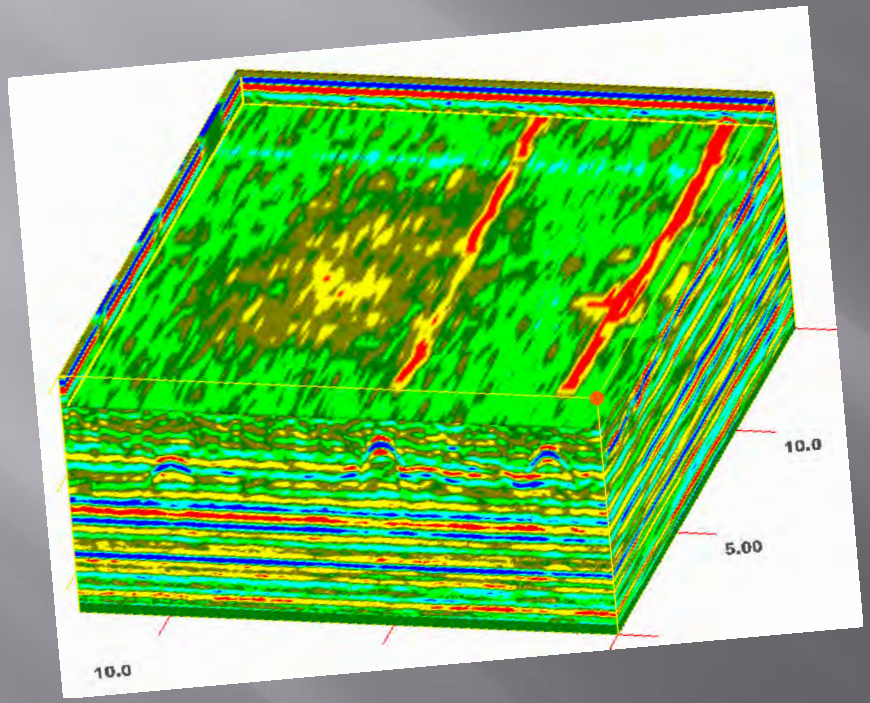
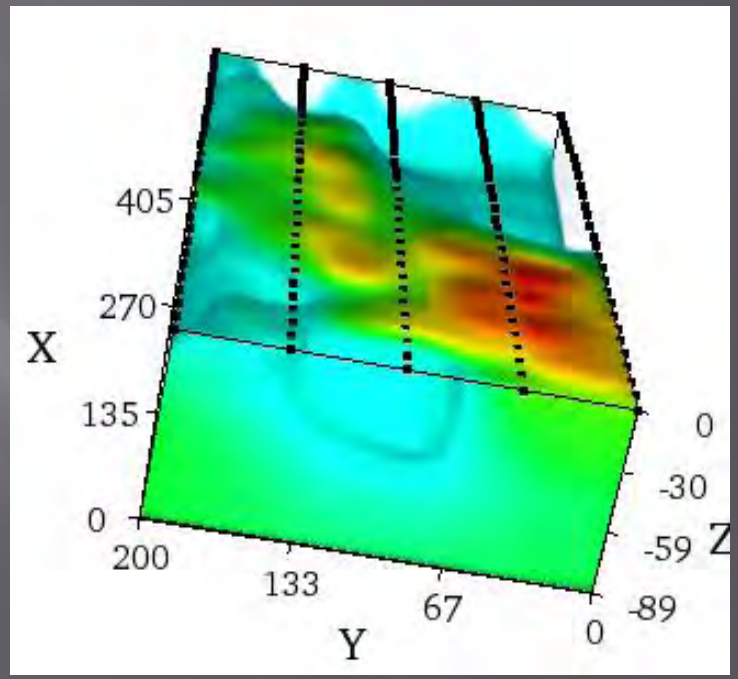
Geophysical Case studies From Texas





FOUNDATION PERFORMANCE ASSOCIATION

PRESENTATION OUTLINE

- Active Growth Faults in Metropolitan Houston
  1. Hockley
  2. Tomball
  3. Long Point
  4. Pearland
- Foundation Case Studies
- Karst Geophysics in Austin: Cave, Conduit and Fault Mapping
- Conclusions

Definitions of Geophysics

➔Geophysics is the study of earth materials and processes using the methods of physics.

➔It is, in general, a non-invasive and relatively inexpensive technology that provides unique constrains which are NOT obtainable using traditional engineering geology for site characterization.

➔**REMINDER: Geophysics is just another**

Definitions of Geophyicist

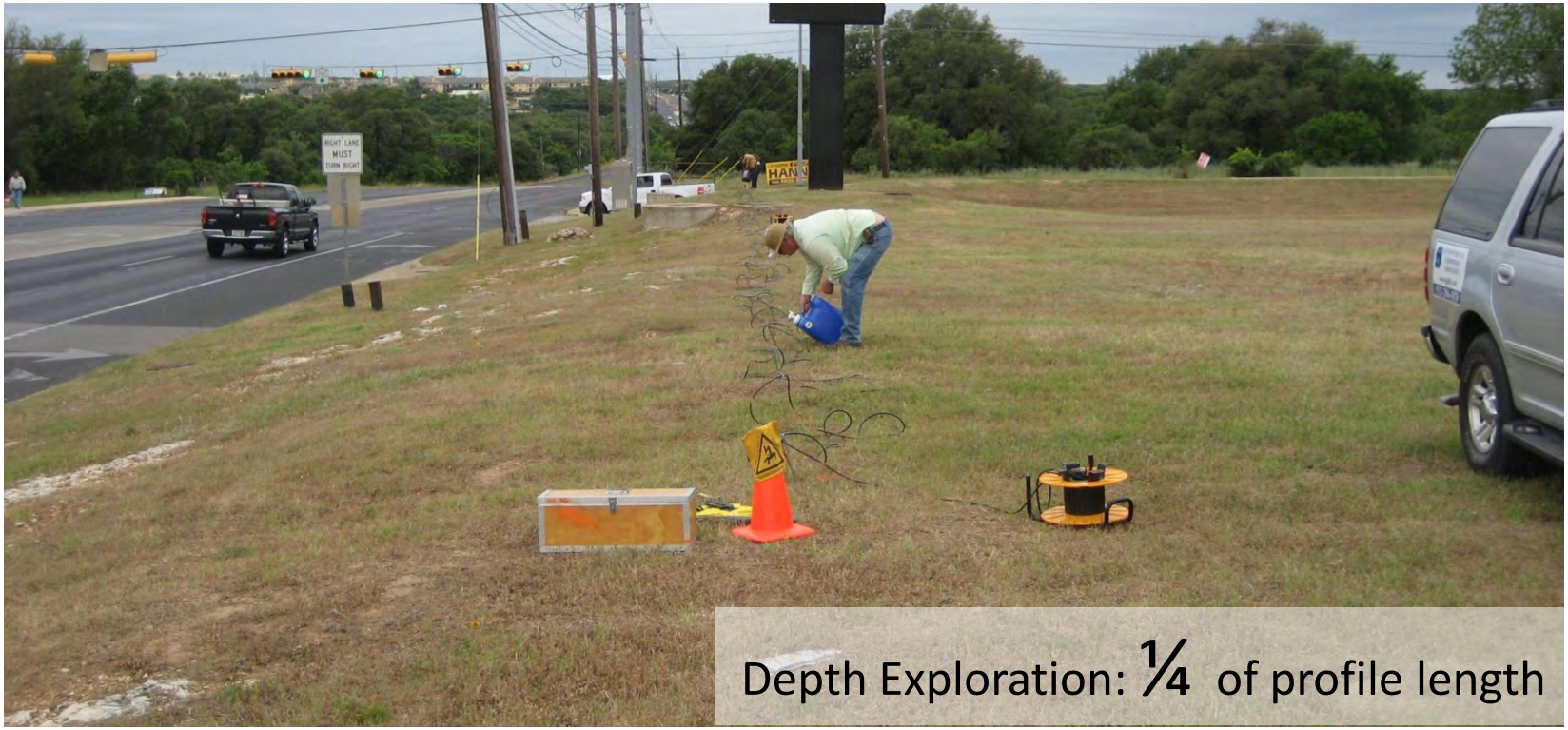
➔**Geophysicist: One who studies and applies geophysics to the solution of geological, environmental and geotechnical problems.**

➔ ***Alternative Definition of a Geophysicist from Google: A slightly below average classical physicist, a slightly below average geologist, a slightly below average engineer.!!***

Resistivity Method

-High-resolution image of shallow subsurface

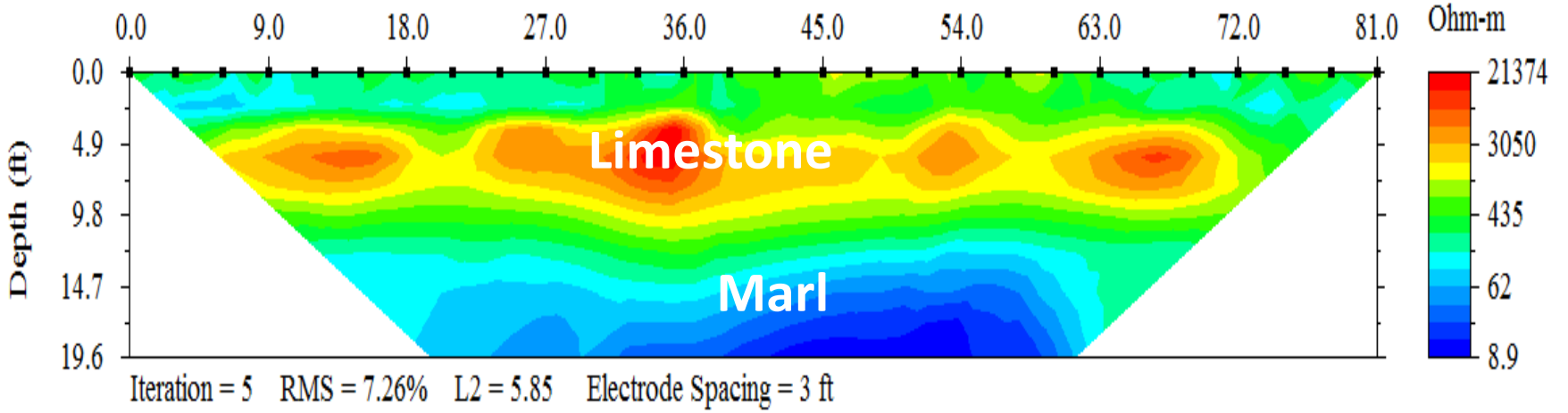
-Targets: bedrock vs. faults, voids, internal stratigraphy

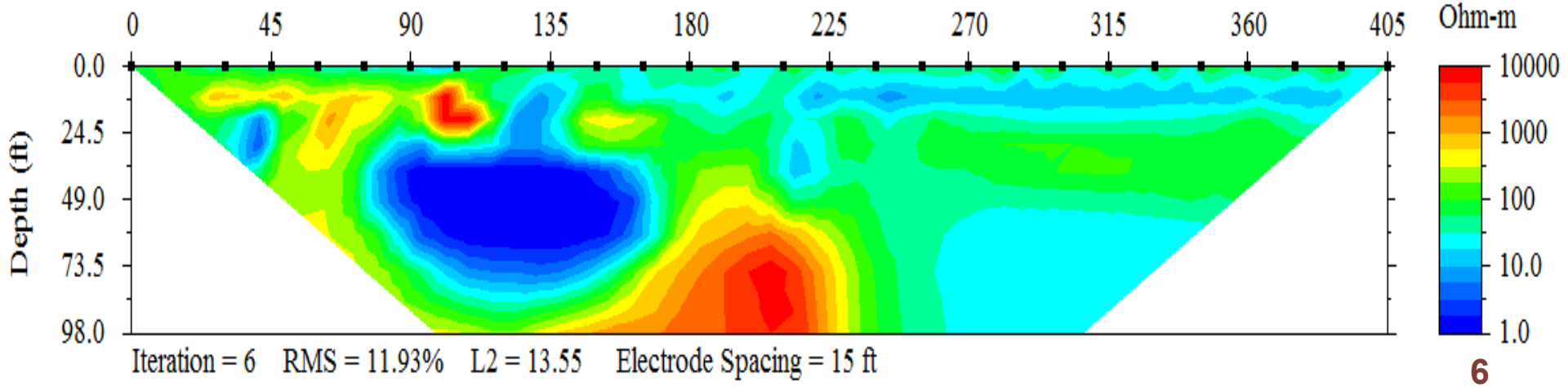


Depth Exploration: ¼ of profile length

EXAMPLEs OF RESISTIVITY IMAGING PROFILE WITHOUT AND WITH "ANOMALY"

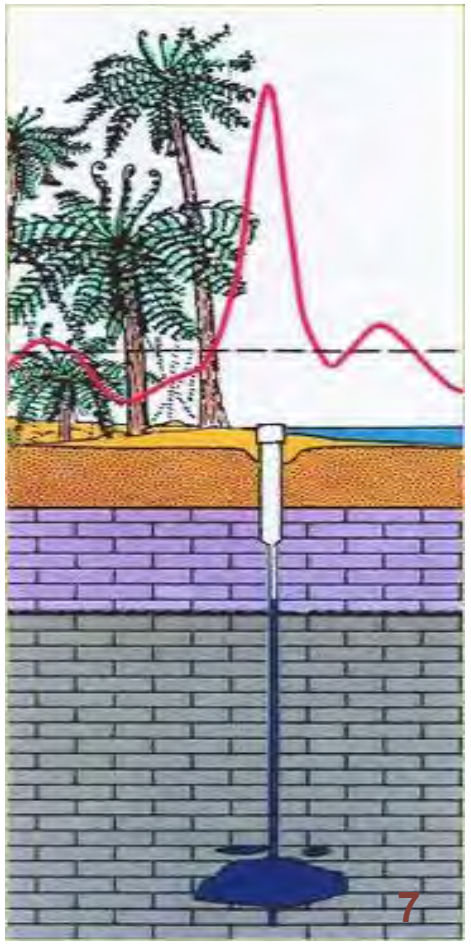
N S

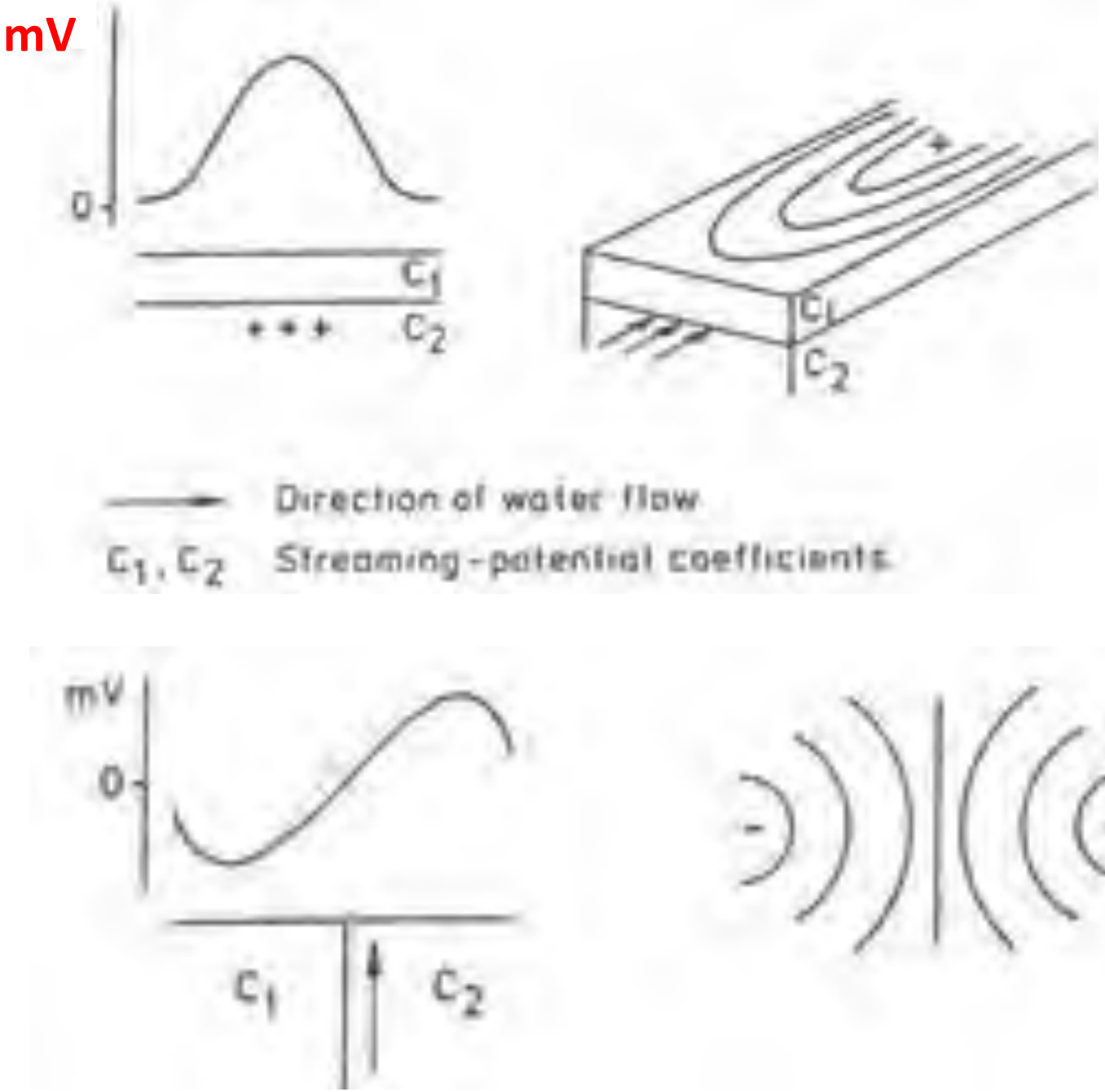




Natural-Potential Method (NP)

- Utilizes the earth's natural-electric field at the ground surface to detect and map groundwater pathways and geologic features, such as faults, fractures, conduits, caves
  - Movement of water
  - Target: Seepage, Voids



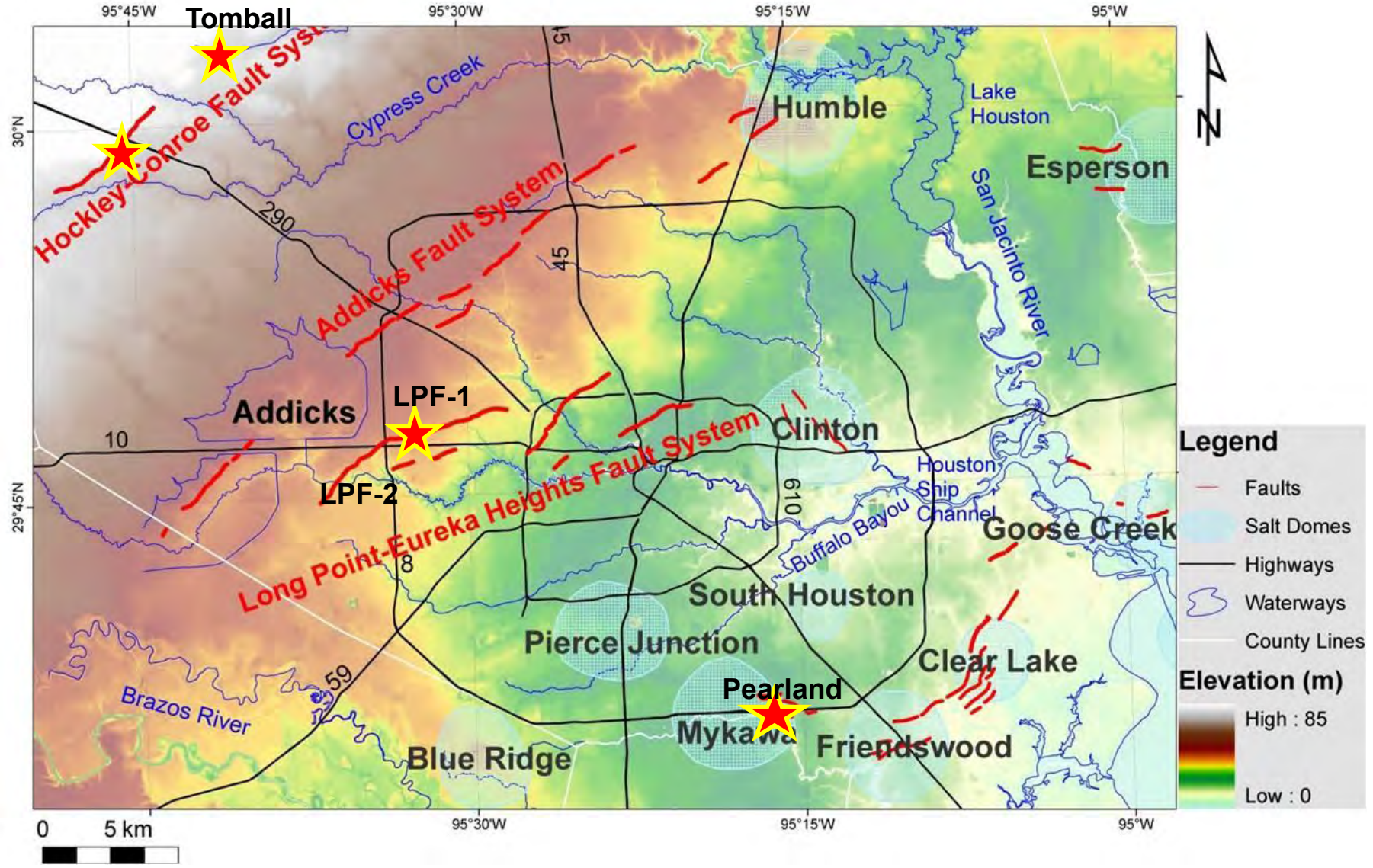

mV
0
C1
C2
+ + +
C1
C2
Direction of water flow
C1, C2 Streaming-potential coefficients
mV
0
C1
C2
-
+

Natural-Potential Method (NP), cont.

