

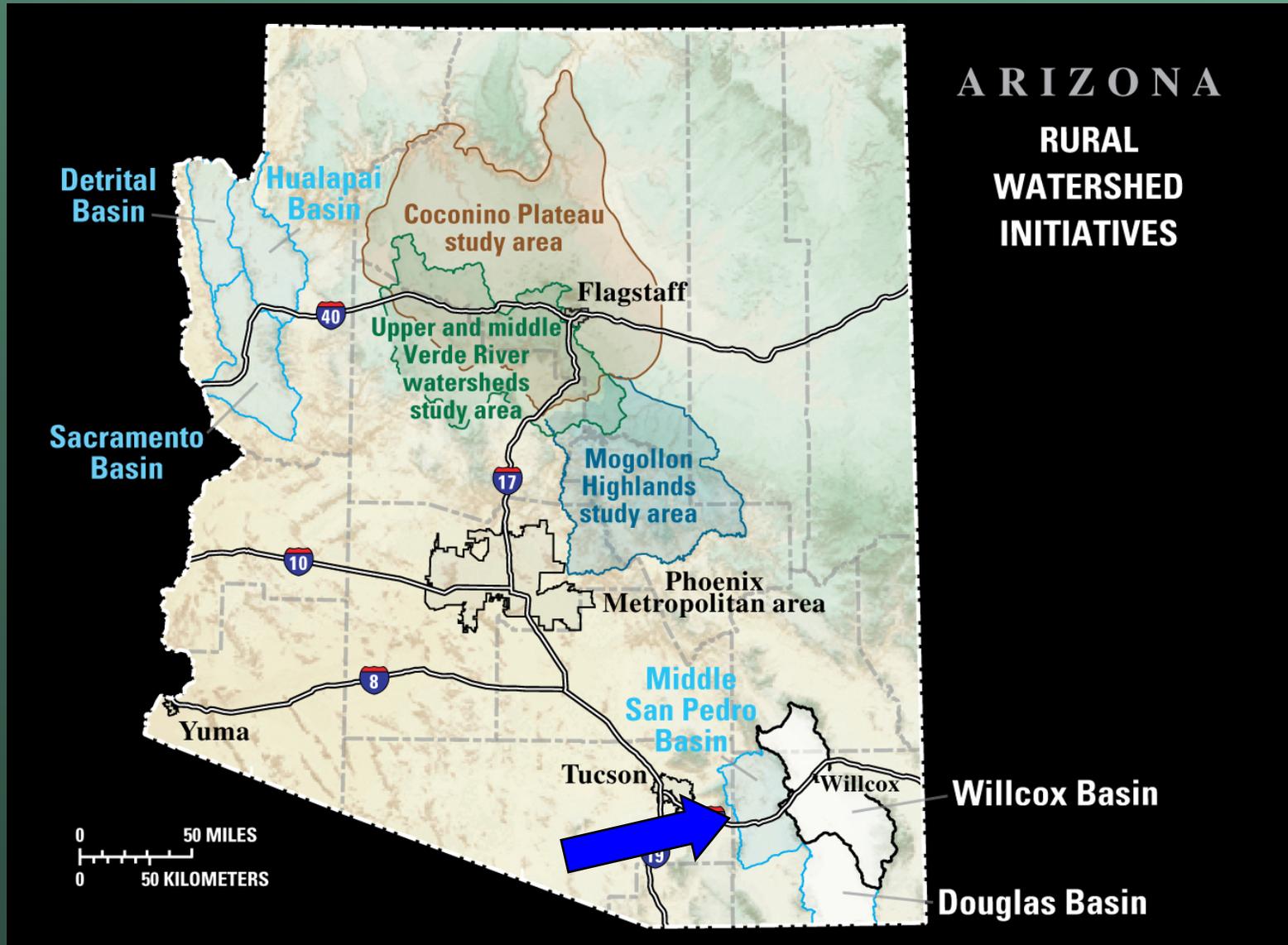


# Hydrologic Investigations of the Middle San Pedro Area

Cooperative Study of the U.S. Geological Survey and  
Arizona Department of Water Resources

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Blake Thomas  
Jeff Cordova  
Don Pool  
Jamie Macy  
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# Rural Watershed Study Areas



# Middle San Pedro Watershed

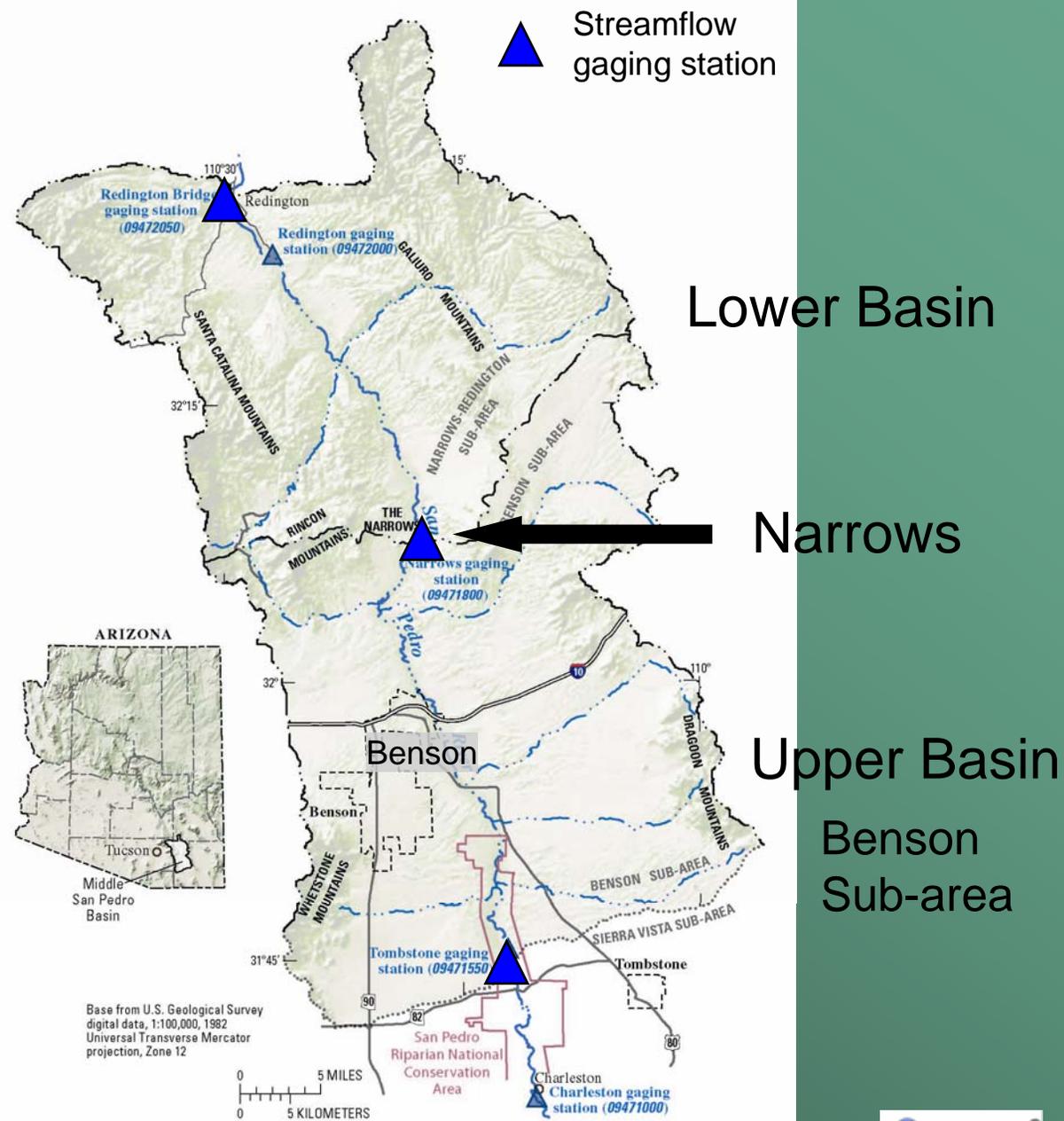
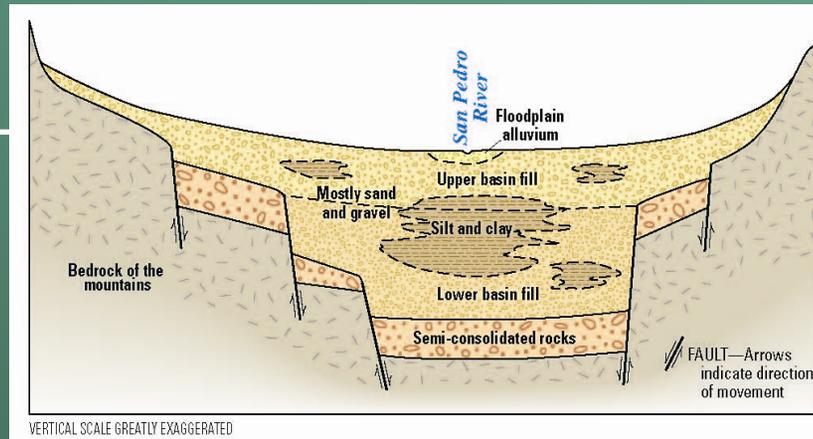


