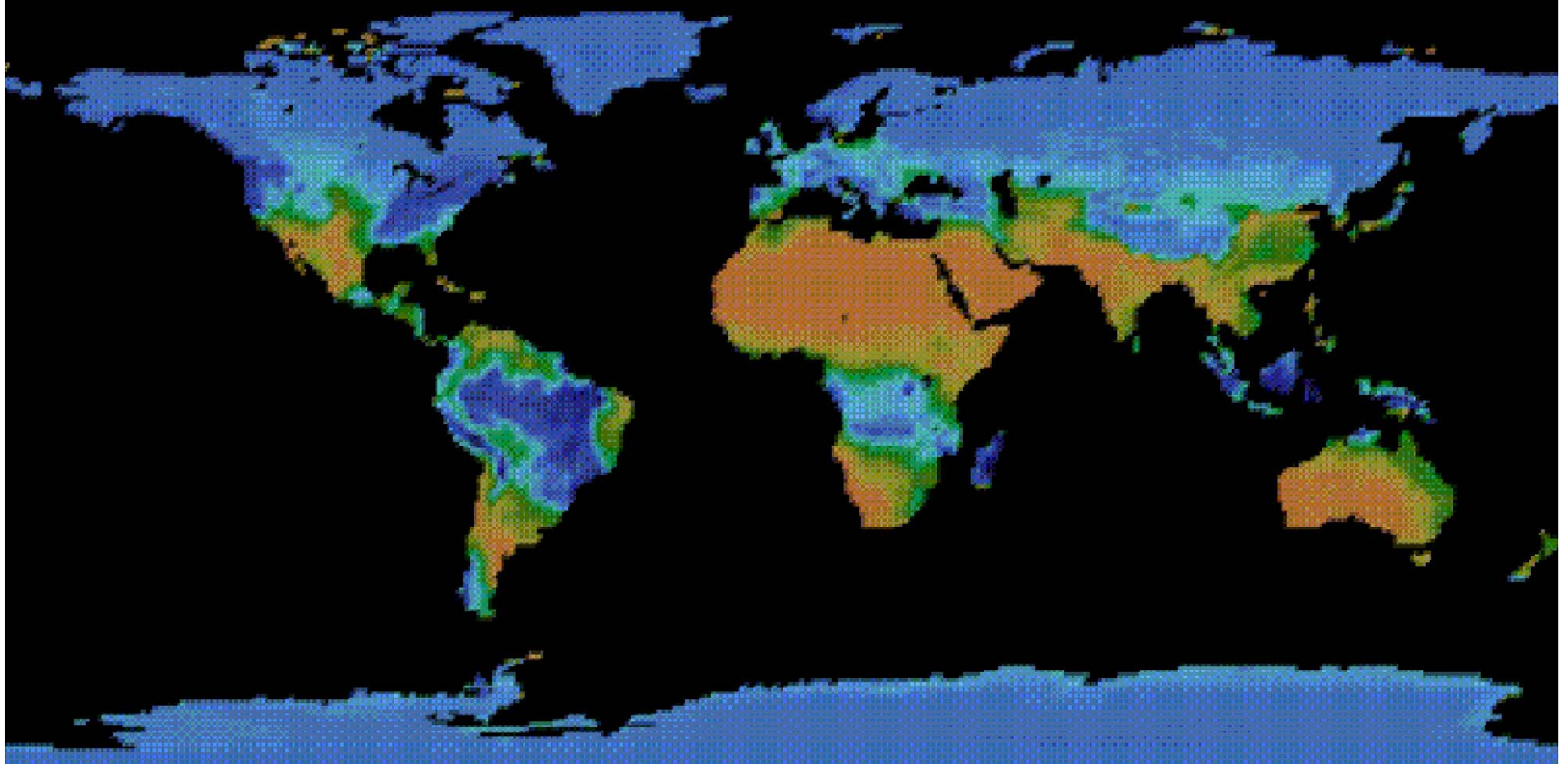
Hadley Cells and 30° Deserts



30°N and S marks the location of the descending limb of atmospheric Hadley and Ferrel cells. The air at the top is cool and doesn't contain much water vapor. As it descends it warms up and could hold much more water vapor, which it picks up from evaporation on the Earth's surface, drying out the land.

<http://ag.arizona.edu/~lmi/lich/desert1.html>

Volumetric Soil Moisture (%)



