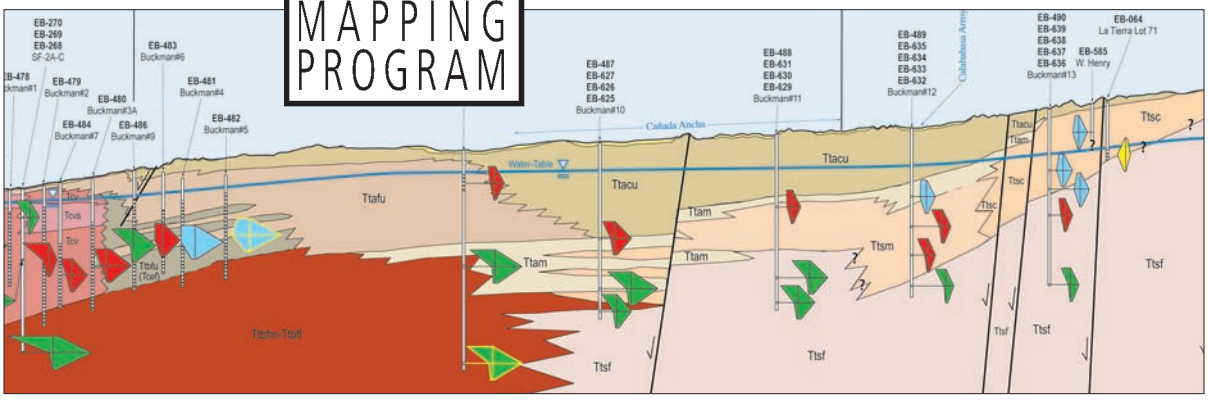
AQUIFER MAPPING PROGRAM

Aquifer Mapping in New Mexico



New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
Earth Science for the 21st Century

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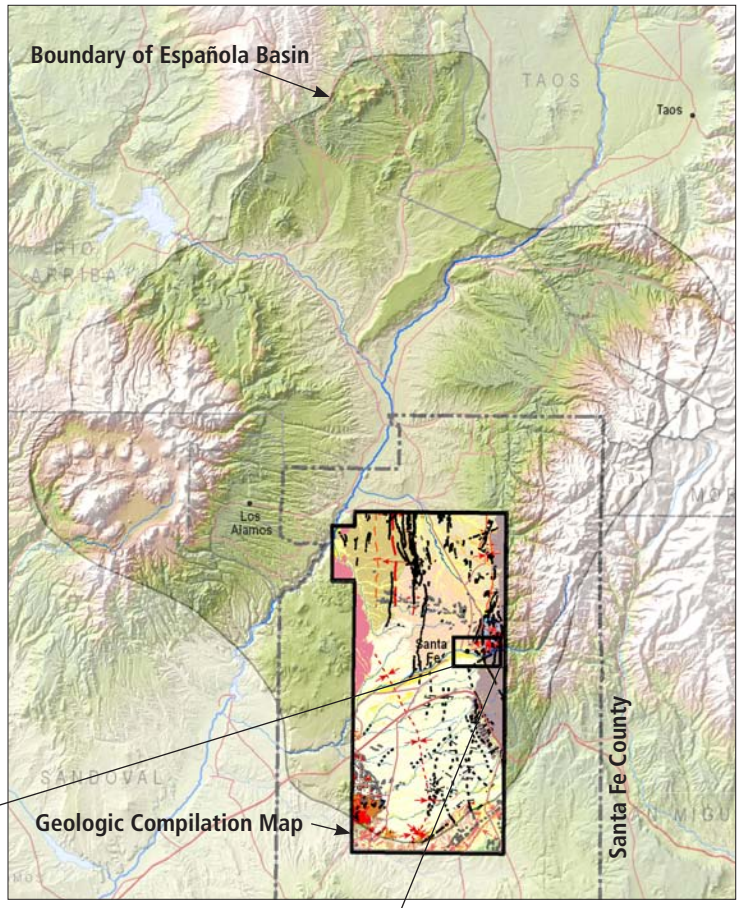
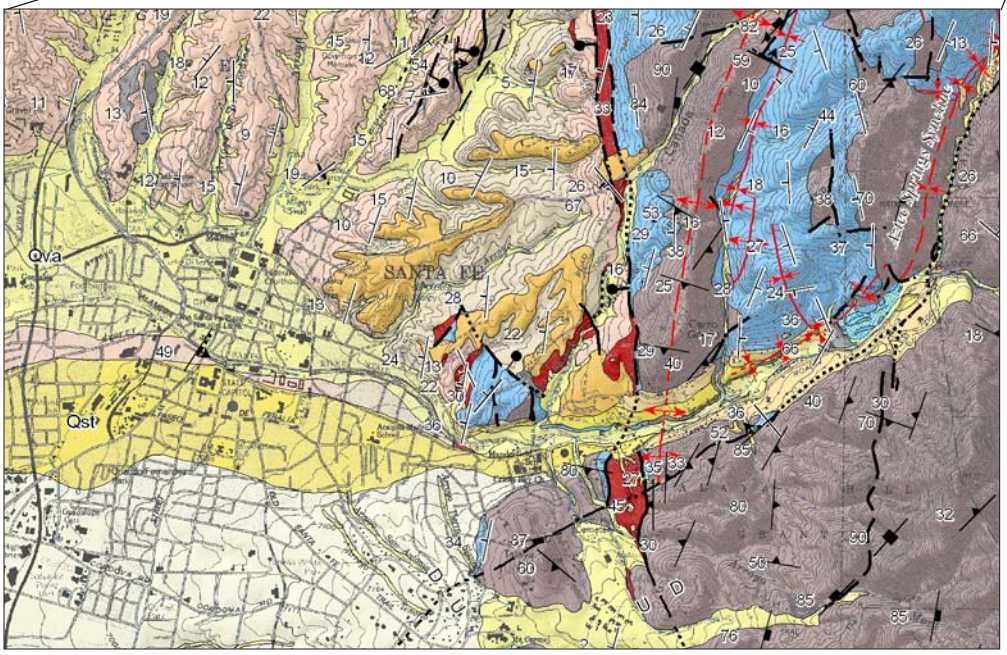
An Example of Aquifer Mapping from the Santa Fe Area