Figure 1. Location of middle San Pedro Basin, southeastern Arizona.



# Key Study Area Characteristics



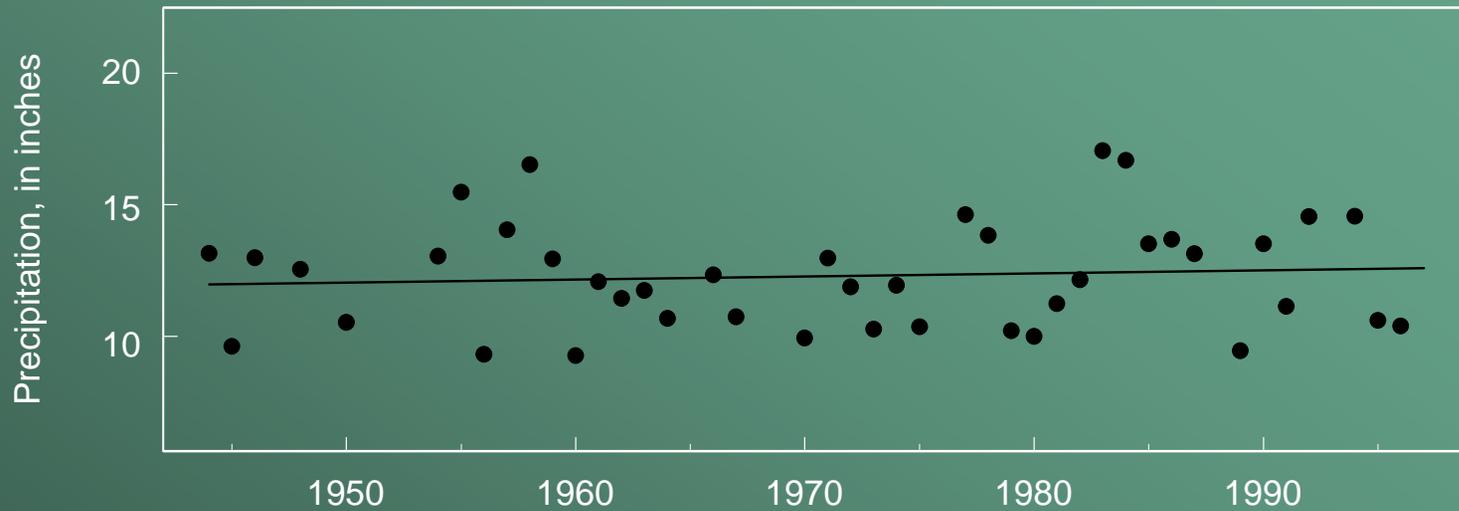
- Alluvial basin and basin-fill aquifer
- Ephemeral San Pedro River with valuable riparian habitat
- Satellite community for Tucson metro area
- Competing water demands with Sierra Vista and Fort Huachuca

# Issues and need for study

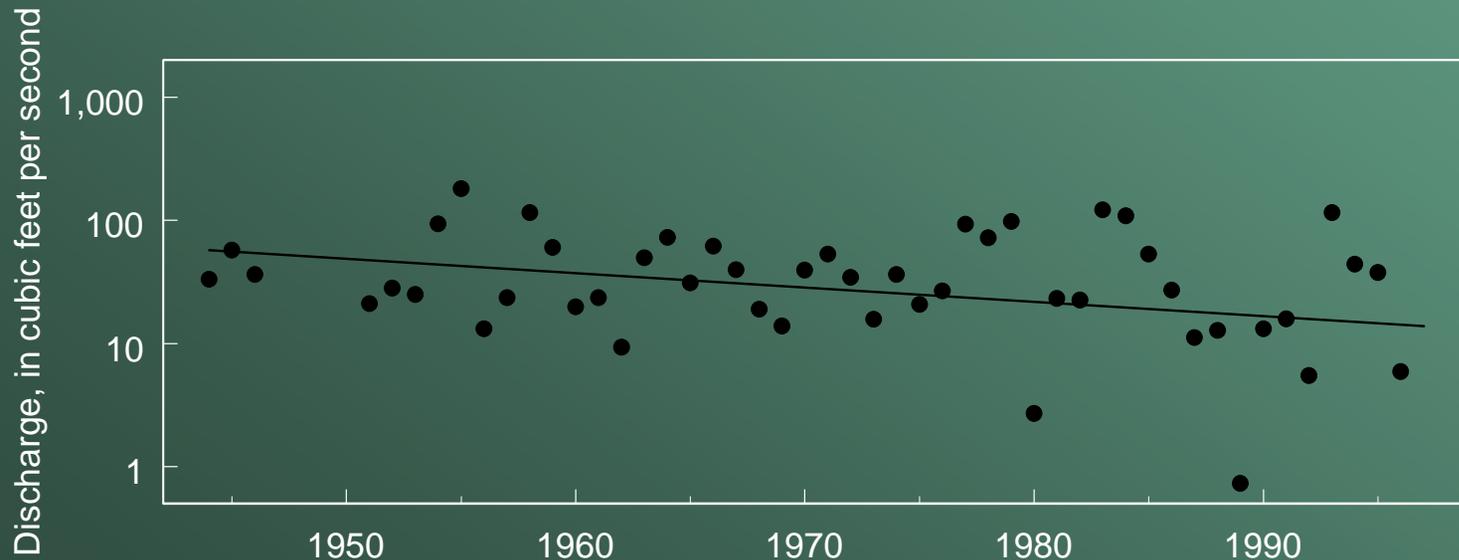
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- Population of Benson is expected to increase from 5,000 to 50,000 during the next 25 years
- Ground water is only source of water
- Decreasing flows in San Pedro River