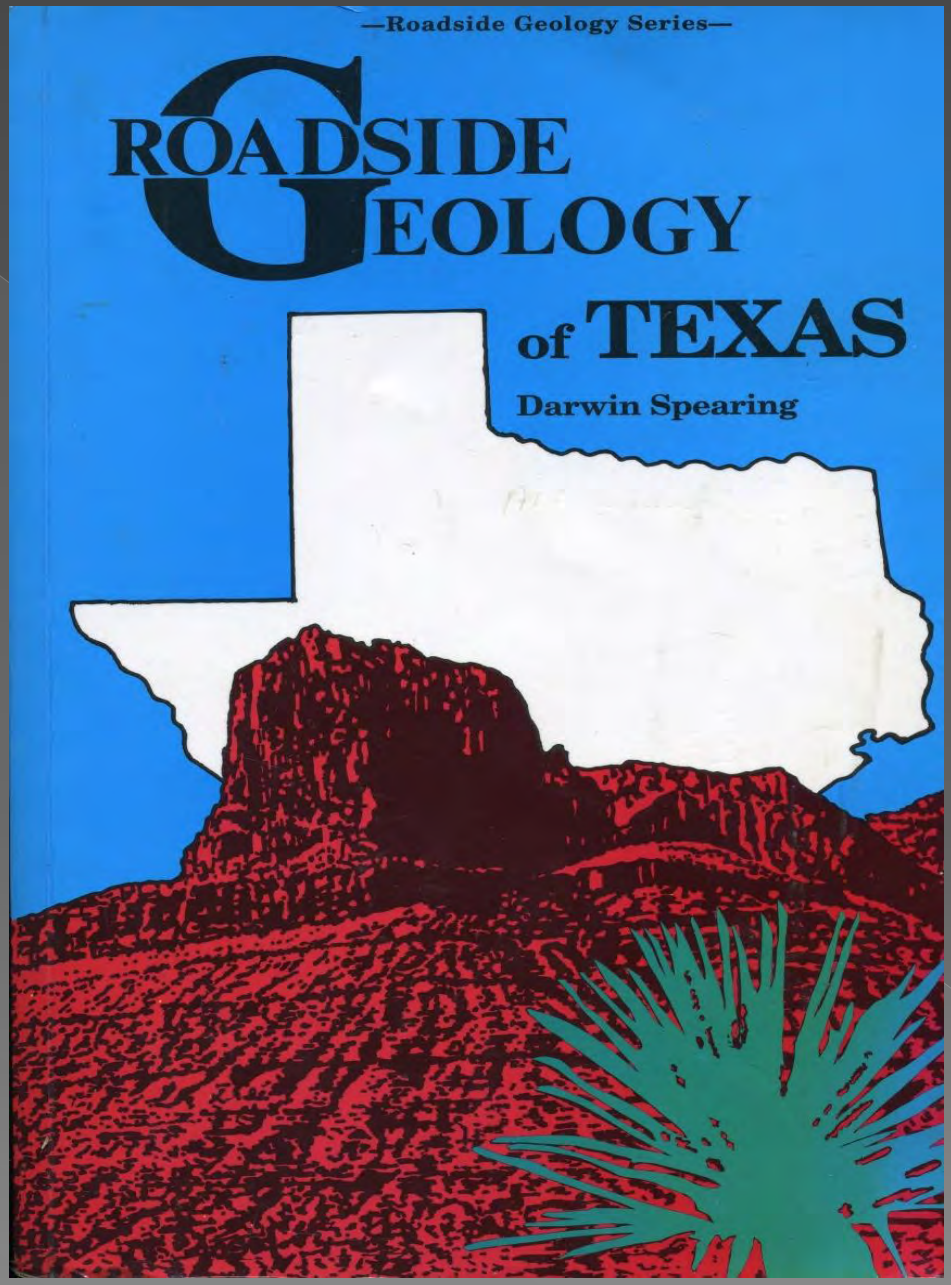
Long-Line Method

Gradient method

How GPR Does Work?



Lidar elevation map showing major Houston Faults


—Roadside Geology Series—
ROADSIDE GEOLOGY of TEXAS
Darwin Spearing

A schematic cross-section of a growth fault

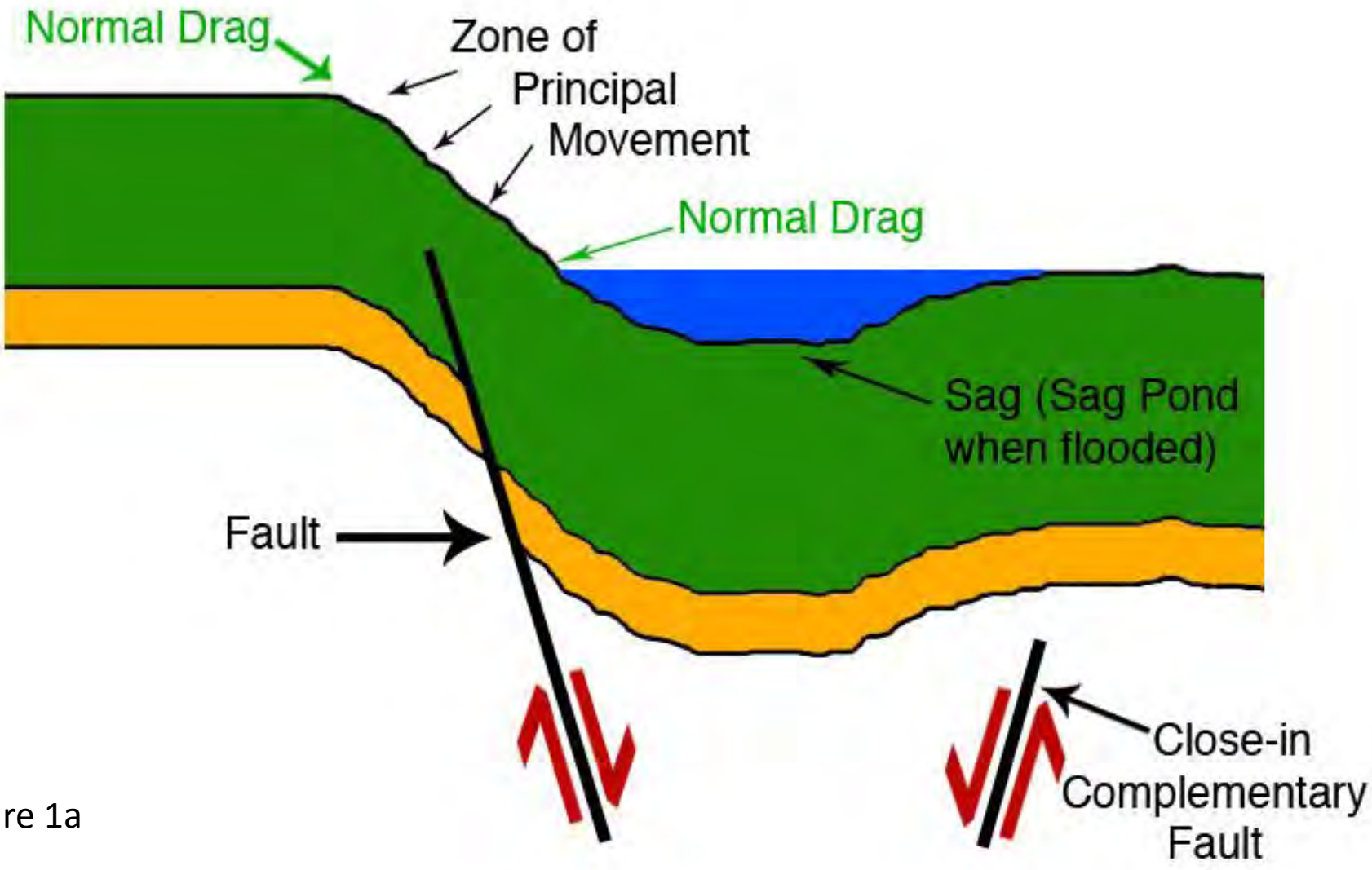
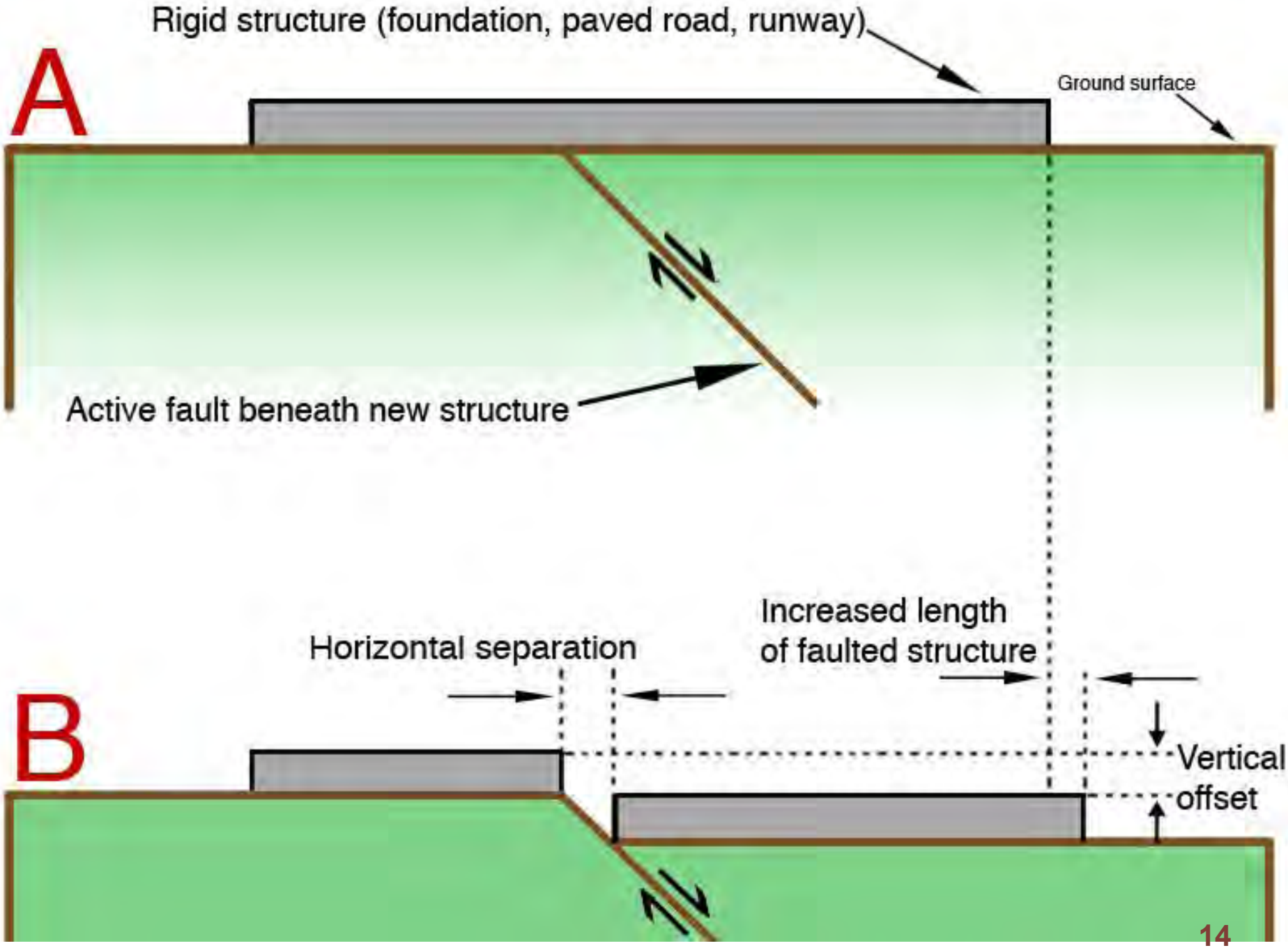
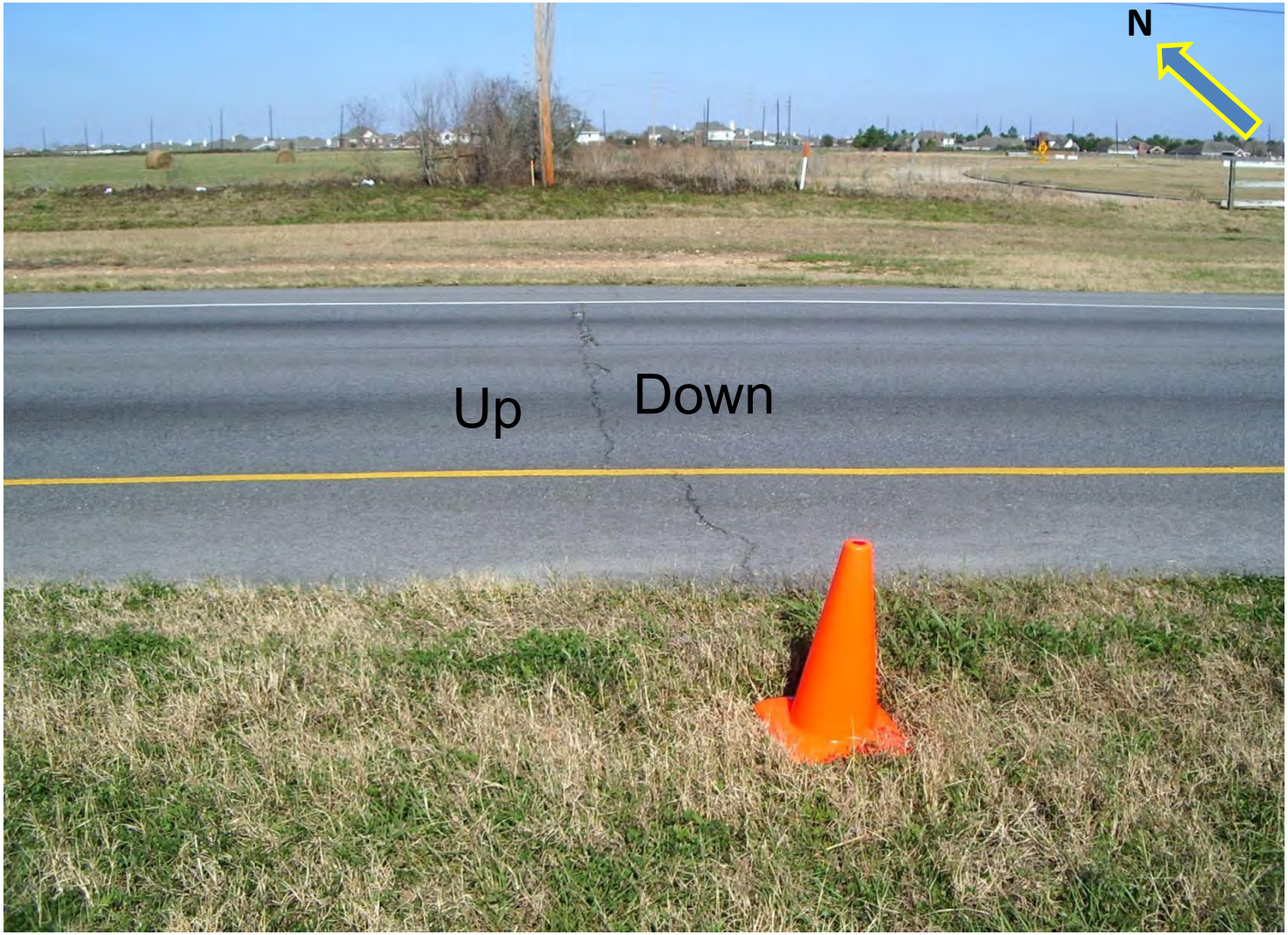


Figure 1a

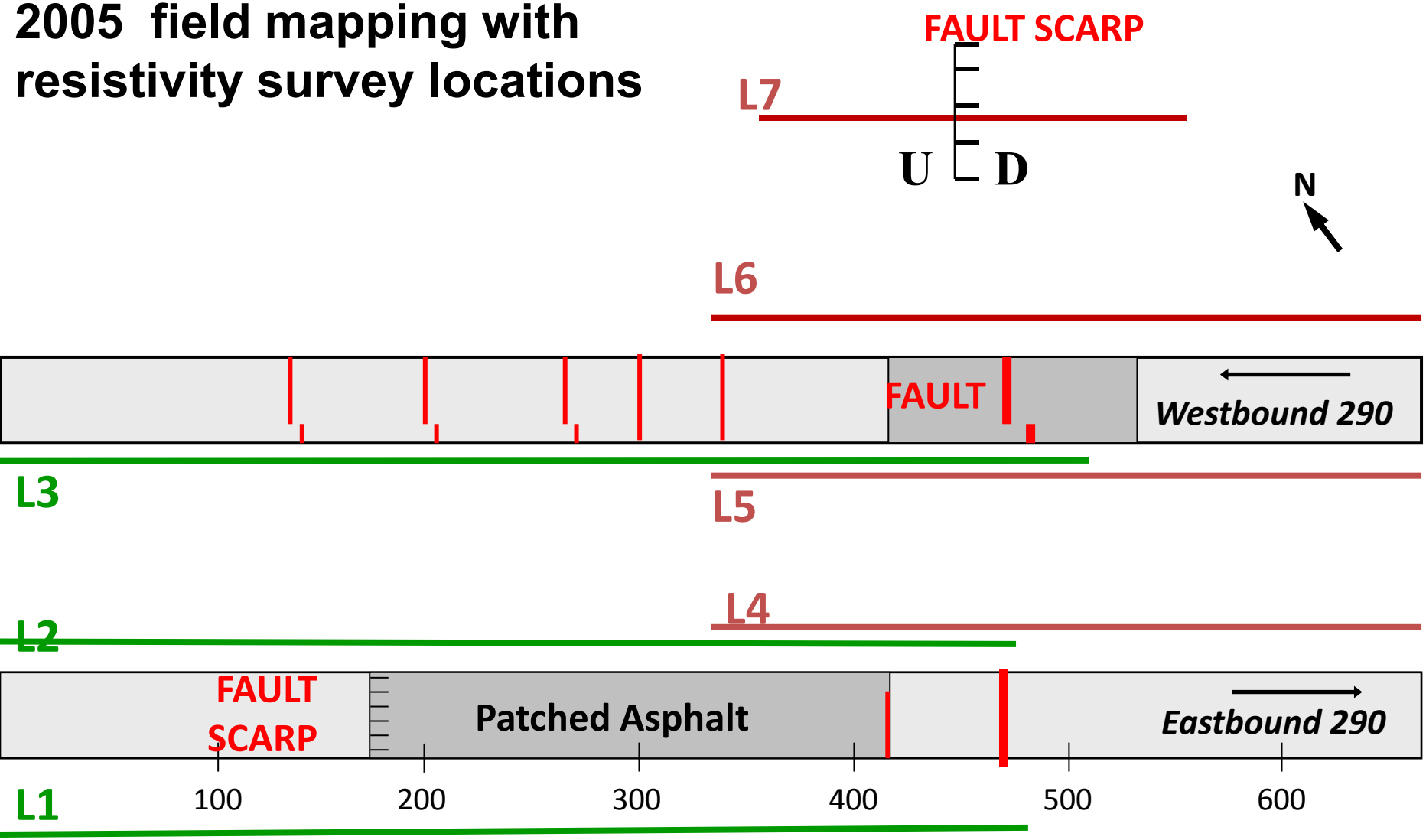

Rigid structure (foundation, paved road, runway)
Ground surface
A
Active fault beneath new structure
Increased length
of faulted structure
Horizontal separation
B
Vertical
offset