<http://ag.arizona.edu/~lmilich/desert1.html>

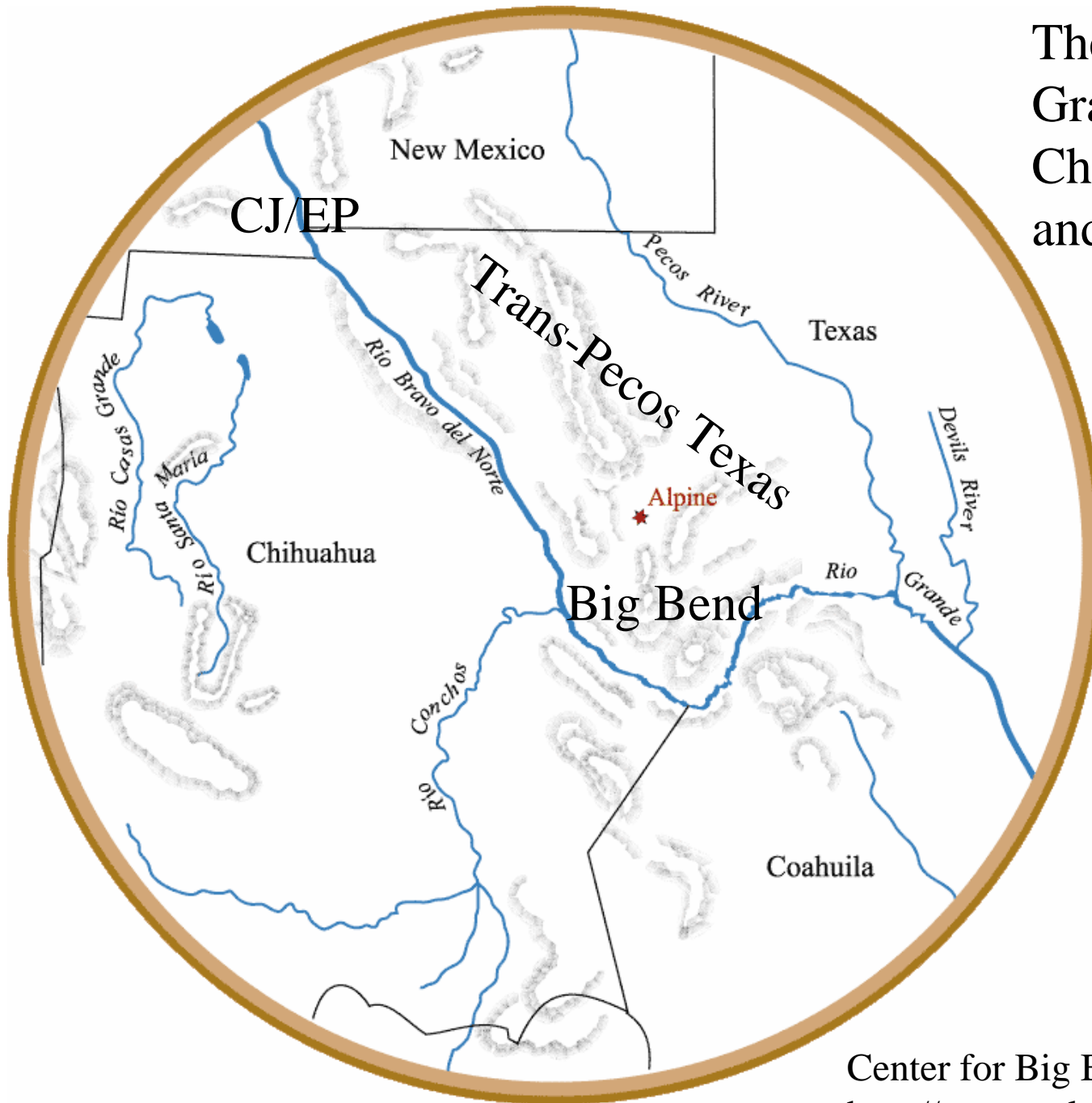
The Chihuahuan Desert

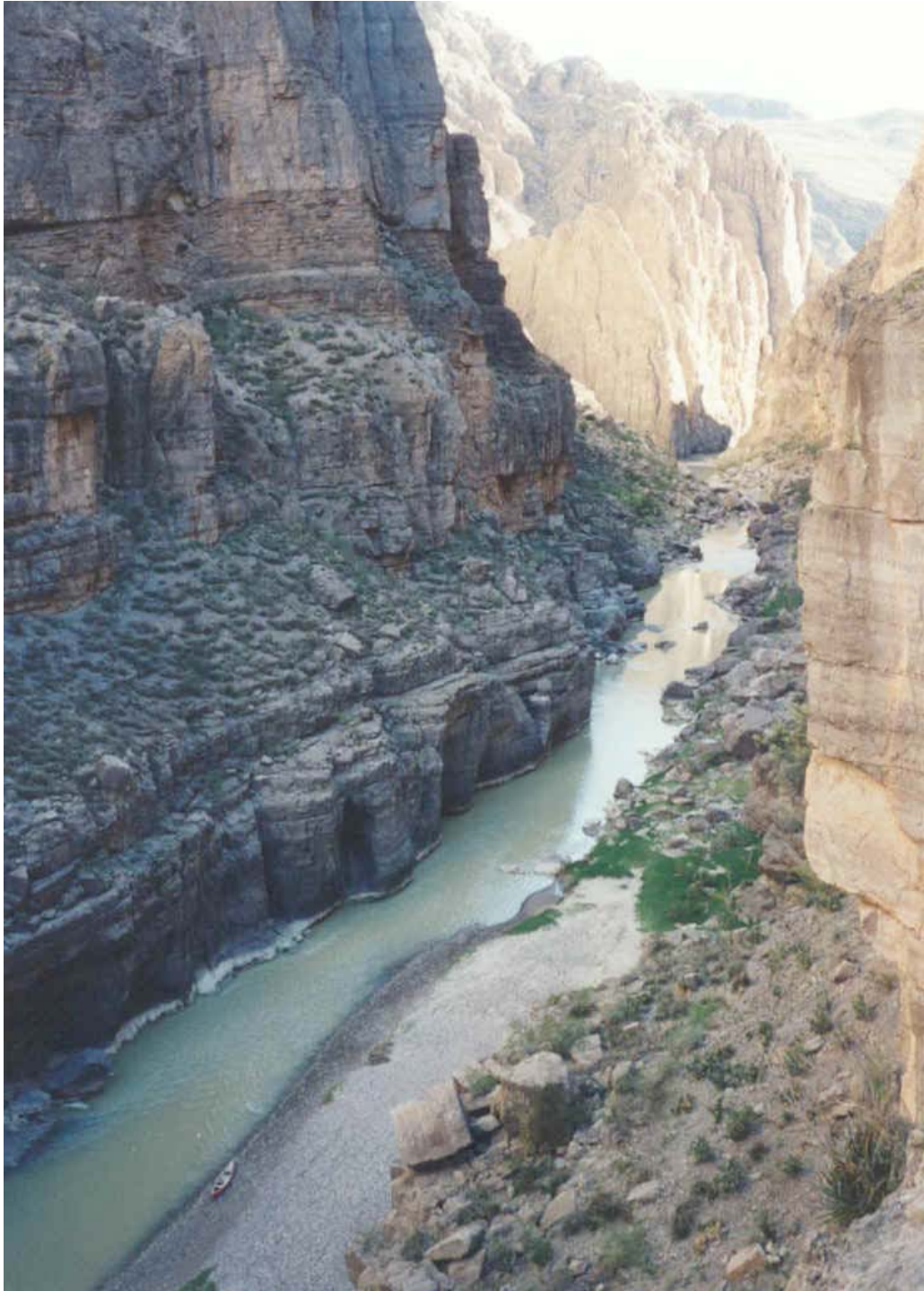
Arid to Semiarid climate. The climate leaves the states along the border highly vulnerable to drought, particularly along the Rio Grande region.