# Precipitation at Tombstone



# Streamflow of San Pedro River at Redington



# Objectives

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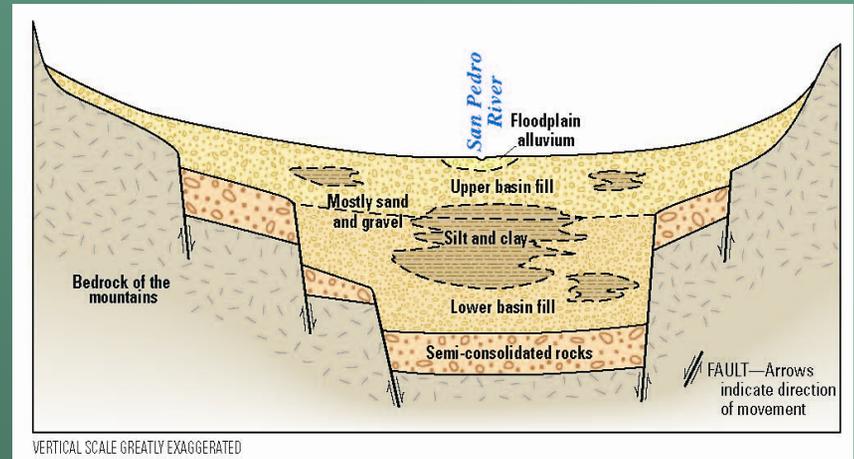
- Determine current and future water availability
  - Describe the hydrogeologic framework of the ground-water system
  - Describe ground-water flow, recharge, storage, and discharge
- Determine potential impacts of increased ground-water withdrawals
- Communicate study results to public and government decision makers

# Hydrogeologic framework

- Boundaries and properties of aquifers and confining beds

- Data collection

- Geophysical surveys
- Well information – lithology, pumping, water levels
- Geologic information



# Ground-water flow system

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- Ground-water levels, flow direction, recharge, discharge, storage
- Data collection
  - Water levels – measurements and long-term monitoring
  - Precipitation
  - Streamflow monitoring
  - Water chemistry, isotopes
  - Evapotranspiration from riparian vegetation

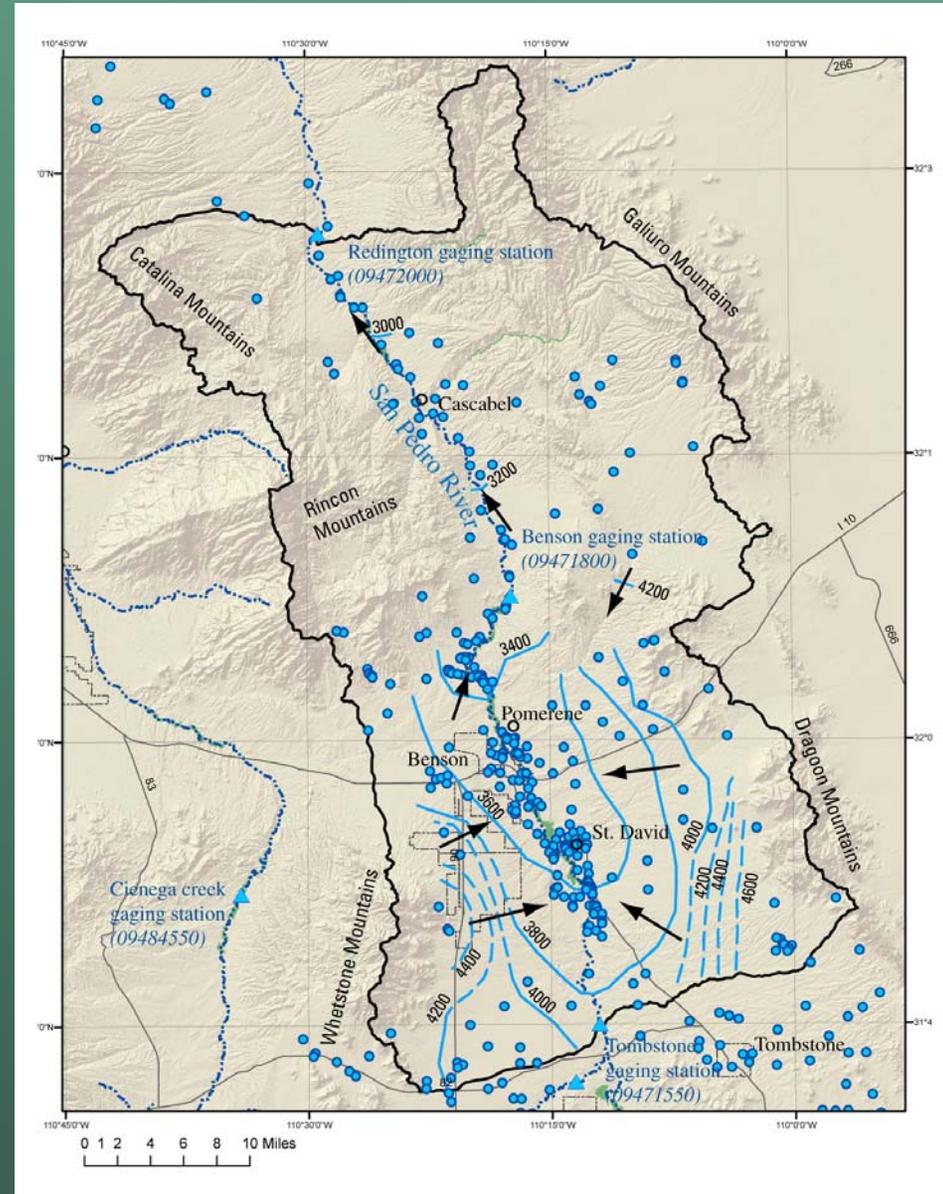
# Potential impacts of increased ground-water withdrawals

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- **Construct a numerical ground-water flow model to determine potential impacts**
  - Decreased water availability
  - Water-level declines
  - Increased cost of pumping
  - Decreased quality of drinking water
  - Damage to riparian vegetation of San Pedro River

