HYDROGEOLOGY OF THE NORTHERN TAOS PLATEAU, TAOS COUNTY, NORTHERN NEW MEXICO

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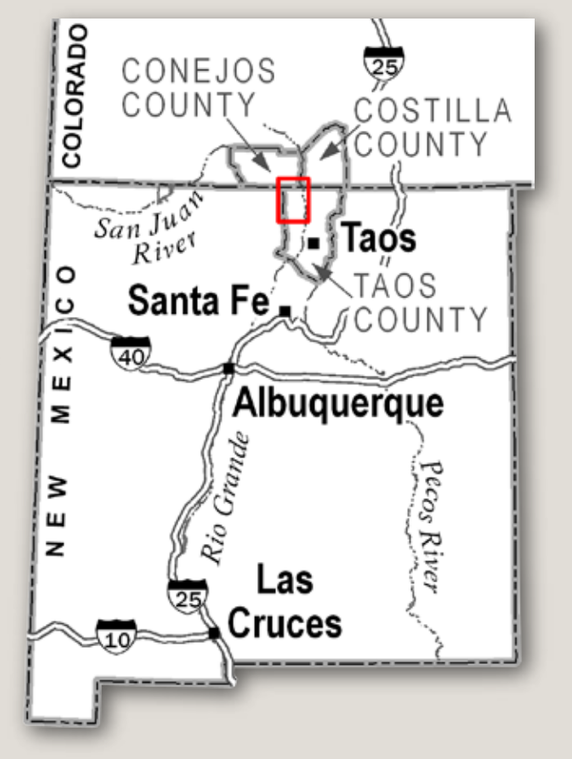
AQUIFER MAPPING PROGRAM

ABSTRACT



The Taos Plateau is capped by the largest and compositionally most diverse volcanic field of the Rio Grande rift and contains seven major rift-related fault zones. Pliocene Servilleta flood basalts form the major aquifer. Other aquifer units include volcanic domes and buried vents, Santa Fe Group alluvial deposits, lower Tertiary volcaniclastic units, and Proterozoic granite. A water-table surface defines: 1) Regional west-to-east groundwater flow from the Tusas Mountains; 2) A groundwater divide aligned with the Rio San Antonio in southern Colorado; 3) A remarkably flat hydraulic gradient in the eastern half of the plateau; and 4) Recharge mounds beneath the Rio San Antonio, the Rio Grande in the Ute Mountain reach, and volcanic domes.

Chemical, thermal and isotopic data from wells and springs were applied to evaluate groundwater sources, flow patterns, recharge and discharge zones, and residence times. Three groundwater sources are identified: 1) Deep inflow from the Tusas Mountains with depleted deuterium, a positive ^{18}O thermal shift, high silica, warm temperatures, and a ^{14}C residence time of 5500 to 8000 years; 2) Cool (<16 ºC), low TDS, Ca-Na-Mg-HCO_3 water representative of central Taos Plateau recharge, with a mixed residence time of 3500 to 5000 (RCYBP) years, measureable ^{3}H, and 3045 year-old CFC-12 ages; and 3) High TDS, Na-HCO_3-Cl water upwelling from a deep saline source near the Red River and Ute Mountain fault zones.

The Taos Plateau regional aquifer first discharges to the Rio Grande 33 miles downstream from the CO border in a 1.5-mile reach at the Red River fault zone. Spring discharge to the Rio Grande is strongly controlled by faults, with most inflow occurring along two short river segments coincident with the Olla/Ute Mountain and Red River fault zones.

Taos Plateau water well and tank, with Ute Mountain in the distance.

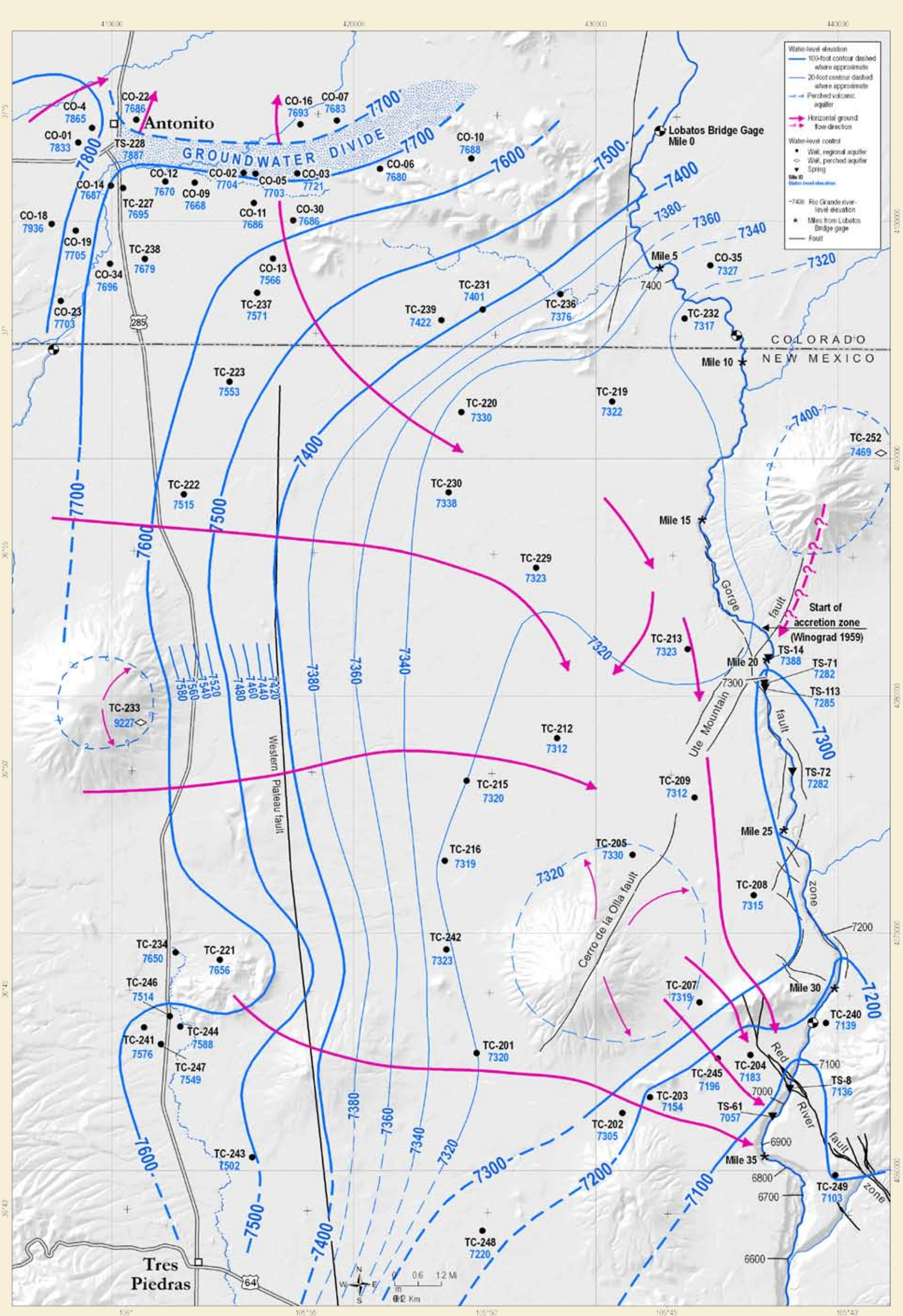
HYDROLOGY

The Taos Plateau regional aquifer is unconfined within Servilleta Basalt and the upper Santa Fe Group. Most Taos Plateau wells in New Mexico draw groundwater from the Servilleta Basalt. In Colorado, wells tap Santa Fe Group alluvium. West of the inferred Western Plateau fault, the Hinsdale Formation and older volcanic units form the regional aquifer.