The Chihuahuan Desert occupies the extreme west of Texas and part of New Mexico, but the largest part of this desert occurs in Mexico.

The Lower Rio Grande through the Chihuahuan Desert and Big Bend



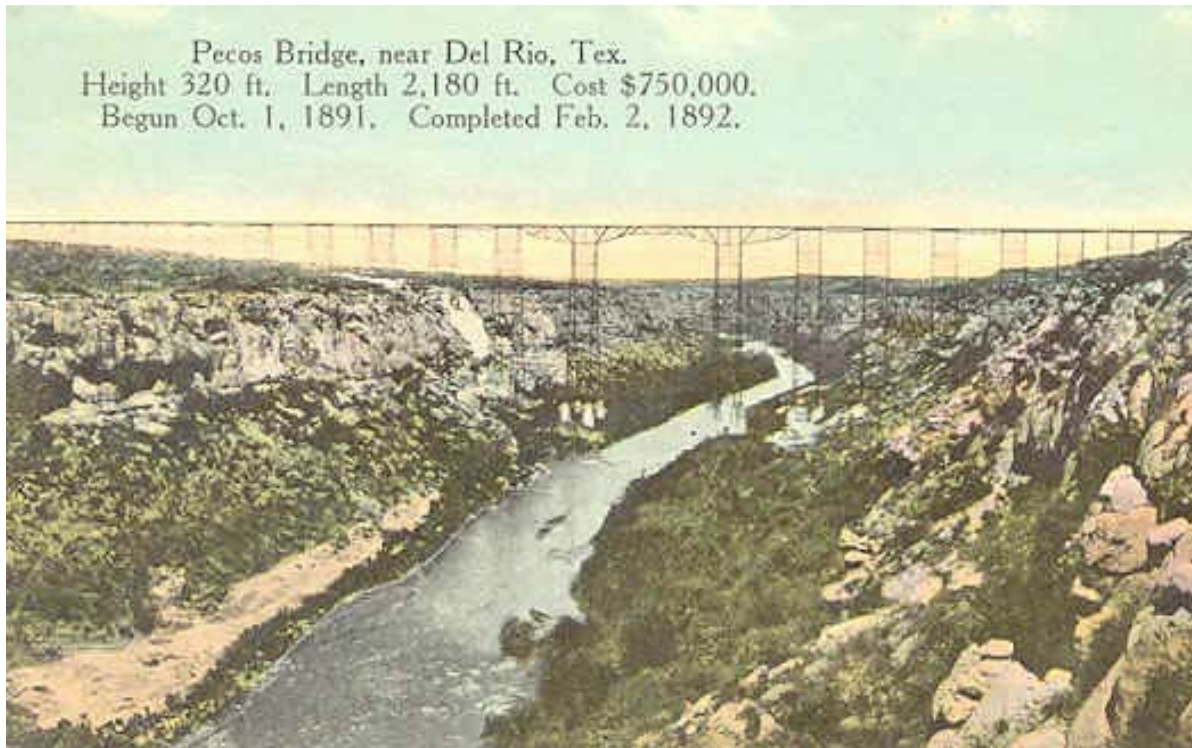


Big Bend National Park photo gallery
<http://www.nps.gov/bibe/photogallery/photogallery.htm>



Penguin Canyon, Chihuahua

Pecos River



Pecos Bridge, near Del Rio, Tex.
Height 320 ft. Length 2,180 ft. Cost \$750,000.
Begun Oct. 1, 1891. Completed Feb. 2, 1892.