An ideal water resource study consists of:

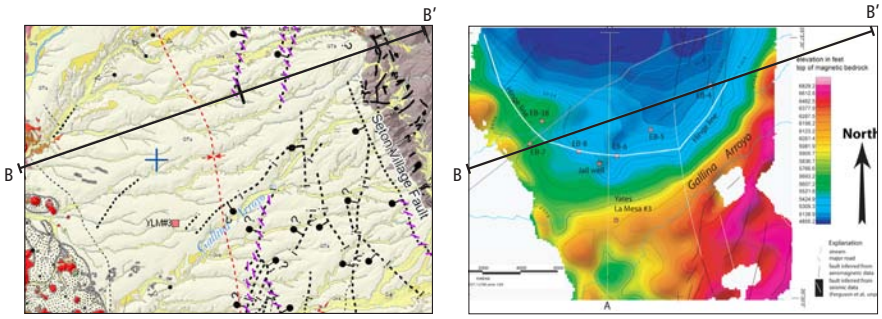
- **Geologic Mapping**
- **Geophysical Surveys**
  (gravity, magnetic, seismic, TDEM, temperature)
- **Deep Drill Holes and Interpretation of Subsurface Geology**
- **3-D Geologic Model**
- **Hydrologic Data Collection and Characterization**
  (water level monitoring, hydrologic database, aquifer properties, geochemistry and water quality)
- **Hydrogeologic 3-D Conceptual Model**
- **Hydrologic Computer Model**

Then, apply the science to planning, and policy.



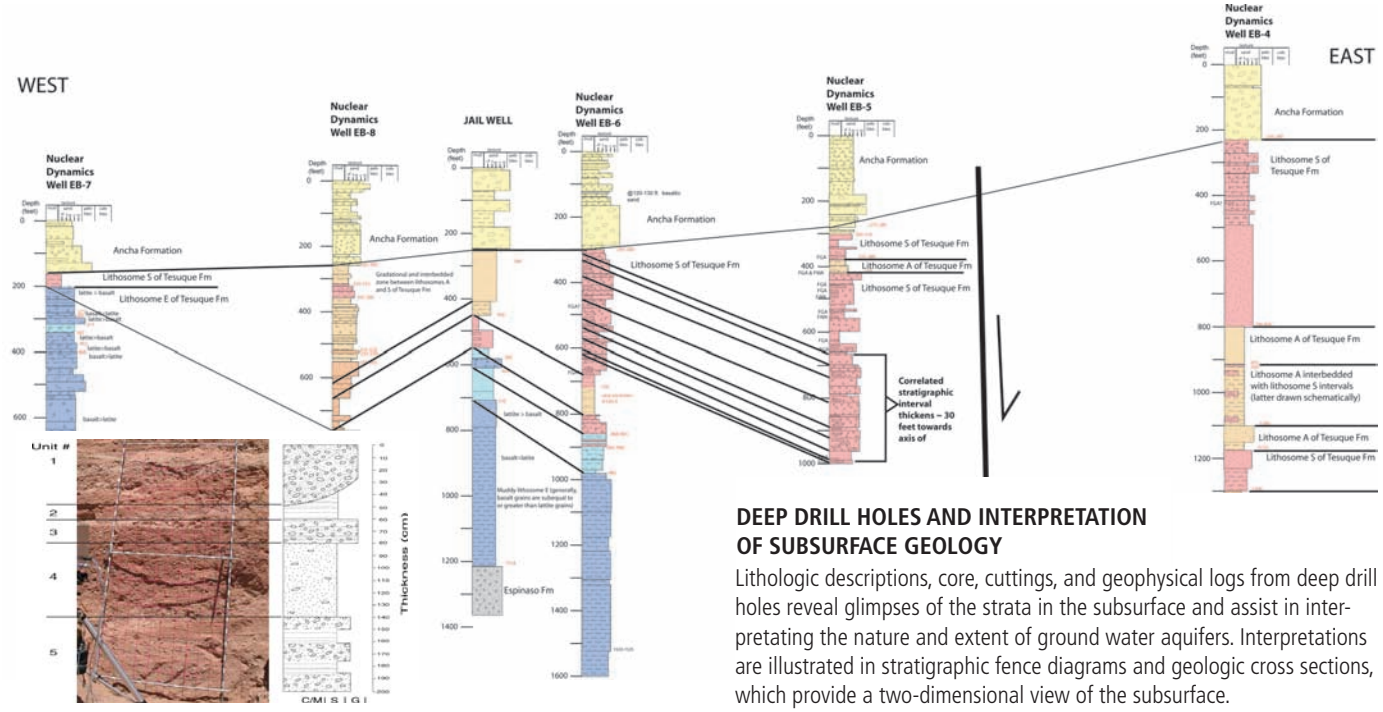


GEOLOGIC MAP OF THE SOUTHERN ESPAÑOLA BASIN
Six geologic quadrangle maps produced from the STATEMAP program were compiled into one map at 1:50,000 scale. The map provides detailed surface geologic information for the greater Santa Fe area, including the type and relative age of materials, and the presence of geologic structures such as faults, folds, and fractures.



