

Multidisciplinary Studies of the Edwards Aquifer and Adjacent Trinity Aquifer of South-Central Texas*

By

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Search and Discovery Article #80018 (2008)

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Abstract

A five-year USGS project, funded primarily by the National Cooperative Geologic Mapping Program (NCGMP), has partnered with federal, state, and municipal agencies to conduct geologic mapping, hydrologic studies, and geophysical surveys of the Edwards and southern Trinity aquifers in south-central Texas. This multidisciplinary effort has successfully produced results (<http://esp.cr.usgs.gov/info/edwards/index.html>) to help characterize the geohydrologic framework of two critically important ground-water systems: (1) the Edwards aquifer extending from south of Austin to west of San Antonio and (2) the southern fringe of the Trinity aquifer in the Texas Hill Country west and south of Austin. Digital geologic map compilations and subsurface well data have provided the foundations for constructing 3-D EarthVision™ geologic models of the Edwards aquifer recharge and catchment areas. An airborne magnetic survey of western Medina and eastern Uvalde counties identified numerous subsurface volcanic intrusives that potentially affect ground-water pathways through the western portion of the Edwards aquifer. Ground and airborne geophysical surveys have provided critical data on fault morphology and displacement, potential areas of karst development, and the geohydrologic properties of water-bearing units. Noble gas geochemistry exploited helium-3/tritium as excellent ground-water tracers to determine the ages and origins of ground water in Uvalde County and along the Edwards saline-fresh-water interface. Additional geologic mapping of Kinney and Bexar Counties, infiltration potential modeling of Comal County, and geochronologic age dating of volcanic intrusives from Bracketville to Austin are near completion. A project synthesis with URLs to all project studies was recently released as USGS Fact Sheet available online at URL: (<http://pubs.usgs.gov/fs/2006/3145>).

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Edwards Mapping Project Web Page:

<http://esp.cr.usgs.gov/info/edwards/>

Geohydrologic Framework of the Edwards and Trinity Aquifers, South-Central Texas

This five-year USGS project, funded by the National Cooperative Geologic Mapping Program (NCGMP), is using multi-disciplinary approaches to reveal the surface and subsurface geologic architecture of two important Texas aquifers: (1) the Edwards aquifer that extends from south of Austin to west of San Antonio and (2) the southern part of the Trinity aquifer in the Texas Hill Country west and south 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 and it intercepts some surface flow above the Edwards recharge zone. The Trinity may also contribute to the Edwards' water budget by subsurface flow across formation boundaries at considerable depths. Dissolution, karst development, and faulting and fracturing in both aquifers directly control aquifer geometry by compartmentalizing the aquifer and creating unique 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 stratigraphic and structural framework of 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 (also called the contributing area) and travels down gradient 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).



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

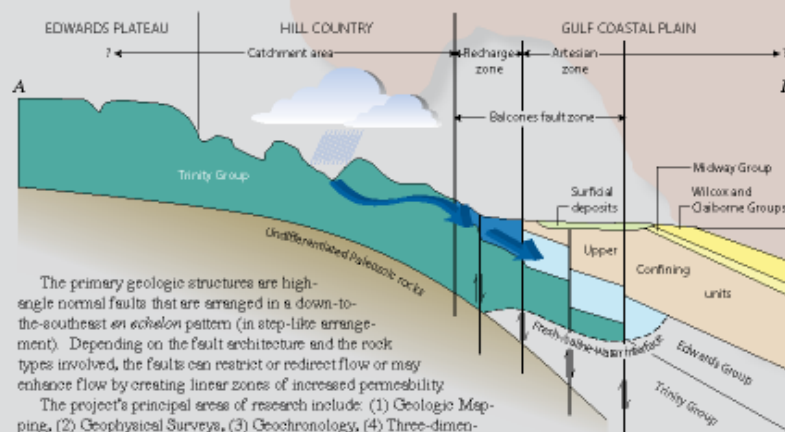


Figure 2. Structural schematic cross section of the Edwards aquifer and catchment area (Trinity aquifer).

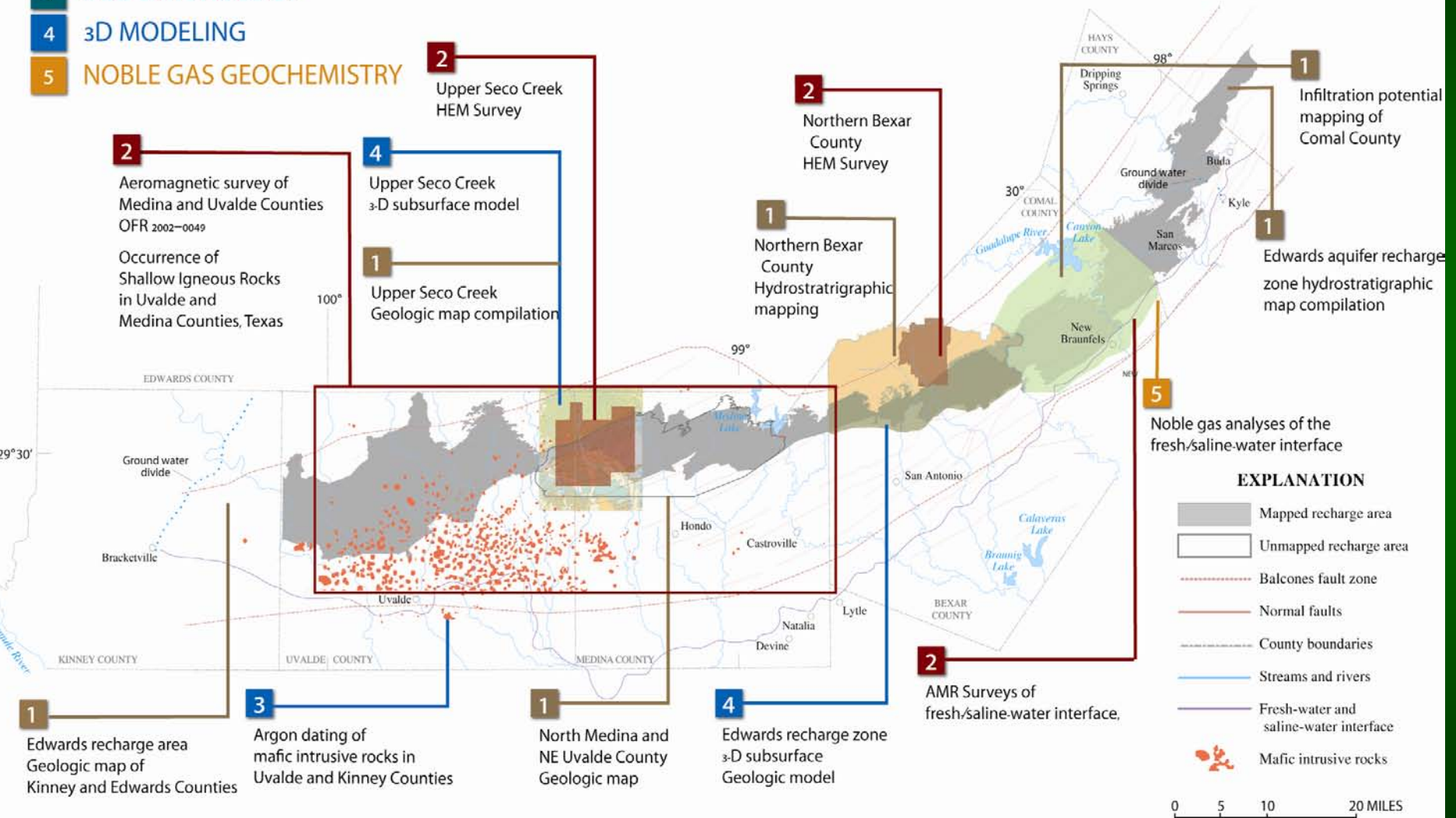
Edwards Fact Sheet

2006-3145

<http://pubs.usgs.gov/fs/2006/3145/>

PROJECT RESEARCH AREAS

- 1 GEOLOGIC MAPPING
- 2 GEOPHYSICAL SURVEYS
- 3 GEOCHRONOLOGY
- 4 3D MODELING
- 5 NOBLE GAS GEOCHEMISTRY



Noble gas analyses of the fresh/saline-water interface

EXPLANATION

- Mapped recharge area
- Unmapped recharge area
- Balcones fault zone
- Normal faults
- County boundaries
- Streams and rivers
- Fresh-water and saline-water interface
- Mafic intrusive rocks

1 Edwards recharge area Geologic map of Kinney and Edwards Counties

3 Argon dating of mafic intrusive rocks in Uvalde and Kinney Counties

1 North Medina and NE Uvalde County Geologic map

4 Edwards recharge zone 3-D subsurface Geologic model

2 Aeromagnetic survey of Medina and Uvalde Counties OFR 2002-0049
Occurrence of Shallow Igneous Rocks in Uvalde and Medina Counties, Texas