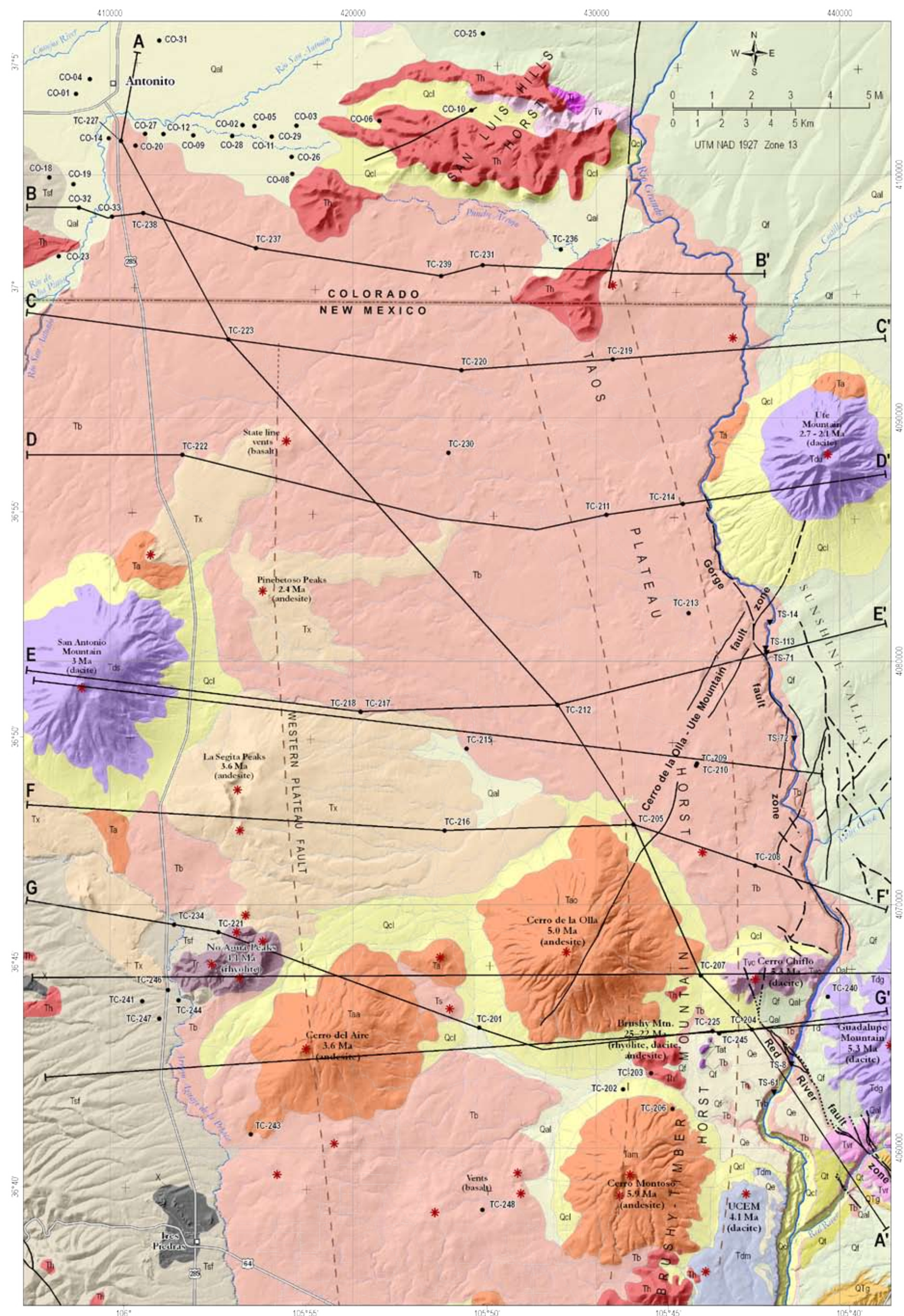
Groundwater Conditions

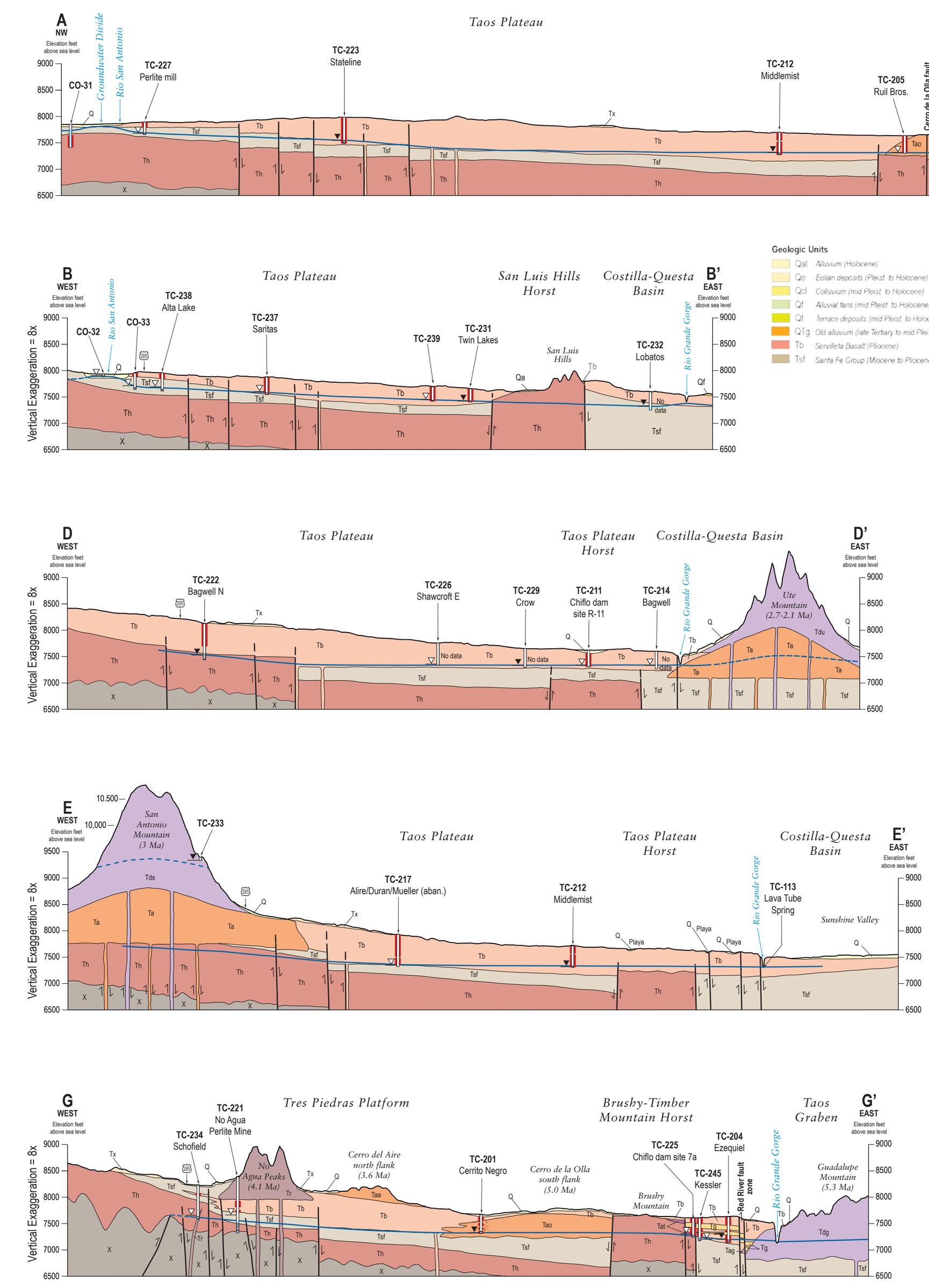
Groundwater flows west to east from the Tusas Mountains towards the Rio Grande gorge.