# Water-Level Measurements by ADWR

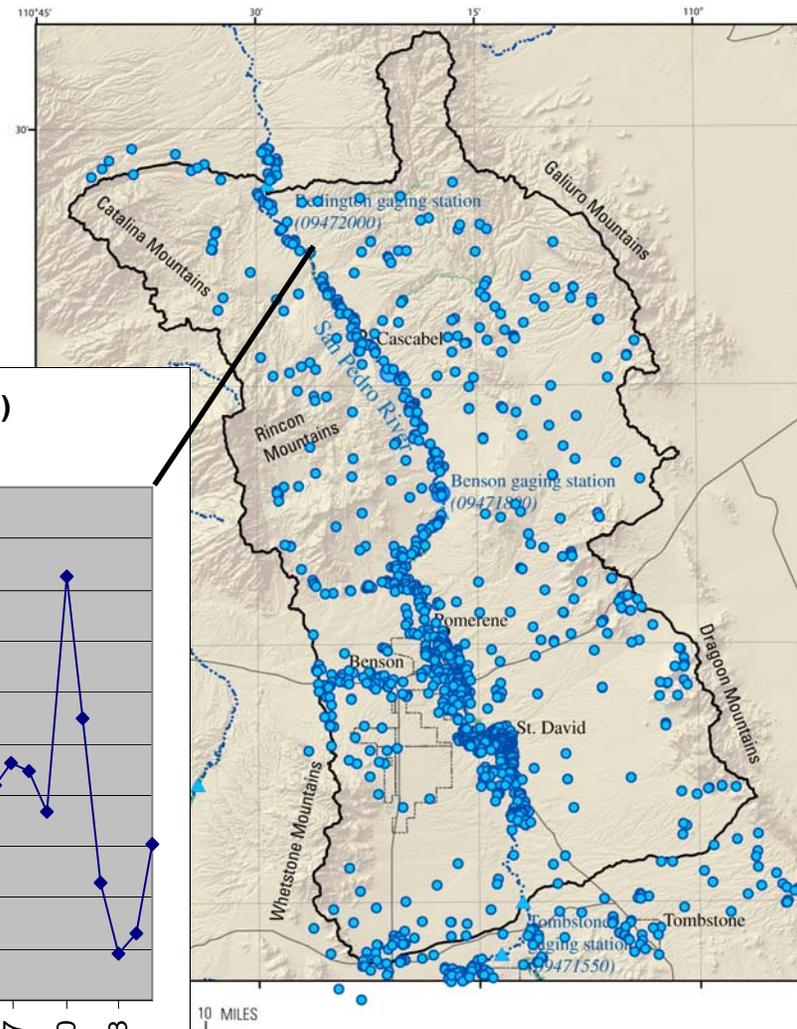
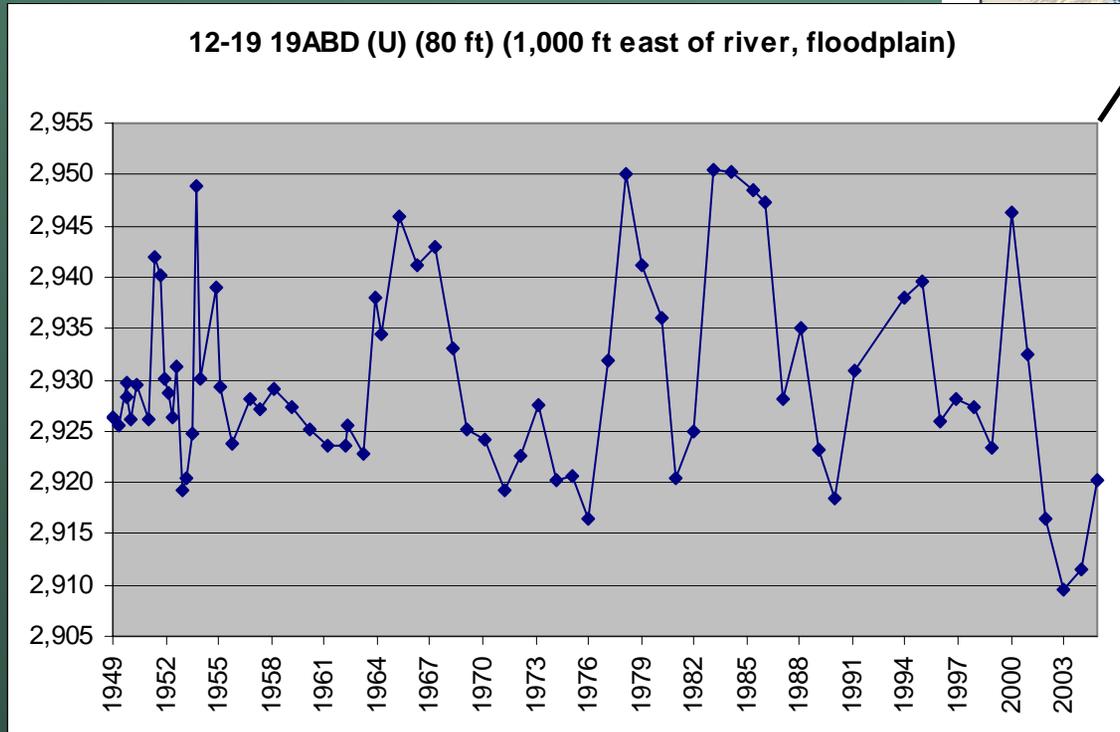
- Water-level contours and generalized ground-water flow directions for fall 2006



# Water Levels (1949-2006)

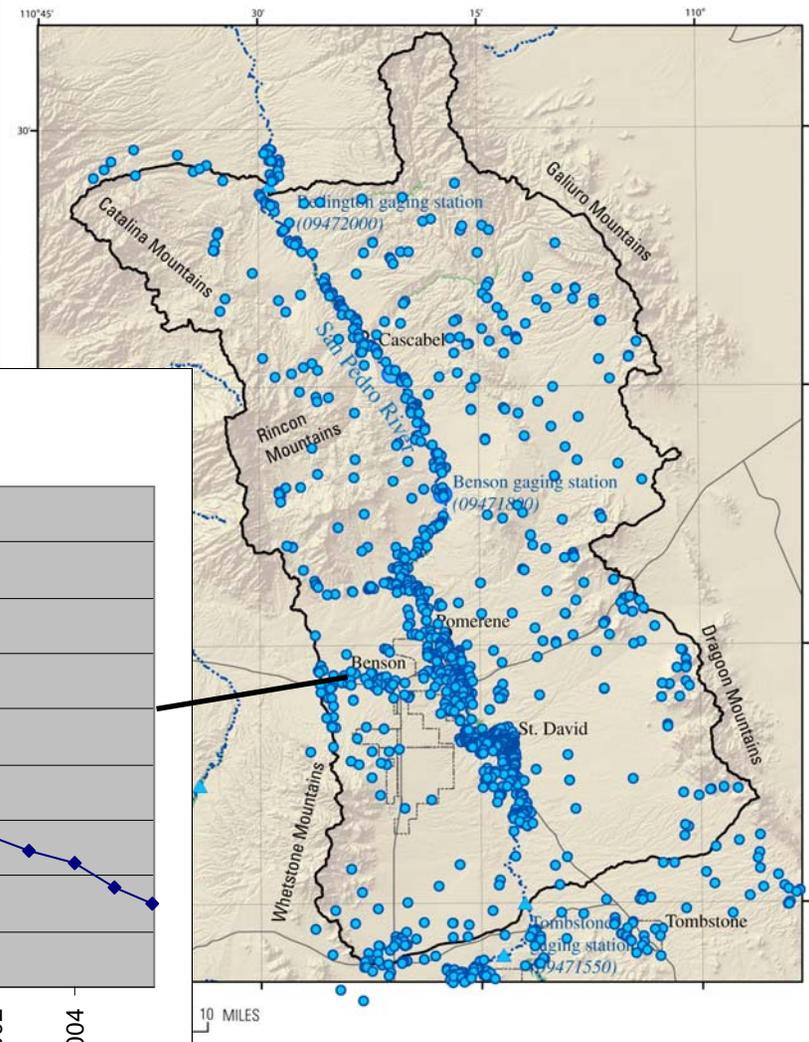
## Well depth = 80 ft

Water-level altitude, in feet



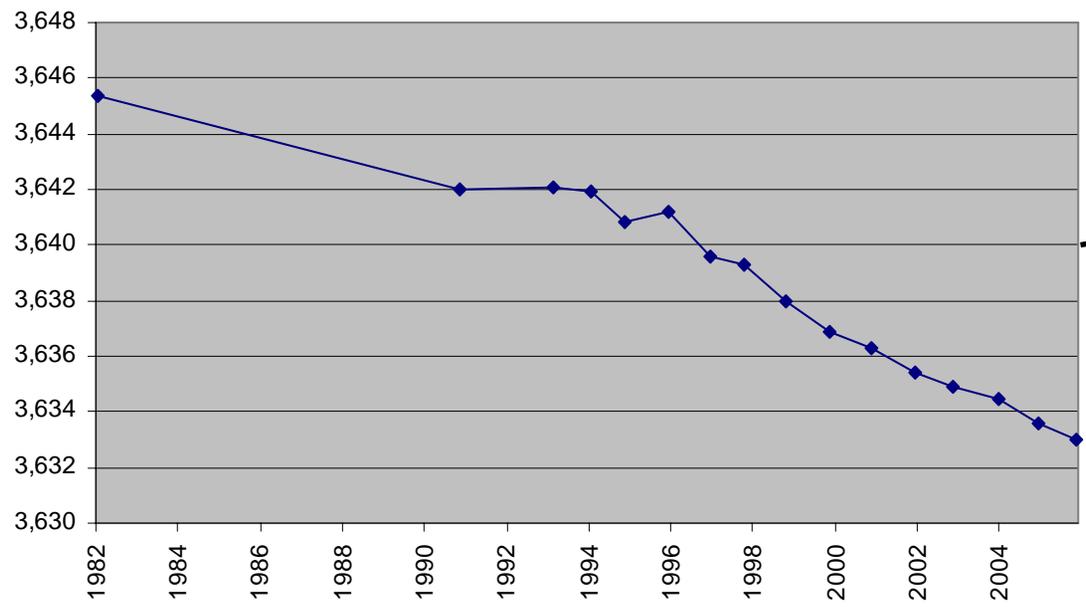
# Water levels (1982-2006)