4 Upper Seco Creek 3-D subsurface model
1 Upper Seco Creek Geologic map compilation

2 Upper Seco Creek HEM Survey

2 Northern Bexar County HEM Survey

1 Northern Bexar County Hydrostratigraphic mapping

1 Infiltration potential mapping of Comal County

1 Edwards aquifer recharge zone hydrostratigraphic map compilation

2 AMR Surveys of fresh/saline-water interface,

0 5 10 20 MILES

EXPLANATION

City

MAVERICK BASIN
STRATIGRAPHIC UNITS

Not mapped or recharge area
Not mapped or recharge area

DEVILS RIVER
STRATIGRAPHIC UNITS

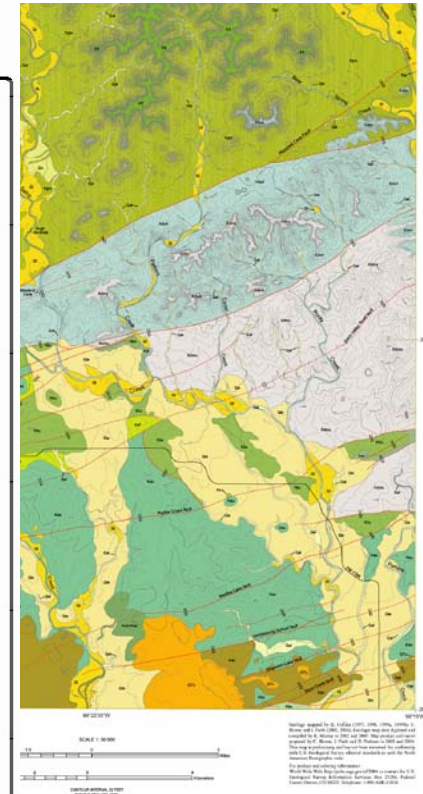
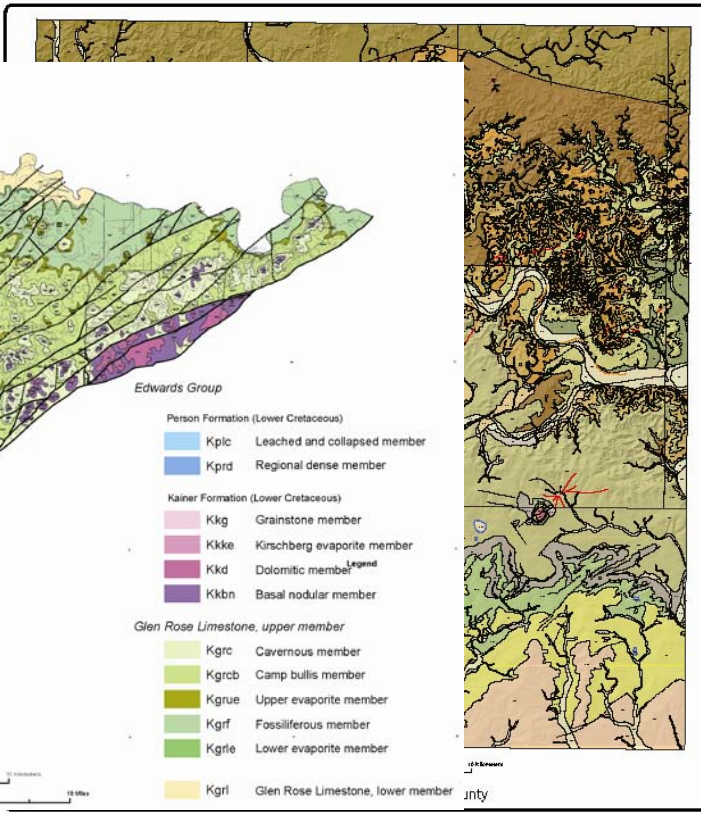
ALLIAMI
LEONA FORMATION

1:200K-scale

USGS U.S. GEOLOGICAL SURVEY

1 Geologic Map of Kinney and Edwards Counties

1:50K-scale four-quad. compilation



MAP COMPILATION OF THE UPPER SECO CREEK AREA,
AND UVALDE COUNTIES, SOUTH-CENTRAL TEXAS
by
D. Blome, Jason R. Faith, Edward W. Collins, Diana E. Pedraza, and Kyle E. Murray
2004

GEOLOGIC MAP COMPILATION OF THE EDWARDS AQUIFER RECHARGE ZONE, SOUTH-CENTRAL TEXAS
Charles D. Blome, Jason R. Faith, Diana E. Pedraza, George B. Czuba, James C. Cole, Alan K. Clark, Ted A. Smeal and Robert R. Morris
ORIGINAL GEOLOGIC MAPPING
Ted A. Smeal, Alan K. Clark, John A. Hanson, Nico M. Haanveit, George B. Czuba, and William G. Stein

PROJECT RESEARCH AREAS

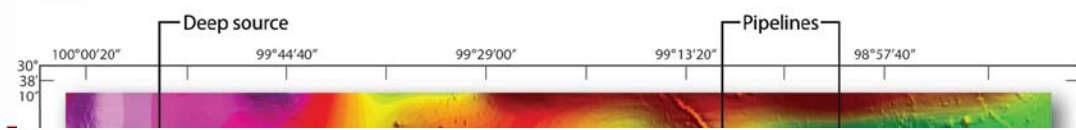
2

GEOPHYSICAL SURVEYS

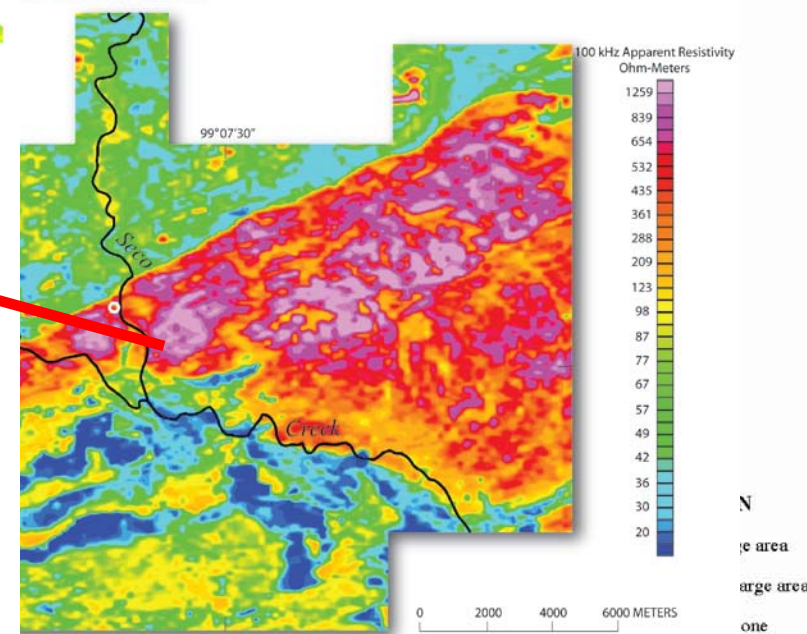
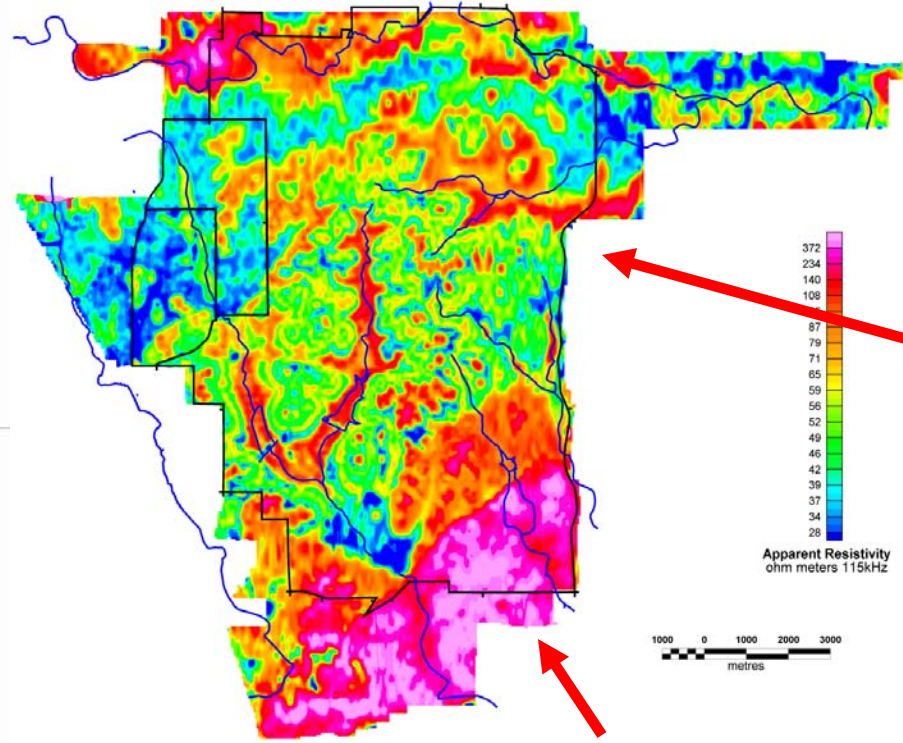
3