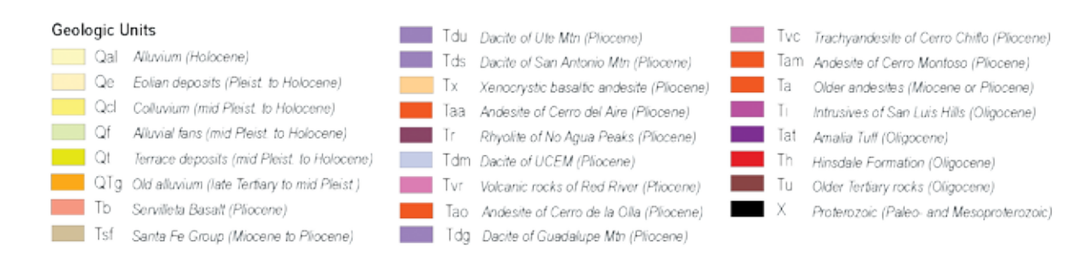
- Gradient change across Western Plateau fault reflects a permeability contrast between Hinsdale Formation and Servilleta Basalt
- Flat gradient in eastern half of plateau with south and southeasterly flow
- Recharge mounds beneath Rio San Antonio and Rio Grande
- Groundwater divide at Rio San Antonio
- Perched aquifers and recharge mounds associated with volcanic domes



GEOLOGY







Faults and Structures

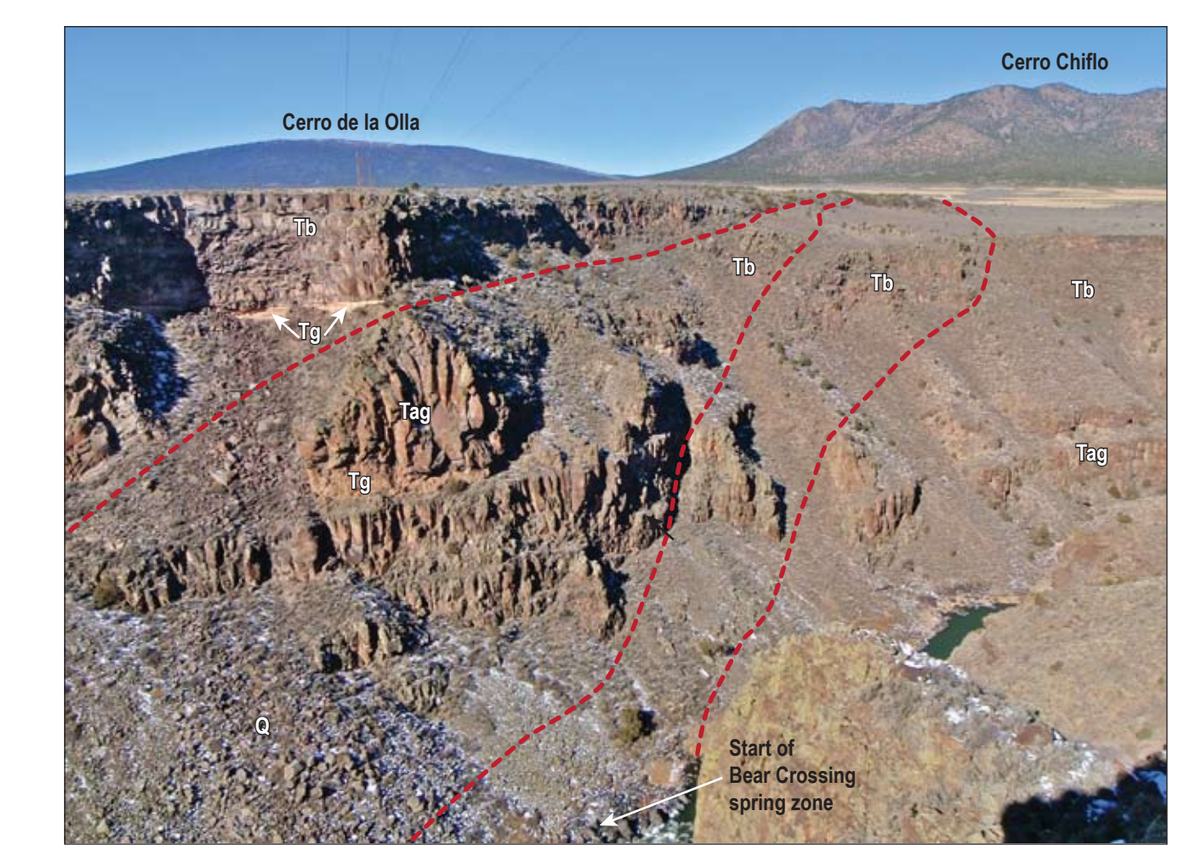
Several faults and associated horst structures exert some control over regional groundwater flow:

- Red River fault zone
- Gorge fault zone
- San Luis Hills, Brushy/Timber Mountain, and inferred Taos Plateau horsts
- Inferred Western Plateau fault
- Cerro de la Olla-Ute Mountain fault zone

Data suggest that heat flow and upwelling thermal water along rift-margin structures influence both the flow and chemical characteristics of groundwater in the Taos Plateau regional aquifer.

San Luis Hills are mainly composed of pre-rift volcanic units.

Tertiary volcanic rocks of the Brushy-Timber Mountain horst.