## Well depth = 670 ft



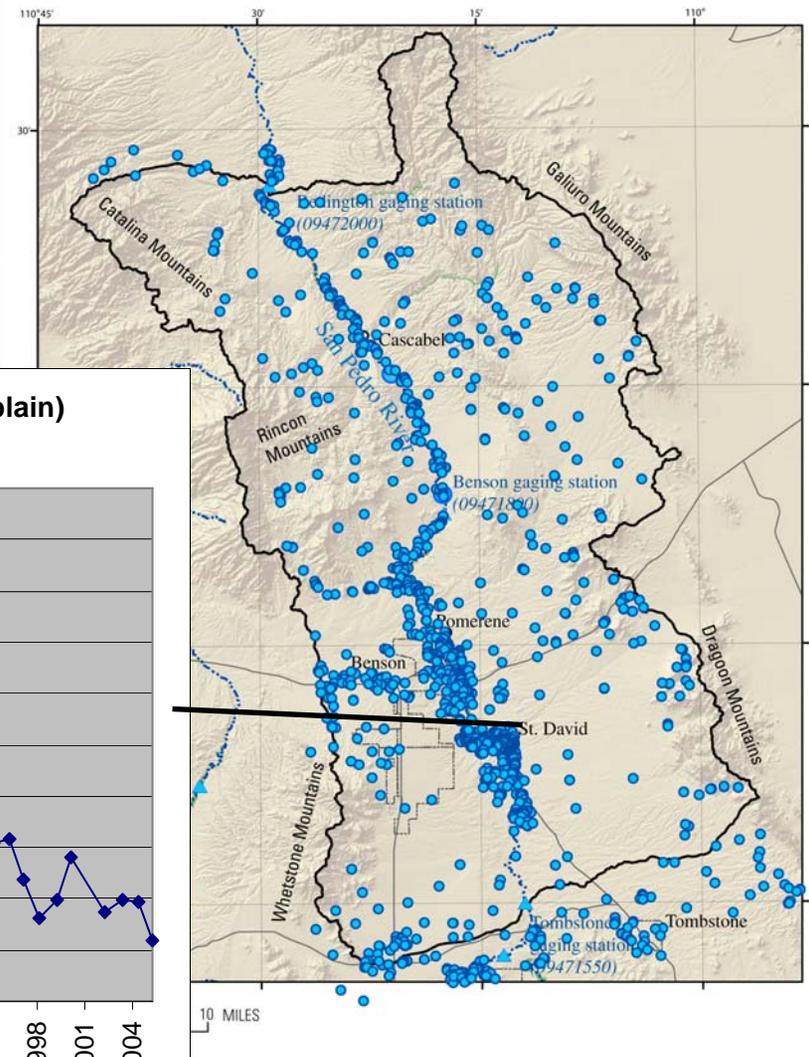
17-19 14ACA (U) (670 ft) (30,000 ft west of river)

Water-level altitude, in feet

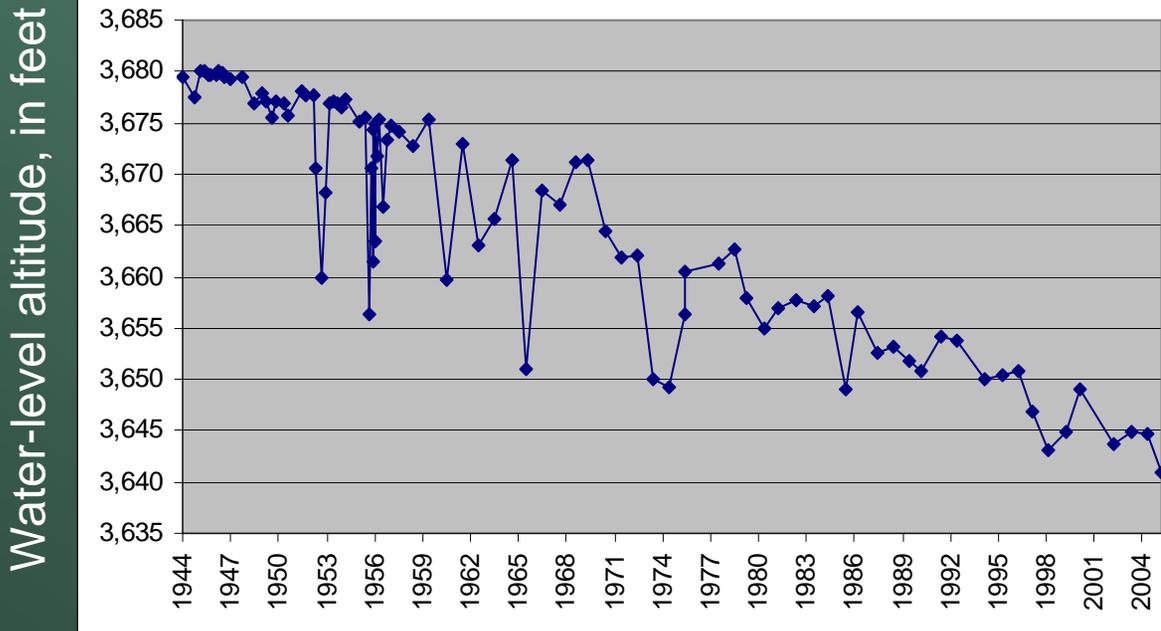


# Water Levels (1944-2006)

## Well depth = 520 ft



17-21 32BAB (S) (520 ft) (9,000 ft east of river, not in floodplain)