GEOCHRONOLOGY

2



GEOPHYSICAL SURVEYS



3

Argon dating of mafic intrusive rocks in Uvalde and Kinney Counties

Emplacement at 82-80 and 74-72 m.y. ago

2

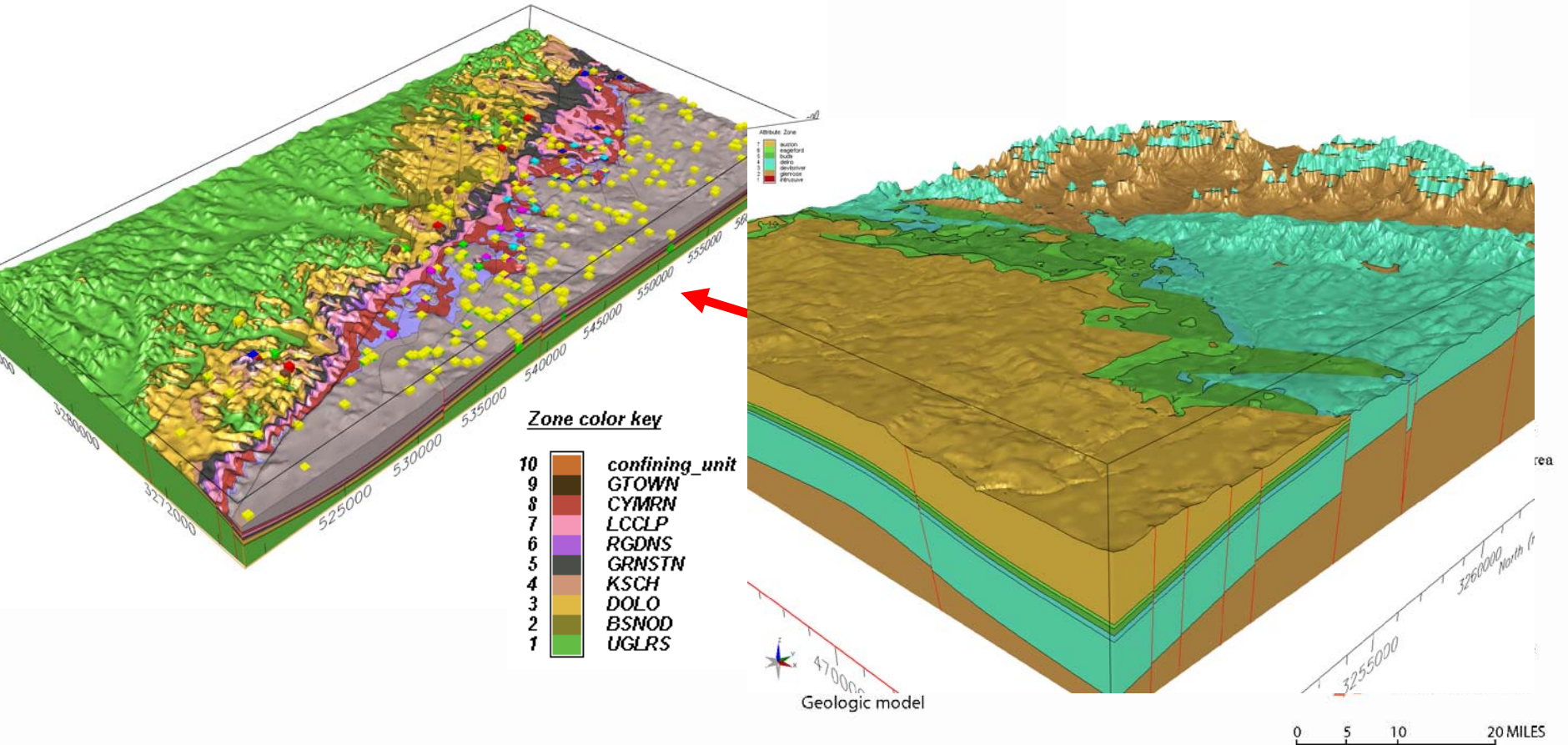
AMR Surveys of fresh/saline-water interface.

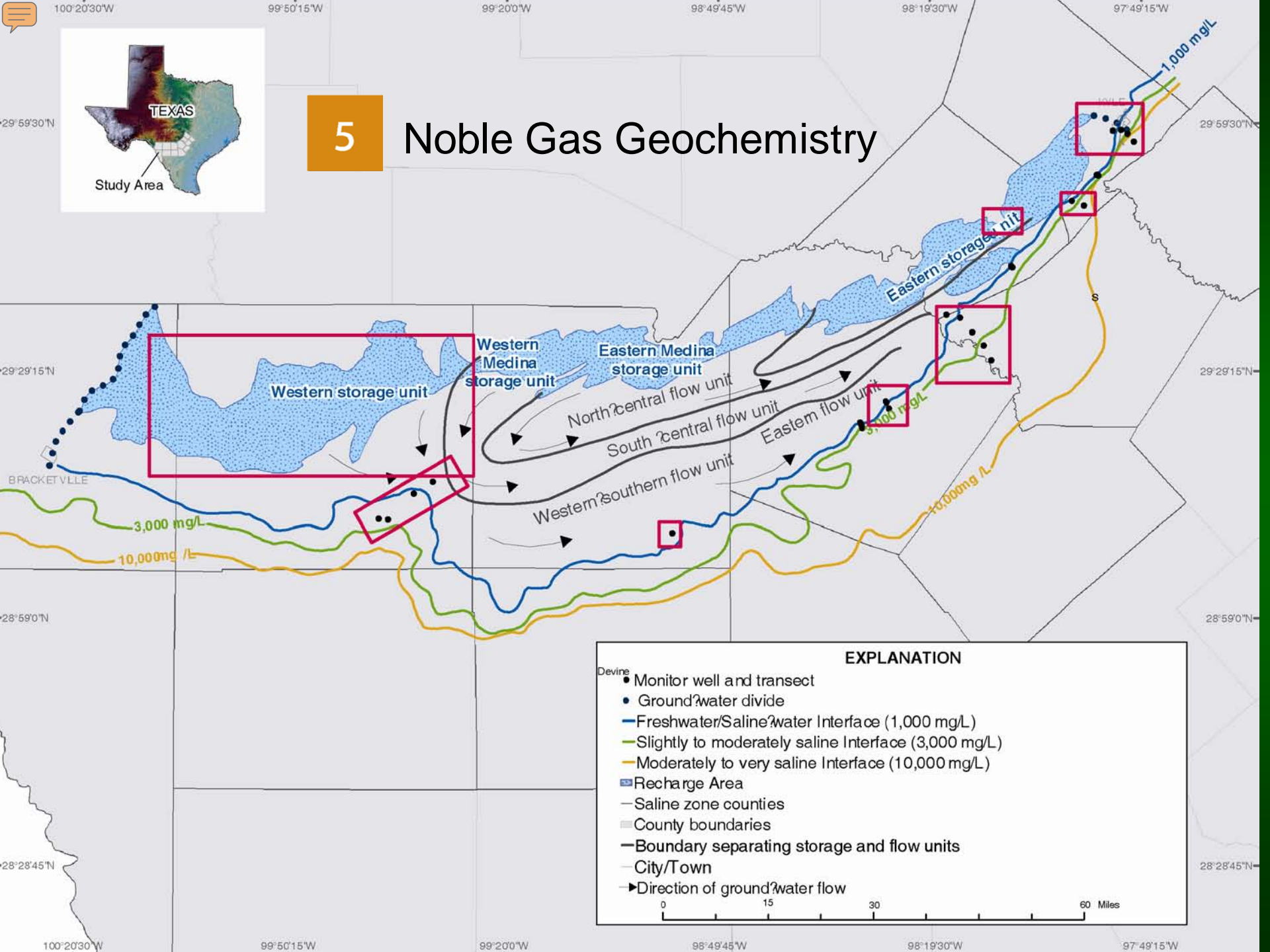
- Streams and rivers
- Fresh-water and saline-water interface
- Mafic intrusive rocks

0 5 10 20 MILES

PROJECT RESEARCH AREAS

4 3D MODELING





5

Noble Gas Geochemistry

EXPLANATION

- Monitor well and transect
- Groundwater divide
- Freshwater/Saline-water Interface (1,000 mg/L)
- Slightly to moderately saline Interface (3,000 mg/L)
- Moderately to very saline Interface (10,000 mg/L)
- Recharge Area
- Saline zone counties
- County boundaries
- Boundary separating storage and flow units
- City/Town
- Direction of groundwater flow