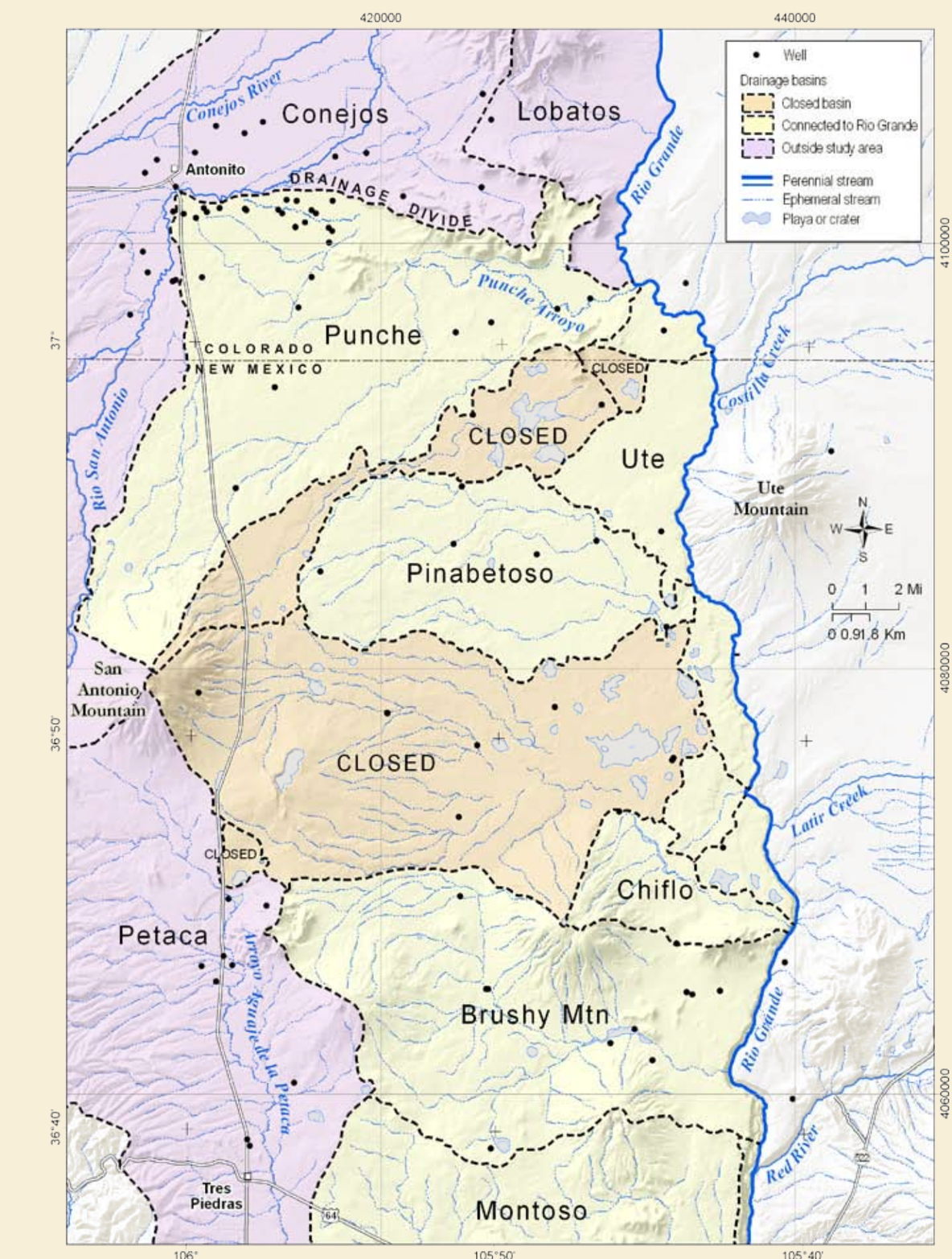


The Red River fault zone cuts across the Rio Grande Gorge.

GEOMORPHOLOGY

Streamflow from the Tusas Mountains is diverted around the Taos Plateau volcanic field and San Antonio Mountain via the Rio San Antonio and the ephemeral Arroyo Aguaje de la Petaca. Indicators of infiltration and recharge through the Taos Plateau volcanic field to local and regional aquifers include:

- Basalt-capped plateau and volcanic domes lack well-integrated surface drainage.
- Two-thirds of the study area (453 mi^2) consists of closed or poorly developed drainage basins, many of which contain active playas.
- Precipitation increases with elevation on volcanic domes.