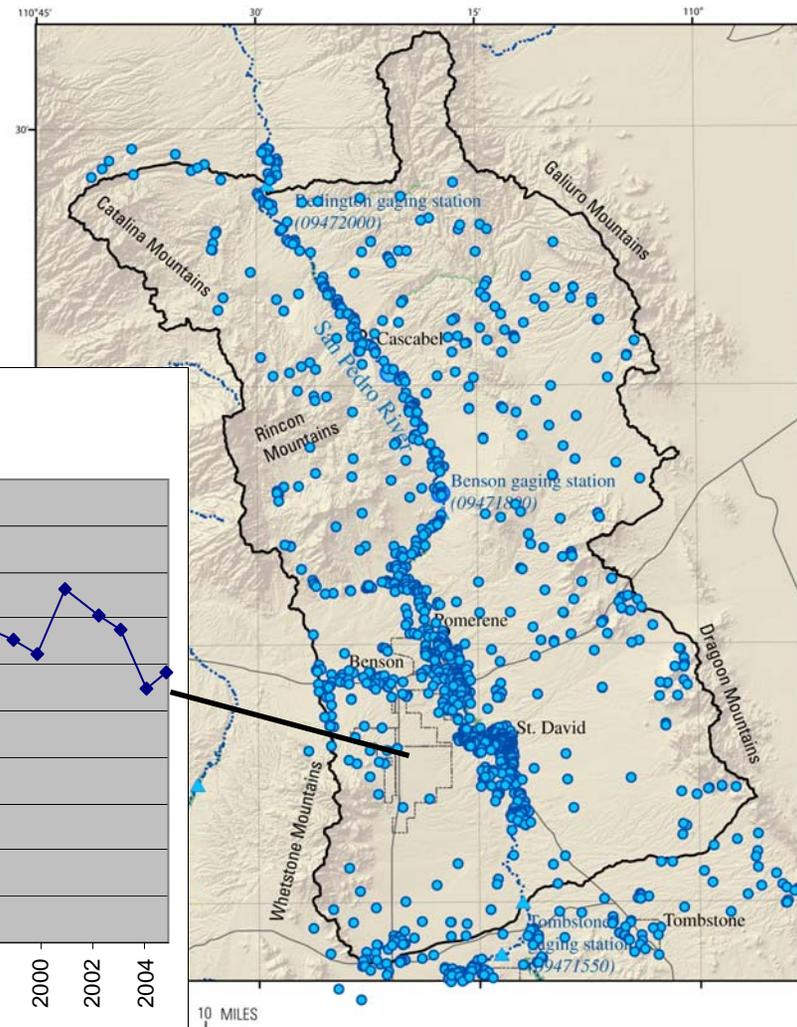
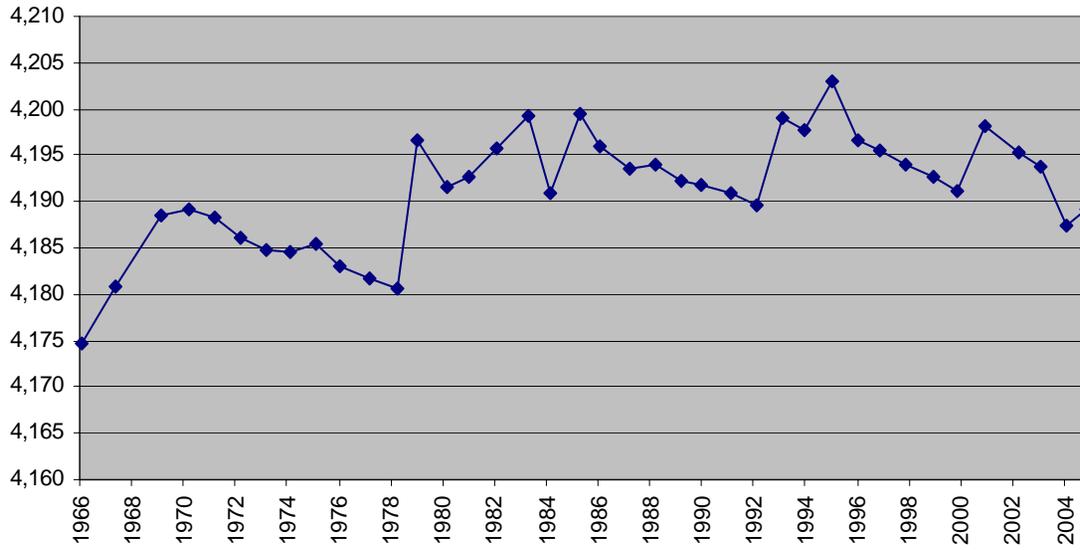


# Water Levels (1966-2006)

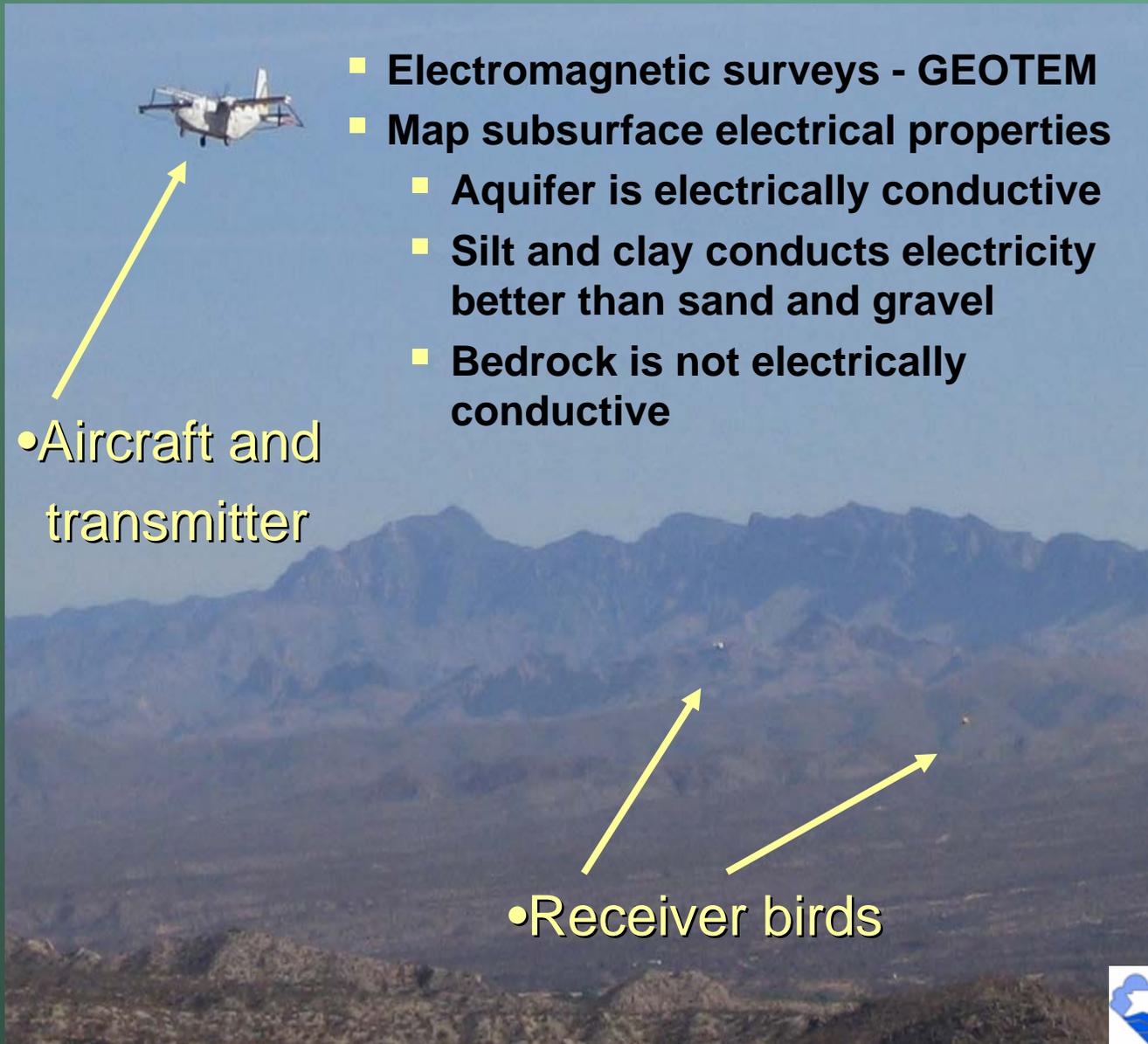
Well depth = 350 ft

Water-level altitude, in feet

18-20 06BDD (S) (350 ft) (35,000 ft west of river)



# Aerial Transient Electromagnetic (TEM) Surveys



• Aircraft and transmitter

- Electromagnetic surveys - GEOTEM
- Map subsurface electrical properties
  - Aquifer is electrically conductive
  - Silt and clay conducts electricity better than sand and gravel
  - Bedrock is not electrically conductive