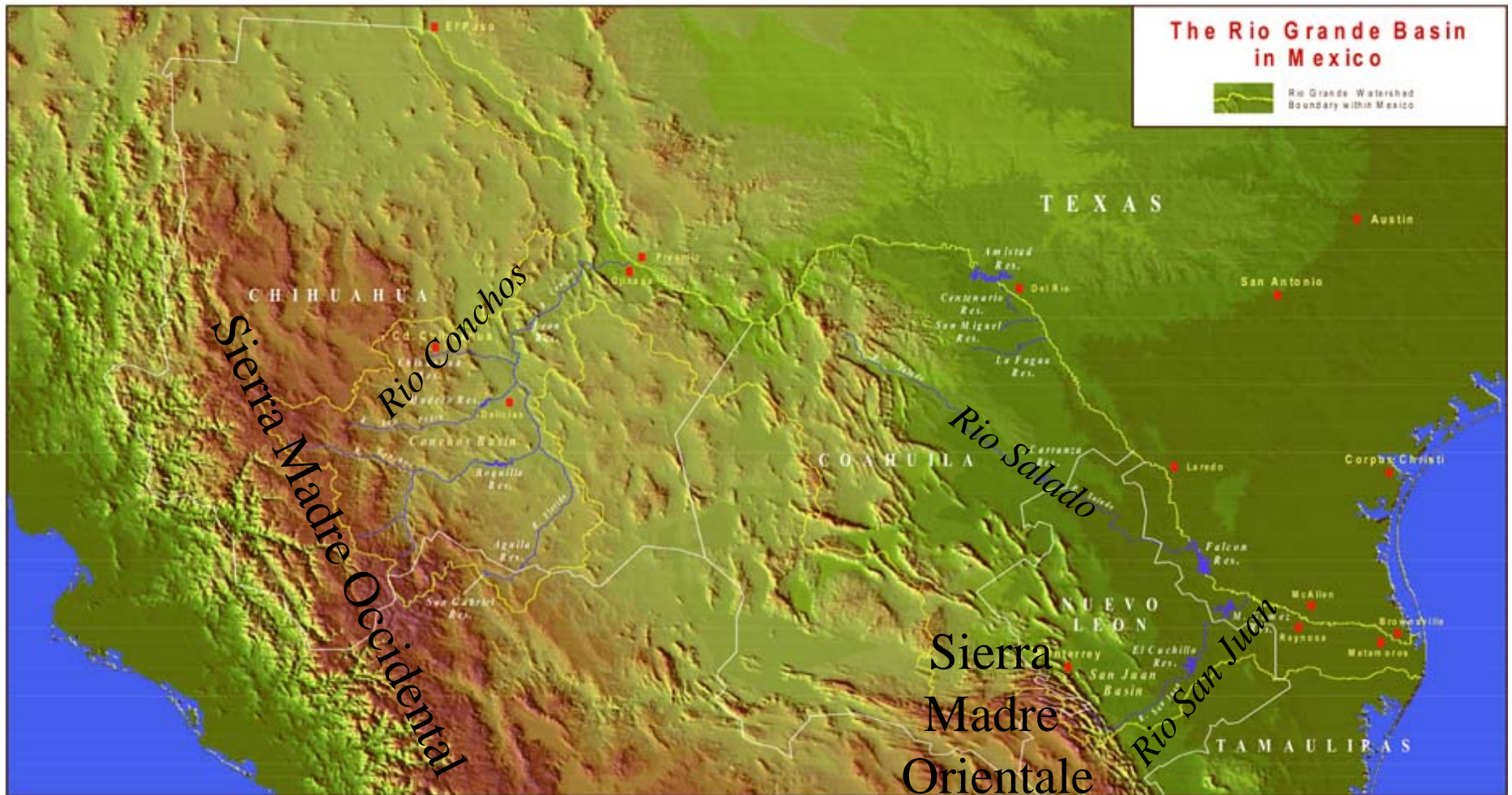
The Pecos River, the only major tributary of the Rio Grande from the north, rises on the western slope of the Sangre de Cristo mountains of New Mexico. Through most of its more than 900-mile-long course, the Pecos River parallels the Rio Grande. The Pecos serves as the eastern boundary of the most mountainous and arid region of Texas, generally known as the Trans-Pecos. Gaspar Castaño de Sosa, who followed the Pecos northward in 1590, called it the Río Salado because of its salty taste, which caused it to be shunned by men and animals alike. To Mexicans the river was long known as the Río Puerco ("dirty river"). Handbook of Texas On-line

Rio Conchos

The Rio Conchos is one of the most important river systems in all of northern Mexico. The Conchos supplies the Rio Grande below Presidio, Texas, with about 2/3 of its flow. Deforestation in the Sierra Madre in Chihuahua has contributed to one of the worst droughts in Mexico's history, reducing the flows of the Conchos River

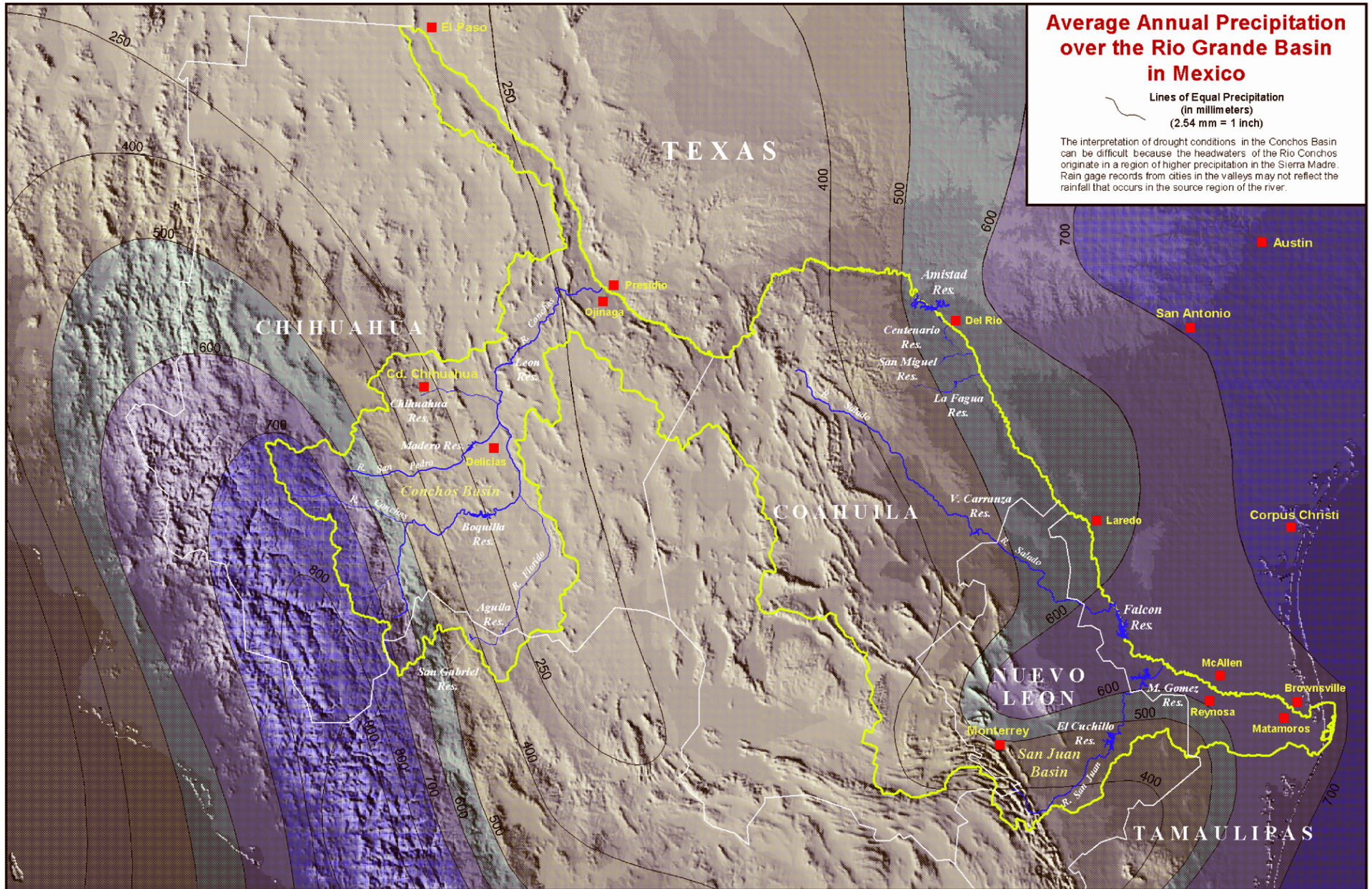
<http://www.texascenter.org/borderwater/rioonchos>