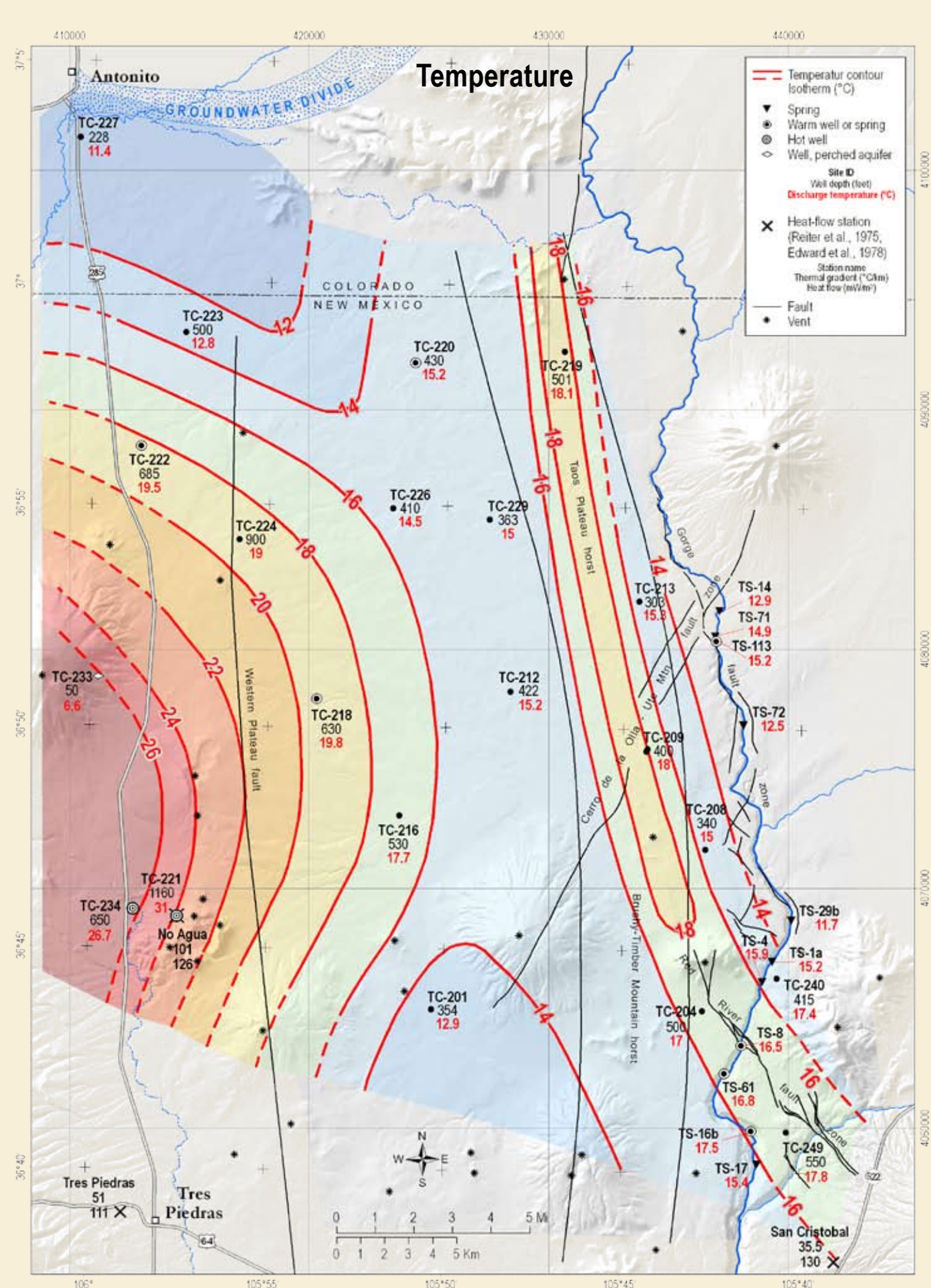


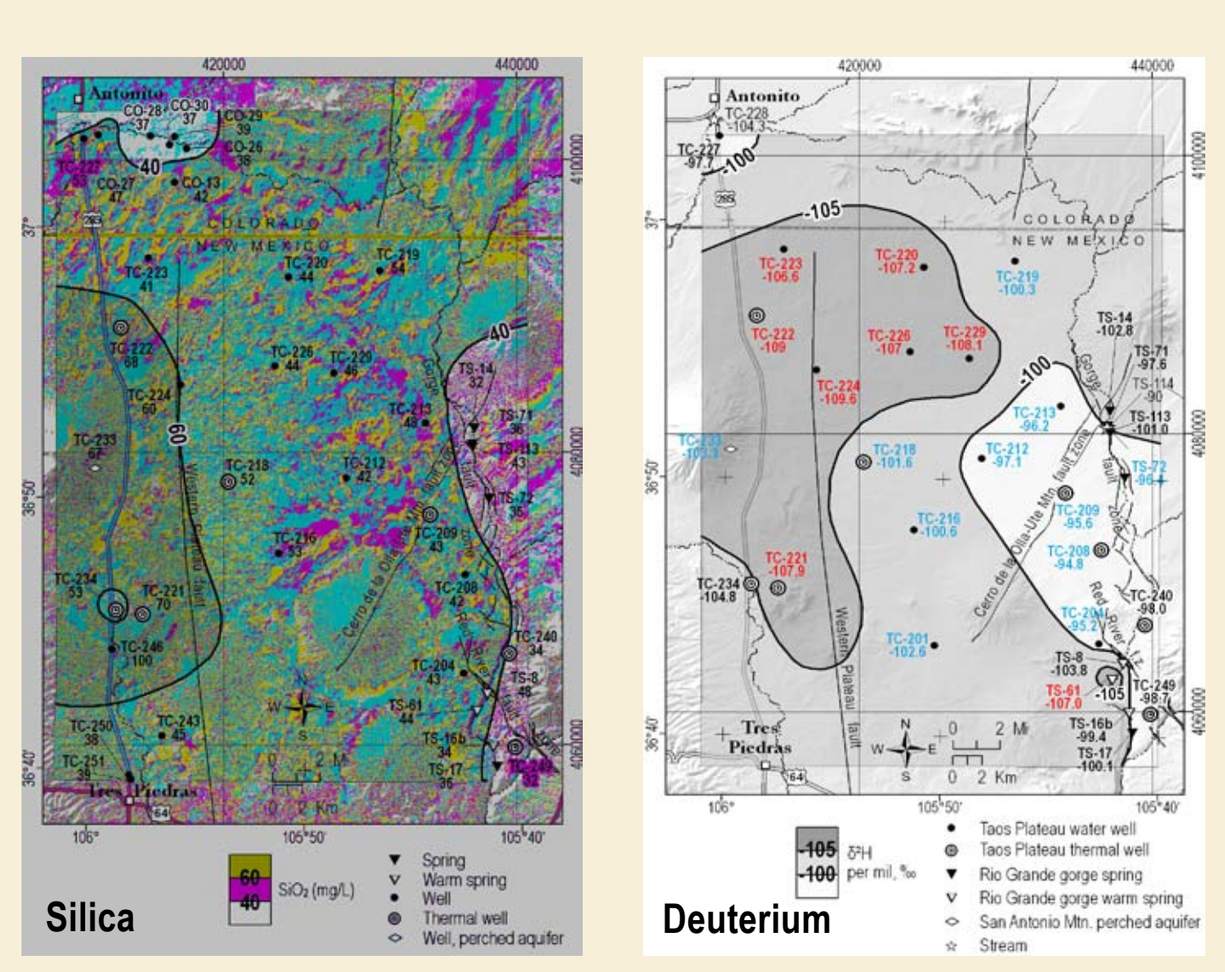
Small playa lake in a large closed basin north of Cerro de la Olla.

GROUNDWATER SOURCES AND RECHARGE

Underflow from the Tusas Mountains characterized by:

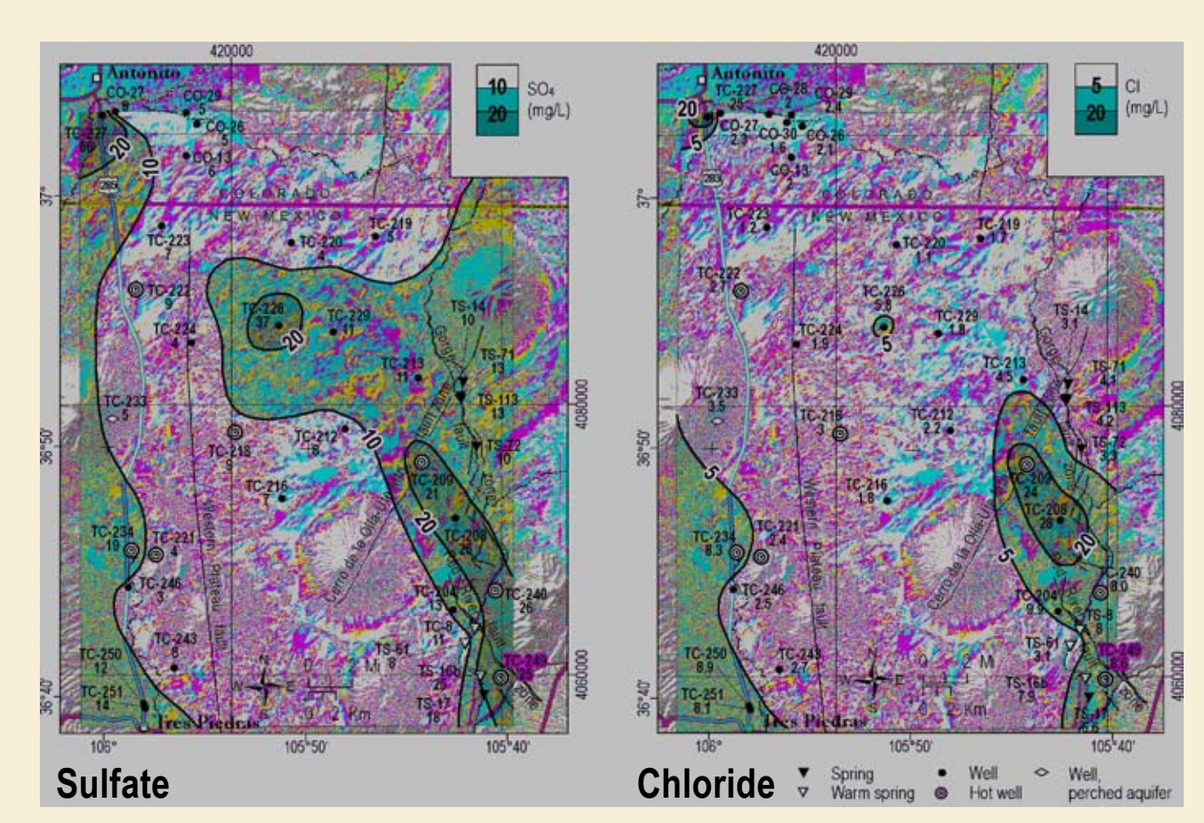
- Warm discharge temperature (>19 ºC)
- High TDS (>200 mg/L), elevated Ca, Mg, F, Li
- Elevated dissolved SiO_2 (>60 mg/L)
- Depleted ^{2}H (<-105 ‰)—high altitude source
- Positive ^{18}O shift of 0.5-1.0 ‰—thermal exchange

