Texas
Austin
San Antonio
Rio Grande
Pecos River
Colorado River
Gulf of Mexico
Travis
Kinney
Uvalde
Bandera
Kendall
Real
Edwards
Kerr
Atascosa
Bexar
Guadalupe
Comal
Hays
Blanco
Gillespie
Medina
Colorado River
A
B
Edwards and Trinity aquifers catchment area
Outcrop and recharge zone of the Edwards aquifer
Edwards aquifer artesian zone
EXPLANATION
0 0 100 200 KILOMETERS
100 200 MILES
Catchment area? ?
EDWARDS PLATEAU HILL COUNTRY GULF COASTAL PLAIN
A B
Trinity Group
Recharge zone
Artesian zone
Balcones fault zone
Upper Confining units
Midway Group
Surficial deposits
Wilcox and Claiborne Groups
Edwards Group
Trinity Group
Fresh-/saline-water interface
Undifferentiated Paleozoic rocks
15,000
20,000
and fault displacement
U.S. Department of the Interior
U.S. Geological Survey
Fact Sheet 2006–3145
June 2007
This five-year USGS project, funded by the National Cooperative Strategic Mapping Program (NCSMP), is using multi-disciplinary approaches to reveal the surface and subsurface geologic architecture of the Edwards and Trinity aquifers. The primary research objectives are to (1) map geohydrologic and structural controls that extend from south of Austin to west of San Antonio and (2) the recharge zone of the Trinity aquifer in the Texas Hill Country west and north of Austin (fig. 1).

The Edwards aquifer is one of the most productive carbonate aquifers in the United States. It also has been designated a sole source aquifer by the U.S. Environmental Protection Agency and is the primary source of water for San Antonio, the nation's seventh-largest city. The Trinity aquifer forms the catchment area for the Edwards-aquifer system, but it also is recharged and discharged by the Edwards system. The Trinity may also contribute to the Edwards' water balance by recharge beneath flow paths in its surficial deposits at considerable depths. Discharge, karst development, and faulting and fracturing in both aquifers strongly control groundwater geometry by compartmentalizing the aquifer and creating linear ground water flow paths.

The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas or zones: (1) catchment area (exposed Trinity aquifer rocks), (2) recharge zone, and (3) artesian or confined zone. The Edwards and Trinity aquifers are conceptualized along cross-section A–B (fig. 2). Precipitation falls on Lower Cretaceous Trinity Group rocks in the catchment area and travels downgradient as surface water until crossing the Edwards recharge zone. There, the water enters the aquifer through fractures and faults and eventually reaches the artesian zone (fig. 2).

The primary geologic structures are high-angle normal faults that are arranged in a down-to-the-southeast en echelon pattern. Depending on the fault architecture and the rock types involved, the faults can restrict or redirect flow or may enhance flow by creating linear zones of increased permeability.

The project's principal areas of research include: (1) Geologic Mapping, (2) Geophysical Surveys, (3) Geochronology, (4) Three-dimensional Modeling, and (5) Noble Gas Geochemistry. Individual study areas and published products can also be viewed at http://esp.cr.usgs.gov/info/edwards/index.html.

Figure 1. Distribution of the Edwards aquifer and catchment area (Trinity aquifer).

Figure 2. Structural schematic cross section of the Edwards aquifer and catchment area (Trinity aquifer).
Geologic Mapping

The 3-D subsurface geologic model of the Edwards recharge zone (fig. 4) is based on interpretations for the southern two quadrangles. This map, as well as the remaining interpretations for the upper Seco Creek area, are shown as a function of depth.

Geologic mapping of the Edwards recharge zone, as defined by the Texas Commission on Environmental Quality (TCEQ), includes lithologic units responsible for the Lower Cretaceous Edwards Group, which is underlain by the Upper Cretaceous Edwards Group. The Edwards Group, which includes a 10-meter Digital Elevation Model (DEM) grid and the 3-D subsurface geologic model of the Edwards recharge zone, is used in a helicopter electromagnetic (HEM) geophysical survey (fig. 1).

Heavier magnetic susceptibilities on the order of 0-5 × 10⁻⁵ SI are found in the granitic rocks. The Edwards Group, which comprises the Upper Cretaceous Edwards Group, is the most magnetic of the aquifers and is characterized by the Kainer, Person, and Georgetown Formations, which are subdivided into eight informal hydrostratigraphic units. The AMT sounding locations were specifically selected to resolve a number of geologic features, including a volcanic plug, the flow front near the town of Knippa in Uvalde County. Additional AMT studies conducted along the San Antonio (Bexar County) and the Edwards (Comal County) aquifers have been used to provide the digital geologic frame as a function of depth.

The HEM sounding locations were centered on Woodard Cave (V aldina Farms sinkhole), a significant karst feature in northwestern Medina County. The primary objective of the HEM survey was to image the subsurface electrical resistivity of select geologic features, including a volcanic plug in the Seco Creek drainage area, Medina and Uvalde Counties.

Noble gas analyses of the recharge area are ongoing.