Rio Conchos drains Sierra Madre Occidental, Rio San Juan drains Sierra Madre Orientale, Rio Salado drains lowlands of Coahuila



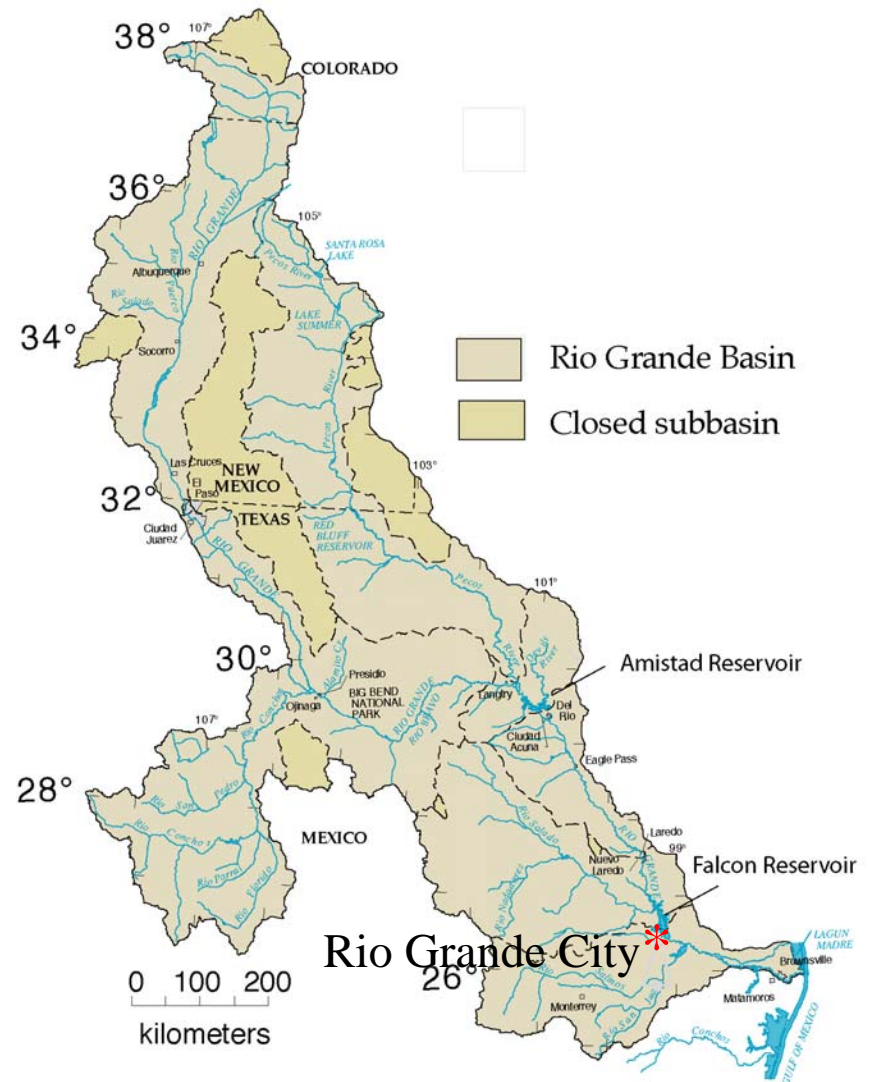
“An Update of Surface Water Availability in the Rio Grande Basin of Mexico” UT Center for Space Research 2003