MAIN HOCKLEY FAULT AT HWY. 290

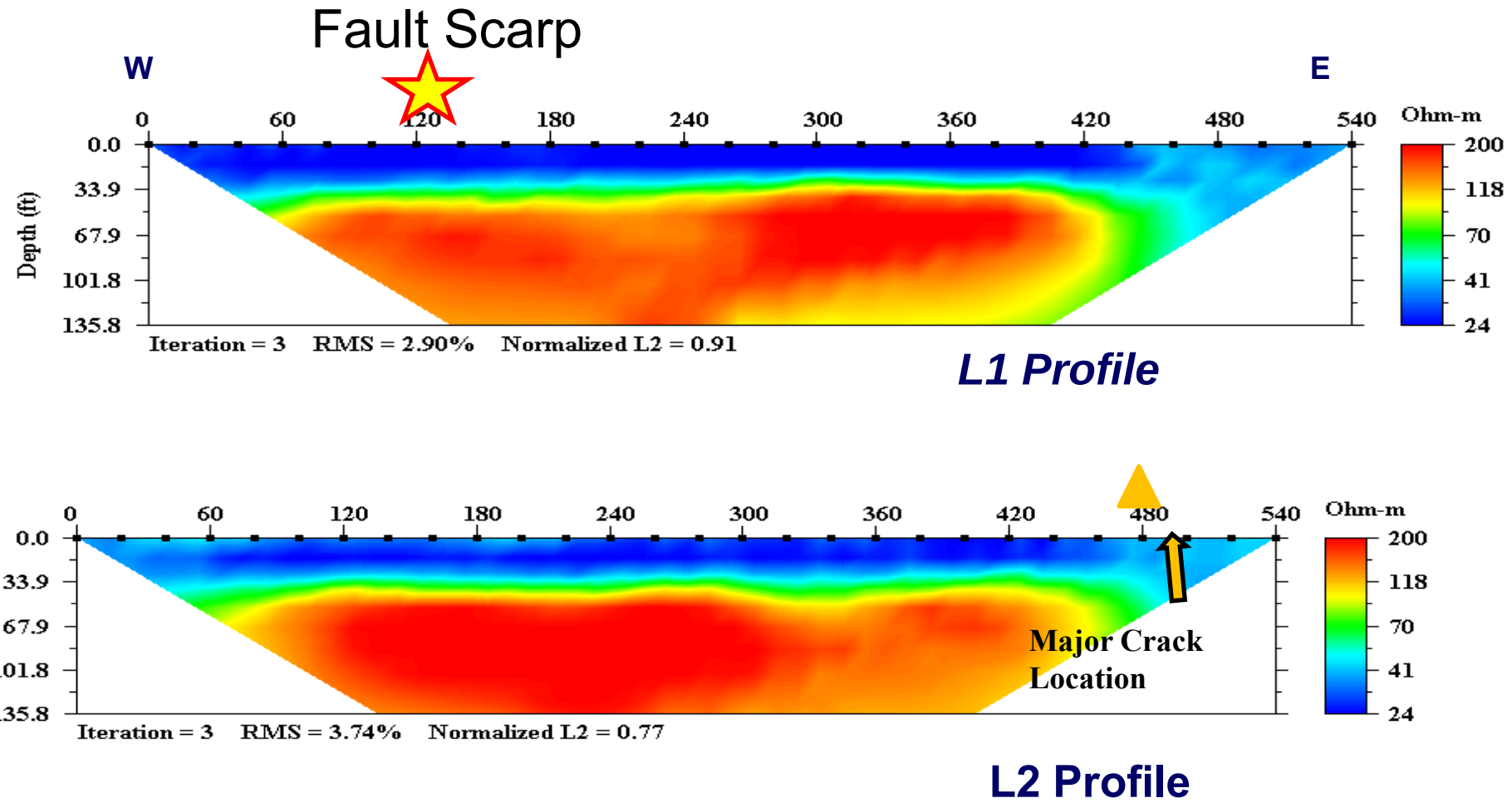



Shopping Mall
being built
UP
Down
L1
Highway 290-East Bound

2005 field mapping with resistivity survey locations

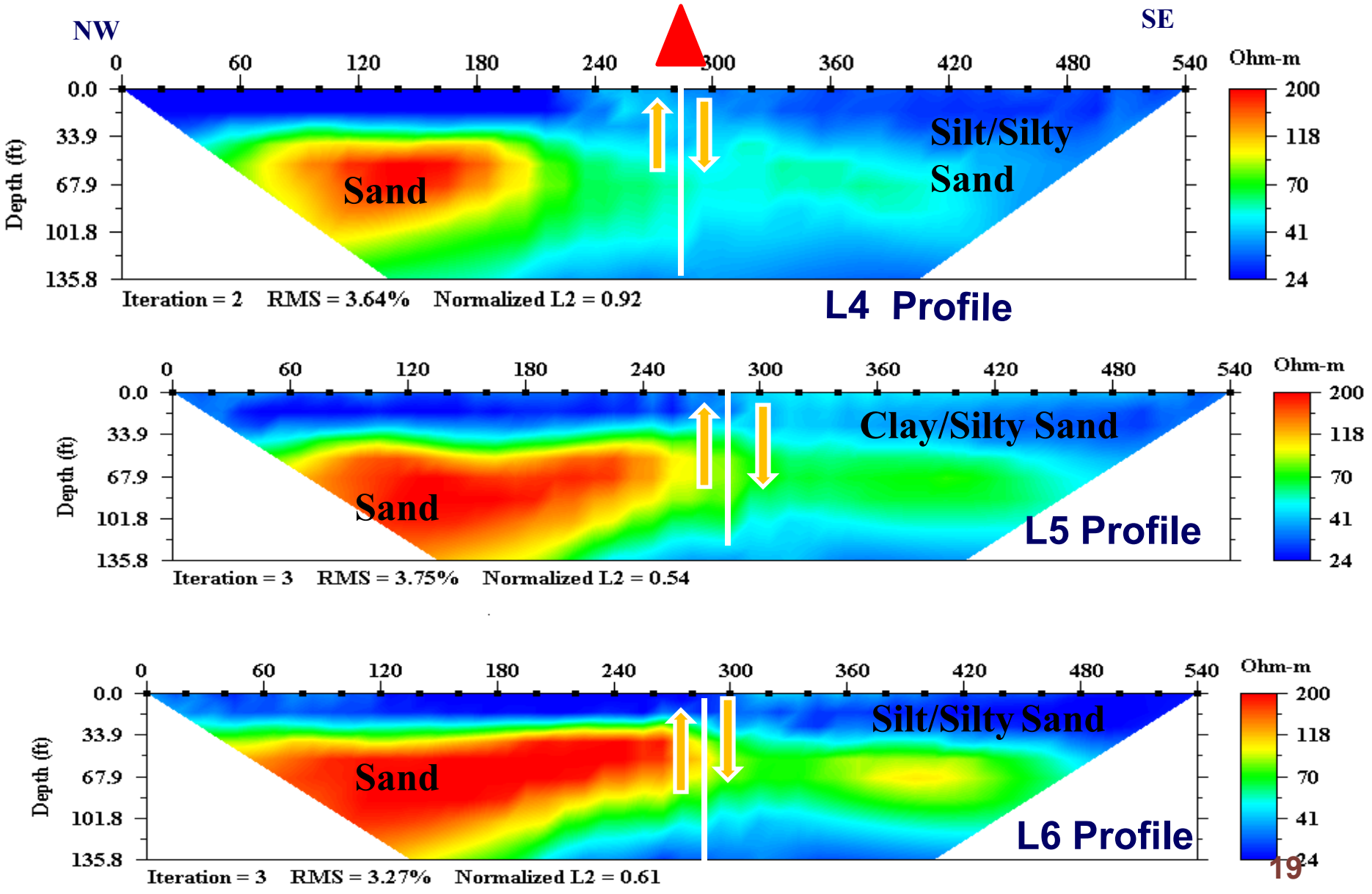


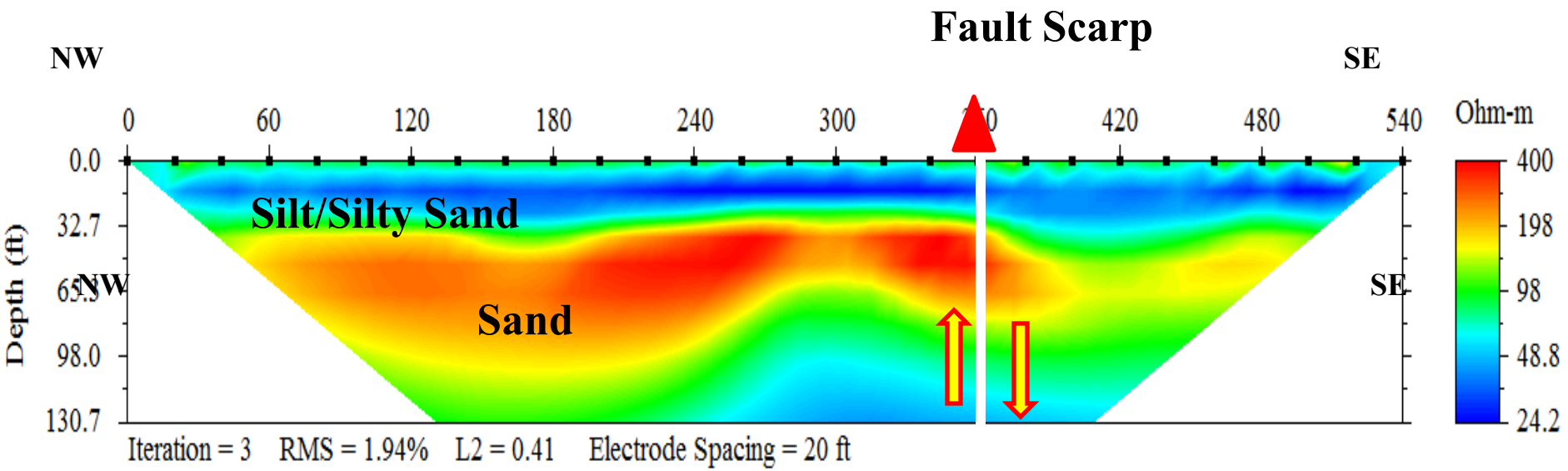
(A GPR profile is taken along Line 1)



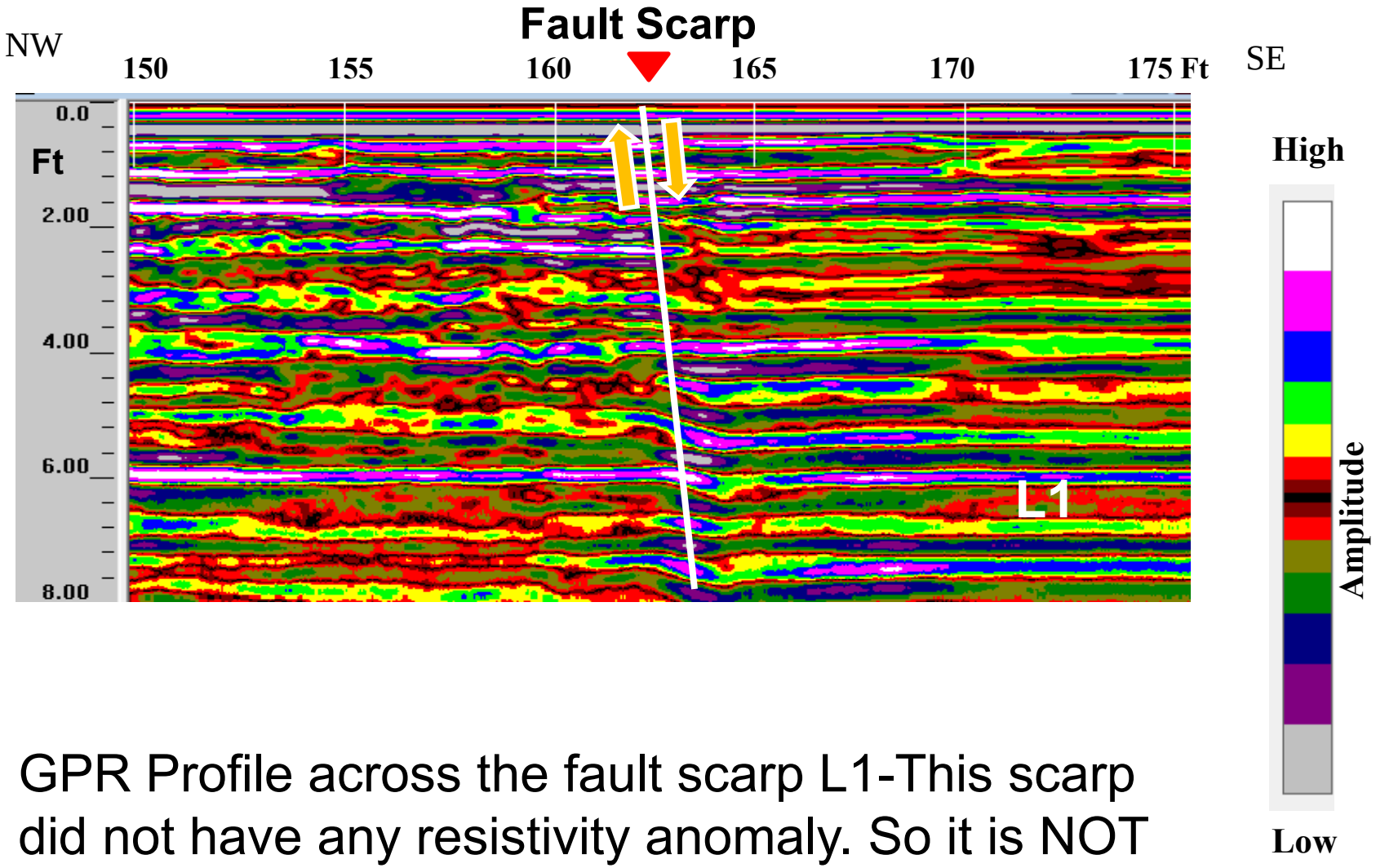
Resistivity profiles at Hockley Fault

Resistivity Profiles Across the Main Hockley Fault

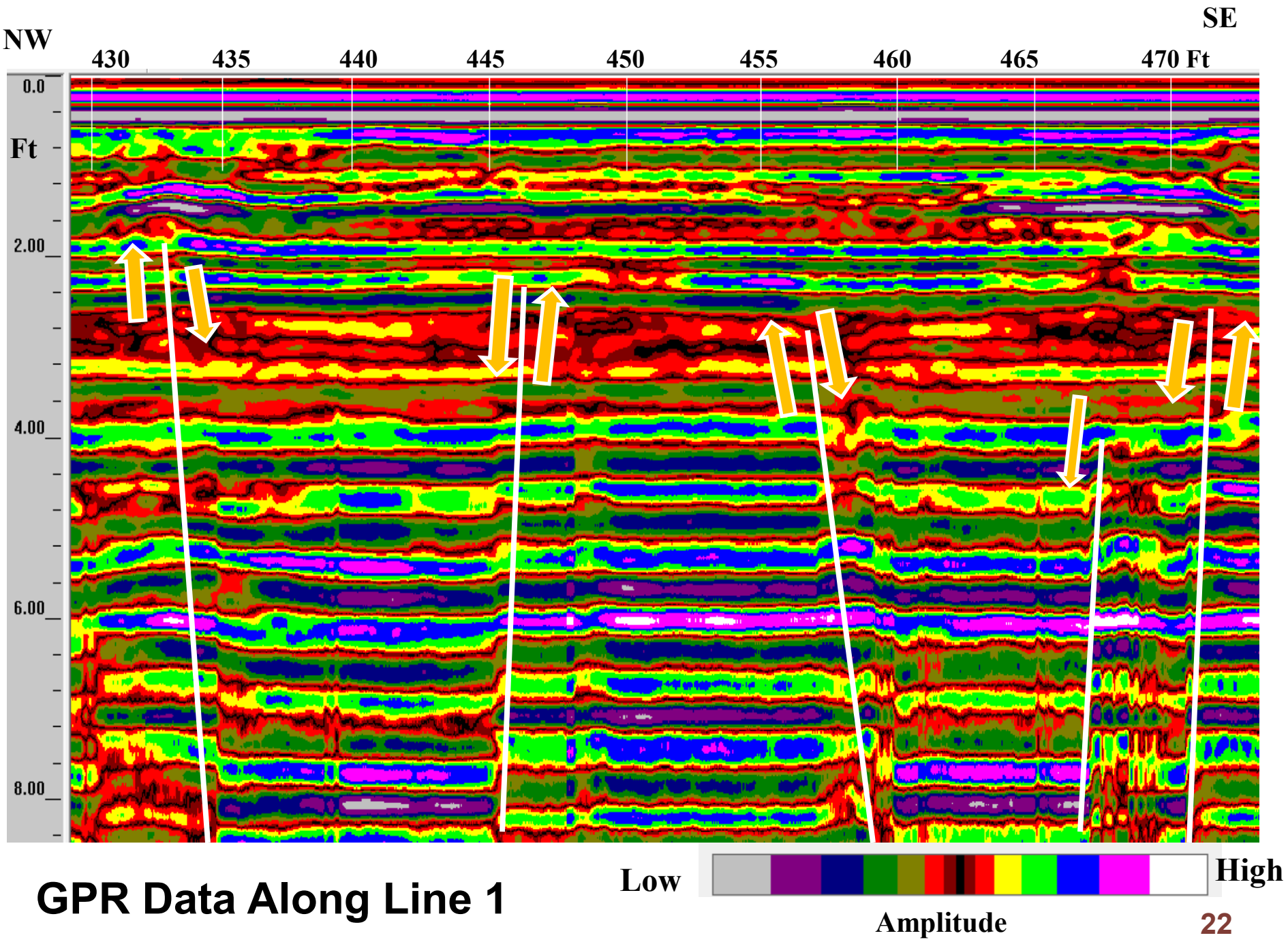




Resistivity profile across the Main Hockley Fault



GPR Profile across the fault scarp L1-This scarp did not have any resistivity anomaly. So it is NOT considered the main Hockley fault.



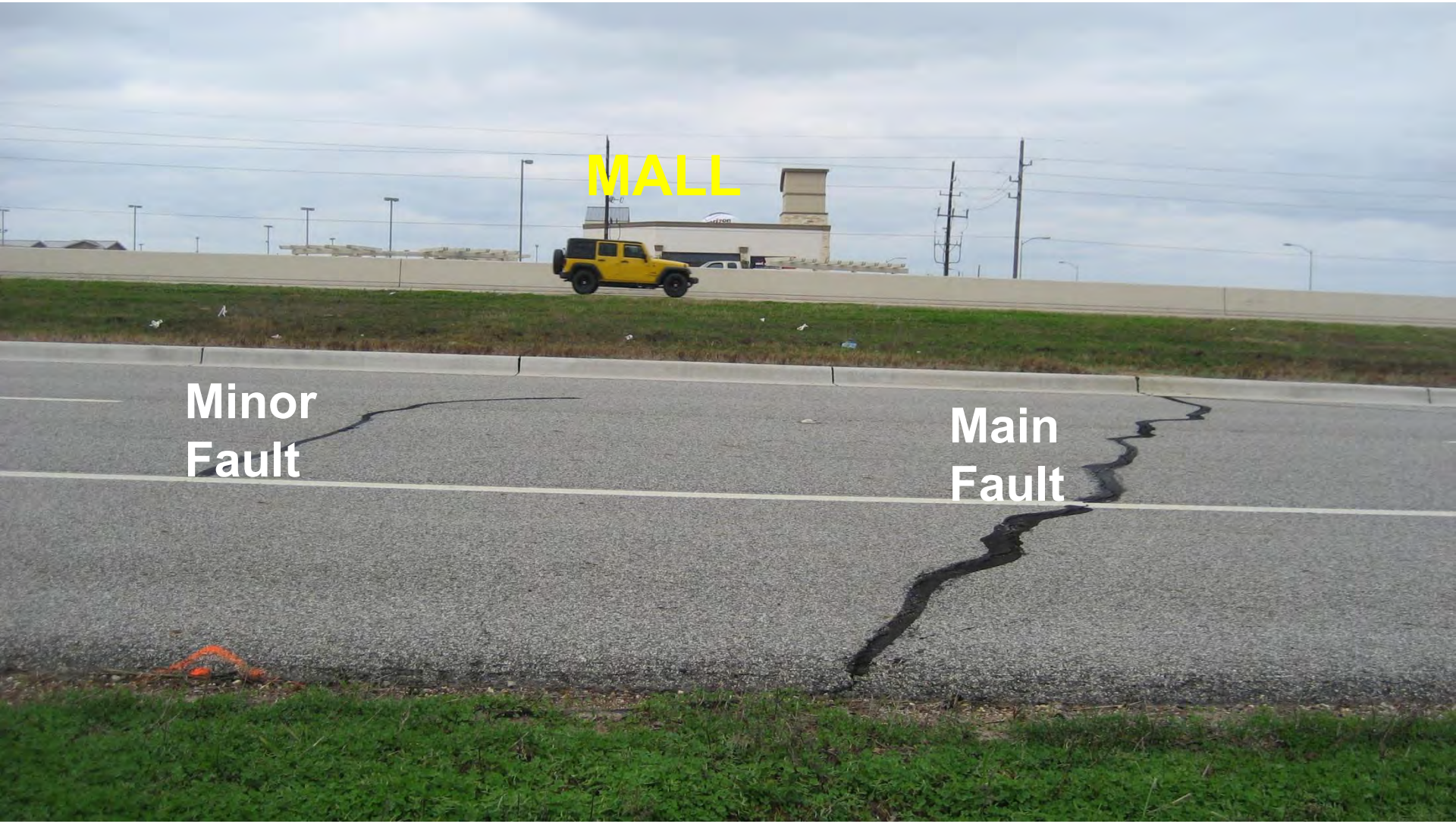
GPR Data Along Line 1

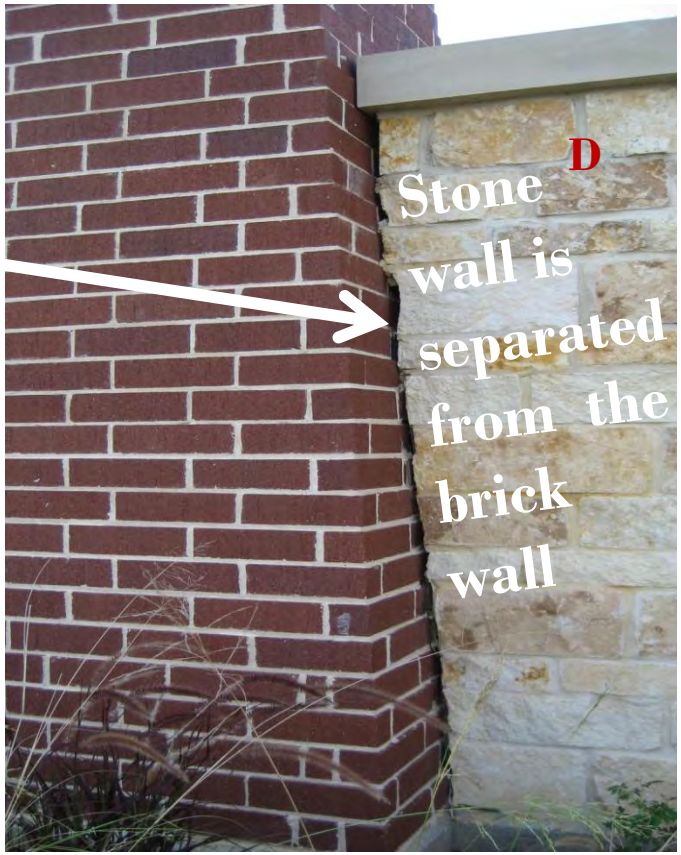
Location of Hockley fault determined by resistivity surveys

Location of Fault Zone based on geophysics results

POSTSCRIPT TO GEOPHYSICAL SURVEYS

Main Hockley Fault and its minor fault along east feeder

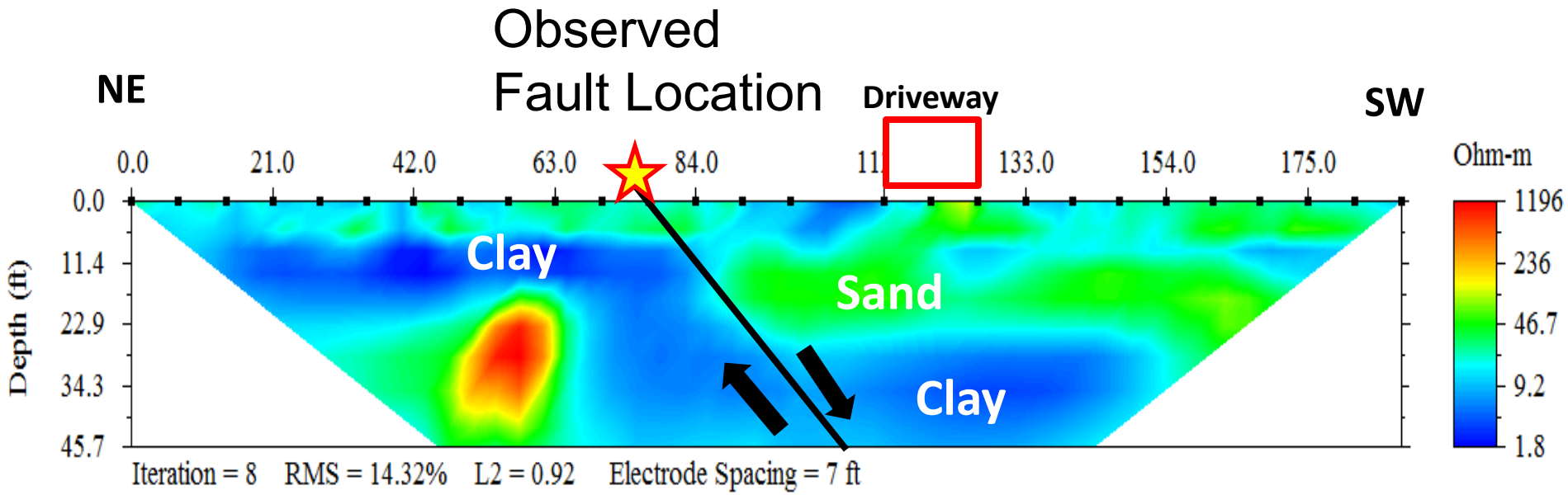




Minor faults immediately to the west of the main fault along the wet feeder

If you follow the main fault on the road towards the newly built building you will see the crack at the corner of the building!