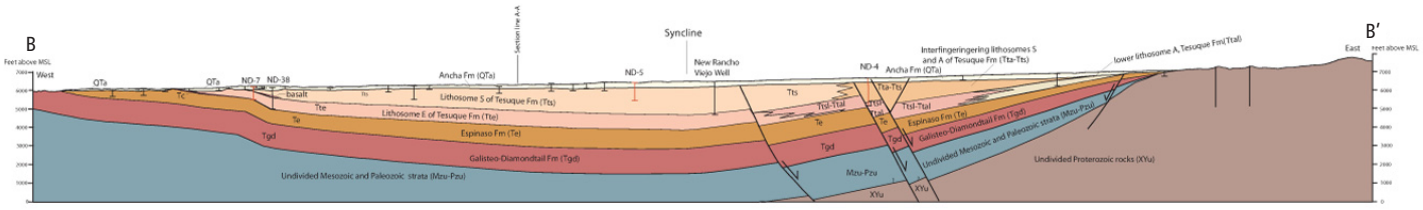
USGS AEROMAGNETIC MAP OF THE SANTA FE AREA

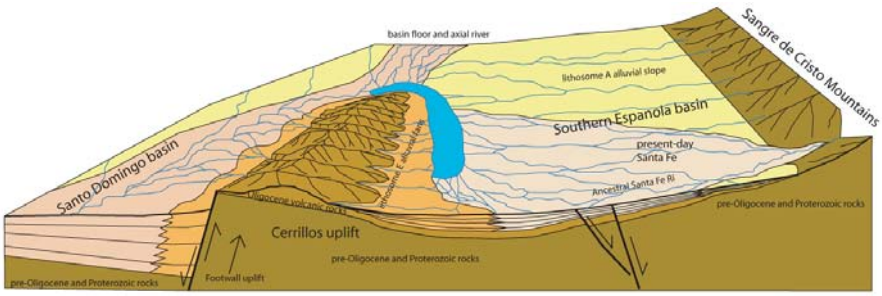
Geophysical studies such as high-resolution aeromagnetic and seismic surveys contribute valuable information regarding the location of hidden faults, the depth to bedrock and volcanic units, geologic controls on ground water flow, and the thickness of sediments that form the primary aquifers.



DEEP DRILL HOLES AND INTERPRETATION OF SUBSURFACE GEOLOGY

Lithologic descriptions, core, cuttings, and geophysical logs from deep drill holes reveal glimpses of the strata in the subsurface and assist in interpretating the nature and extent of ground water aquifers. Interpretations are illustrated in stratigraphic fence diagrams and geologic cross sections, which provide a two-dimensional view of the subsurface.

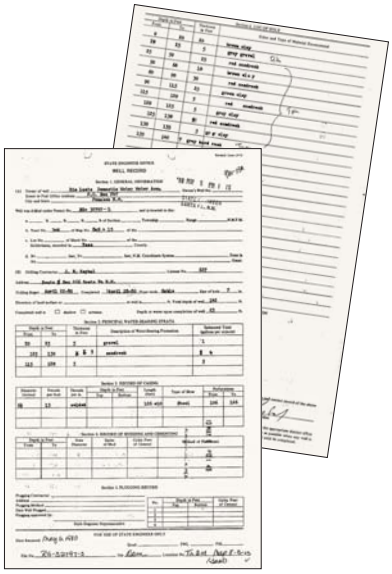




3-D GEOLOGIC MODEL

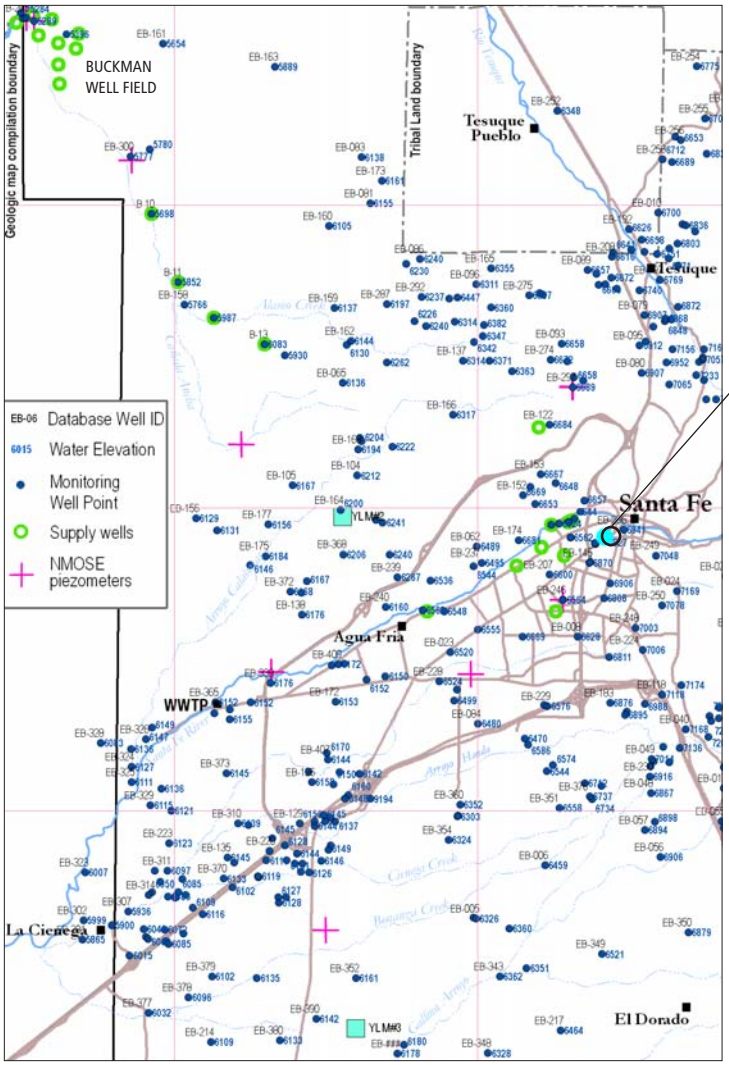
By interpolating between two-dimensional views, geologic information on shallow deposits is compiled into three-dimensional, process-based models as a means of predicting what likely occurs between and beyond our points of observation. Interpolations of intervening geology are best guided by a firm understanding of the geologic processes responsible for the deposits.