Conchos Basin has good rainfall

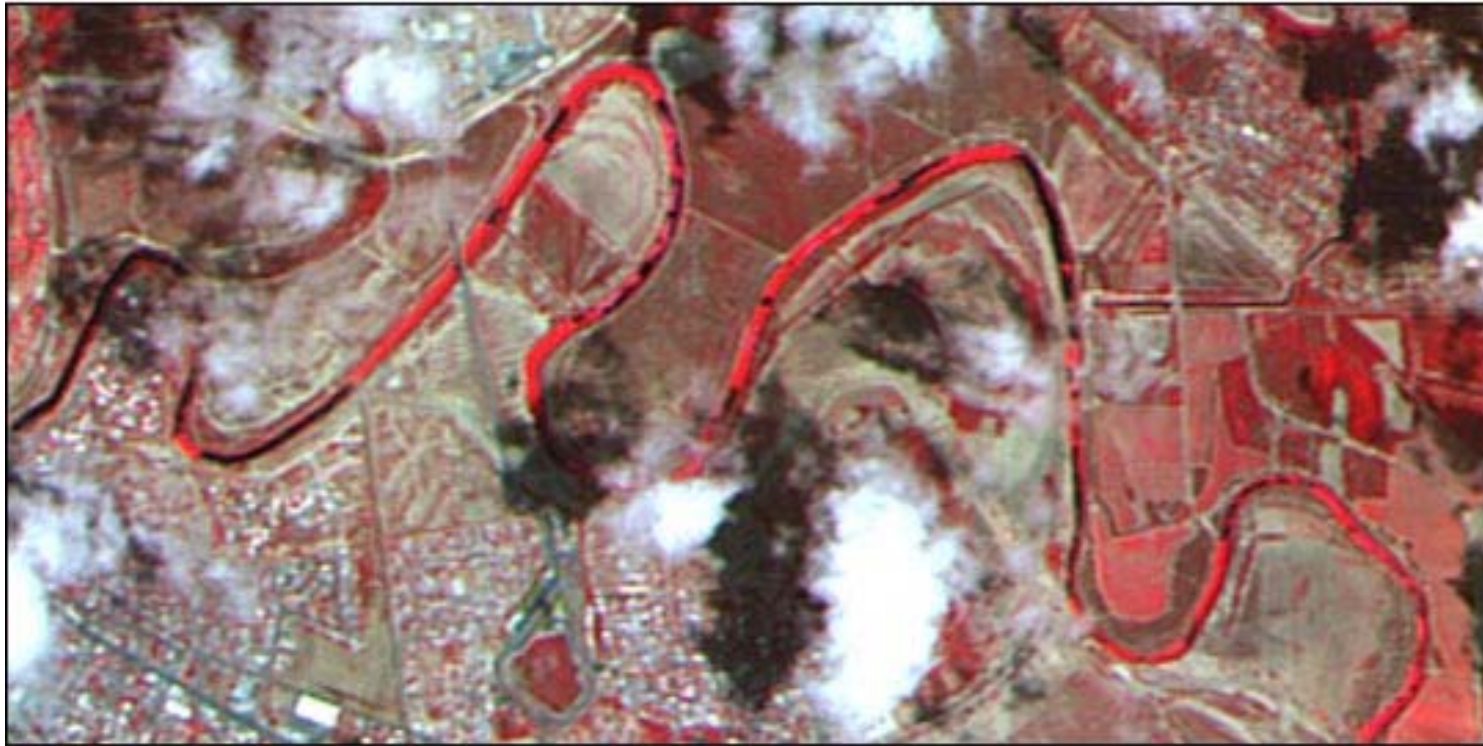


Lower Rio Grande

From El Paso to Rio Grande City, the river is entrenched in its channel. From Rio Grande City to the Gulf of Mexico, the river meanders through 241 miles of horseshoe bends (bancos) to reach the coast. Before these were straightened, the channels frequently twisted back upon themselves, creating cut-offs and confusion about where the border was.