0 15 30 60 Miles

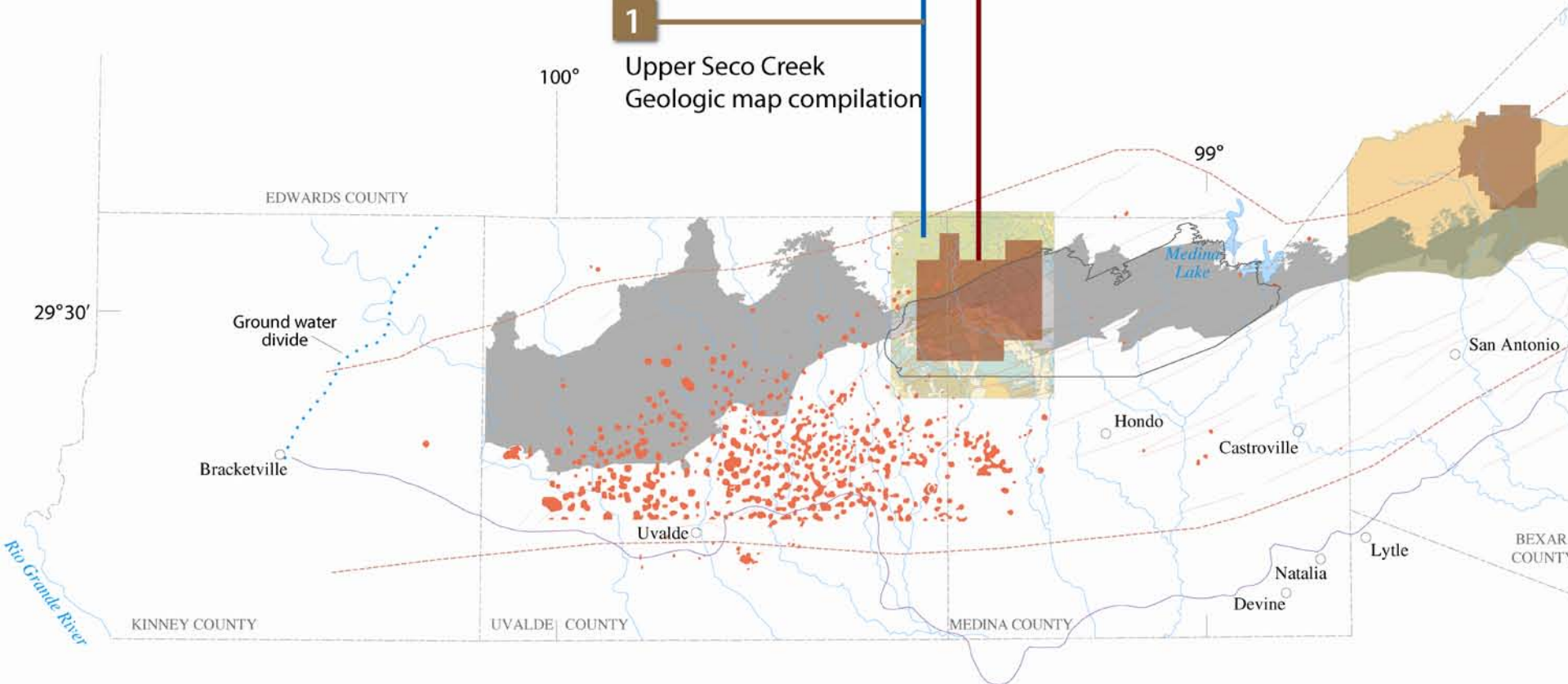
PROJECT RESEARCH AREAS

- 1** GEOLOGIC MAPPING
- 2** GEOPHYSICAL SURVEYS
- 4** 3D MODELING

2 Upper Seco Creek
HEM Survey

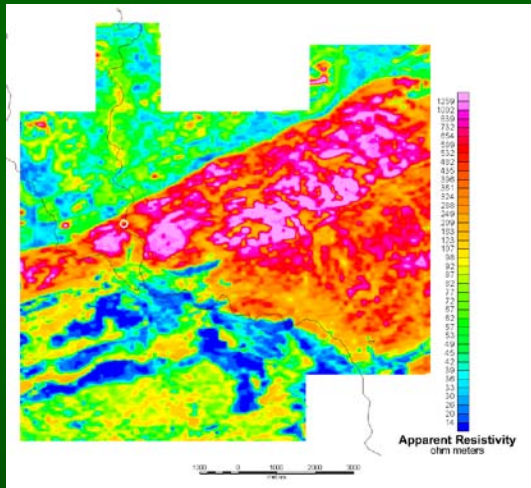
4 Upper Seco Creek
3-D subsurface model

1 Upper Seco Creek
Geologic map compilation

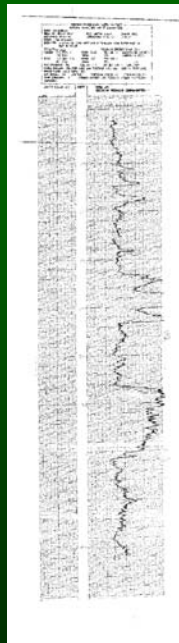


Seco Creek Area

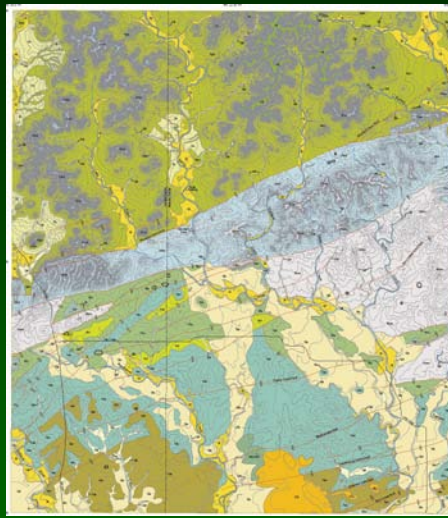
Geophysical Surveys



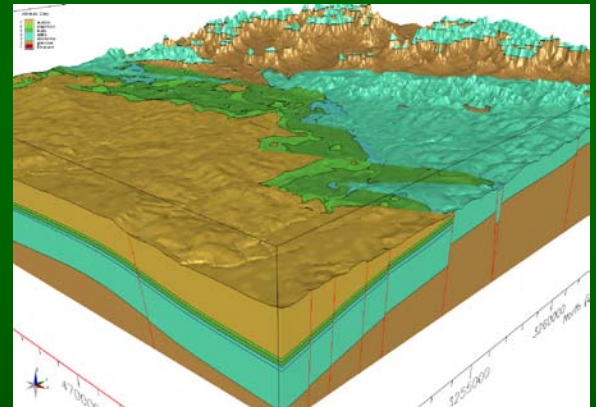
Drillhole Geophysics



Geologic Mapping



3-D Modeling



CATCHMENT AREA

HEM SURVEY

Valdina Farms Sink hole and flight line

RECHARGE ZONE

CONFINED ZONE

LIST OF MAP UNITS

- Qal Alluvium (Quaternary)
- Qu Undivided terrace, slope-wash deposits, and fan deposits (Quaternary)
- Qt Terrace deposits (Quaternary)
- Qle Leona Formation (Pleistocene)
- QTu Uvalde Gravel, older alluvium (Quaternary & Upper Tertiary)
- M Mafic intrusive rocks (Upper Cretaceous)
- Kes Escondido Formation (Upper Cretaceous)
- Kan Anacacho Limestone (Upper Cretaceous)
- Kan+Kau Anacacho Limestone and Austin Group, undivided (Upper Cretaceous)
- Kau Austin Group (Upper Cretaceous)
- Kef Eagle Ford Formation (Upper Cretaceous)
- Kbu Buda Formation (Upper Cretaceous)
- Kdr Del Rio Clay (Upper Cretaceous)
- Kdrvu upper Devils River Formation (Lower Cretaceous)
- Kdrvl lower Devils River Formation (Lower Cretaceous)
- KR Fort Terrett Formation (Lower Cretaceous)
- Kgrvu upper Glen Rose Limestone (Lower Cretaceous)

Explanation of Map Symbols

- Roads
- Medina and Uvalde County boundary
- Stream/River
- Quadrangle boundary
- Geologic contact-certain
- Normal fault-certain
- Normal fault-inferred
- Collapse feature
- Cave

Quadrangle Mapping Base Index

Flatpox Crossing Collins, 1996b	Texas Mountain Collins, 1997
Comanche Waterhole Collins, 1999a	Sabinal NE Collins, 1998

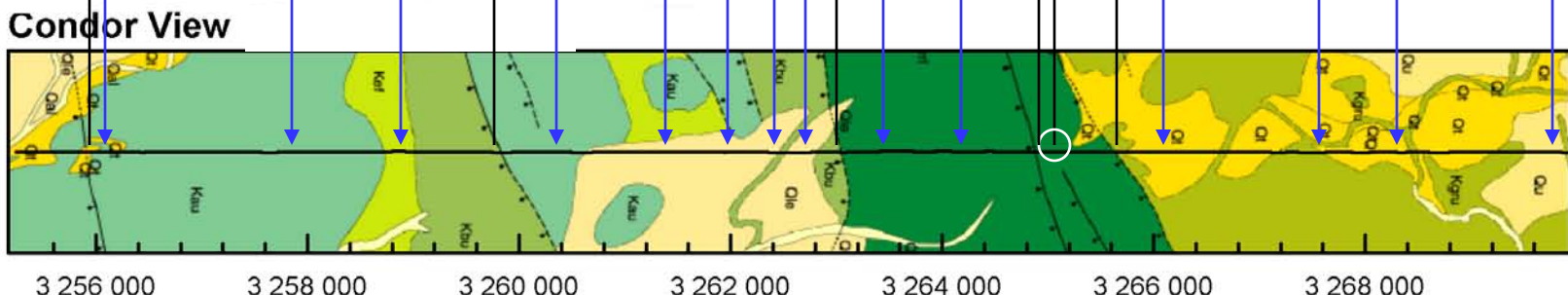
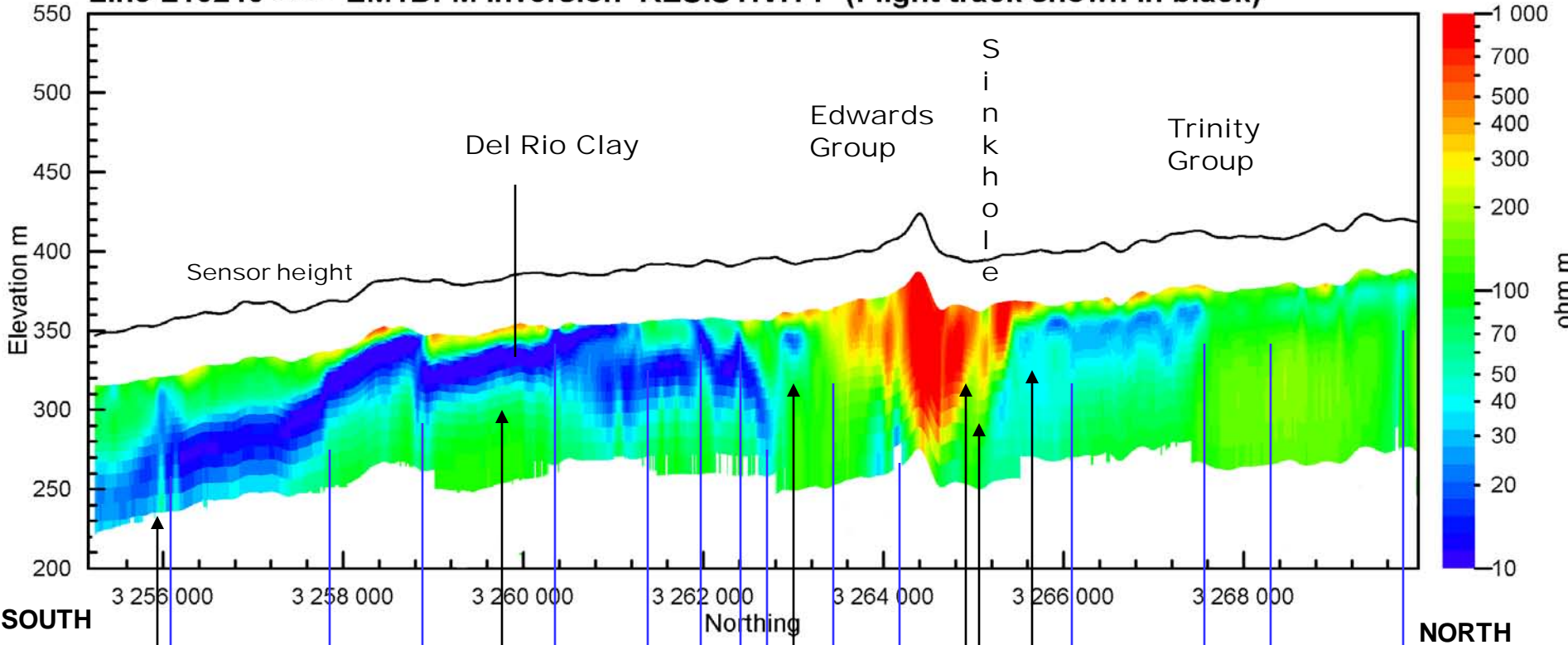


Base modified from U.S. Geological Survey 1:24,000 quadrangles. Universal Transverse Mercator projection, Zone 14, NAD 27

SCALE 1:50,000

Geology mapped by E. Collins (1995, 1998, 1999a, 1999b), C. Blum and J. Faith (2003, 2004). Geologic map data digitized and compiled by K. Murray in 2002 and 2003. Map product and report prepared by C. Blum, J. Faith and D. Pedroni in 2003 and 2004. This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or with the North American Stratigraphic Code.