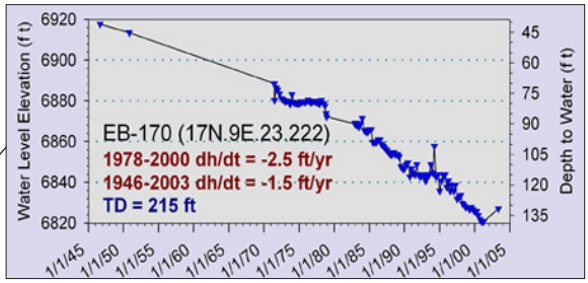
Hydrologic Data Collection and Aquifer Characterization



WELL LEVEL MONITORING NETWORK

Domestic, municipal, and commercial water wells are located and matched with well records that provide well construction and geologic information. Suitable wells are used as points of measurement to monitor water levels in shallow and deep aquifers. Eventually a network of such monitoring wells is established that allows monitoring of aquifer levels over time. Established wells with long records of historic water levels are an important part of resource management.





A WATER-LEVEL HYDROGRAPH illustrates the depth to water in an aquifer and how it changes over time. This well reflects a drop in water levels over 57 years at a rate of 1.5 feet per year.

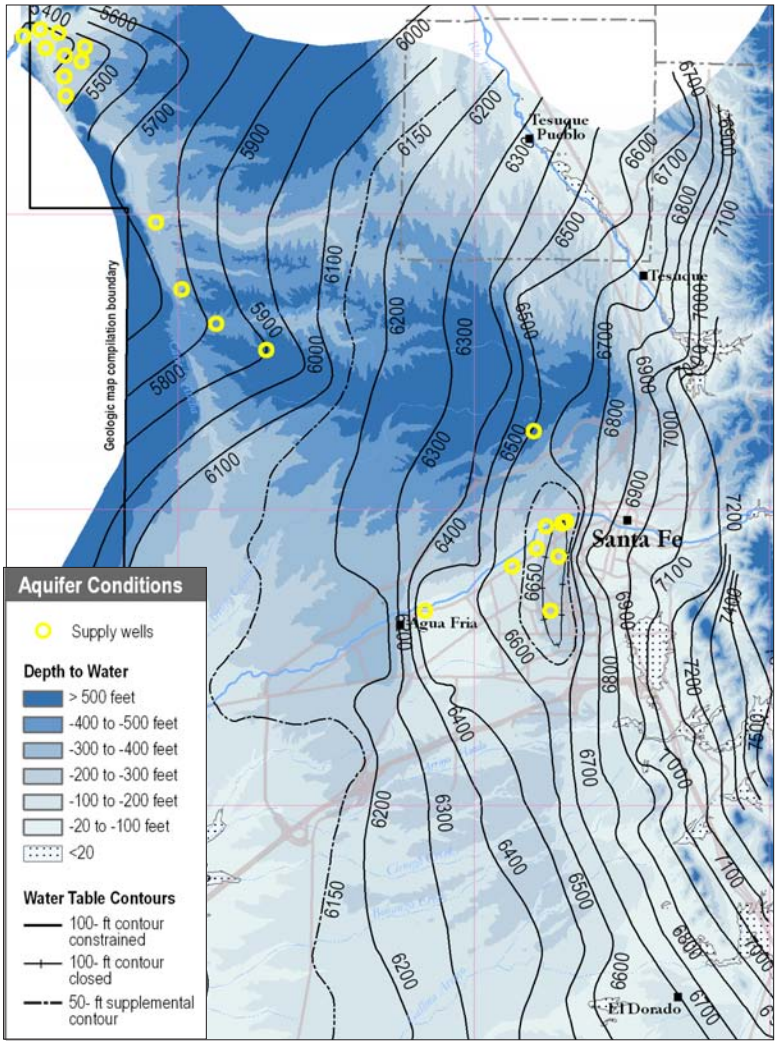
HYDROLOGIC AND WELL DATABASE

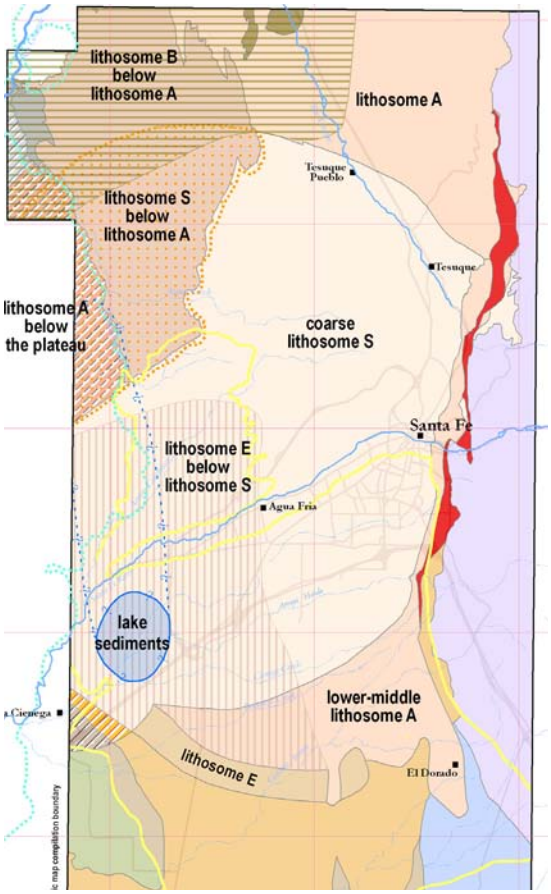
A user-friendly database has been designed to store well, water level, water quality and location information for long-term use and public distribution.

STRUCTURE OF WELL DATABASE

GROUND WATER CONDITIONS

New depth-to-water measurements are converted to water level elevations and contoured to produce a map of the water-table surface. This interpretative map product helps us illustrate and understand ground water flow conditions, the effects of geologic features on ground water flow, and how well-field pumping affects aquifer levels.



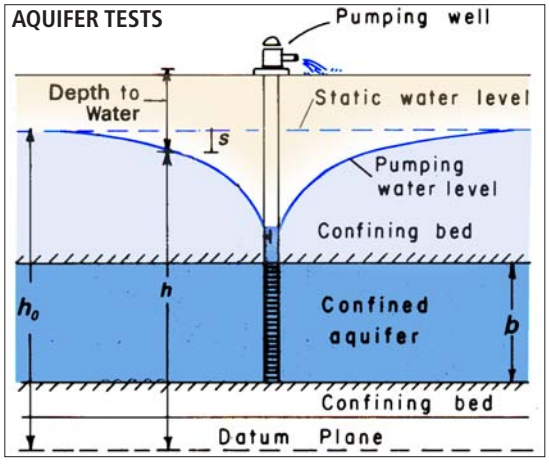


GEOHYDROLOGIC MAPPING OF AQUIFER MATERIALS

Geologic units are mapped in a way that defines the distribution of physical characteristics, like grain size, which relate to hydrologic characteristics like hydraulic conductivity.

AQUIFER HYDRAULIC PROPERTIES

Estimates of hydraulic conductivity derived from aquifer tests are correlated to mapped geologic units to provide a physical basis for hydraulic properties assigned to aquifers during development of ground water flow models.