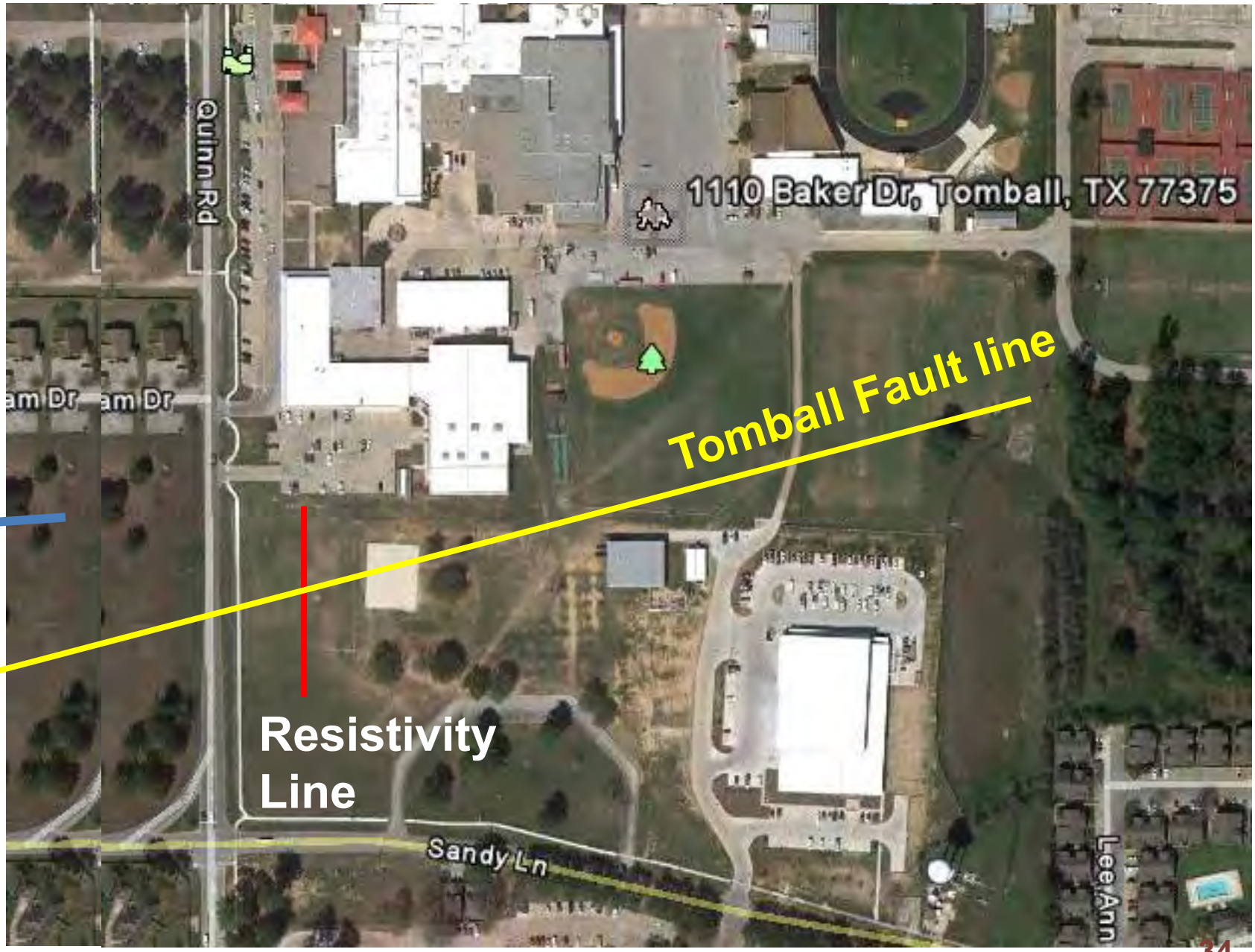
LONG POINT FAULT AT
MOOREHEAD STREET



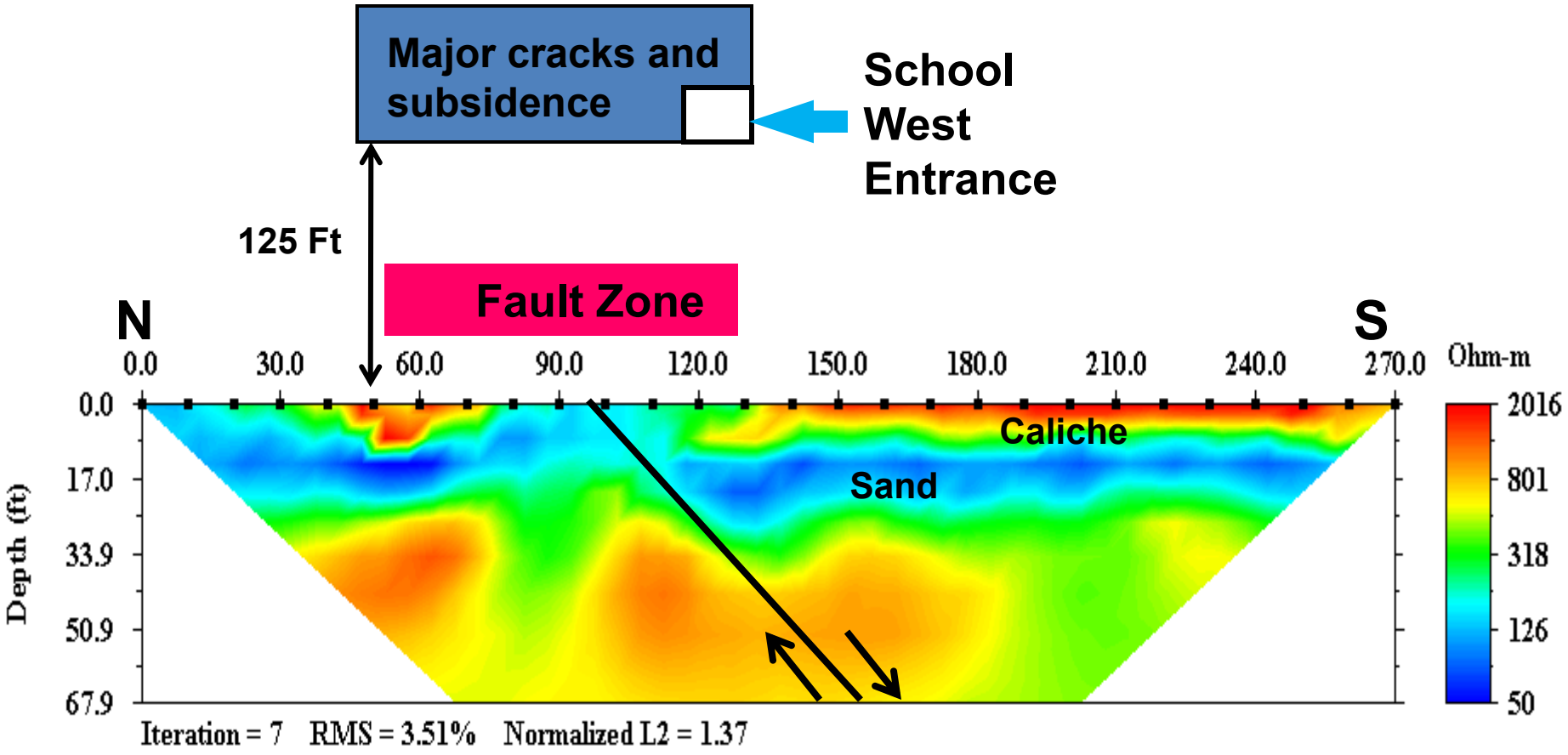
Resistivity imaging section across the LPF.


UP
Down
14 11:59AM

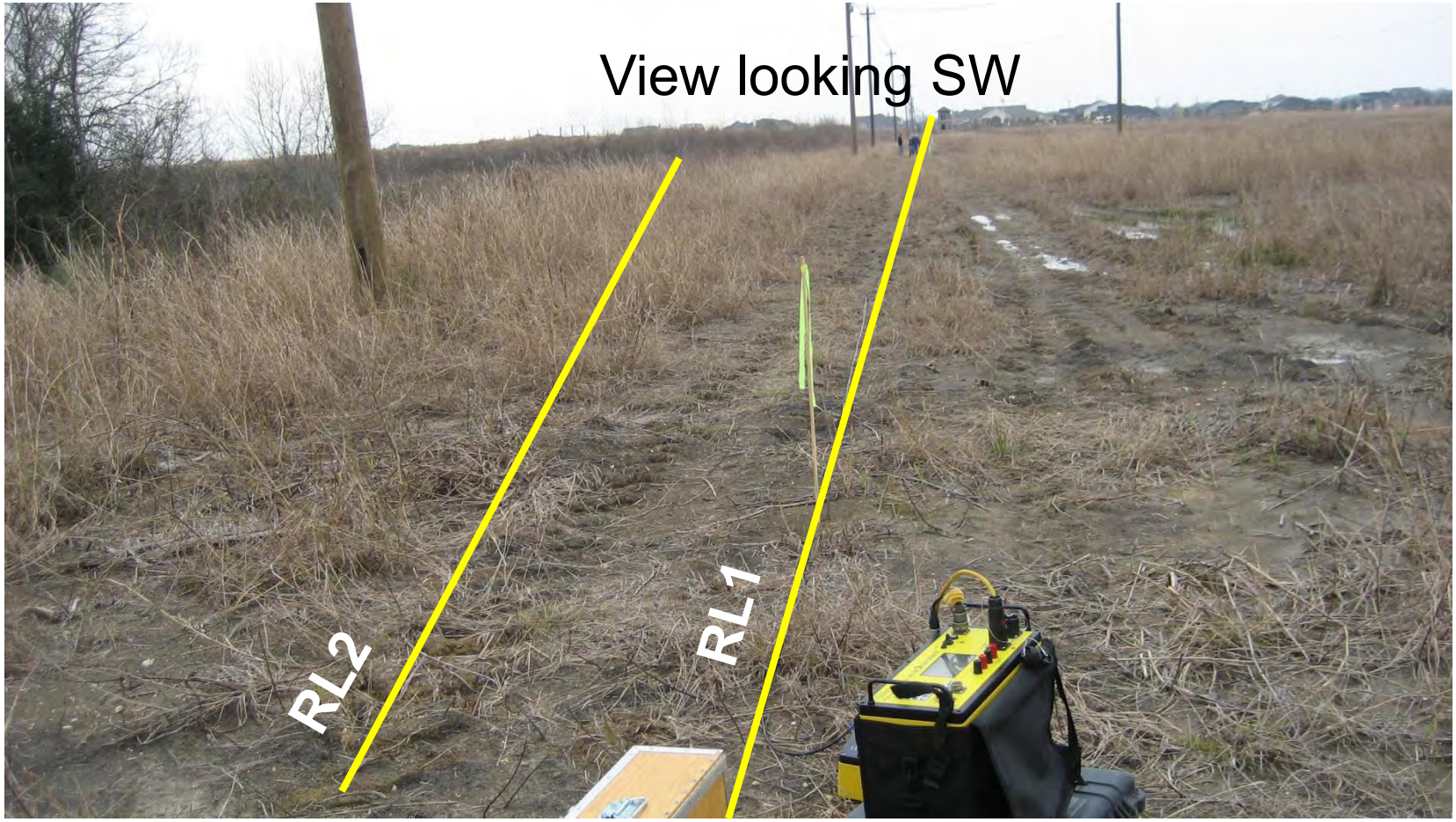
A mansion is being built few houses west of Long Point Fault!


1110 Baker Dr, Tomball, TX 77375
Quinn Rd
Tomball Fault line
Resistivity Line
Sandy Ln
LeeAnn
HWY. 249

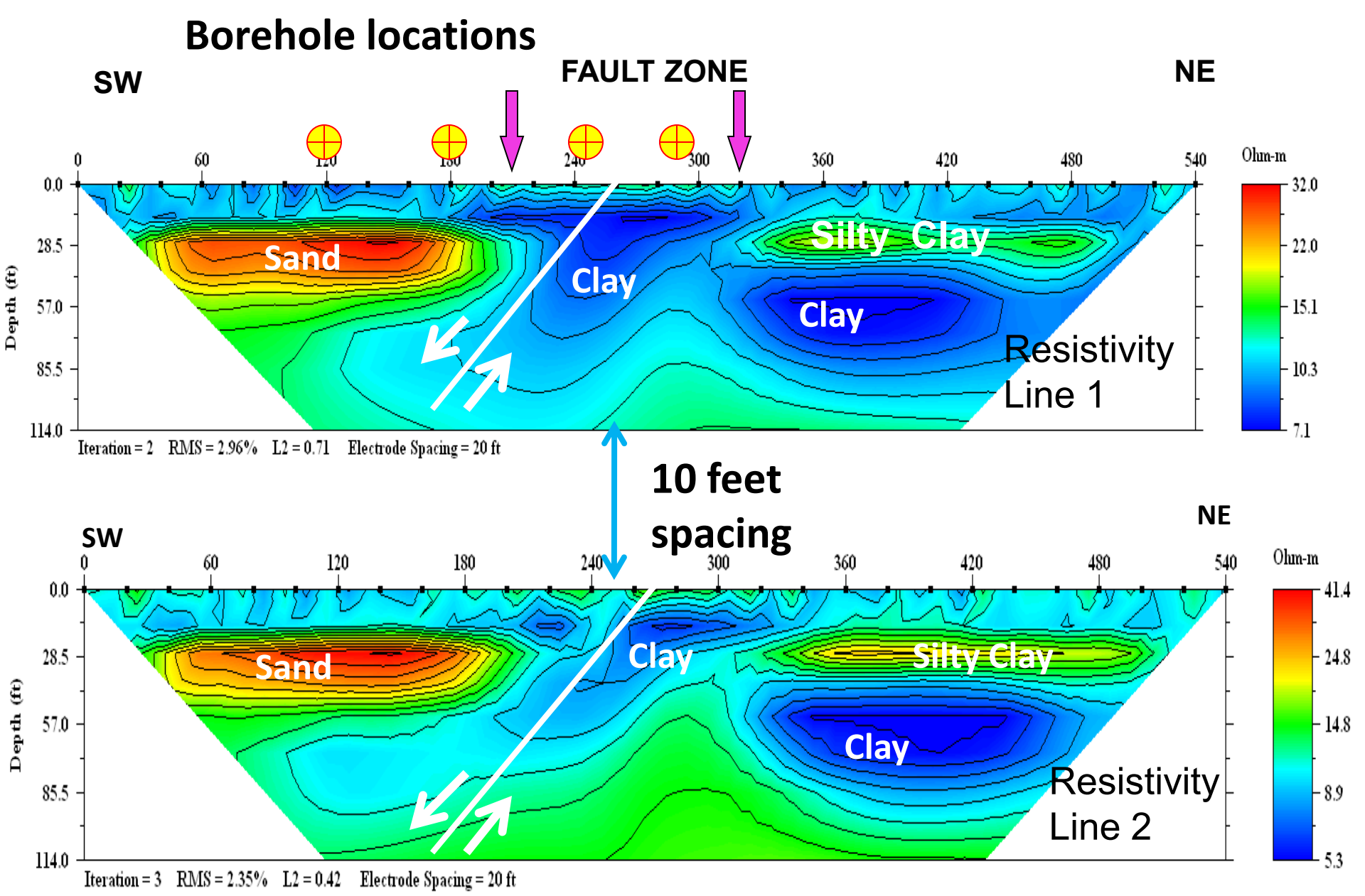
A View of Tomball Fault at Demolished Beckondorf Middle School-View to East