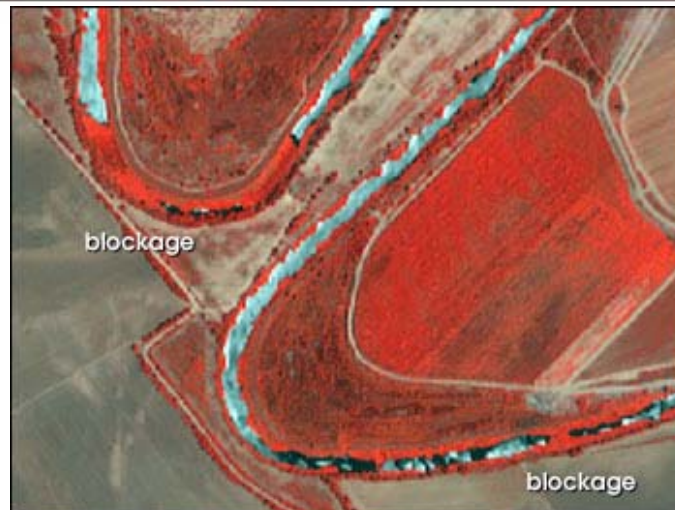
Rio Grande below Rio Grande City



Bancos
(horseshoe
bends or
river
meanders)
ASTER

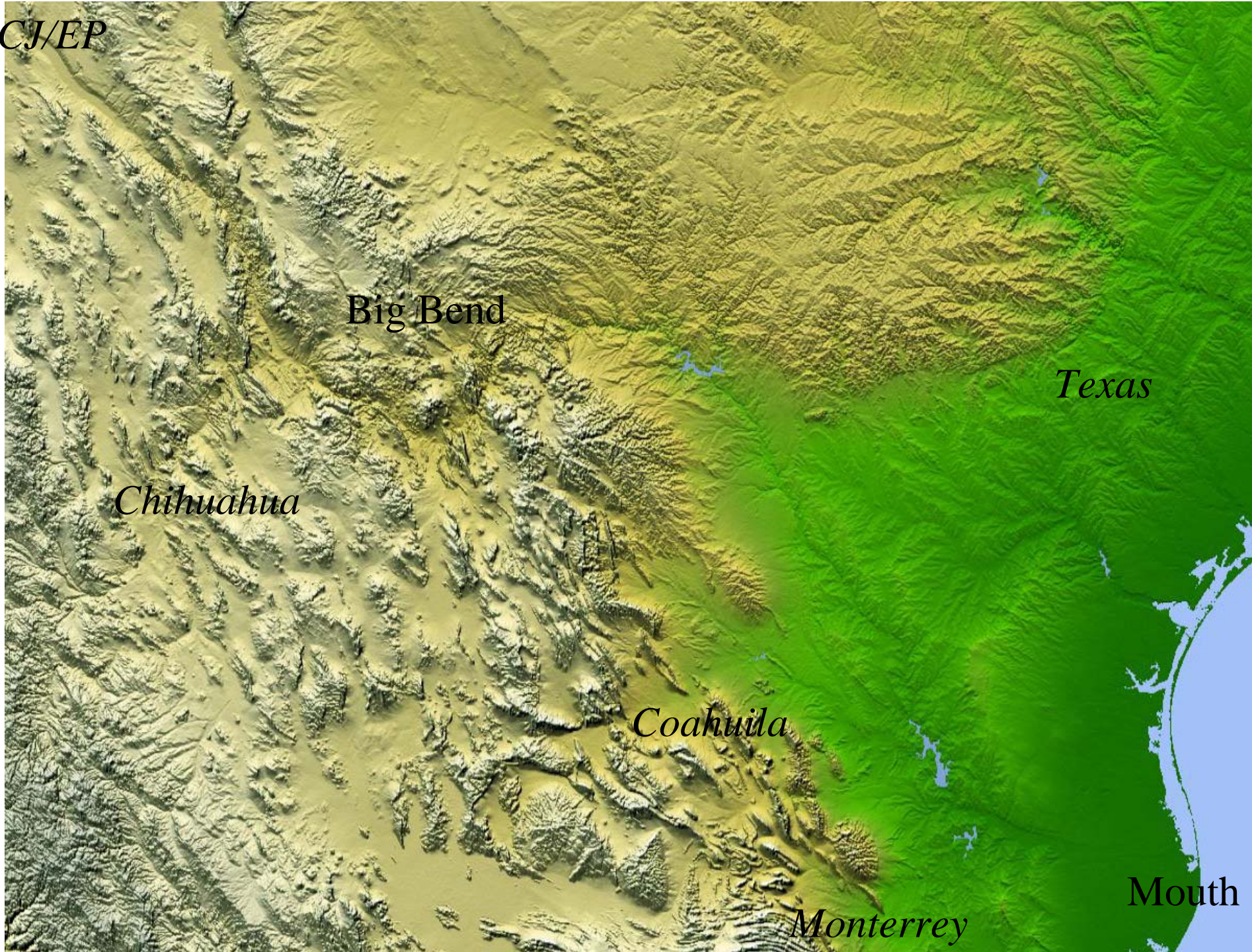
May 9, 2002

Water hyacinth
blockage
(IKONOS)



<http://earthobservatory.nasa.gov/Study/RioGrande/>

CJ/EP



Big Bend

Chihuahua

Coahuila

Texas

Monterrey

Mouth

Water Resources in the 21st Century: The Challenges facing the Lower Rio Grande



Transboundary Rivers

Transboundary waters are any surface or ground waters which cross or are located on the boundaries between two or more nations or states.

It is not just the river itself that must be considered, but the entire catchment or drainage basin.

The Rio Grande/Rio Bravo system is an outstanding example of a transboundary river system; the Colorado River system in the western U.S. is another good example.

http://www.cdc.noaa.gov/pubs/2003/details/pulwarty_01abs.html

Transboundary rivers in arid regions pose especially great challenges to the nations that share these waters.



The Nile in Africa:
A good example of
the challenges
associated with
allocating waters of
a transboundary
river in an arid
region.

Transboundary Rivers in Arid Regions

- Water use dominated by upstream riparian nation (Colorado River of W. U.S. - Mexico, upper Rio Grande)
- Downstream riparian nation dominates (Nile, Jordan)
- Riparians are equal partners (Lower Rio Grande, Niger, Tigris-Euphrates)



The International Boundary and Water Commission

- Established 1889, modern functions established by 1944 treaty
- Composed of US section (under US State Dept.) and Mexican section (under Mex. Secretariat of Foreign Relations).
- Responsible for applying boundary and water treaties between US and Mexico and for settling differences.
- Focus on Rio Grande/Rio Bravo and Colorado rivers
- IBWC is recognized as a model of effective international cooperation for dealing with transboundary water.

<http://www.ibwc.state.gov/>

IBWC Accomplishments

- 1) **Settlement of the Chamizal dispute** (600 acres in El Paso) with the signing of the Chamizal Treaty in 1963. The treaty provided for forcing the Rio Grande through a concrete channel that prevents it from changing course.
- 2) **Construction of two dams**, Falcon (1953) and Amistad (1969), on the Lower Rio Grande. Agreement calls for a third reservoir.
- 3) **Eliminating Bancos**. By 1970 American and Mexican boundary commissions had sliced through 241 bancos by straightening the river. Those bancos that protruded into Mexico went to Mexico, the others to Texas. More than 30,000 acres of land changed hands, most of it in the lower Rio Grande valley. The United States got 18,505 acres, and Mexico received 11,662 acres.

From the “Handbook of Texas On-line”