Line L10240 >>> EM1DFM Inversion RESISTIVITY (Flight track shown in black)



Vertical Exaggeration
~x20

1 Mile

1
0
0
m

2000m

↑
Mapped structure
correlation

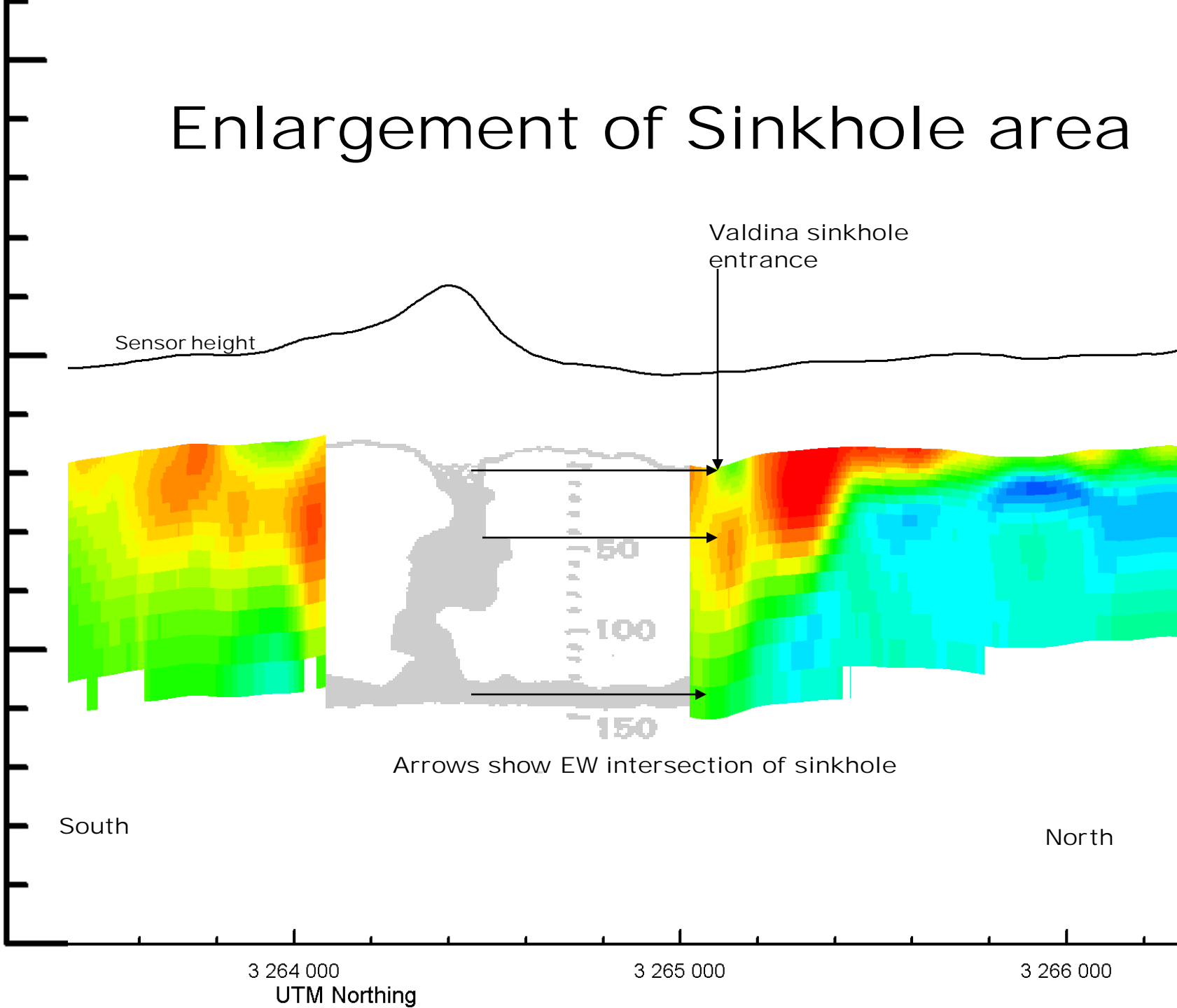
↓
Geophysical structure
correlation



Enlargement of Sinkhole area

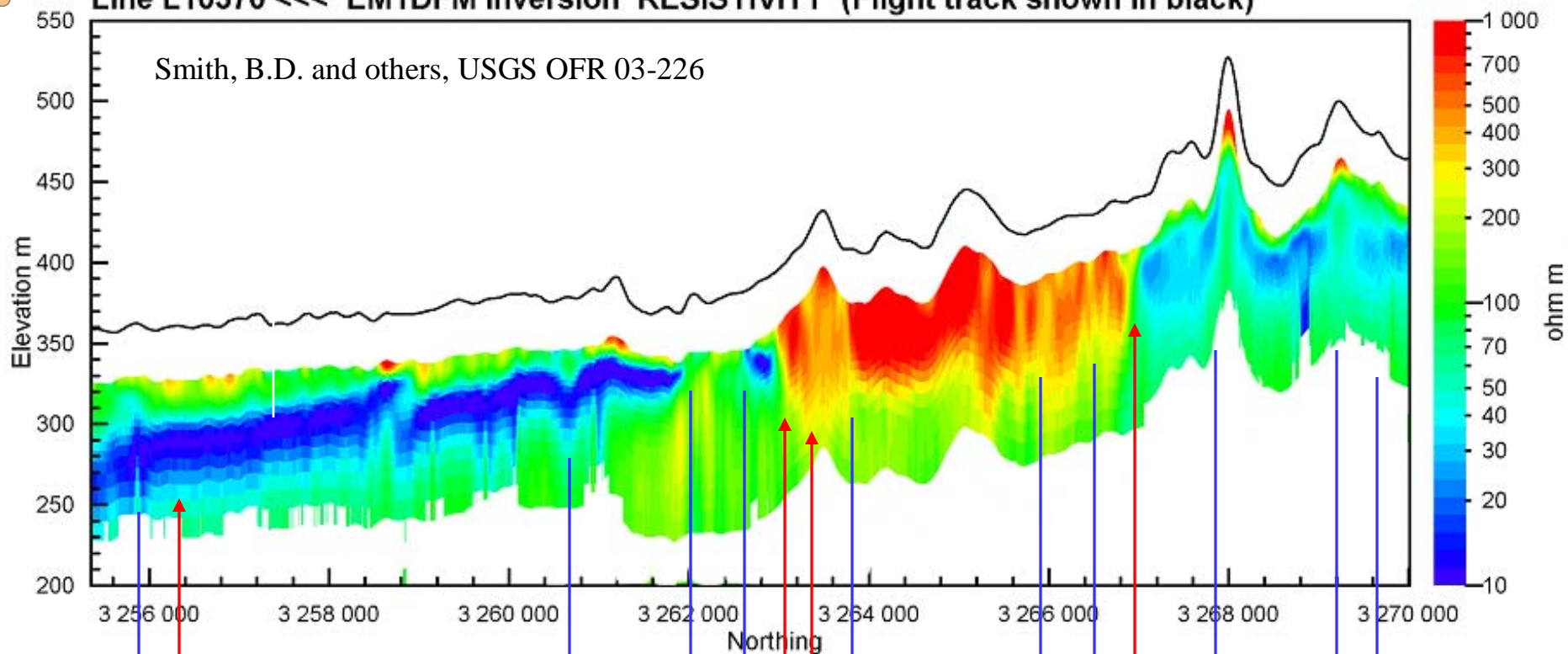
Depth
meters

350
300
250
200

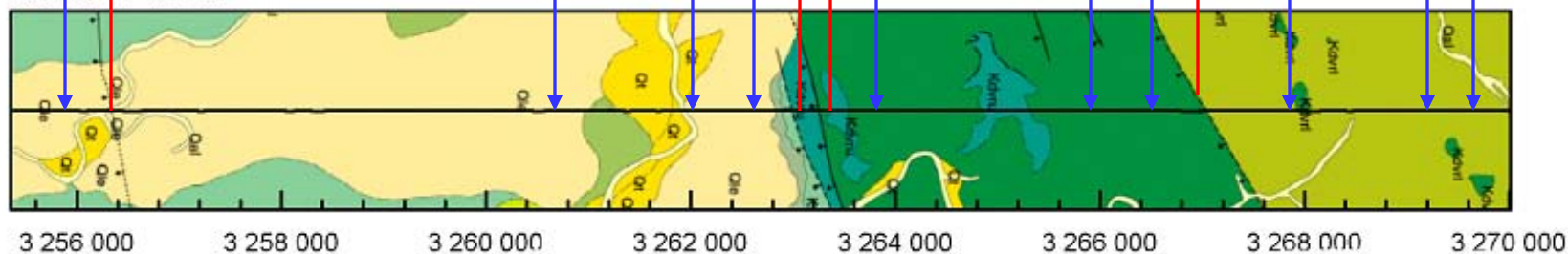


Line L10370 <<< EM1DFM Inversion RESISTIVITY (Flight track shown in black)