Geologic Mapping

An infiltration-potential assessment model for Comal County, Texas, was used to provide the digital geologic framework for infiltration-potential assessment maps for critical parts of the Edwards recharge area. This model, integrated with the Edwards reefal facies (Devils River and Georgetown Formations), is subdivided into eight informal hydrostratigraphic units, which are mapped using the Edwards reefal facies (Devils River and Georgetown Formations). Significant facies changes (fig. 4) exist across the Edwards recharge area.

The geology of the Edwards aquifer in the northeastern part of the Edwards recharge zone, as defined by the Texas Commission on Environmental Quality (TCEQ), includes lithologic units responsible for the Lower Cretaceous Edwards Group, which is underlain by the Upper Cretaceous Edwards Group. The Edwards Group, which includes a 10-meter Digital Elevation Model (DEM) grid and the 3-D subsurface geologic model of the Edwards recharge zone, is used in a helicopter electromagnetic (HEM) geophysical survey (fig. 1).

Heavier magnetic susceptibilities on the order of 0-5 × 10⁻⁵ SI are found in the granitic rocks. The Edwards Group, which comprises the Upper Cretaceous Edwards Group, is the most magnetic of the aquifers and is characterized by the Kainer, Person, and Georgetown Formations, which are subdivided into eight informal hydrostratigraphic units. The AMT sounding locations were specifically selected to resolve a number of geologic features, including a volcanic plug, the flow front near the town of Knippa in Uvalde County. Additional AMT studies conducted along the San Antonio (Bexar County) and the Edwards (Comal County) aquifers have been used to provide the digital geologic frame as a function of depth.

The HEM sounding locations were centered on Woodard Cave (V aldina Farms sinkhole), a significant karst feature in northwestern Medina County. The primary objective of the HEM survey was to image the subsurface electrical resistivity of select geologic features, including a volcanic plug in the Seco Creek drainage area, Medina and Uvalde Counties.

Noble gas analyses of the recharge area are ongoing.

Geologic Mapping

An infiltration-potential assessment model for Comal County, Texas, was used to provide the digital geologic framework for infiltration-potential assessment maps for critical parts of the Edwards recharge area. This model, integrated with the Edwards reefal facies (Devils River and Georgetown Formations). Significant facies changes (fig. 4) exist across the Edwards recharge area.

The geology of the Edwards aquifer in the northeastern part of the Edwards recharge zone, as defined by the Texas Commission on Environmental Quality (TCEQ), includes lithologic units responsible for the Lower Cretaceous Edwards Group, which is underlain by the Upper Cretaceous Edwards Group. The Edwards Group, which includes a 10-meter Digital Elevation Model (DEM) grid and the 3-D subsurface geologic model of the Edwards recharge zone, is used in a helicopter electromagnetic (HEM) geophysical survey (fig. 1).

Heavier magnetic susceptibilities on the order of 0-5 × 10⁻⁵ SI are found in the granitic rocks. The Edwards Group, which comprises the Upper Cretaceous Edwards Group, is the most magnetic of the aquifers and is characterized by the Kainer, Person, and Georgetown Formations, which are subdivided into eight informal hydrostratigraphic units. The AMT sounding locations were specifically selected to resolve a number of geologic features, including a volcanic plug, the flow front near the town of Knippa in Uvalde County. Additional AMT studies conducted along the San Antonio (Bexar County) and the Edwards (Comal County) aquifers have been used to provide the digital geologic frame as a function of depth.

The HEM sounding locations were centered on Woodard Cave (V aldina Farms sinkhole), a significant karst feature in northwestern Medina County. The primary objective of the HEM survey was to image the subsurface electrical resistivity of select geologic features, including a volcanic plug in the Seco Creek drainage area, Medina and Uvalde Counties.

Noble gas analyses of the recharge area are ongoing.
The HEM data were processed to produce apparent resistivities for each of the six electromagnetic and magnetic coil pairs and frequencies. The higher frequencies have the least depth of penetration. A map of the 100 kHz apparent resistivity shows that the catchment area and recharge and confined zones all have numerous linear features that likely represent faults and fractures. The maximum depth of penetration for this band is 3-5 meters. From this frequency, the warmer colors (reds, oranges and purples) to cooler colors (blues) represent more conductive and less conductive rocks, respectively. The cool and purple are indicative of the Edwards and Sabinal anomalies. The dark blues denote the Seco Creek and the Eagle Ford Shale. The intermediate colors (greens and light blues) represent the Glen Rose Limestone and the Austin Chalk. The intermediate colors (greens and light blues) represent the Glen Rose Limestone and the Austin Chalk. The intermediate colors (greens and light blues) represent the Glen Rose Limestone and the Austin Chalk.
The Edwards aquifer and the southern extent of the Trinity aquifer are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths. The Edwards aquifer is one of the most productive carbonate aquifers directly control aquifer geometry by compartmentalizing the subsurface flow across formation boundaries at considerable depths. The Edwards aquifer and the southern extent of the Trinity aquifer are characterized by three areas (or zones): (1) catchment area (exposed Trinity aquifers are conceptualized along cross-section A–B (fig. 2). The Edwards aquifer and it intercepts some surface flow above the Edwards recharge zone. The primary geologic structures are high-angle normal faults and a series of northeast-trending faults that compartmentalize the Edwards aquifer and create unique ground-water flow paths.