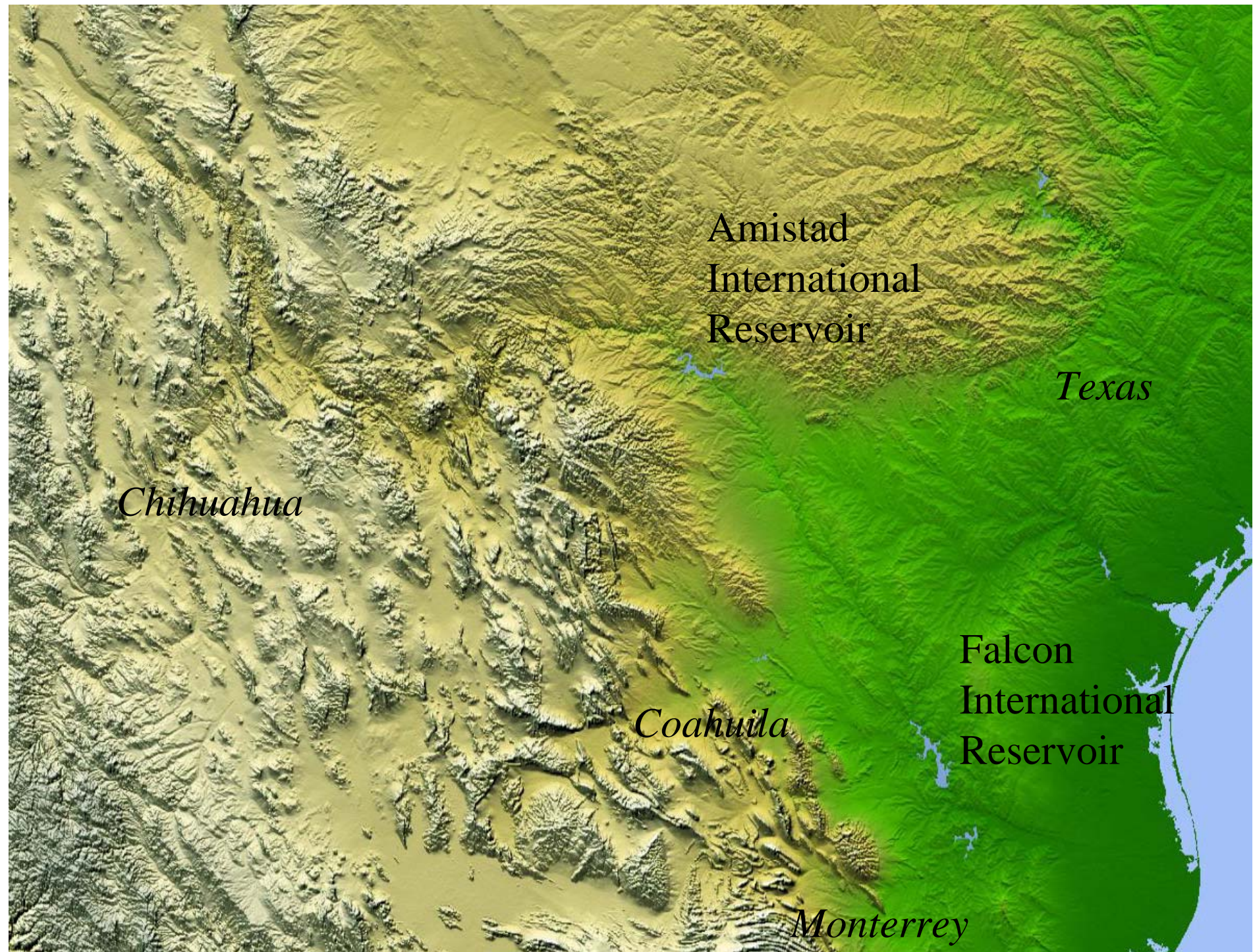


El Paso, USA

North

Juarez, Mexico

Rio Grande



Amistad
International
Reservoir

Texas

Chihuahua

Coahuila

Falcon
International
Reservoir

Monterrey

Amistad-Falcon & Water Storage in the Lower Rio Grande

- Amistad and Falcon reservoirs are considered one system with water frequently released from the upstream dam (Amistad) to replenish Falcon reservoir and meet the demands in the Lower Rio Grande Valley.
- IBWC operates these reservoirs to supply water and control floods.
- US and Mexico separately own water stored in the reservoirs.

Amistad and Falcon



International Amistad Reservoir, in Texas and Coahuila. Formed by Internatl. Amistad Dam (247 ft/75 m high), built in 1969. **International Falcon Reservoir** in Texas and Couahuila. Max. capacity 3,177,000 acre-ft. Formed by Internatl. Falcon L. Dam; 175 ft/53 m high), built in 1953.

Amistad Reservoir



March 31, 1987

December 7, 2000 + May 16, 2001

1987

2000

On 4/24/02 Amistad was at 31% capacity with 974,471 acre-feet.

International Falcon Reservoir

Water levels are also low

“The best way to get a sense of the chronic water shortage afflicting the frontier region between the United States and Mexico is to stand in front of the church on Nuestra Señora del Refugio in the village of Antigua Ciudad Guerrero. The church’s handsome colonial façade is a little battered. But what makes its survival remarkable is that until recently it was submerged beneath Falcon reservoir ... Since 1992, the water level has been falling, exposing the ruins of Antigua Ciudad Guerrero. Today, Falcon reservoir is barely 10% full” (Economist 2002).

Mexico's Water Debt to the U.S.

Currently, Mexico owes the United States 1.5 million acre-feet of water under the 1944 treaty obligations. While Mexico has argued that they cannot meet their treaty obligations due to “persistent and extraordinary drought,” the US and Texas argue that this is not true.

According to a September 2003, Texas A&M University report, irrigated water use from surface and groundwater sources in Chihuahua doubled from 1980 to today, from 2 million acre-feet a year to 3.5 million acre-feet per year. The water owed the US is being used in development of Chihuahua. The economic impact to South Texas of the 1.5 million acre-feet water debt owed to the United States is \$1 billion. Mexican farmers in Coahuila are also suffering.

The Mouth of the Rio Grande today

The Rio Grande ... is in many places just a brown, malodorous rill. Already for the second time in two years its flow is so small that it does not discharge into the Gulf of Mexico, but, about 100 meters far from the sea, it rather peters out in the sand” (Piotrowski 2002).



March 1999: Mouth of
the Rio Grande



April 2002: VW parked where Rio Grande
used to flow into ocean. Now there is a
sandbar



Challenges in the Lower Rio Grande Valley (Texas-Mexico Border)

Rapid population growth. Population growth along the border region is extremely high. 12 million people currently live there. 20 million are expected by 2020.

Extensive industrialization. The North American Free Trade Agreement (NAFTA) has encouraged growth of maquiladora industry near the border. The number of plants operating in Mexico jumped from 1,700 in 1990 to 3,800 in 2001.

Unchecked pollution. Pollution of surface or aquifers (underground water resources).

Salinity problems. Water salinity continues to exceed the standard during certain months of the year.

Aquifer depletion. Because supplies of surface water are unable to meet demand, municipalities are pumping water from the ground. In some cases, groundwater is being pumped at a higher rate than the rate of replenishment.

Preparing for the Future

Inhabitants of the Rio Grande valley have had to face water shortages many times in the past. The situation nowadays appears to be worse: growing population and economic growth have increased the demand for water while its supply has become less, both in quantitative and qualitative terms. What should be done?

Some adjustments in the Rio Grande Basin management and in its regulations might be helpful:

1) *Conserve existing resources.* Water conservation could be achieved by discouraging thirstier crops, by appropriate water pricing, and by metering and charging for water use.

2) *Plan for sustainable economic development.* What is the best use of scarce water in the border region? Agriculture or factories and cities?

3) *Amend the 1906 and 1944 treaties.* These treaties were written to deal with the needs of a small and largely agricultural population. If the region is to develop further, the agreements need to reflect the challenges facing a large and increasingly industrialized economy and urban population.

Most importantly: Find more water!

It is possible to build an aqueduct system that would divert water from water-rich regions to the N and E in the US (E. Texas, Louisiana, Oklahoma) and Mexico (regions to the south) and transport this to the Rio Grande Valley. A larger supply of water would support a larger agricultural and manufacturing industry and larger population at the same time that it better allows the environment to be protected.

Possible Aqueducts