Smith, B.D. and others, USGS OFR 03-226



Condor View



Vertical Exaggeration

2
0
0
m

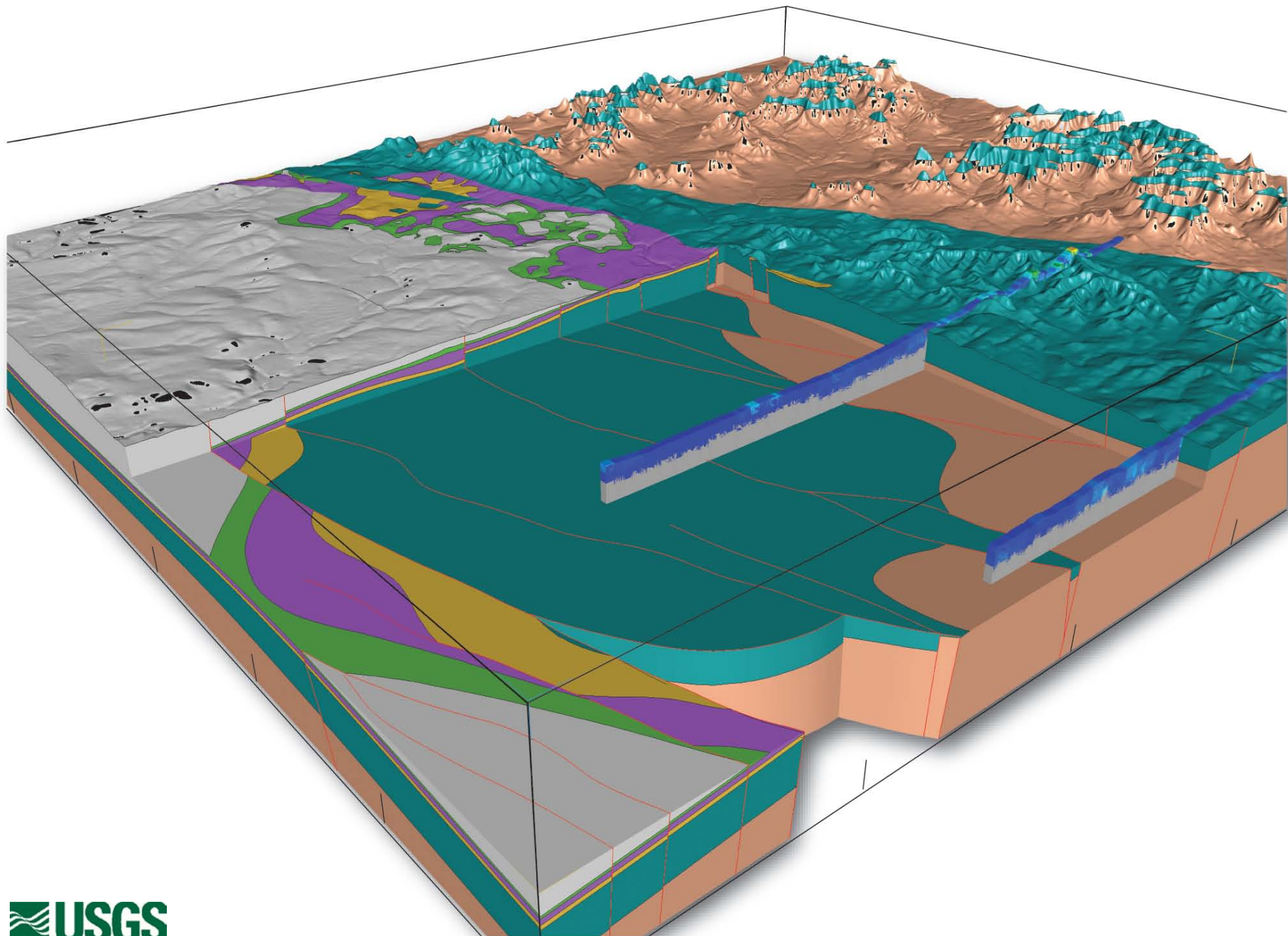
2000m

1 Mile

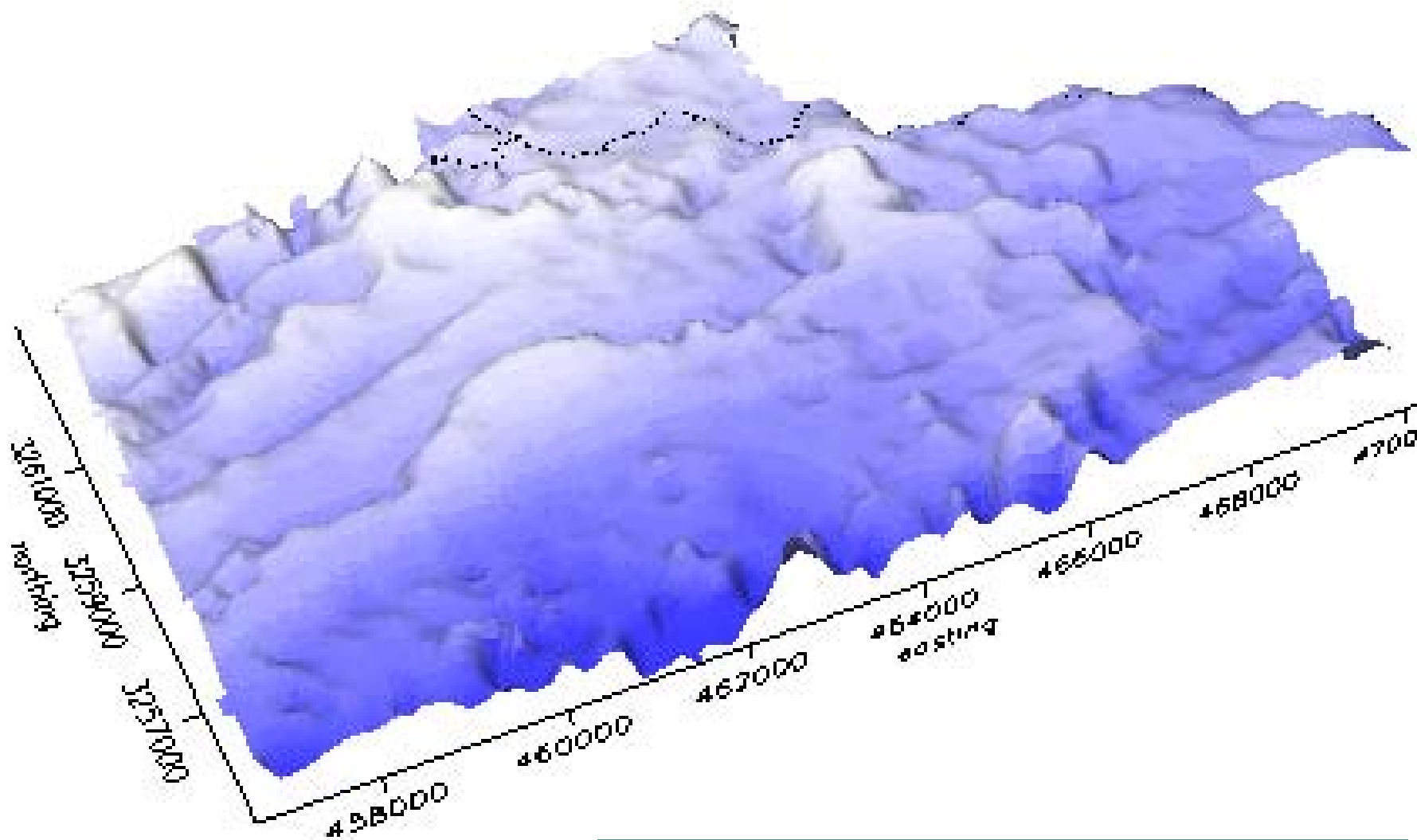
Fault
Structures

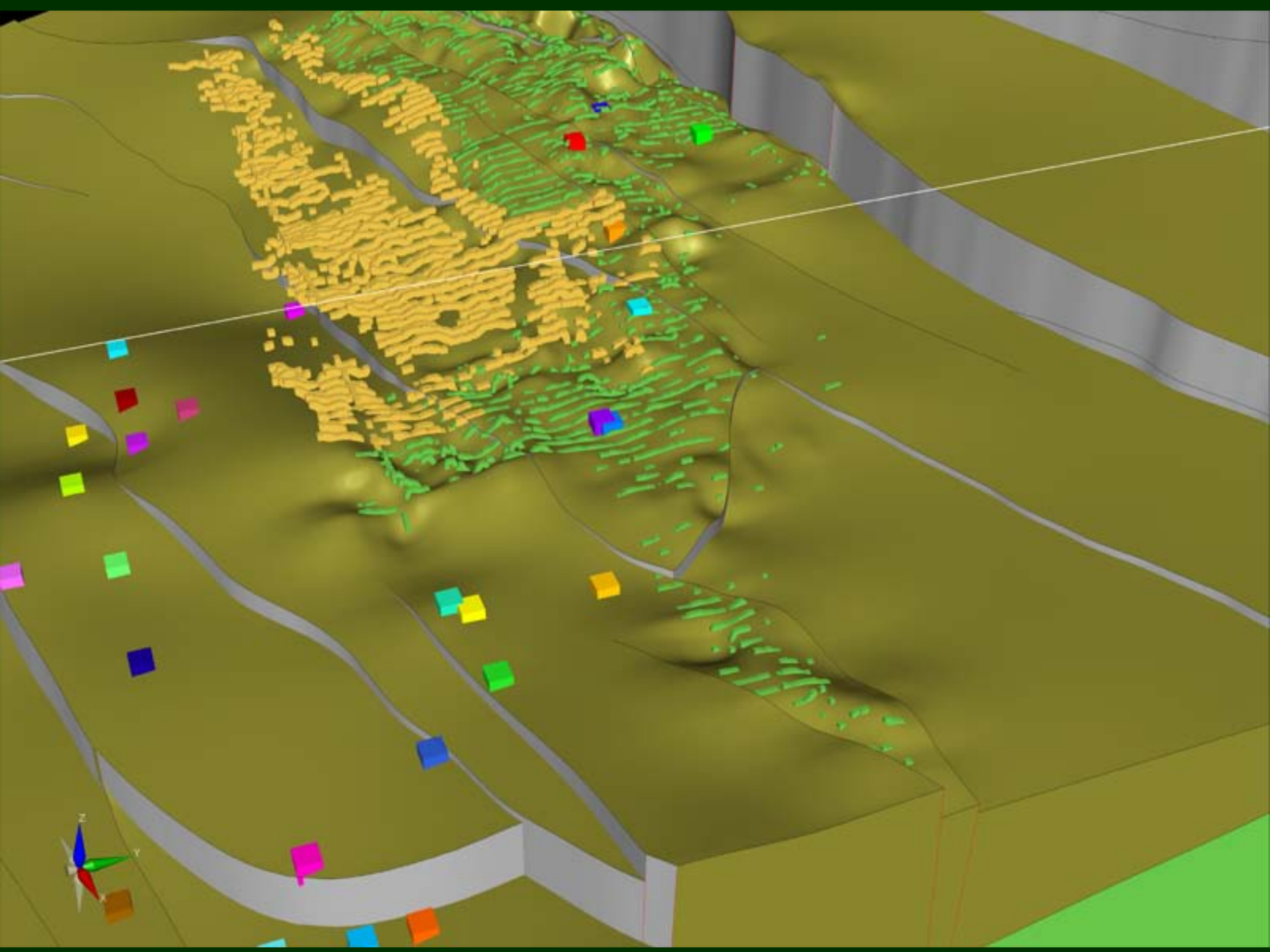
Mapped structure