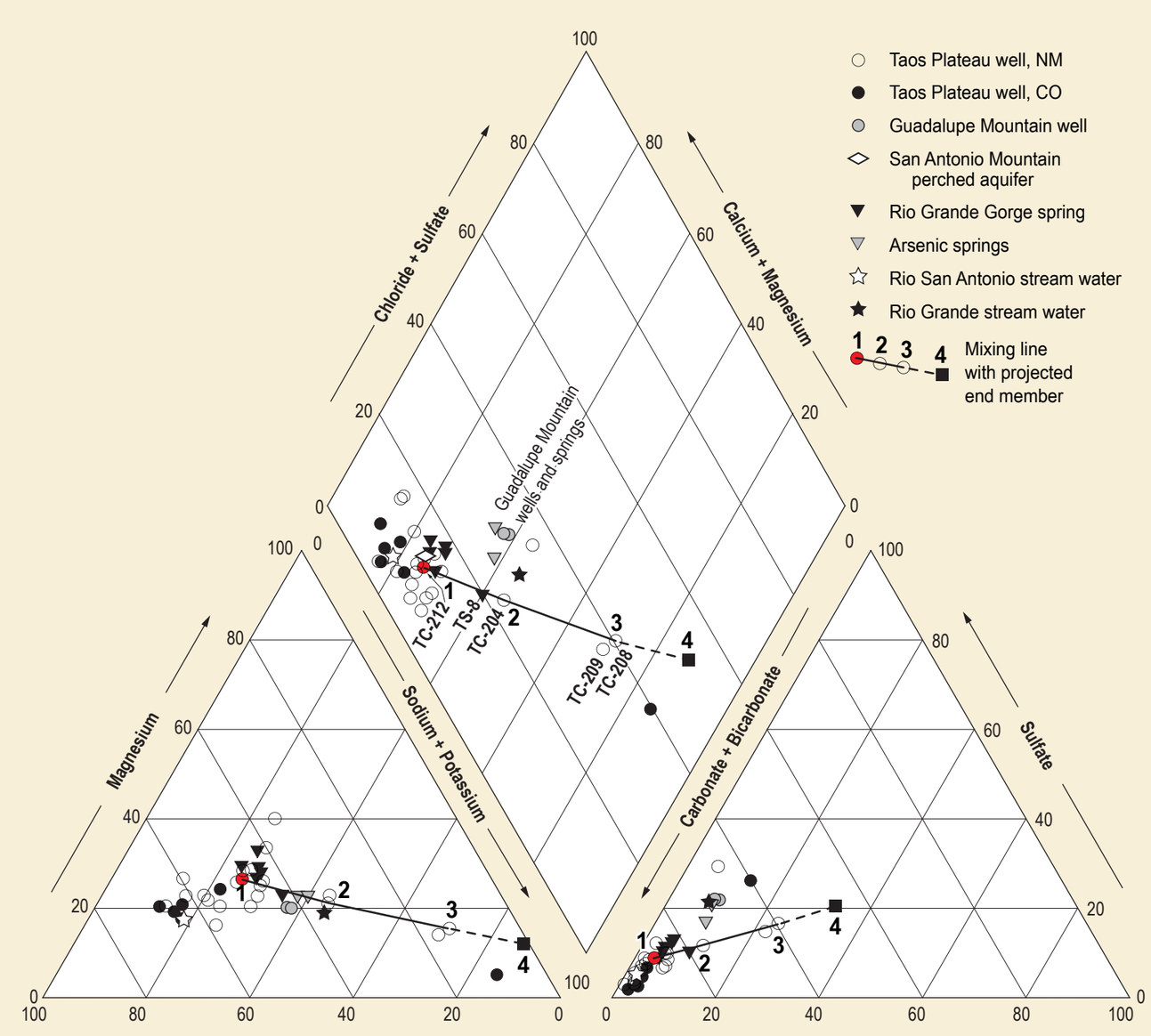




Upflow Along Red River and Ute Mtn Faults characterized by:

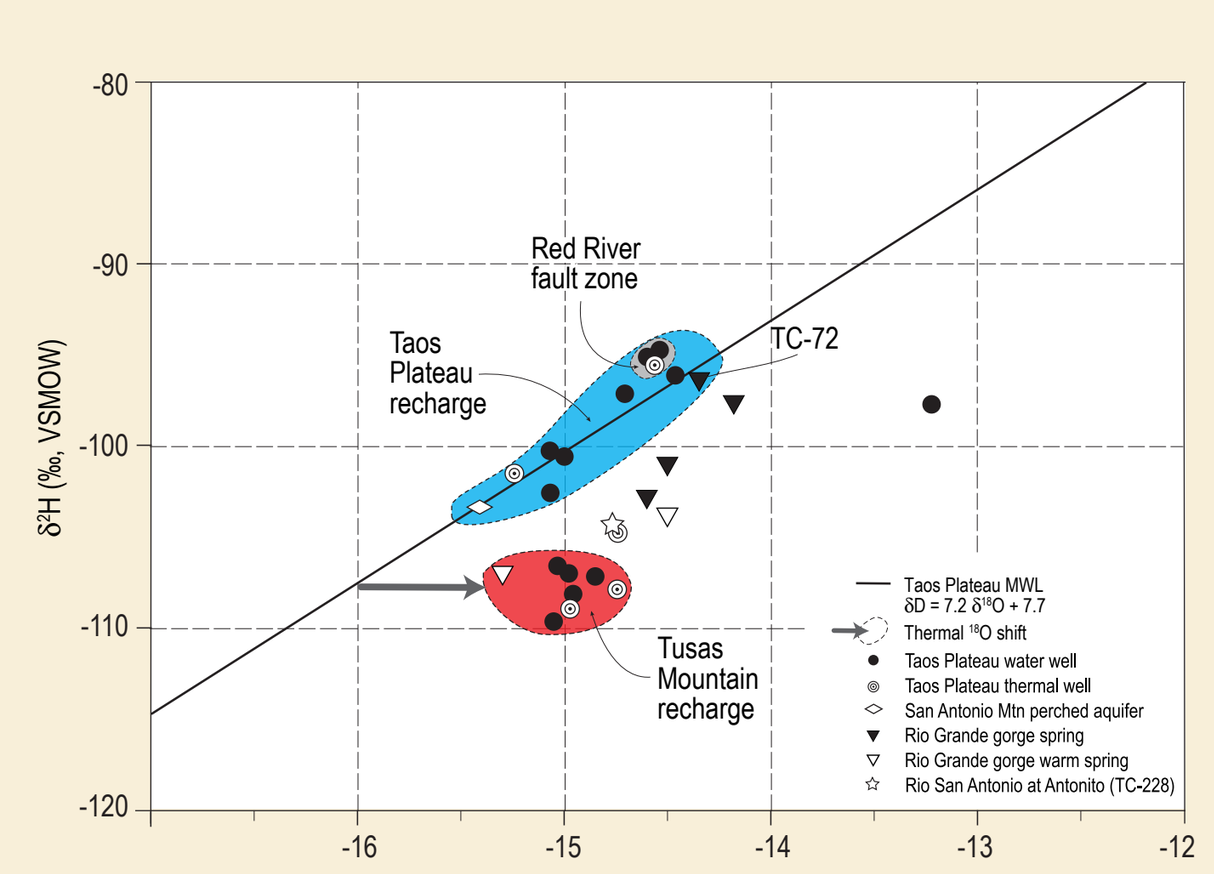
- Warm discharge temperature (16.5–18.1 ºC)
- High TDS (>200 mg/L), Na-HCO_3-Cl water elevated in SO_4, Br, F, B, Li, As
- ^{2}H and ^{18}O composition similar to Taos Plateau
- Simple mixing in down-gradient well (TC-204) and spring (TS-8) – 60% Taos Plateau / 40% deep saline
- Saline end member projected to be Na-Cl-SO_4 water





Recharge from Precipitation on the Plateau characterized by:

- Cool discharge temperature (<16 ºC)
- Low TDS (<200 mg/L), Ca-HCO_3 water, variable Mg, Na
- Enriched ^{2}H (≥-100 ‰)
- ^{2}H and ^{18}O composition trends on a MWL from San Antonio Mtn perched aquifer (TC-233)