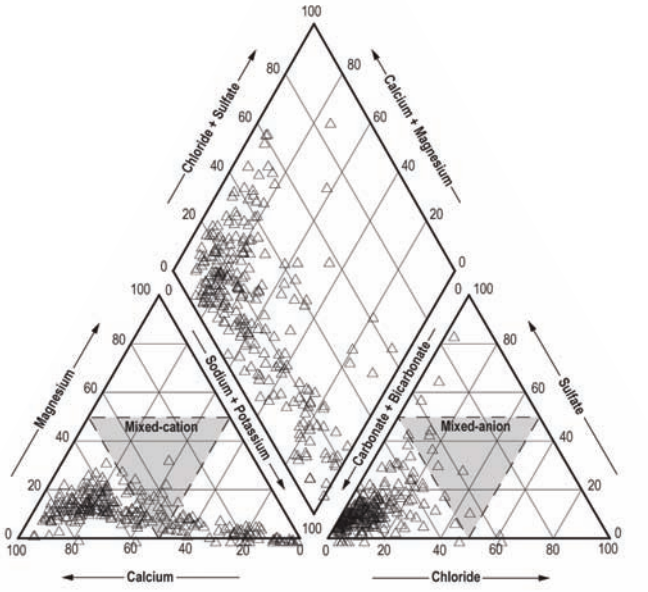


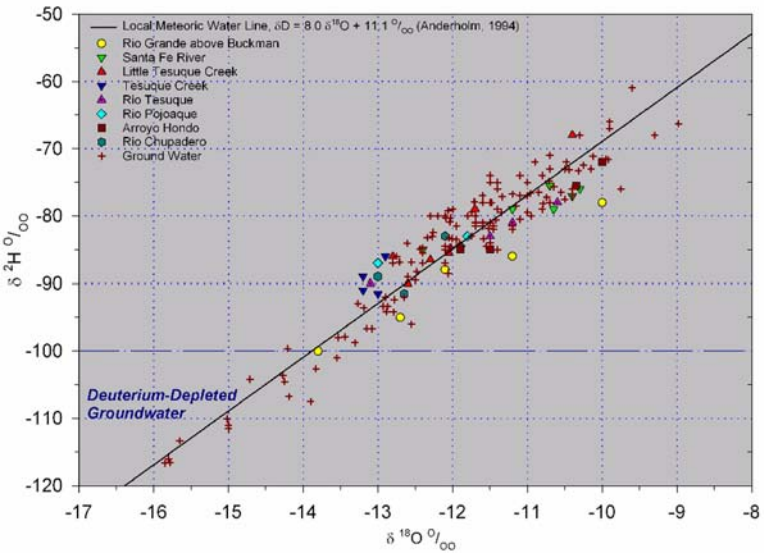
Geochemistry and Water Quality

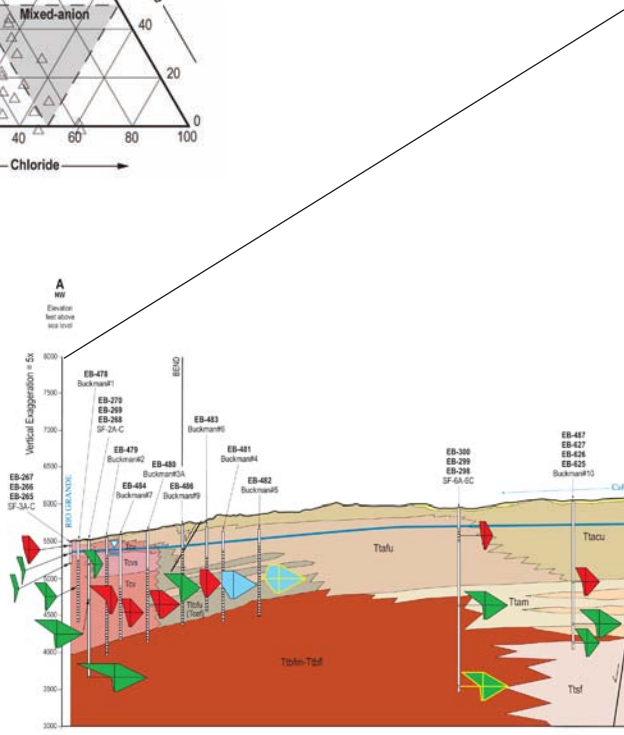
Water samples gathered from streams, springs, and wells surrounding Santa Fe are analyzed for chemical content in laboratories at the Bureau's and New Mexico Tech. The results inform us about the natural occurrence of contaminants such as arsenic and allow us to trace the movement of ground water from recharge in the mountains, through the aquifer, to discharge in streams and springs.

WATER CHEMISTRY TRACES WATER MOVEMENT

By analyzing the distribution of simple chemical components in ground water (such as calcium, sulfate and other ions, or physical parameters such as temperature and dissolved oxygen) we can identify waters of similar composition and flow history, and differentiate between recent recharge and waters with older residence times. Stable isotopes of oxygen and hydrogen can be used to identify sources of water recharged under distinct climatic conditions such as Pleistocene waters over 10,000 years old.