Resistivity imaging data across the Tomball Fault

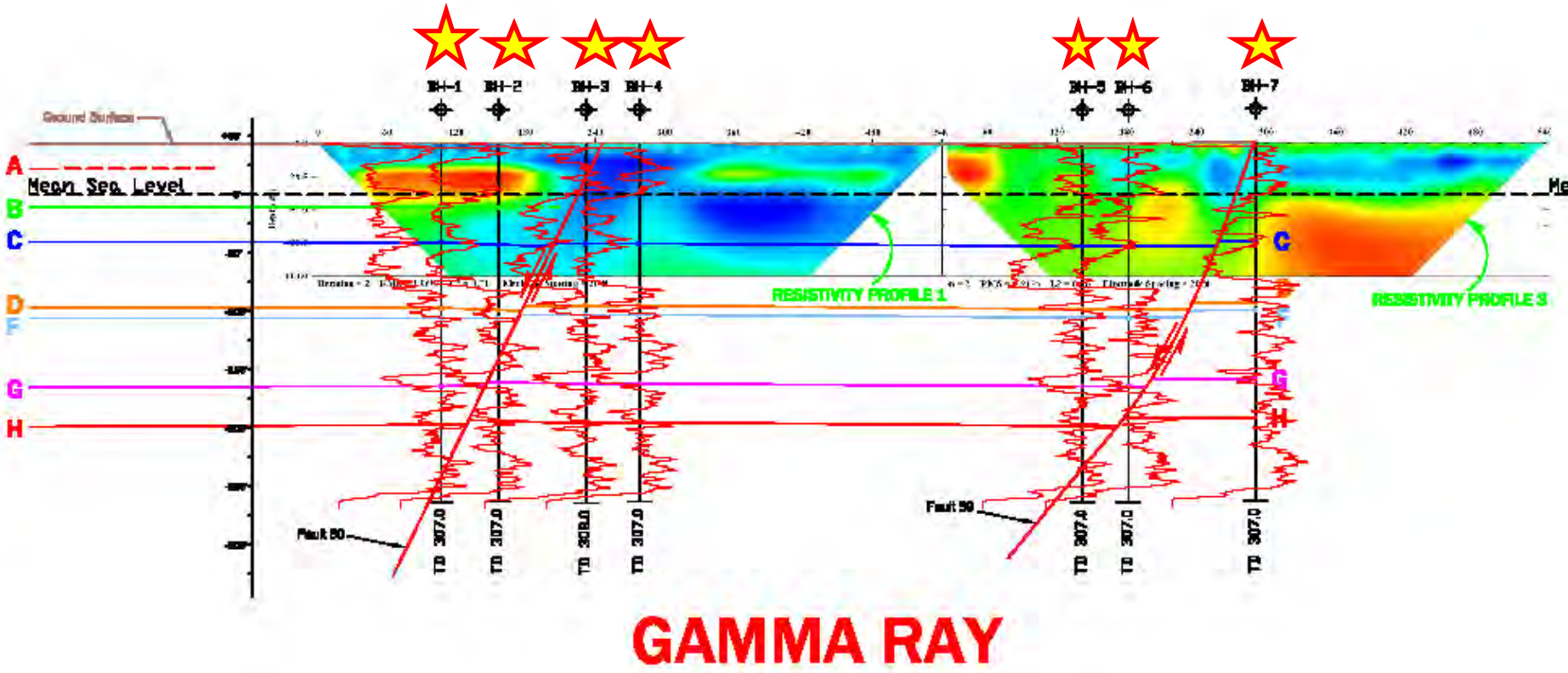


A BLIND TEST OF RESISTIVITY SURVEY OVER PEARLAND FAULT IN SE OF HOUSTON

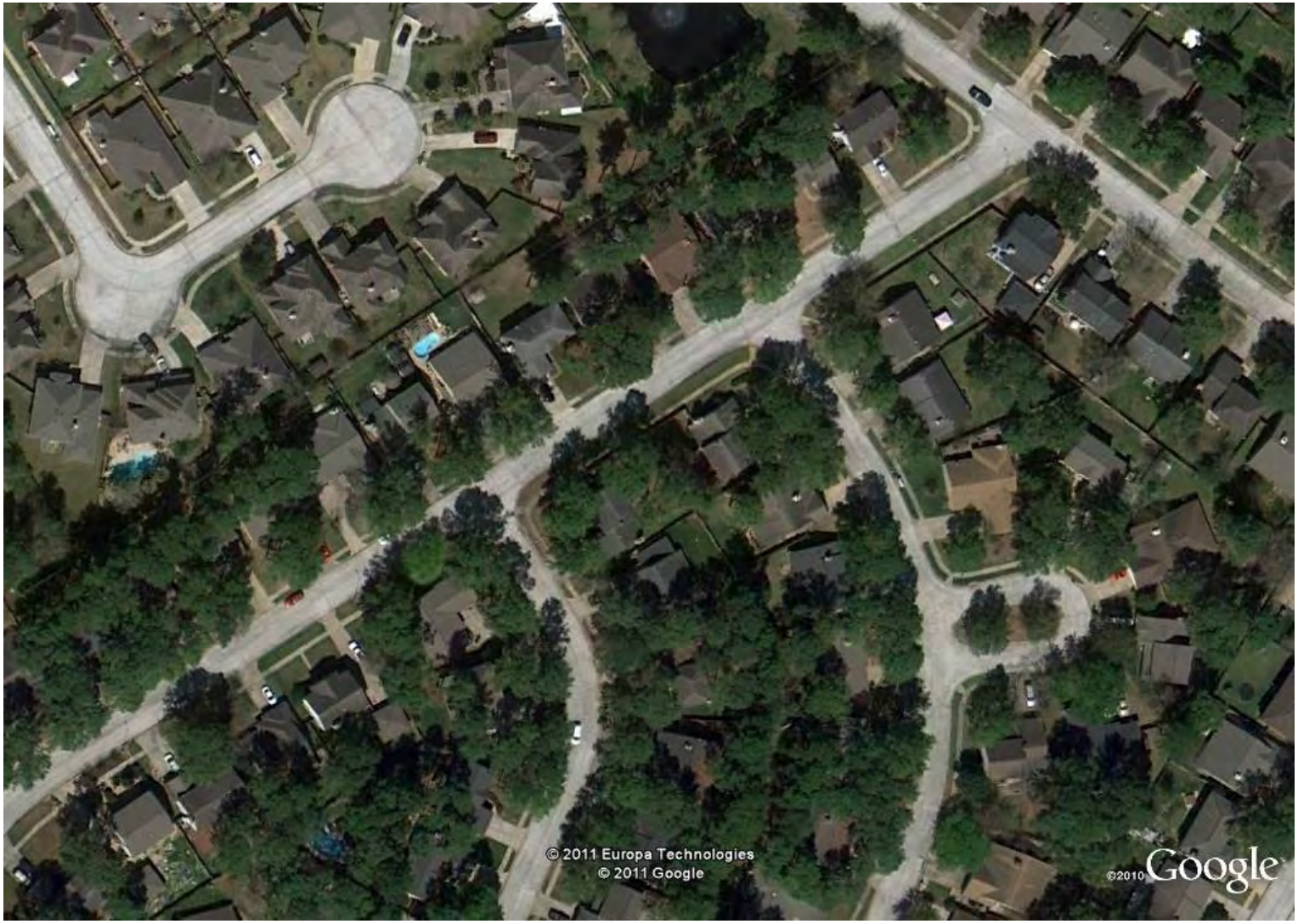


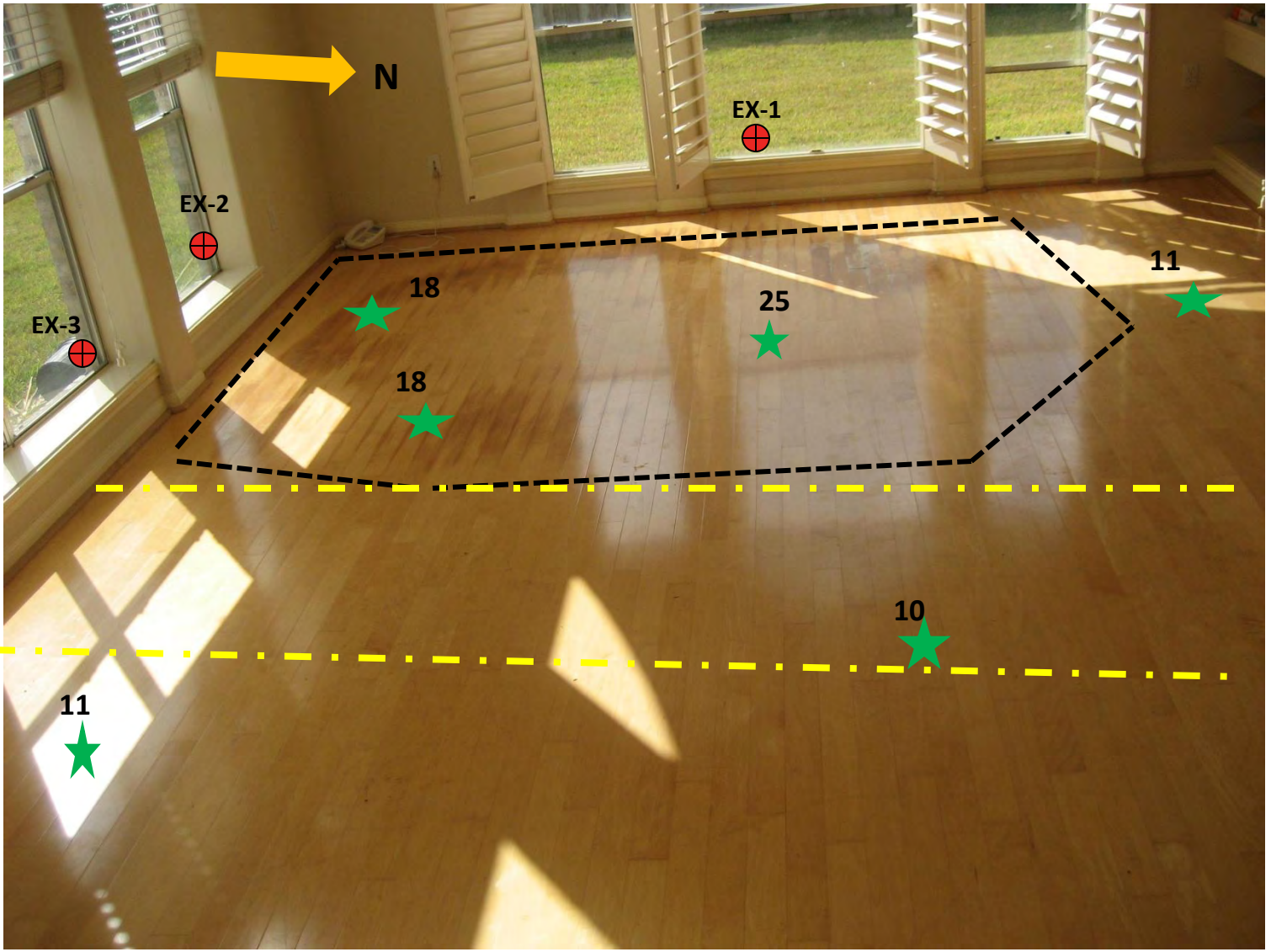
Resistivity imaging data across Pearland Fault

Gamma Ray data overlaid on the resistivity profiles

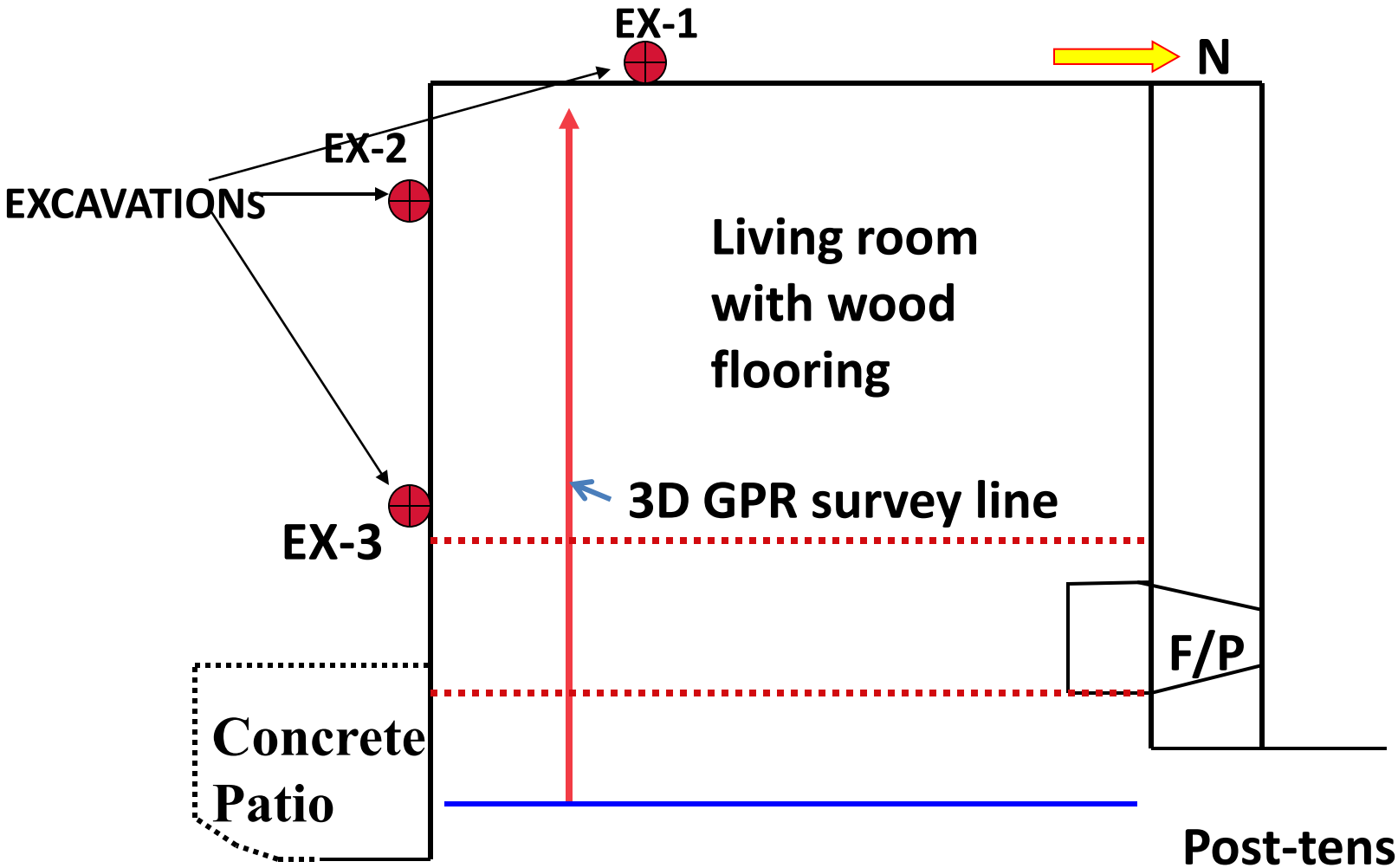


Foundation problems explored via GPR in one of these houses in Spring, Texas



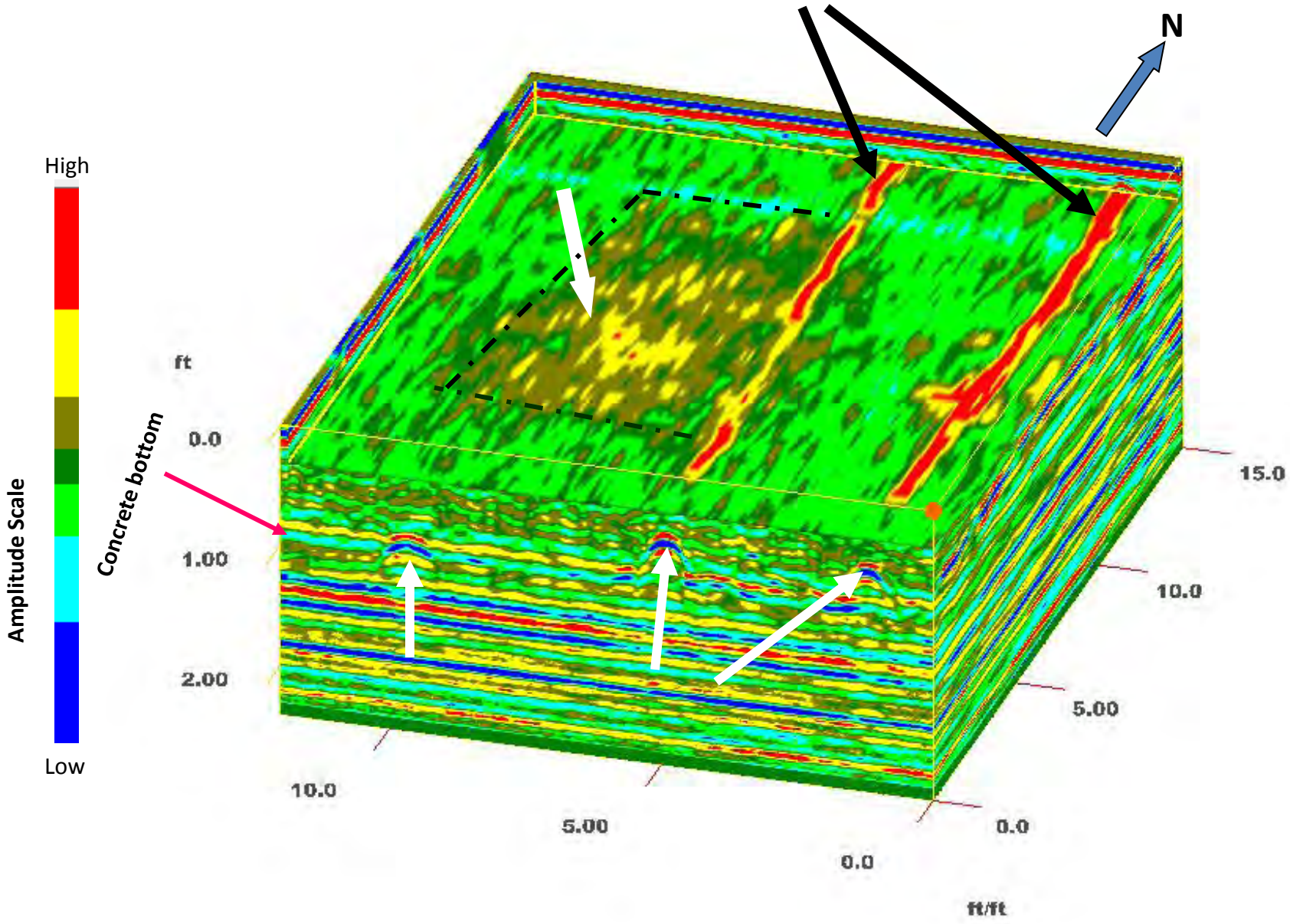


Decayed wood floor in the living room!



GPR SURVEY DESIGN

GPR survey with 1500 MHz antenna



3D GPR DATA FROM 1500 MHz ANTENNA

GPR SURVEY CART WITH 400 MHz Antenna

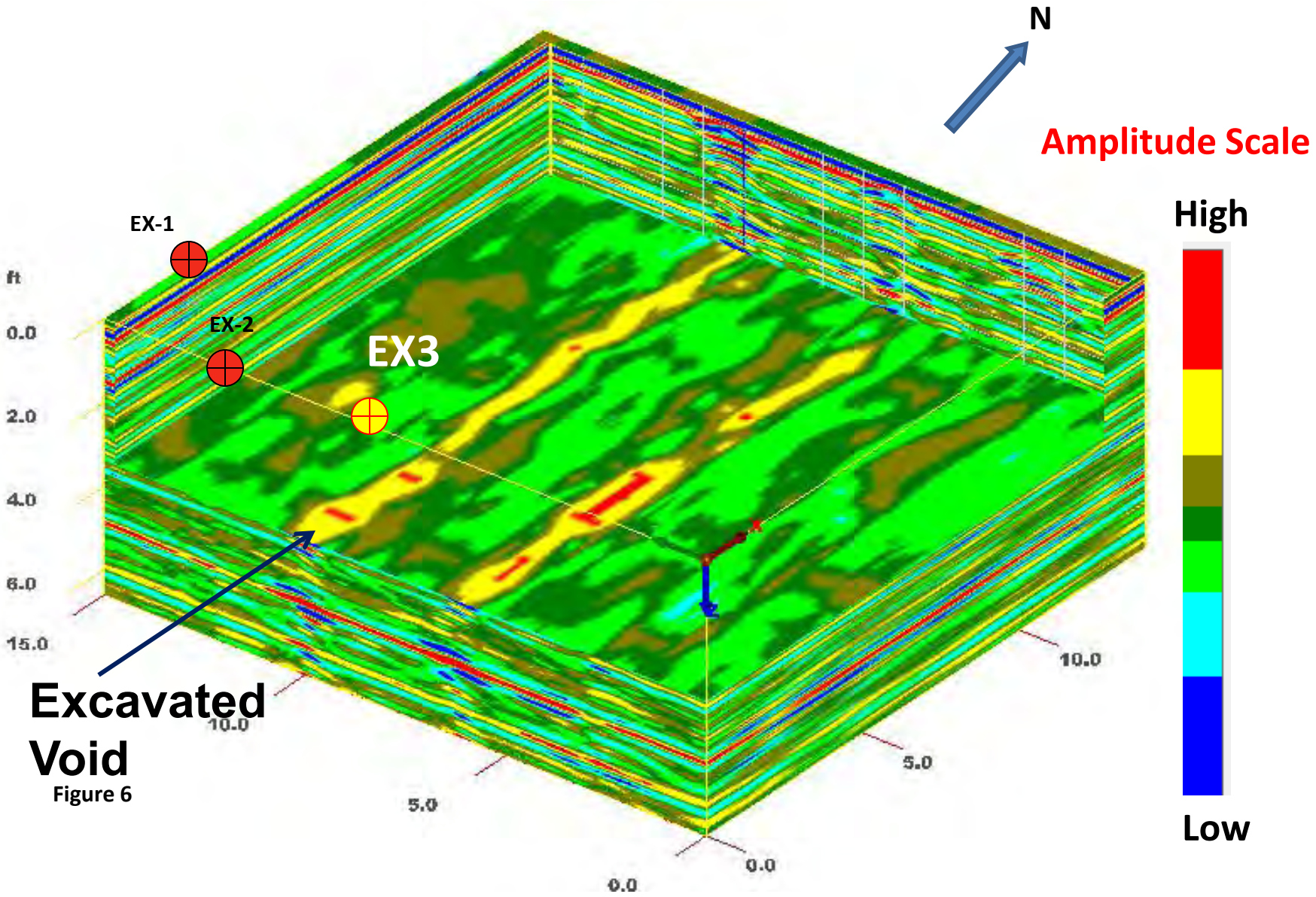
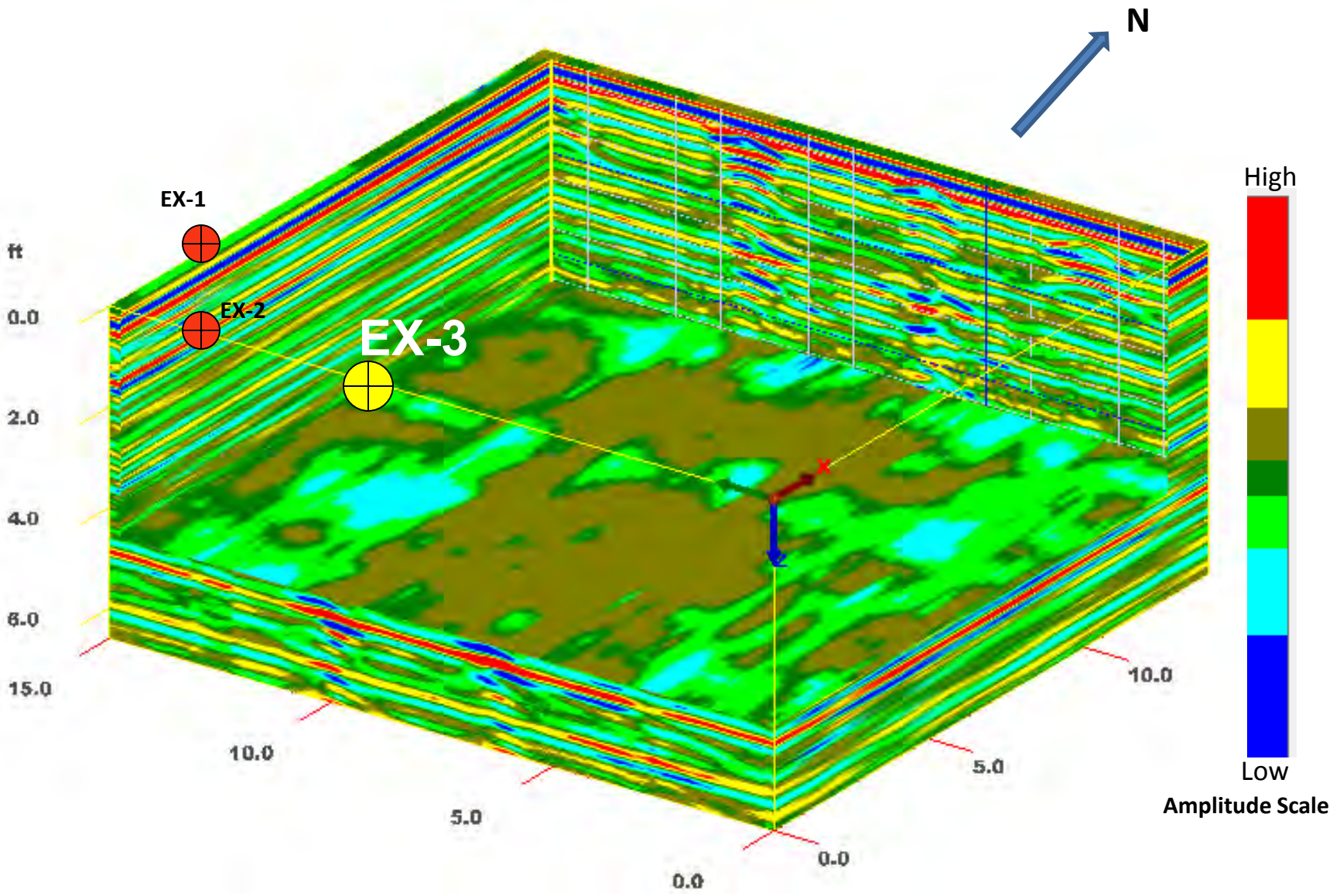


Figure 6

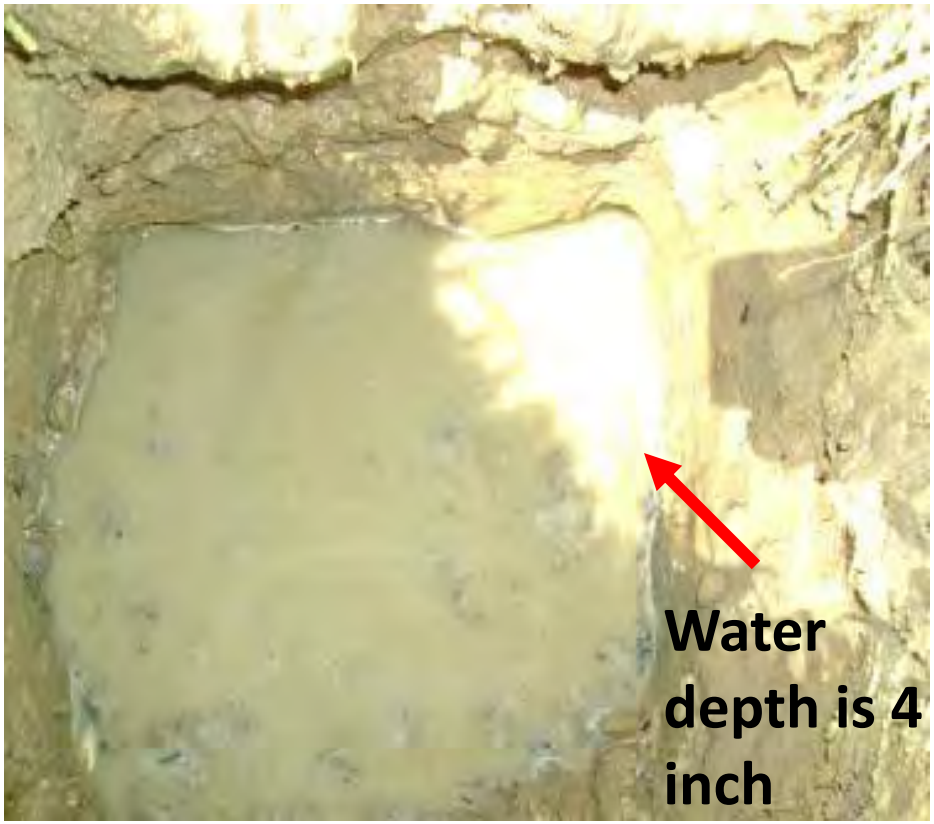
3D GPR DATA for 400 MHz Antenna: 3 ft depth slice