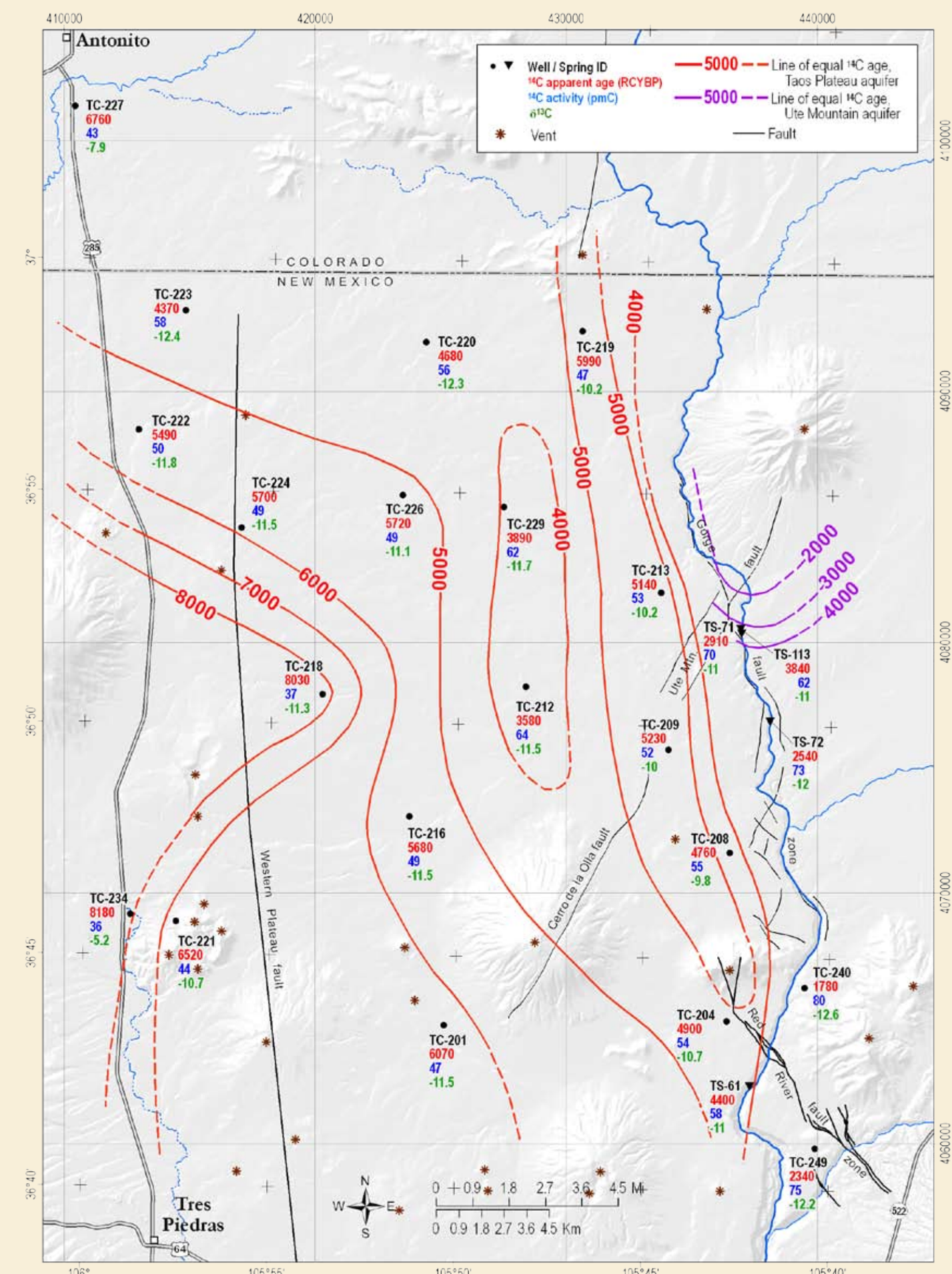
Large playa located at east end of a closed basin in the center of the Taos Plateau was filled by snowmelt and rainwater in May of 2008.

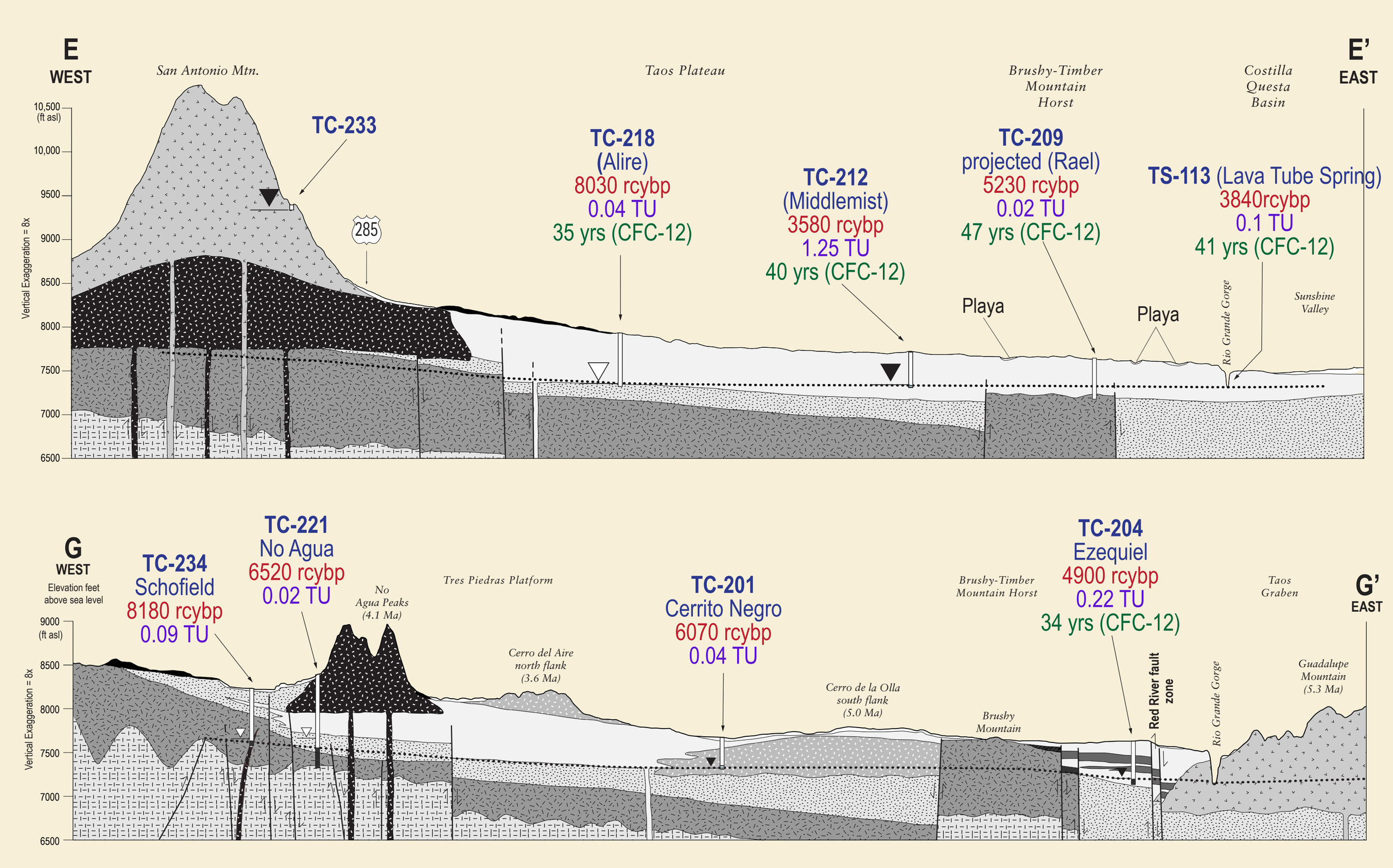
View west of the eastern flanks of San Antonio Mountain.