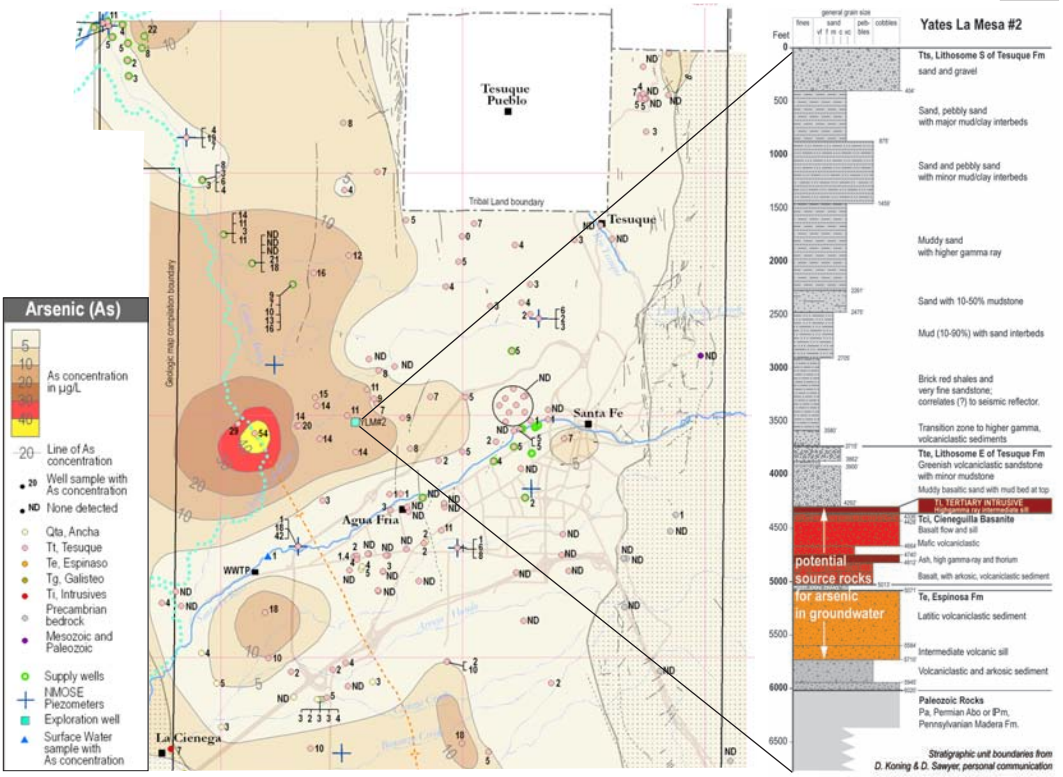


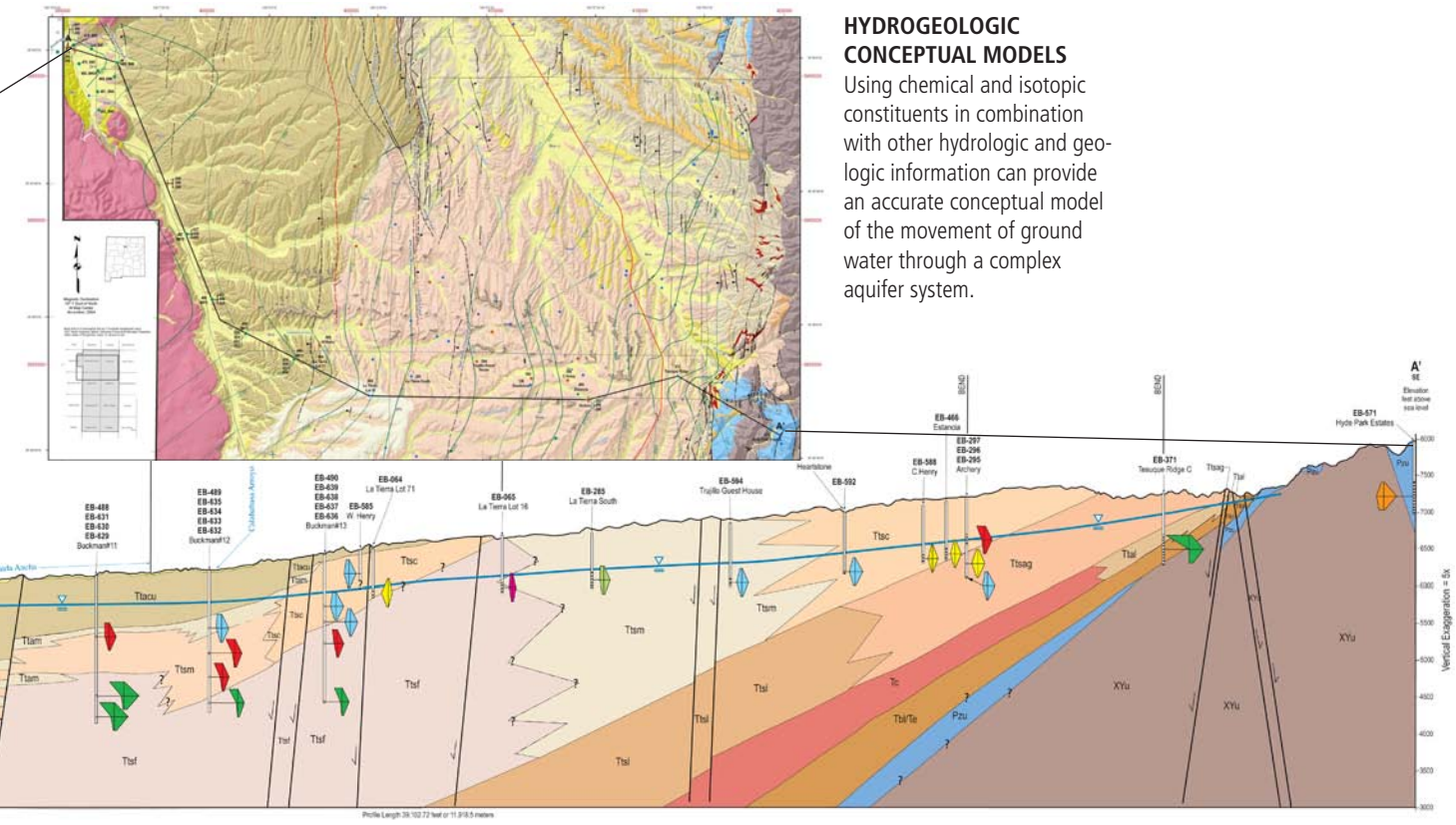




NATURALLY OCCURRING CONTAMINANTS – A GEOLOGIC SOURCE

The distribution of naturally occurring contaminants such as arsenic is evaluated in the context of the surrounding geologic formations. In this case, a likely source of the contamination was identified in underlying volcanic rocks from a nearby drill hole. The magnitude and extent