correlation

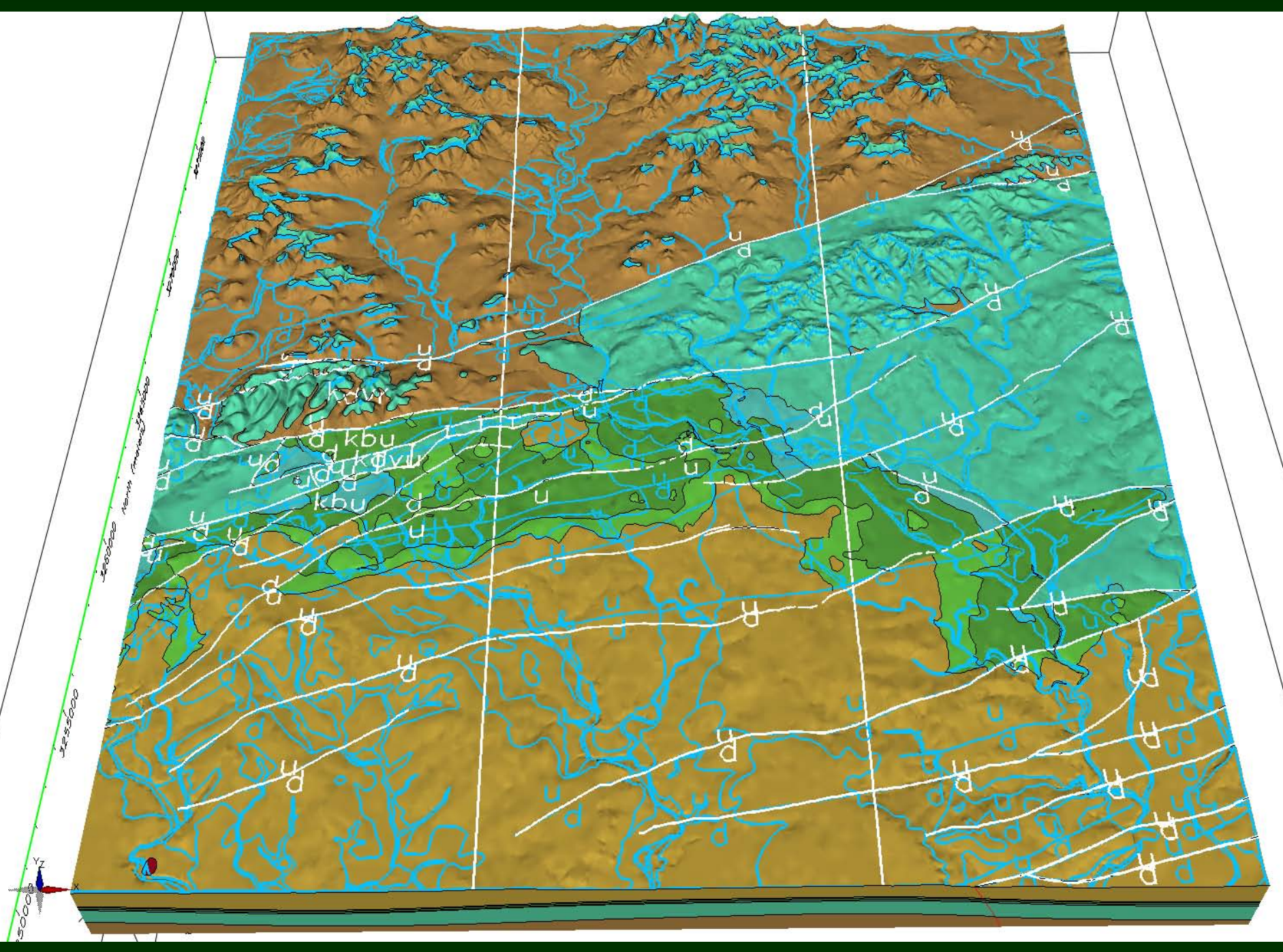
Geophysical structure
correlation



Seco Creek HEM (view SW to NE) Top of conductive units (meters, ASL)

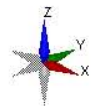
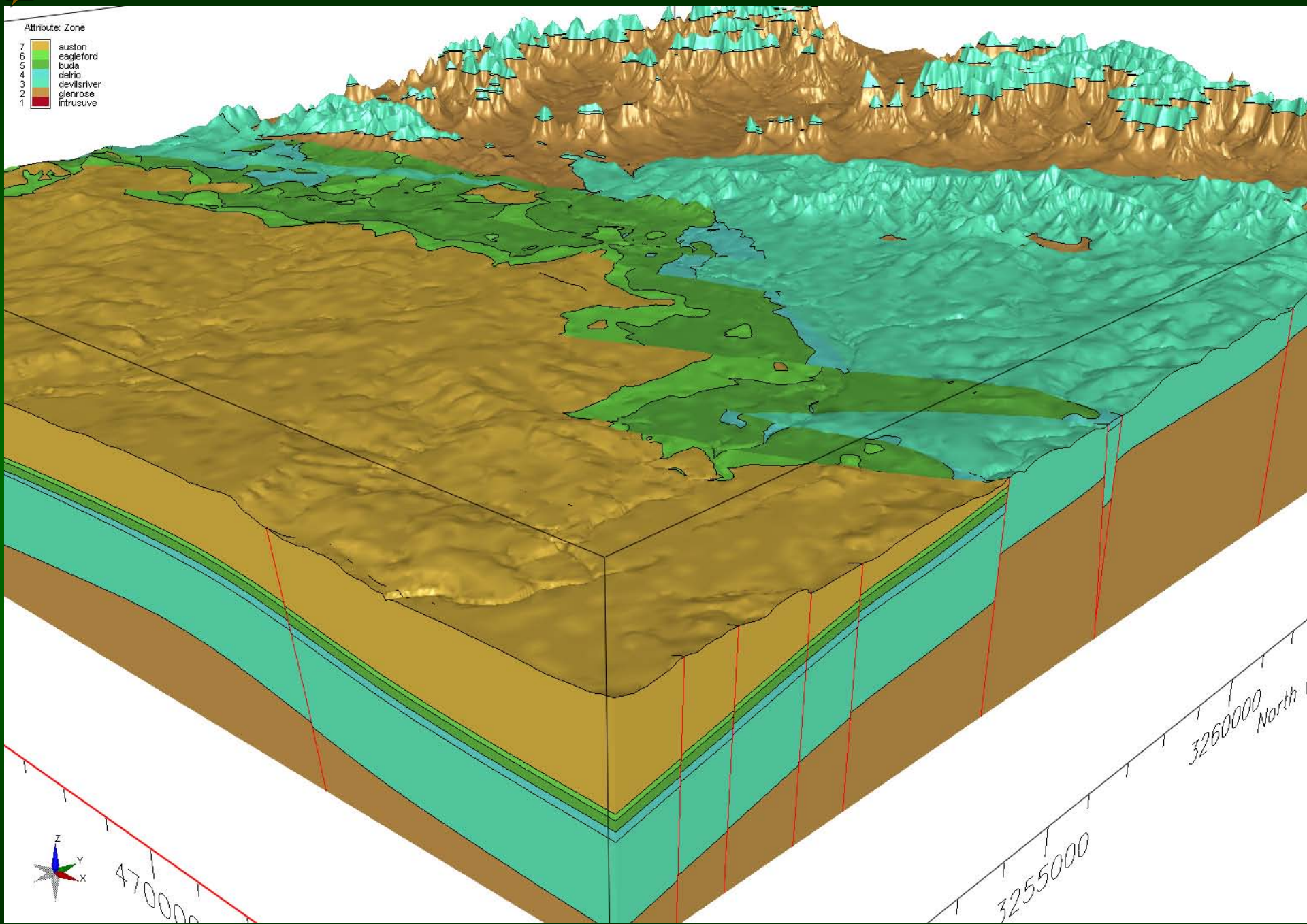