GROUNDWATER RESIDENCE TIME

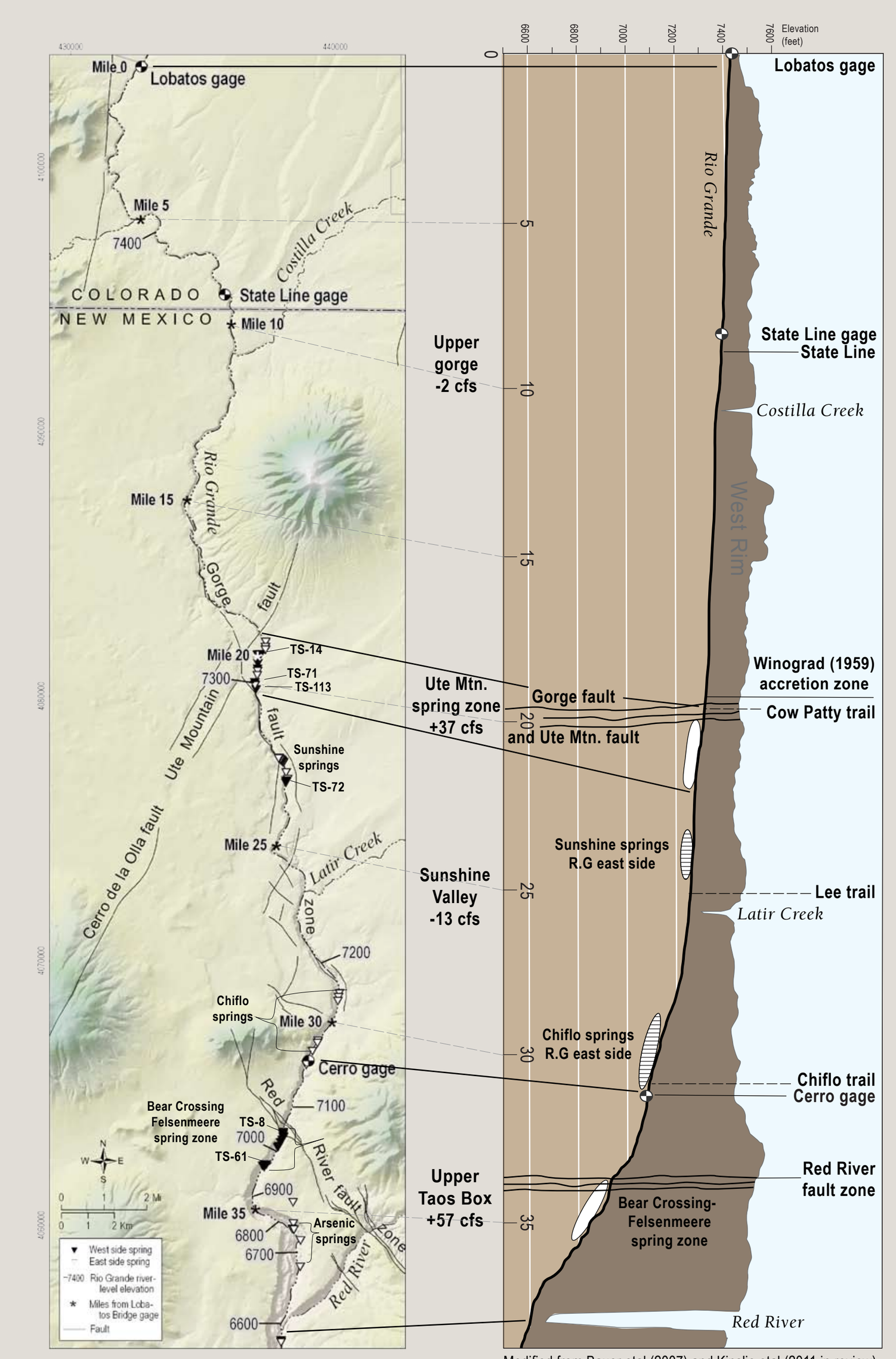
Groundwater age-dating indicates mixing of "old" and "young" waters:

- Apparent ^{14}C ages decrease (young) from west to east (down-gradient) in the aquifer
- Oldest groundwater is underflow from Tusas Mountains (5500 to 8000 rcybp, < 0.1 TU, CFC-12 recharge age >55)
- Youngest water is mixed with recent recharge in the central plateau closed basins (3500 to 4000 rcybp, 0.2–50.8 TU, CFC-12 recharge age 30-40 yrs)
- Discharge in the Ute Mountain spring zone (2910 to 3840 rcybp, 0.1 TU) is younger than any sampled in the Taos Plateau regional aquifer, suggesting a source from Ute Mountain
- Discharge in the Bear Crossing-Felsenmeere spring zone (4400 rcybp, 0.1 TU) is consistent with the Taos Plateau regional aquifer





GROUNDWATER DISCHARGE, STREAM FLOW AND SPRINGS OF THE RIO GRANDE GORGE



Gains in Rio Grande stream flow emanate from groundwater discharge from aquifers west (Taos Plateau) and east (Sunshine Valley) of the gorge via large springs and spring zones. Two principal spring zones—Ute Mountain and the Bear Crossing-Felsenmeere—coincide with the Ute Mountain and Red River fault zones.

Ute Mountain Spring Zone

- River mile 19.5–21 at start of Winograd (1959) accretion zone
- Abundant discrete springs, large spring zones, and seepage faces along both banks and in channel
- Vents typically 5–15 ft above river with discharge from <1 to 100s of gpm
- Discharge increases downstream to Lava Tube spring (13 cfs, 6000 gpm) at the Gorge fault

Bear Crossing-Felsenmeere Spring Zone

- River mile 33–34 where Red River fault zone intersects gorge
- Discharge from vents beneath basalt talus 50 to 100 ft or more above west bank
- Bear Crossing Qtot ≈ 6400 gpm (14 cfs)
- Felsenmeere Springs Qtot ≈ 9700 gpm (21.6 cfs)
- High discharge reflects high river gradient (84 ft/mi) and deep incision through Upper Taos Box

PROJECT FUNDING

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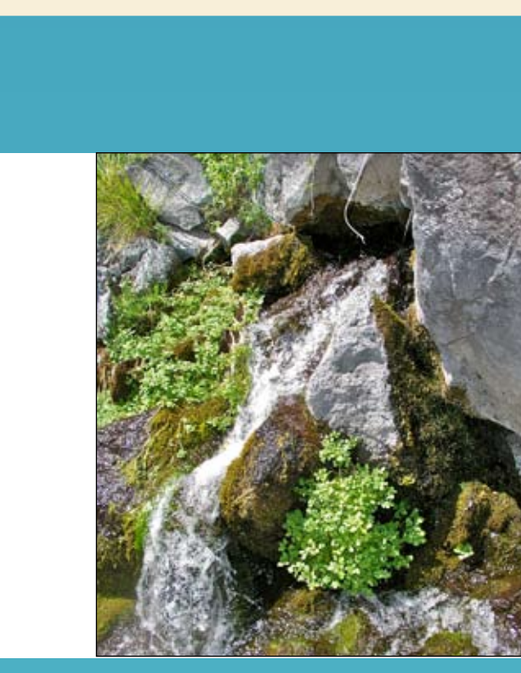

GIS/CARTOGRAPHY/LAYOUT: Brigitte Felix, The New Mexico Bureau of Geology & Mineral Resources