of arsenic contamination is of critical importance to future well placement in Santa Fe County.

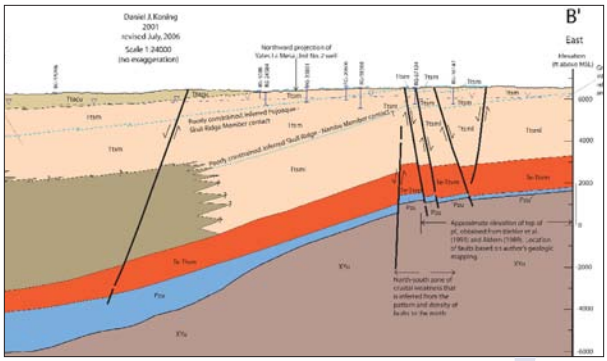




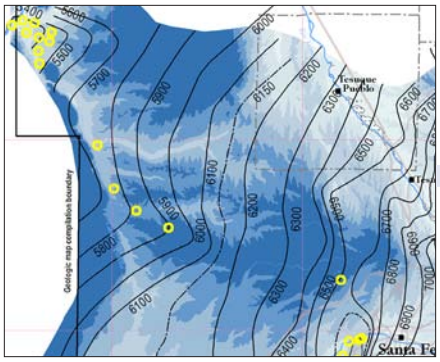
HYDROGEOLOGIC CONCEPTUAL MODELS

Using chemical and isotopic constituents in combination with other hydrologic and geologic information can provide an accurate conceptual model of the movement of ground water through a complex aquifer system.