3D GPR Data for antenna 400 MHz: 5 Ft depth slice


EX-3 Void

October 8, 2008

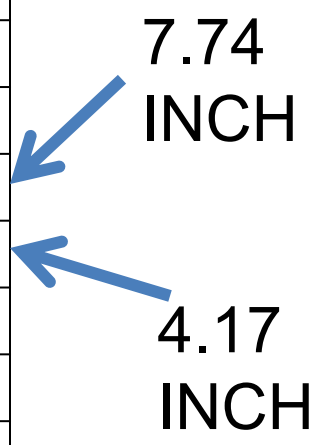


October 28, 2008

Excavated void location based on the GPR data

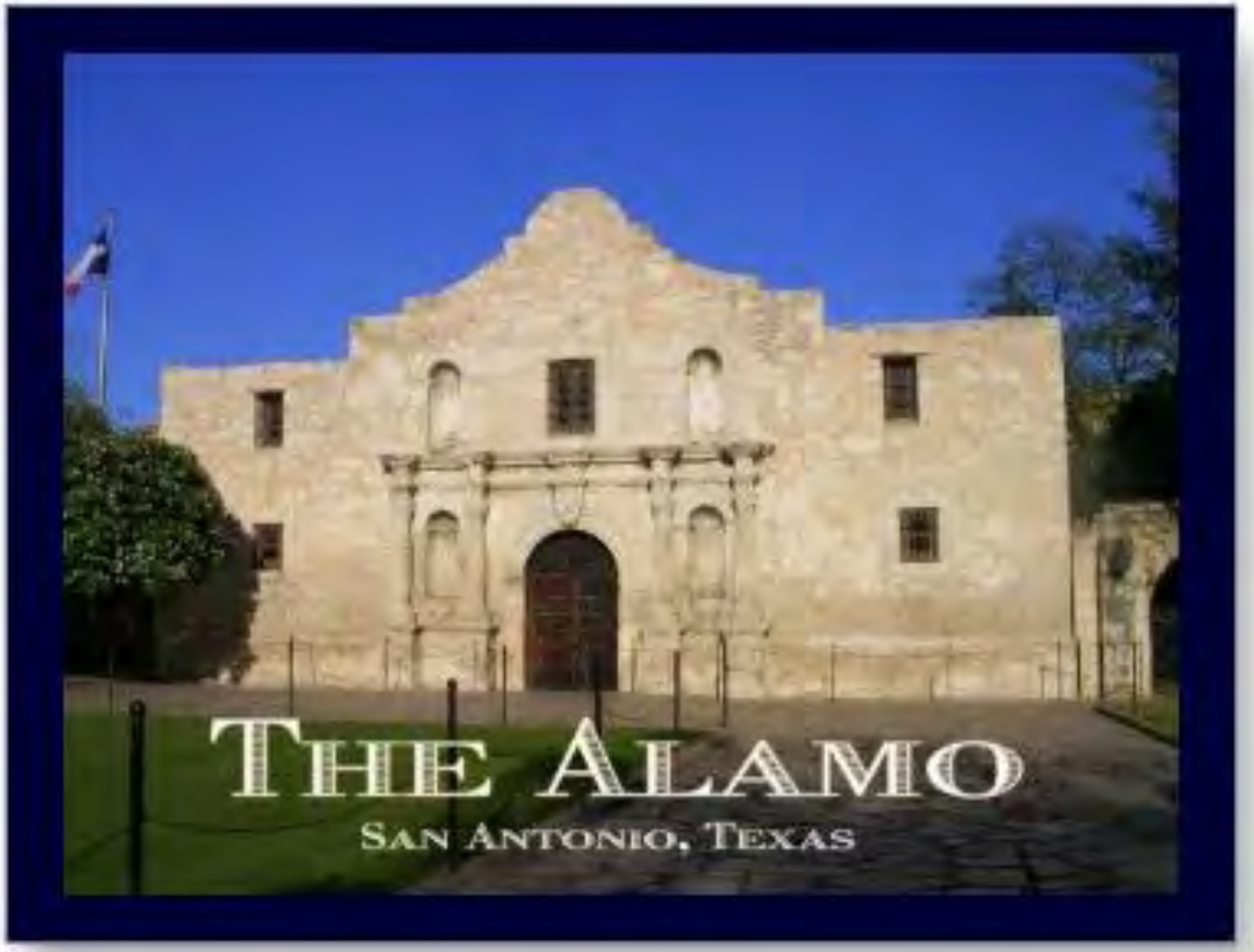
2008 Annual Precipitation at Northwest Houston.

Houston: Bush Intercontinental Airport				
	Average Temp	**Departure**	**Precipitation**	**Departure**
January	**52.2°**	**+0.4°**	**4.62"**	**+0.94"**
February	**60.1°**	**+4.7°**	**4.00"**	**+1.02"**
March	**63.6°**	**+1.3°**	**2.41"**	**-0.95"**
April	**69.4°**	**+0.9°**	**1.46"**	**-2.14"**
May	**77.8°**	**+2.0°**	**4.57"**	**-0.58"**
June	**84.5°**	**+3.2°**	**2.06"**	**-3.29"**
July	**84.9°**	**+1.3°**	**1.09"**	**-2.09"**
August	**84.0°**	**+0.7°**	**7.45"**	**+3.62"**
September	**78.2°**	**-0.7°**	**12.07"**	**+7.74"**
October	**69.5°**	**-0.9°**	**8.67"**	**+4.17"**
November	**62.4°**	**+1.5°**	**2.92"**	**-1.27"**
December	**55.6°**	**+1.9°**	**1.68"**	**-2.01"**
ANNUAL	**71.5°**	**+2.7°**	**53.00"**	**+5.16"**



FRENCH DRAINAGE INSTALLATION

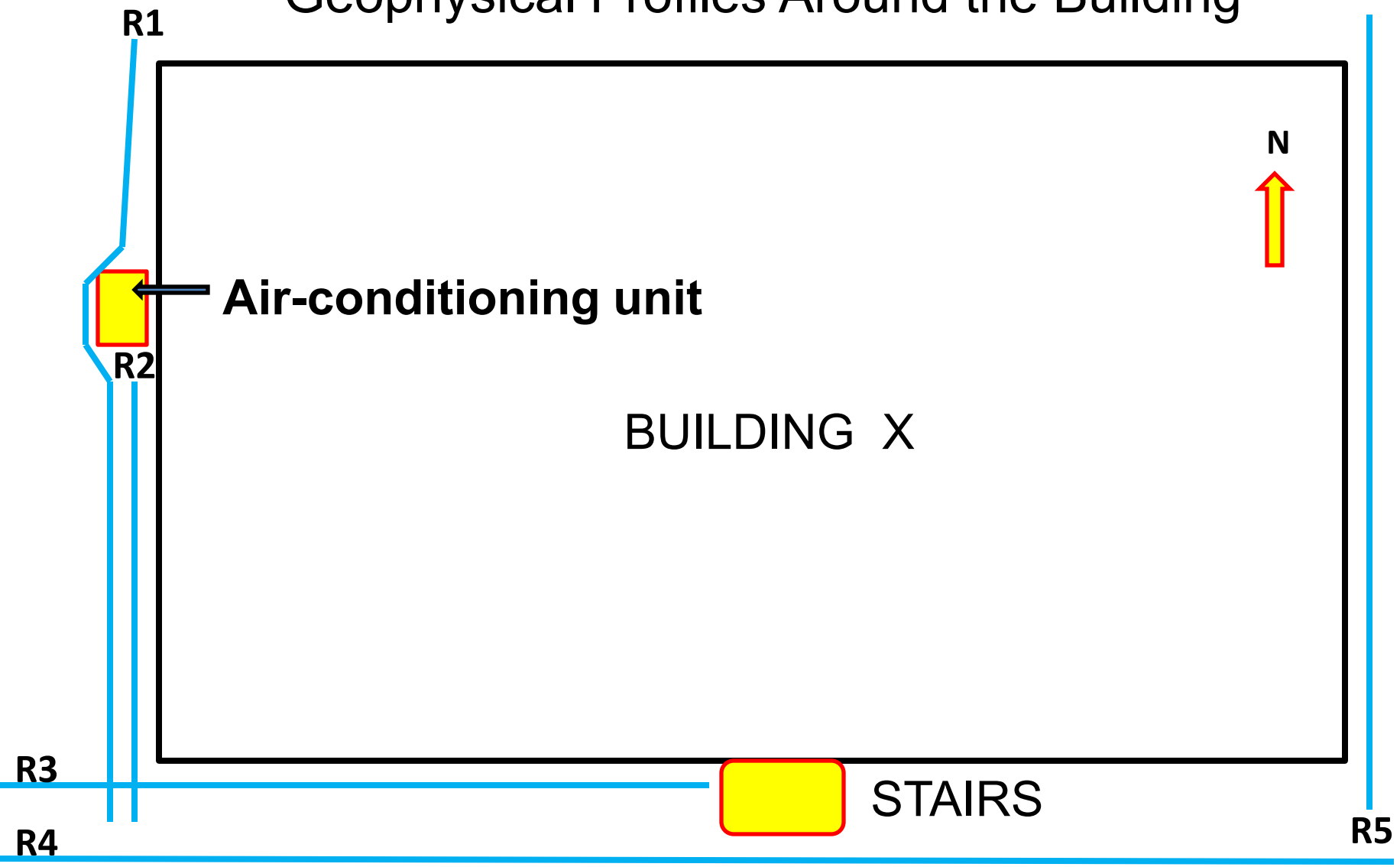
Foundation problems few miles away from The Alamo, San Antonio



Foundation Case Study

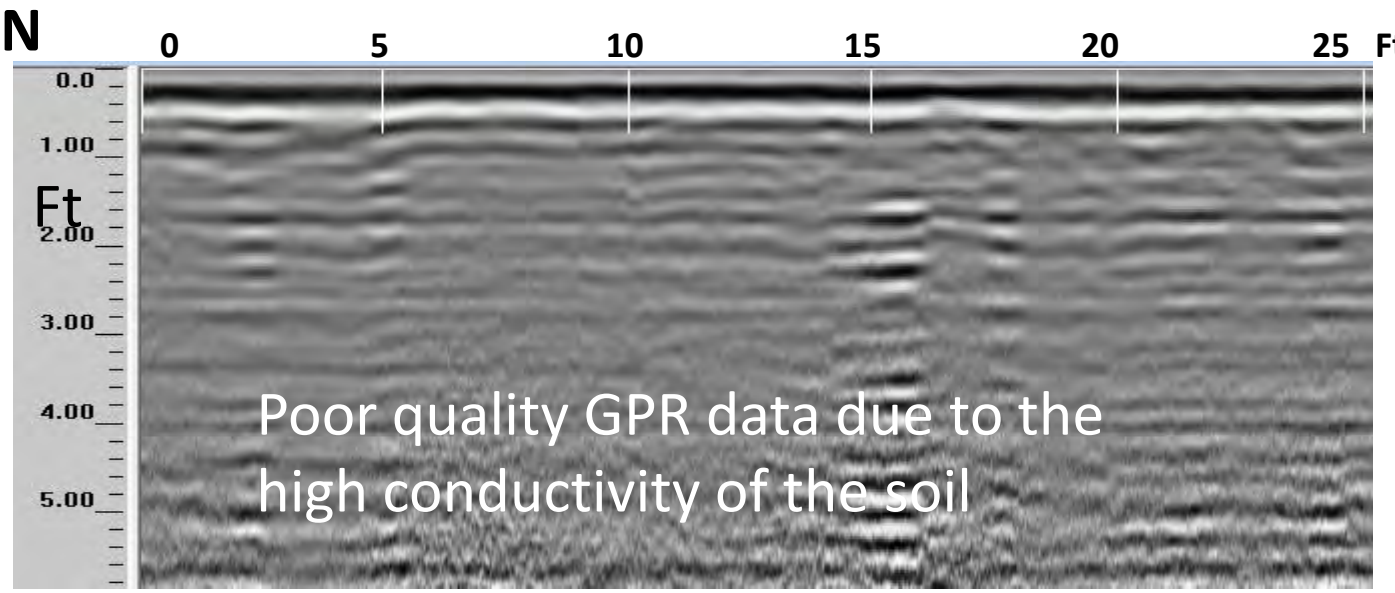
View to the NE

Geophysical Profiles Around the Building

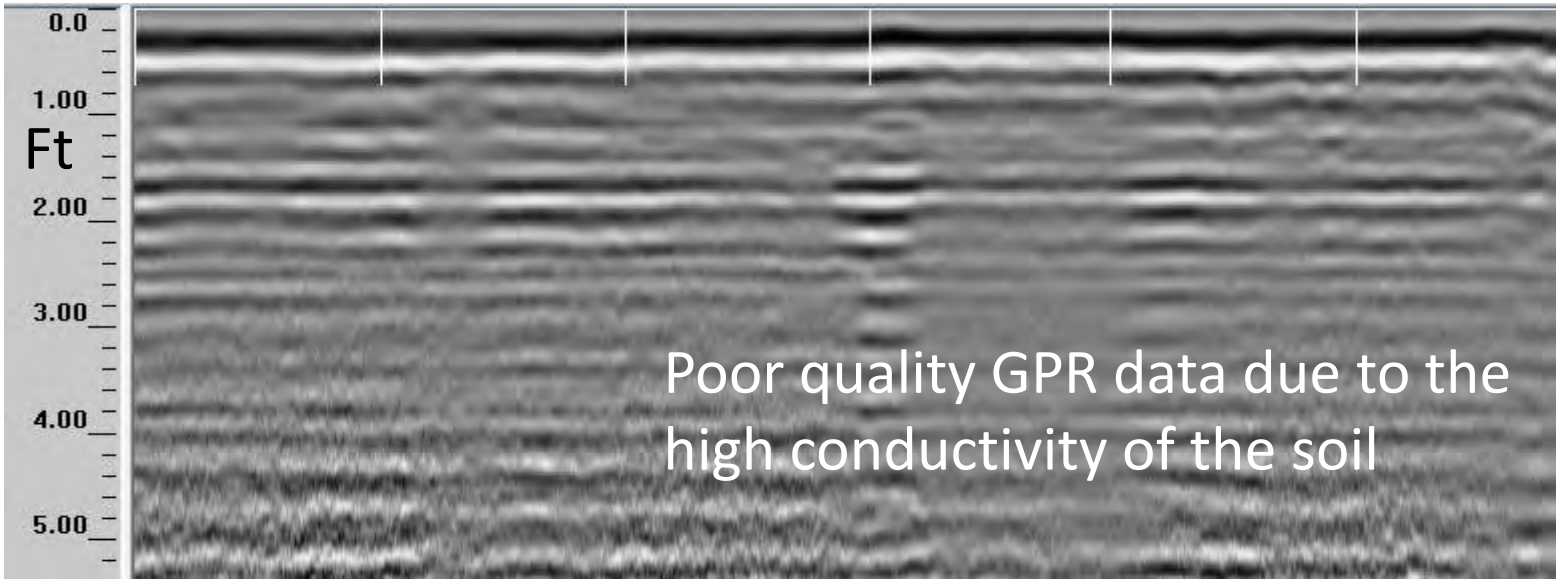


GPR surveys around the building: Note the significant cracks

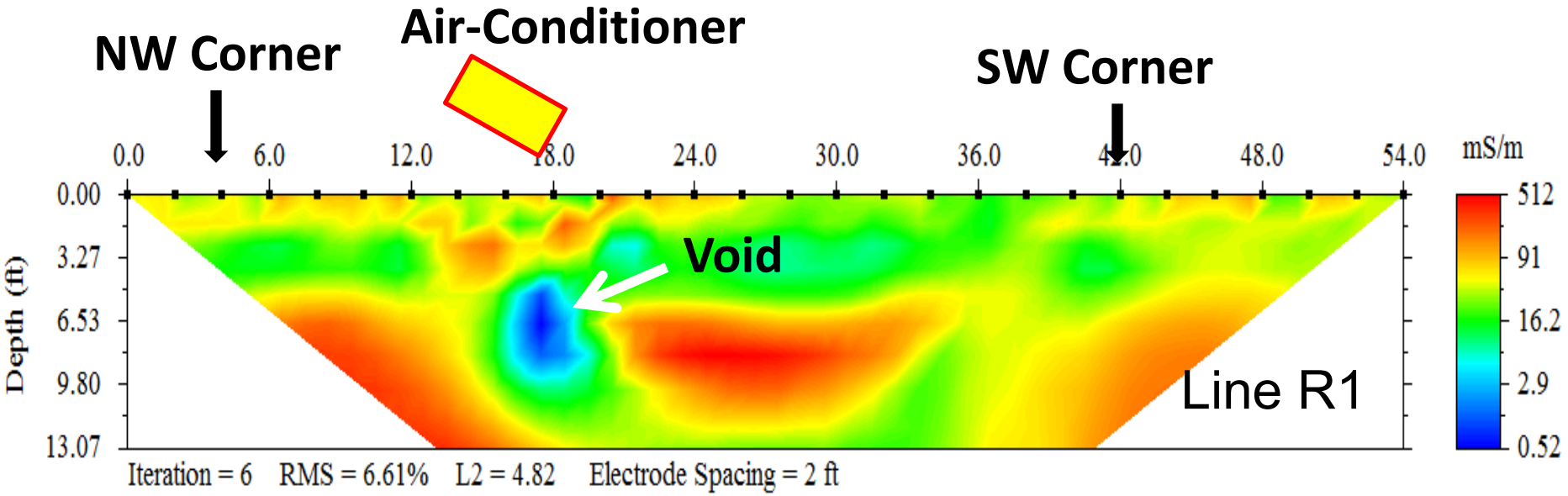
Note the significant cracks



Two GPR Profiles

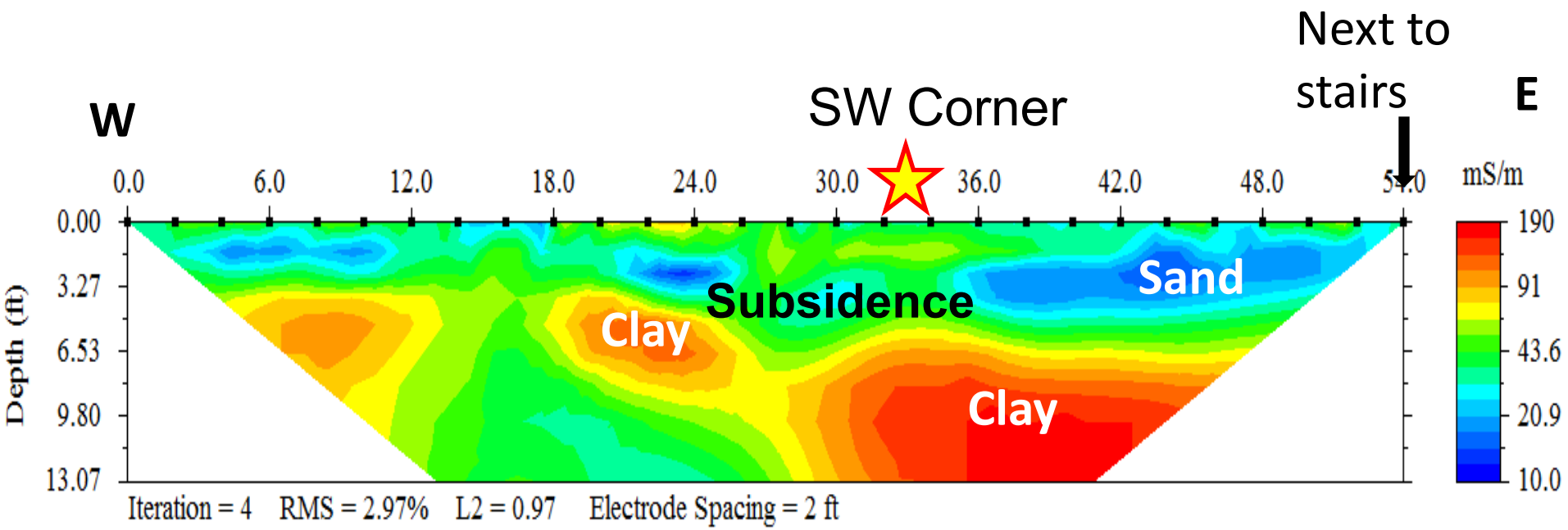


Micro-resistivity survey along the building



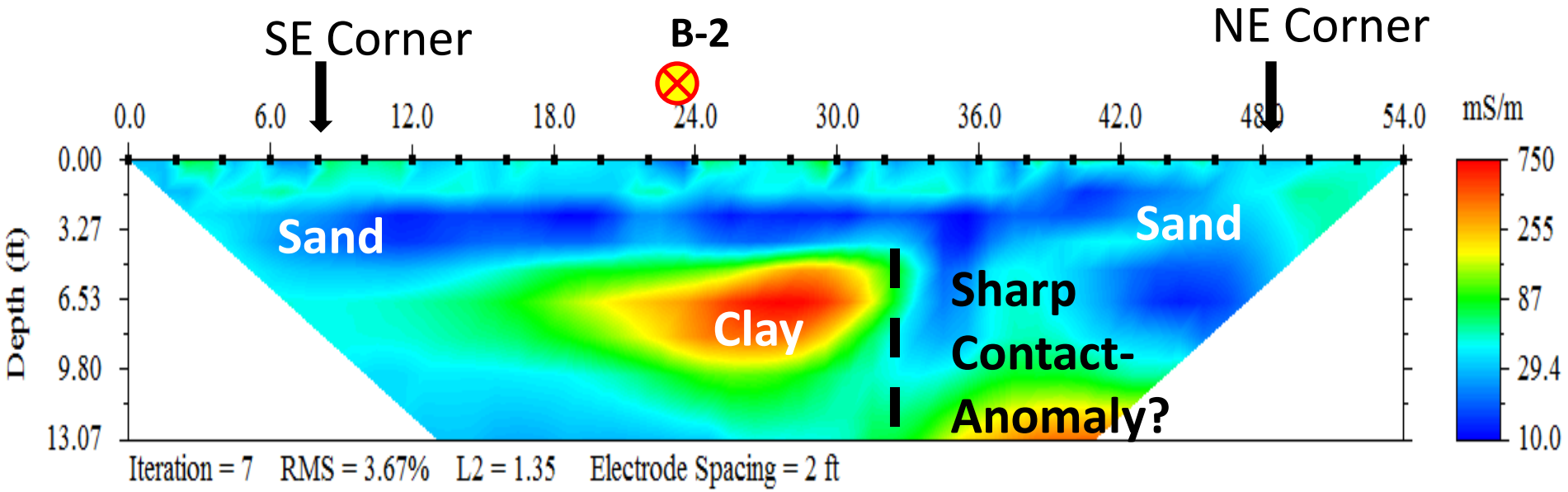
Conductivity data-converted from the resistivity data

Resistivity survey along Line R3



Conductivity profile along R3

A view to the NW

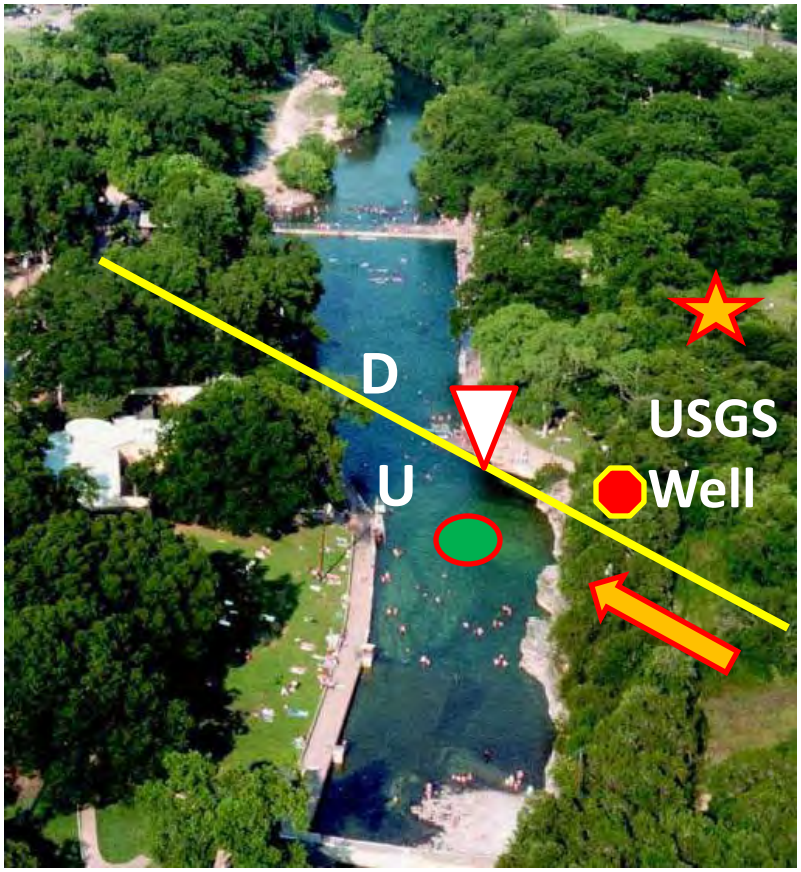


Conductivity profile along R5

RESULTS OF THE FOUNDATION STUDY

Using **micro-resistivity surveys,** we not only located a number of areas of granular soil where substantial amounts of moisture have accumulated. The resistivity data also indicated the presence of an abandoned sewer main under the building that was not known to be present at the time, but has been verified on old base maps.