Attribute: Zone

- 7 auston
- 6 eagleford
- 5 buda
- 4 delrio
- 3 devilsriver
- 2 glenrose
- 1 intrusive



470000

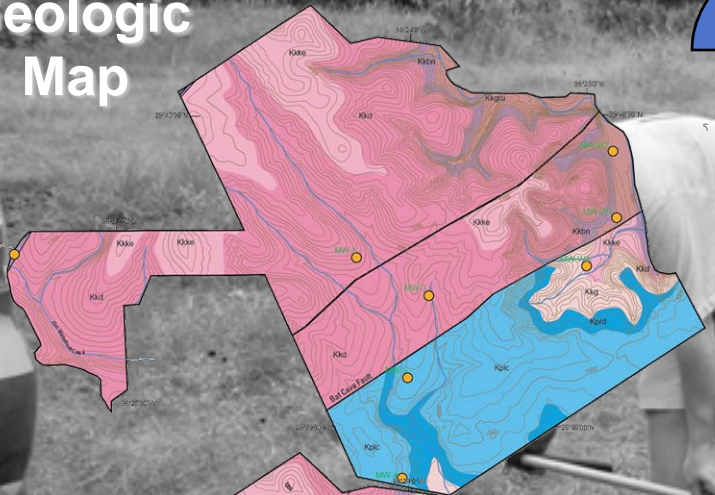
3255000

3260000 North

Integrated Studies - Recharge Zone

Cibolo Canyons Development including the PGA Golf Courses

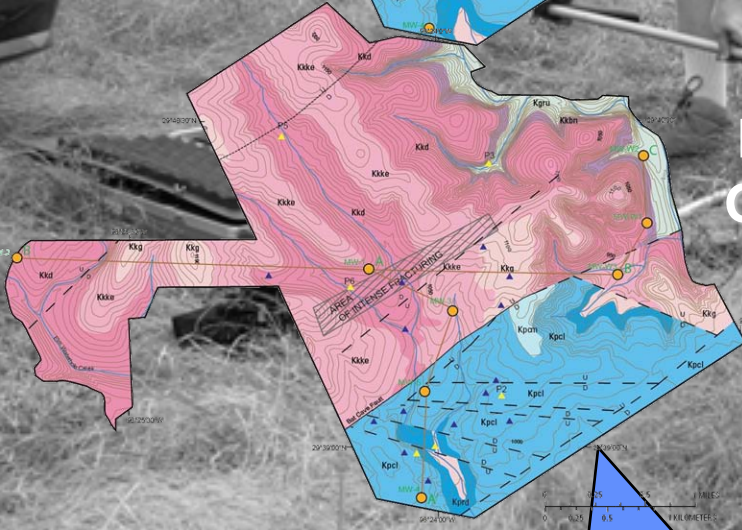
Original
Geologic
Map



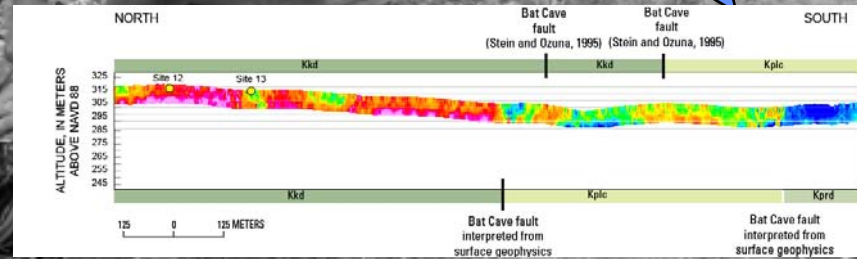
Geologic
Mapping



Revised
Geologic
Map



Geophysical data
collection



Geophysical
analysis



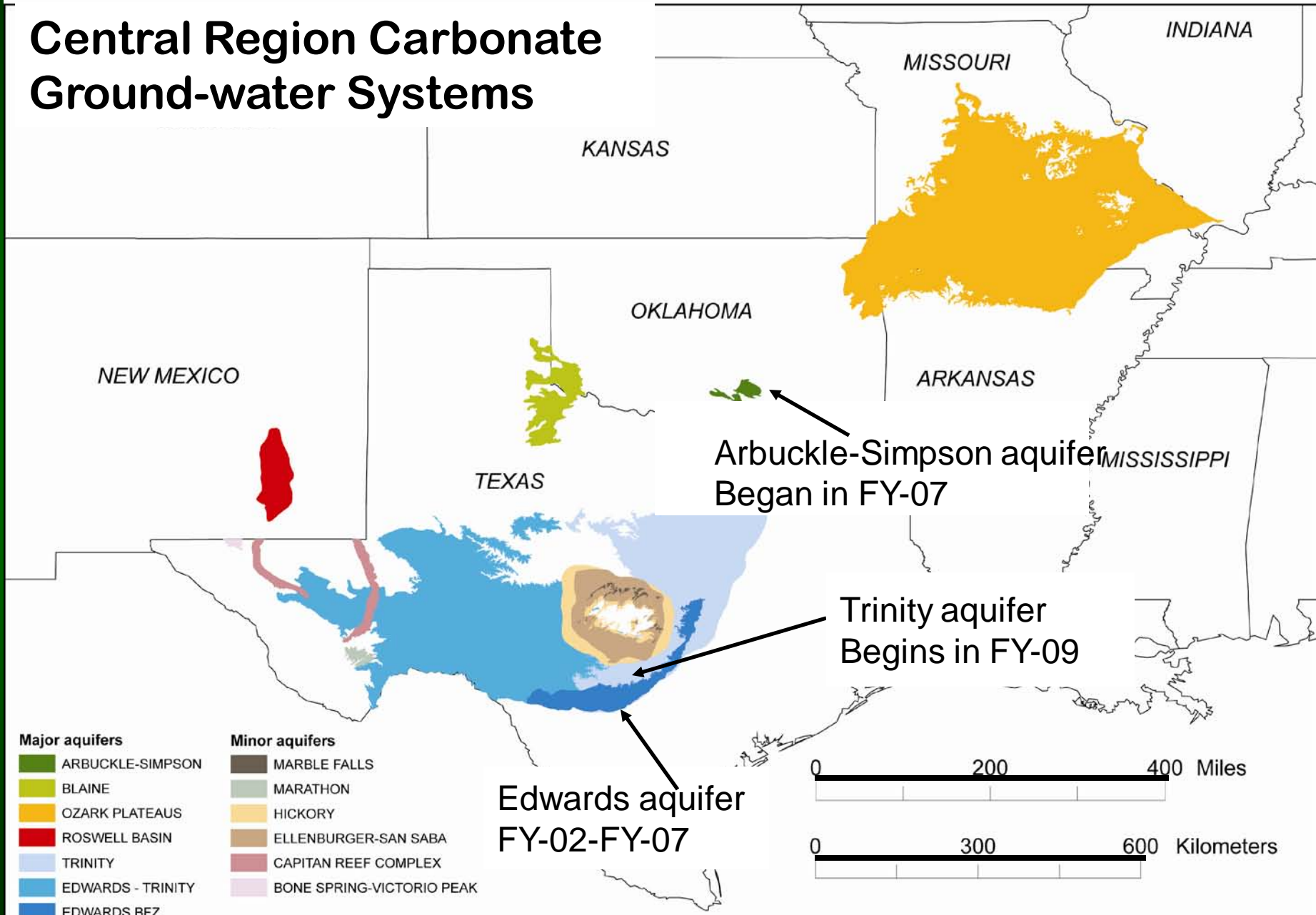
Hydrostatigraphic units Edwards Aquifer Cibolo Study Area

Edwards aquifer hydrostratigraphic subdivision	Hydrologic characterization	Generalized resistivity range (ohm-m)
II	Moderate porosity, high permeability, local low permeability in mudstone	Moderate 100-300
III	High porosity, high permeability	High 300-500
IV	Low porosity, low permeability, barrier to vertical flow	Low Below 100
V	Low porosity except in dissolution enhanced fractures and bedding planes. Local high permeability in dissolution enhanced fractures and bedding planes and with conduit development	Moderate 100-300
VI	High porosity, moderate permeability general lack of conduits because of the high porosity, conduits cannot be structurally supported	High 300-500
VII	Low porosity except in high permeability zones associated with fractures, bedding planes, and caves	Very high Above 500
VIII	Low porosity, low permeability, local high permeability in conduits and bedding planes	Moderate 100-300

Framework Geology of Mid-Centinent Carbonate Aquifers

National Cooperative Geologic Mapping Program

Central Region Carbonate Ground-water Systems



Conclusions

- 1. Geologic mapping provides the stratigraphy and structure used in building hydrogeologic models**
- 2. Geophysical/3-D models continues to test and improve geologic mapping**
- 3. Studies, like Seco Creek and Cibolo development area , demonstrate that mapping and modeling are evolutionary processes that benefit from cooperative interdisciplinary efforts**

Wrap-up Edwards Tasks

A topographic map of Texas is shown in the background. The map uses a color gradient from brown (high elevation) to green and blue (low elevation). A large, semi-transparent cyan rectangular area is overlaid on the map, covering the central and western parts of the state. This cyan area contains the text of the three tasks listed below.

- 1. New description of hydrostratigraphy of Edwards integrating all physical properties (lithology, geophysics, and geochemistry)**
- 2. Professional Paper Publication by 2010 announcement next week**
- 3. Application of lessons learned to new project in Trinity (start 2009)**