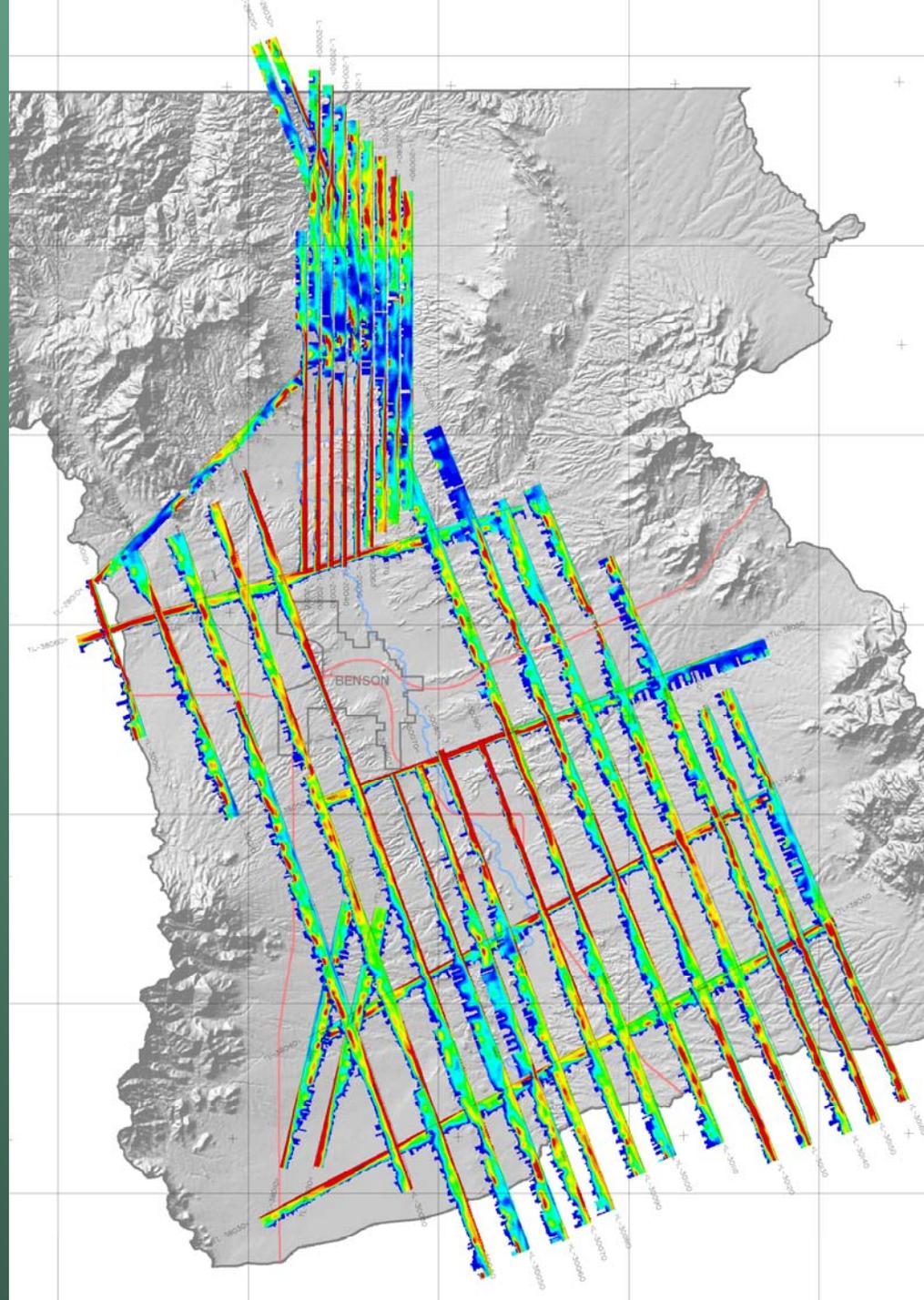
• Receiver birds

# Aerial Transient Electromagnetic (TEM) Surveys



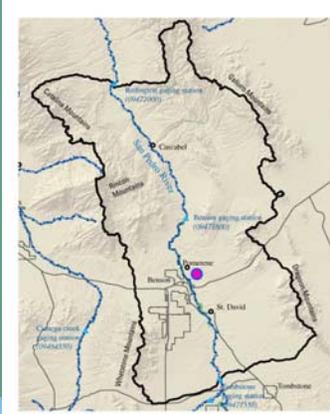
# Aerial TEM data

- **Red**
  - low resistivity
  - generally clay
- **Blue**
  - high resistivity
  - generally bedrock



# TEM surveys

University of Arizona  
Geophysics Field Camp  
March 2007



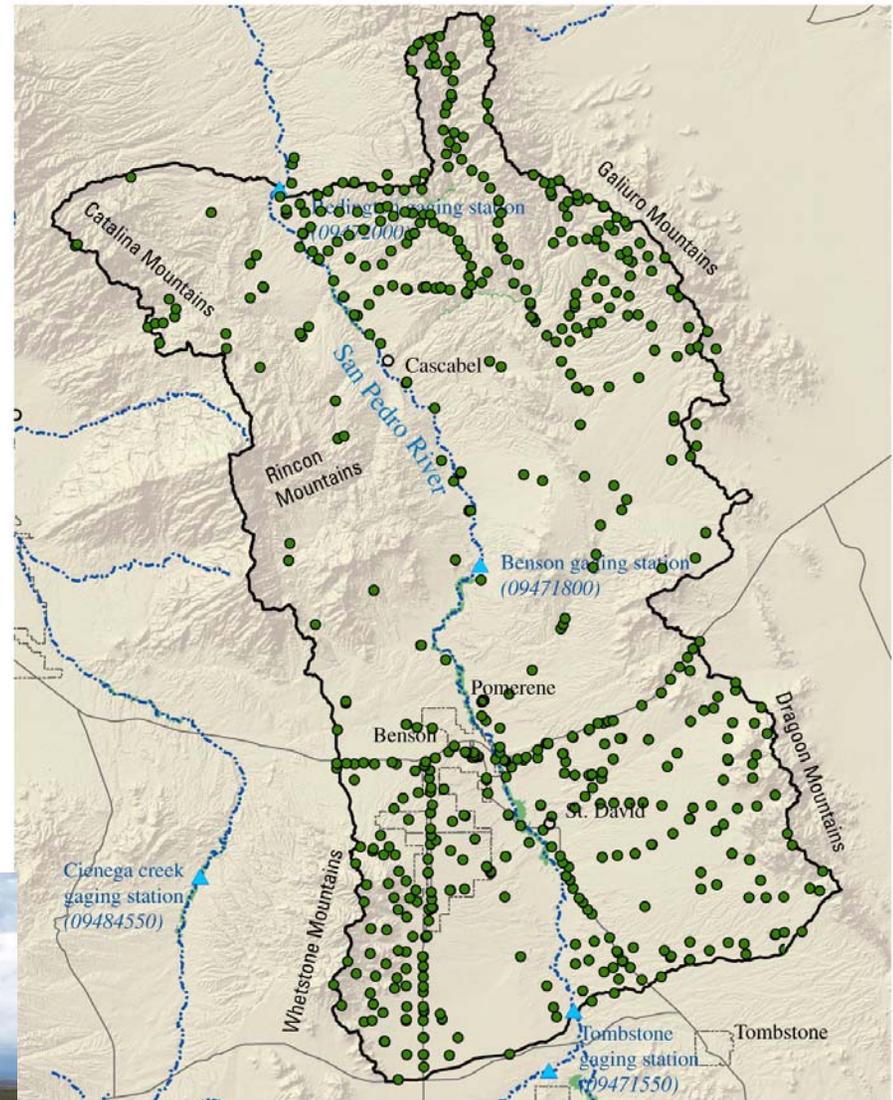
- Identify changes in electrical resistivity in the subsurface