GPR results did not yield any information.



Where is all the water coming from into the Barton Springs Pool?!

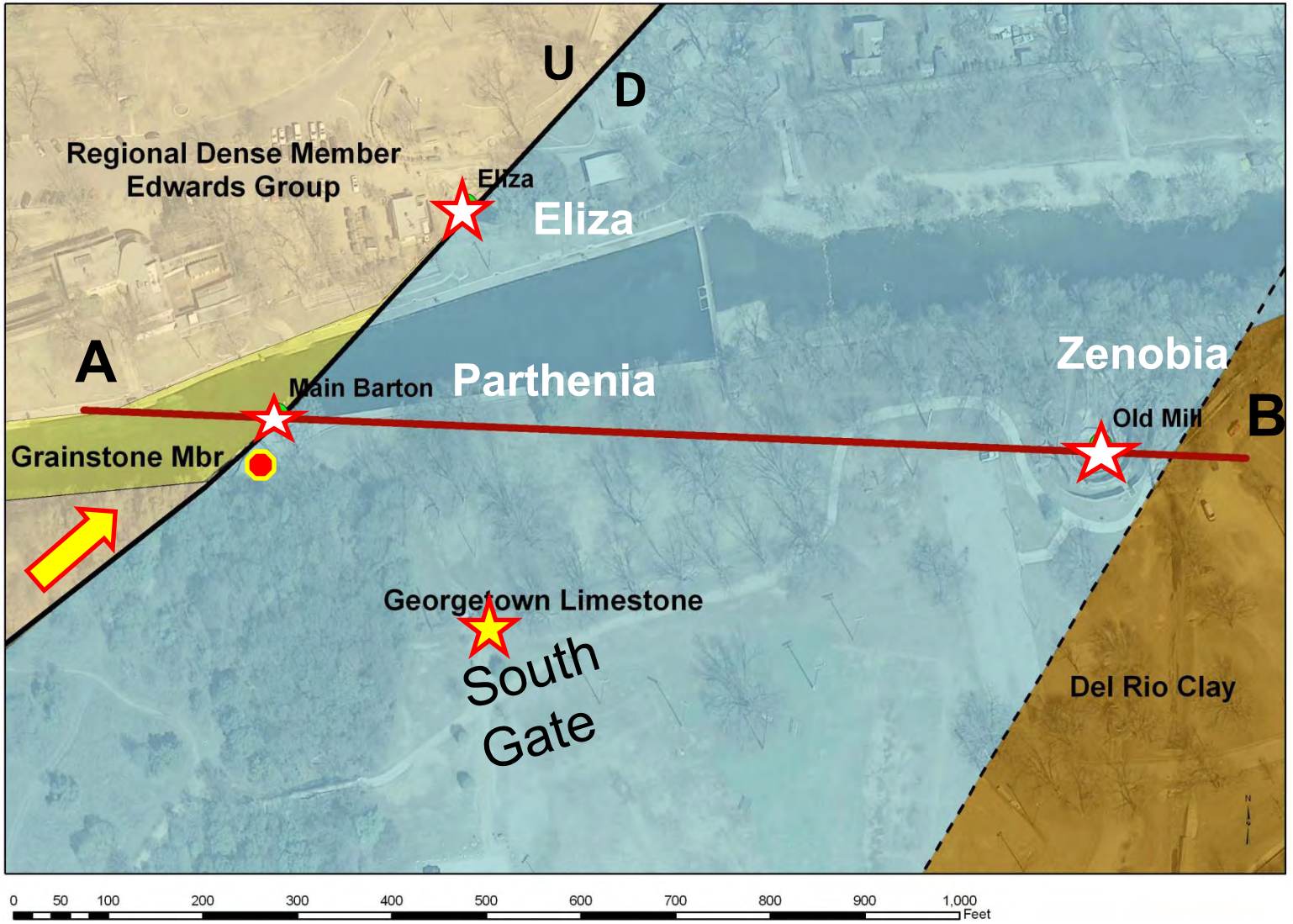
4th largest spring system in Texas

Water temperature: 68°F (22°C)

Mean discharge: 53 cfs (1,500 lps)
(105 acre-feet/day)

Barton Springs
Edwards Aquifer
CONSERVATION DISTRICT

Geological Map of Barton Springs Pool

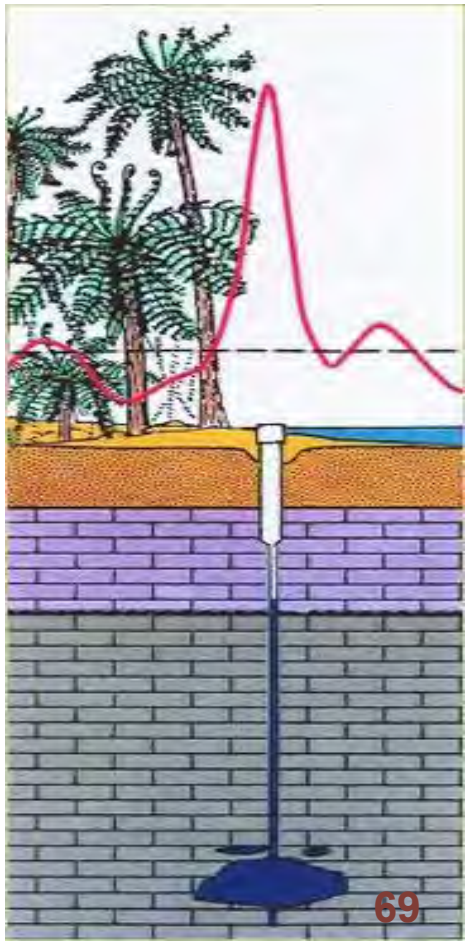


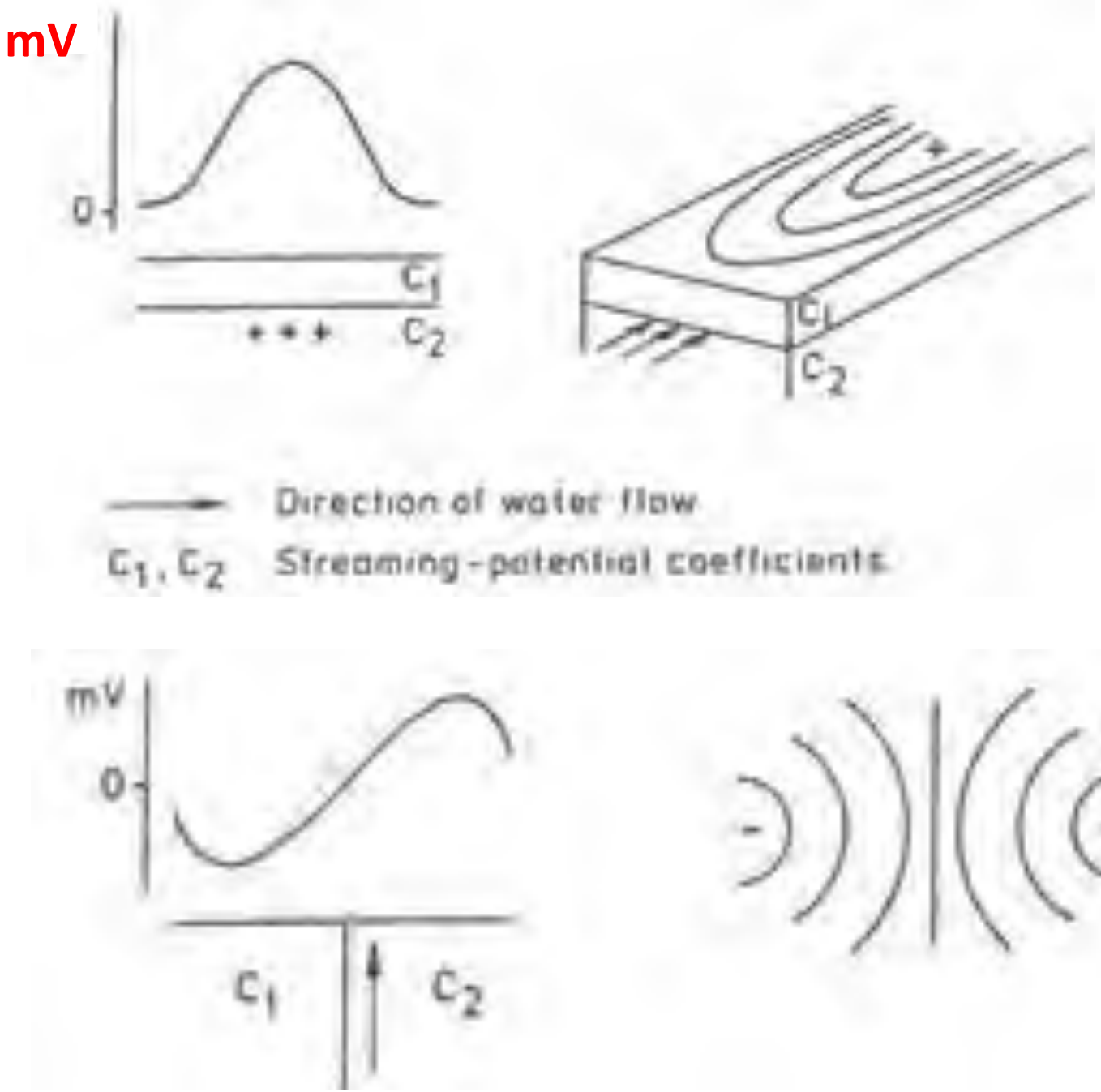
Dye tracing as far as 13 miles away

In the 1830s, William Barton owned the land, which included the three springs to which he gave his three daughters' names: Parthenia, Eliza and Zenobia.

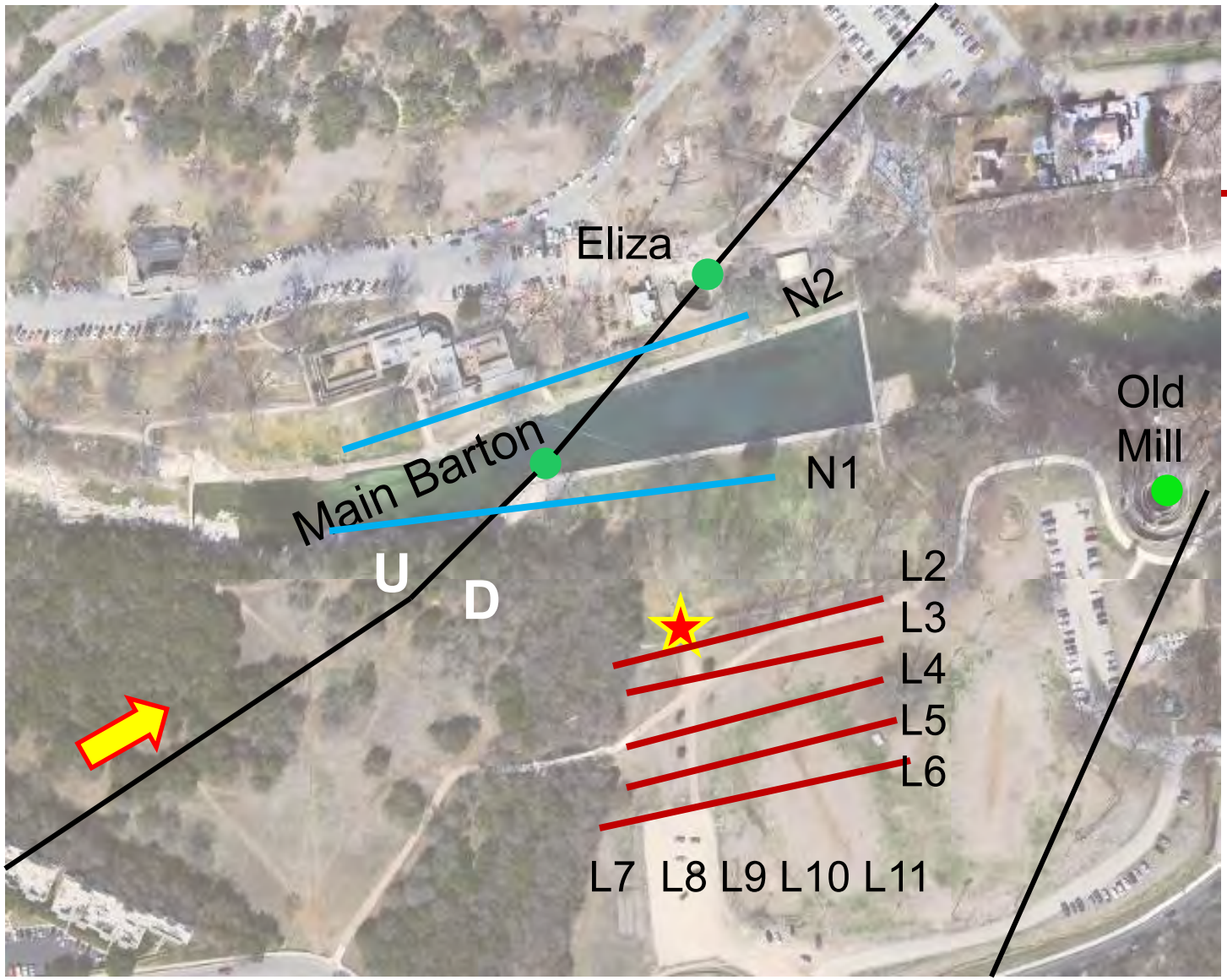
Natural-Potential Method (NP)

- Utilizes the earth's natural-electric field at the ground surface to detect and map groundwater pathways and geologic features, such as faults, fractures, conduits, caves
  - Movement of water
  - Target: Seepage, Voids

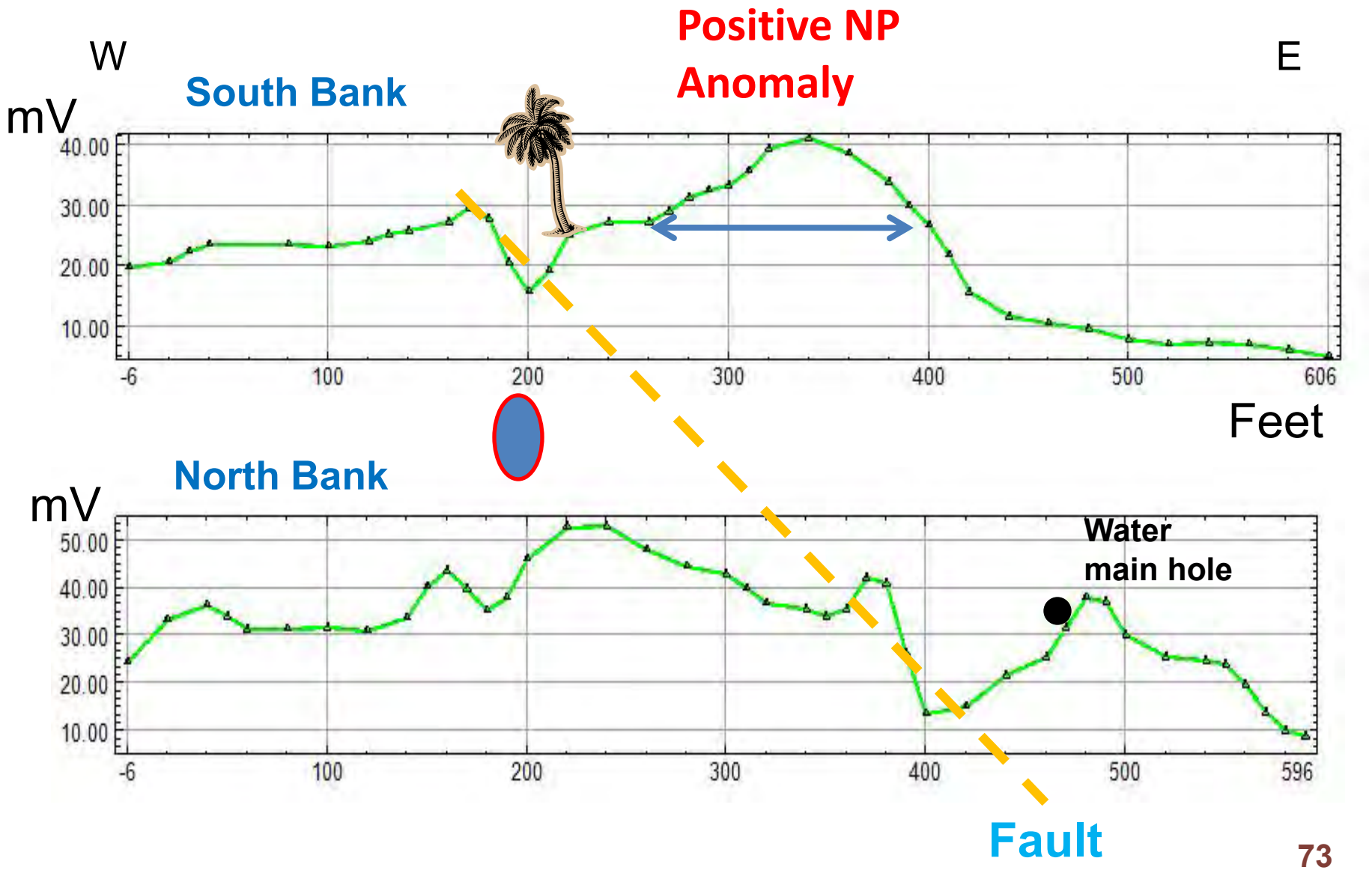



mV
0
C1
C2
+ + +
C1
C2
Direction of water flow
C1, C2 Streaming-potential coefficients
mV
0
C1
C2
-
+

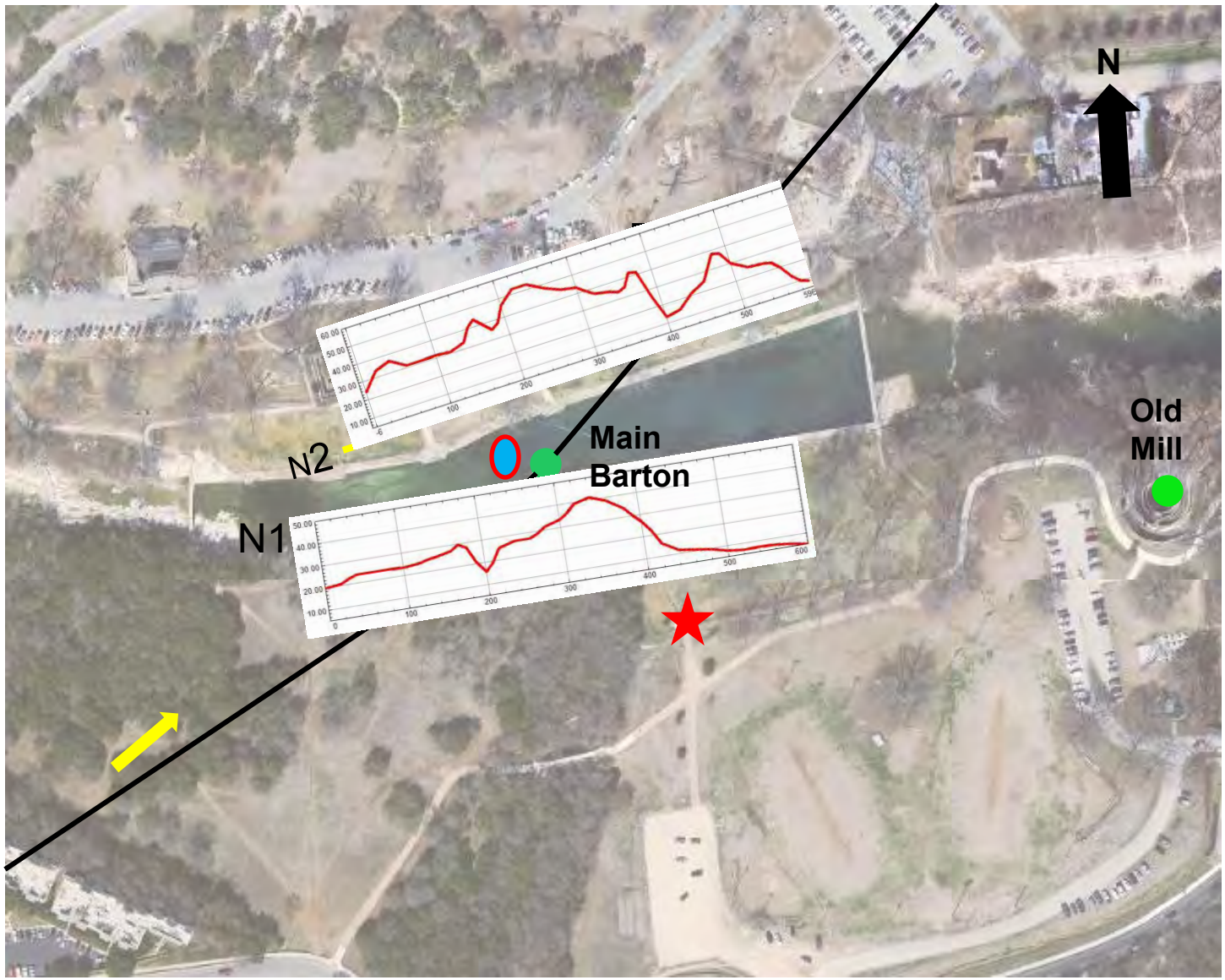
Locations of NP and Resistivity Profiles at Barton Springs