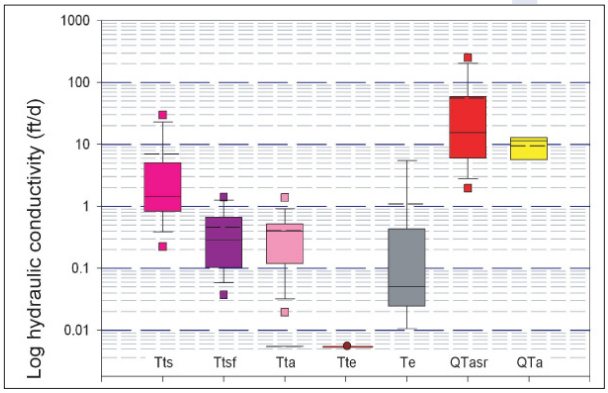
Ground Water Flow Models and Water Management



Geologic Framework



Water Levels

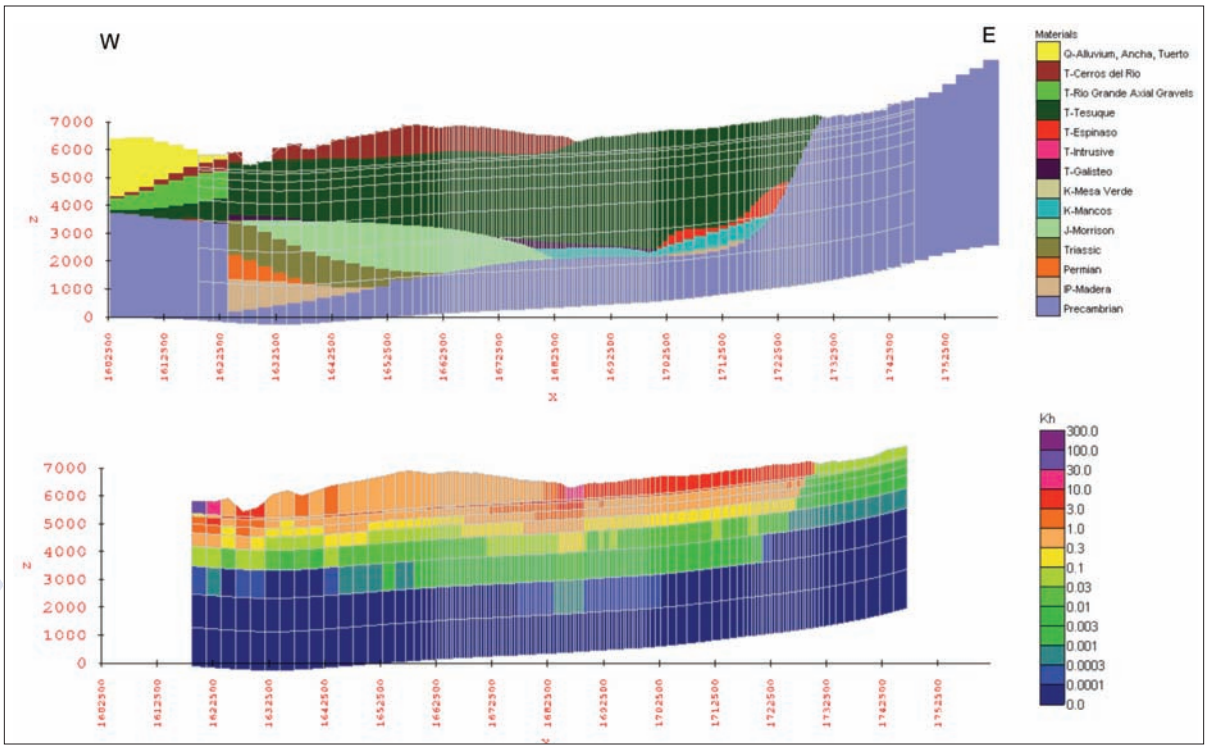


Aquifer Properties

Efforts to develop tools for long-term sustainable development of aquifers are centered on collaborative studies that combine geologic, hydrologic, chemical, geophysical, and engineering information. In the example from Santa Fe, work to improve understanding of regional aquifers has been a multi-agency effort, with the New Mexico Office of the State Engineer, the Bureau, USGS, and LANL providing the best possible technical information to two municipal entities, Santa Fe County and the City of Santa Fe, who are seeking to improve understanding of potential water supply options by developing a regional ground water model.

A model is a tool to represent a simplified version of the real hydrologic system, but is based as much as possible on real-world geologic and hydrologic information. The county and city, together with their consultants, entered into a process of collaborative model development to maximize scientific and economic resources and develop a model of the highest possible quality based on a common set of inputs.

Over the course of several years, the Bureau has made significant contributions to this collaborative effort by providing a geologic framework, updated water levels for model calibration, and a comprehensive set of aquifer properties. Hydrologic model development could not proceed without this basic critical information. Many more opportunities and needs for aquifer mapping exist across New Mexico with numerous benefits to a diverse group of beneficiaries.



Produced by Camp, Dresser, & McKee, Boulder CO. for City of Sante Fe from data provided by the Bureau.

WHO BENEFITS FROM HYDROGEOLOGIC ASSESSMENTS?

1. **State Agencies.**
   - NMOSE/ISC
     - Water rights administration and management
     - Baseline data for assessing Critical Management Areas (CMAs)
     - Assess connection between aquifers and surface water
     - Floodplain management
   - NMED
     - Siting landfills
     - UST and contamination site assessments
     - Arsenic and water quality studies
2. **New Water Sources.** Characterize saline and impaired aquifers for development potential
3. **Drought Planning and Management.** Identify aquifers and areas that are actively recharged (along mountain fronts and streams) that are sensitive to drought impact and may require special management
4. **Policy Makers.** Make scientifically defensible decisions
5. **Planners.** Tool for land use decisions based on water supply and quality
6. **Realtors and Home Buyers.** Water wells, supply and quality
7. **Homeowners and Rural Water Users.** Domestic and rural water well supply and quality
8. **Regional Issues.** Improve understanding of the regional hydrologic system to facilitate resolution of stakeholder conflicts, border conflicts, and endangered species issues

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