- Used to identify lithology of subsurface



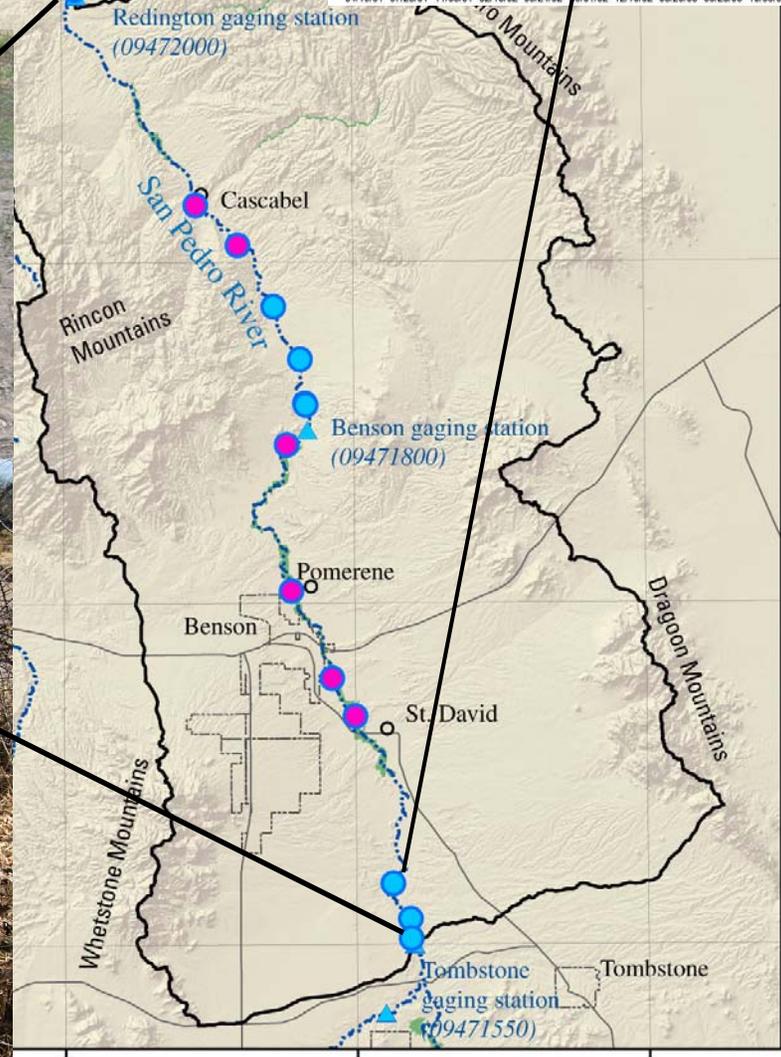
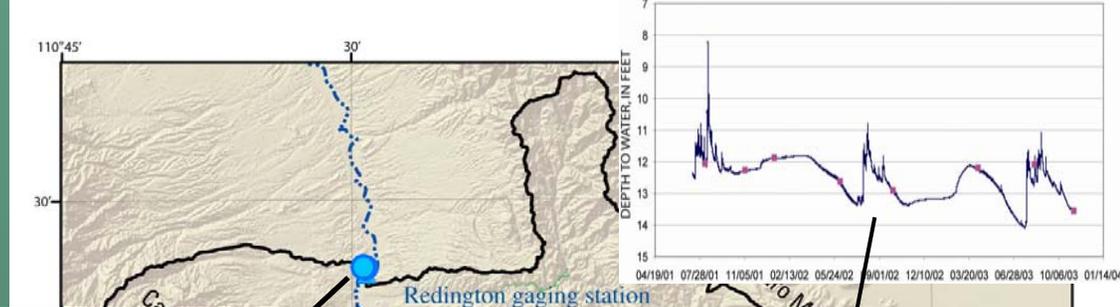
# Gravity measurements

- Determine depth to bedrock and aquifer thickness



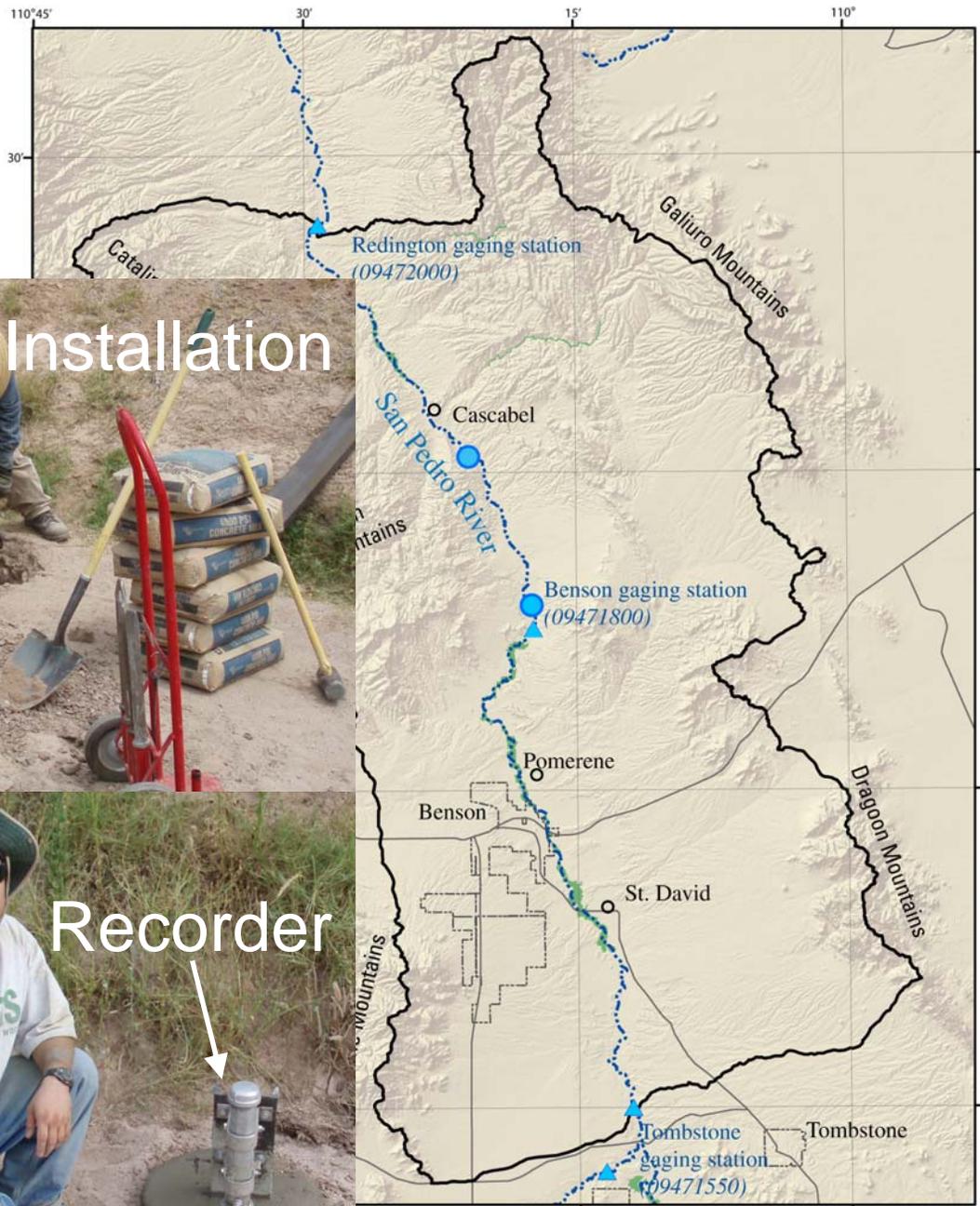
# Monitoring wells

- Ground-water responses to streamflow
- Connection between shallow and deep aquifers



# Stage Recorders in San Pedro River Channel

- Measure stage of the river to infer streamflow rate
- Monitor progression of flows along channel reaches



# Communication of study results

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- Reports and fact sheets
- Project web page ([az.water.usgs.gov/projects/CA000.htm](http://az.water.usgs.gov/projects/CA000.htm))
- Participation in community
- Conferences
- Contact: Jesse Dickinson
- [jdickins@usgs.gov](mailto:jdickins@usgs.gov), 520-670-6671 ext 306

# Questions?

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