NP Data at the Barton Springs Pool



NP Profiles Over Aerial View of Pool



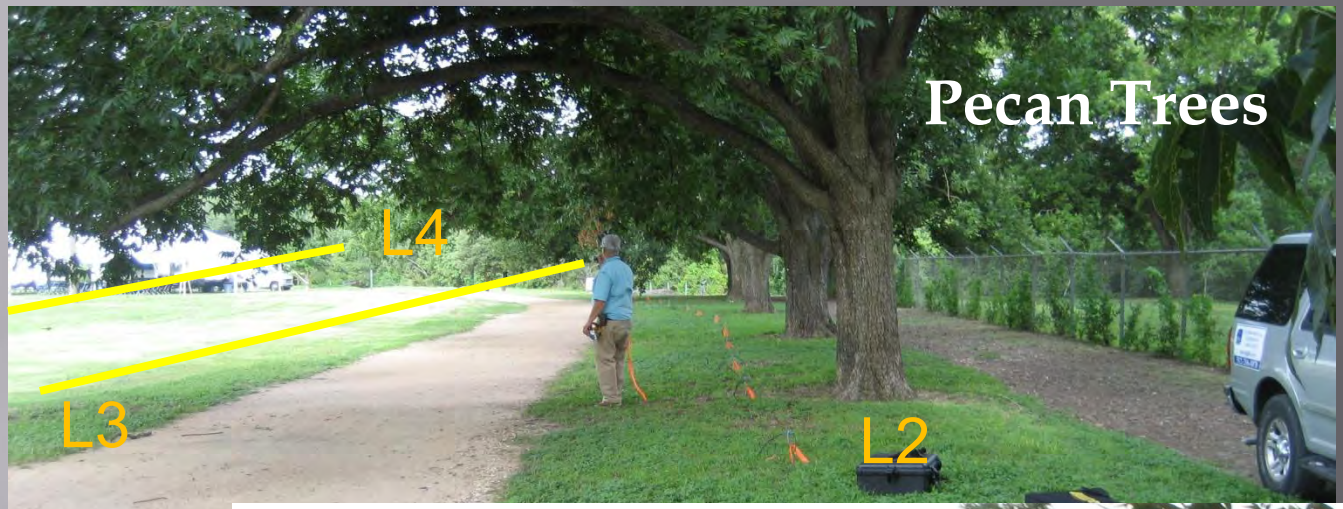
NP profile data

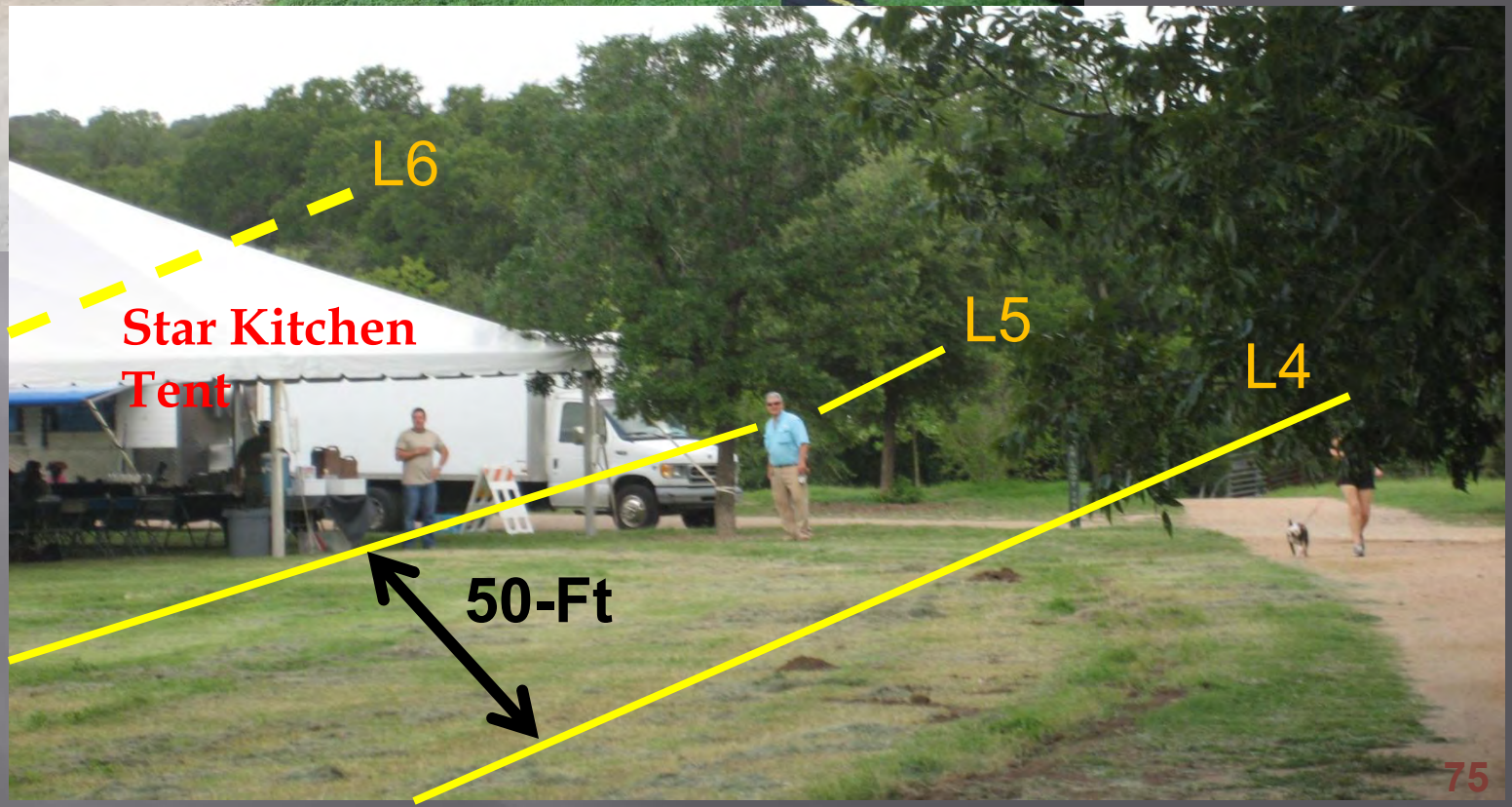
Springs

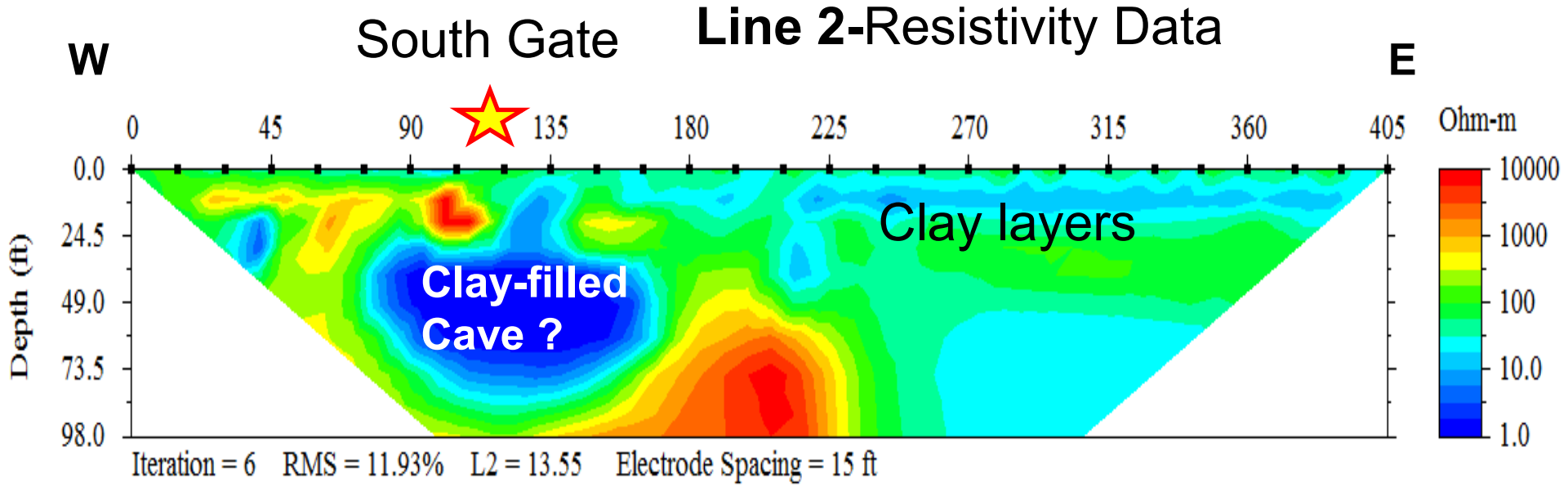
Fault

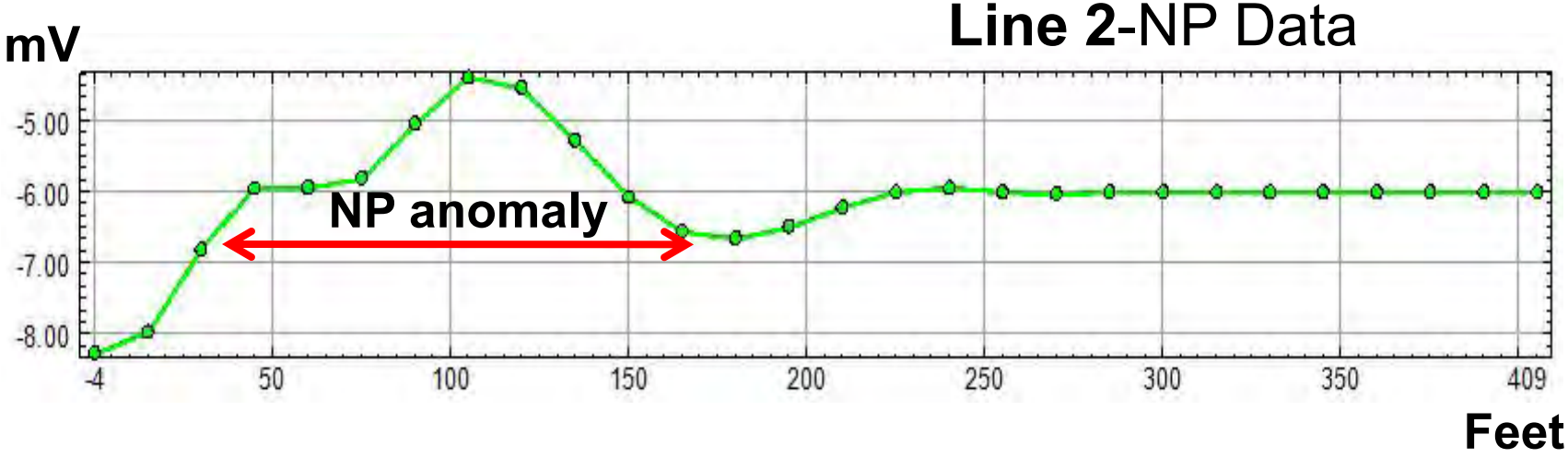
Flow-path

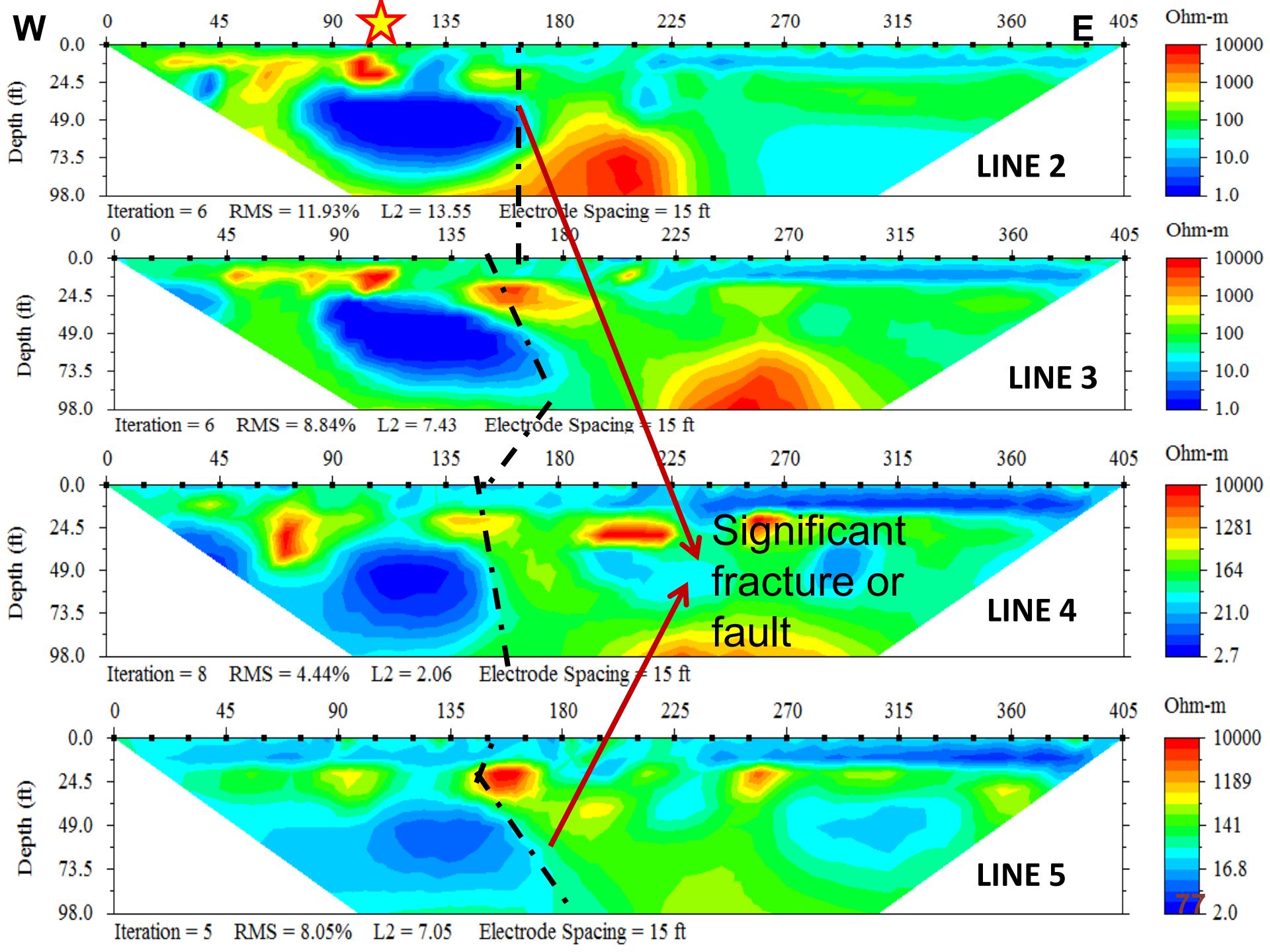
Gate to the Pool

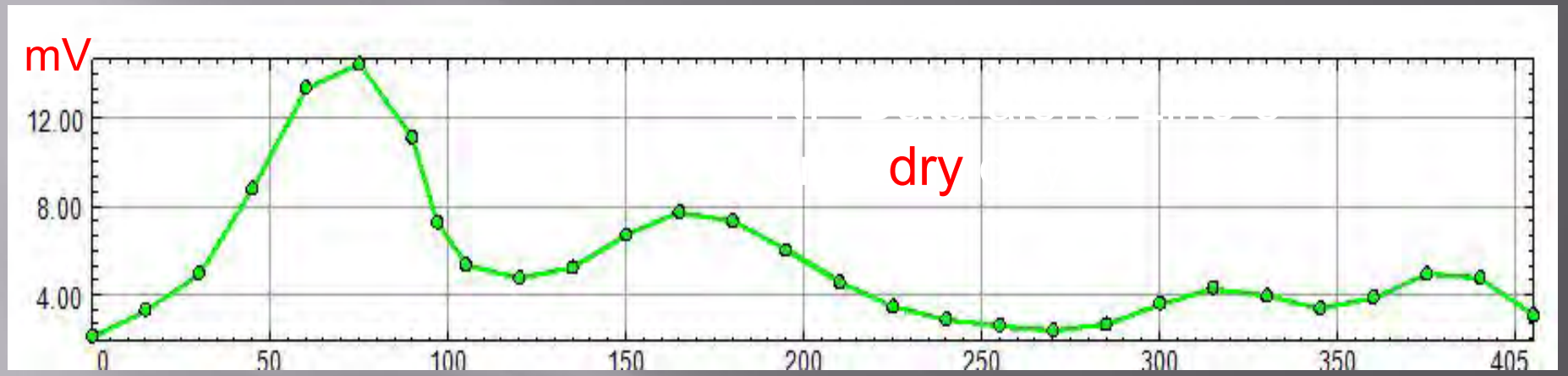

Pecan Trees
L4
L3
L2


L6
Star Kitchen
Tent
L5
L4
50-Ft


W
South Gate
Line 2-Resistivity Data
E
0
45
90
135
180
225
270
315
360
405
Ohm-m
10000
1000
100
10.0
1.0
0.0
24.5
49.0
73.5
98.0
Depth (ft)
Clay-filled
Cave ?
Clay layers
Iteration = 6 RMS = 11.93% L2 = 13.55 Electrode Spacing = 15 ft


mV
Line 2-NP Data
-5.00
-6.00
-7.00
-8.00
NP anomaly
-4
50
100
150
200
250
300
350
409
Feet

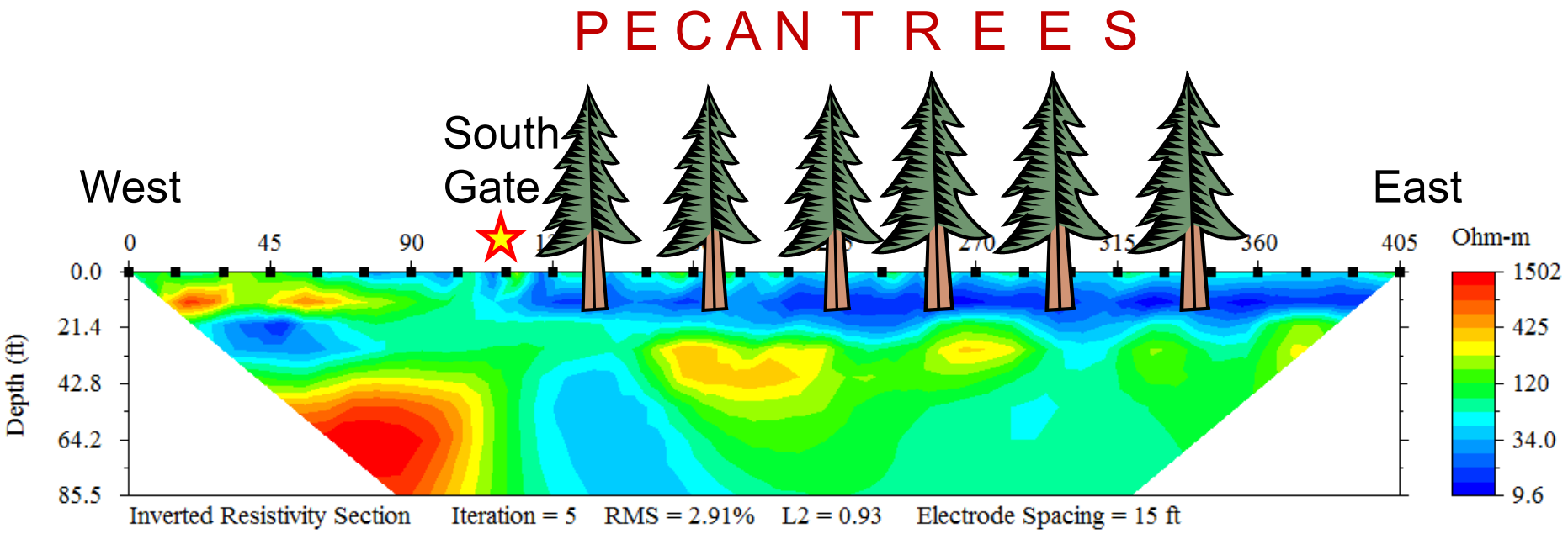

W
E
0
45
90
135
180
225
270
315
360
405
Depth (ft)
0.0
24.5
49.0
73.5
98.0
Ohm-m
10000
1000
100
10.0
1.0
LINE 2
Iteration = 6 RMS = 11.93% L2 = 13.55 Electrode Spacing = 15 ft
LINE 3
Iteration = 6 RMS = 8.84% L2 = 7.43 Electrode Spacing = 15 ft
1281
164
21.0
2.7
Significant fracture or fault
LINE 4
Iteration = 8 RMS = 4.44% L2 = 2.06 Electrode Spacing = 15 ft
1189
141
16.8
2.0
LINE 5
Iteration = 5 RMS = 8.05% L2 = 7.05 Electrode Spacing = 15 ft



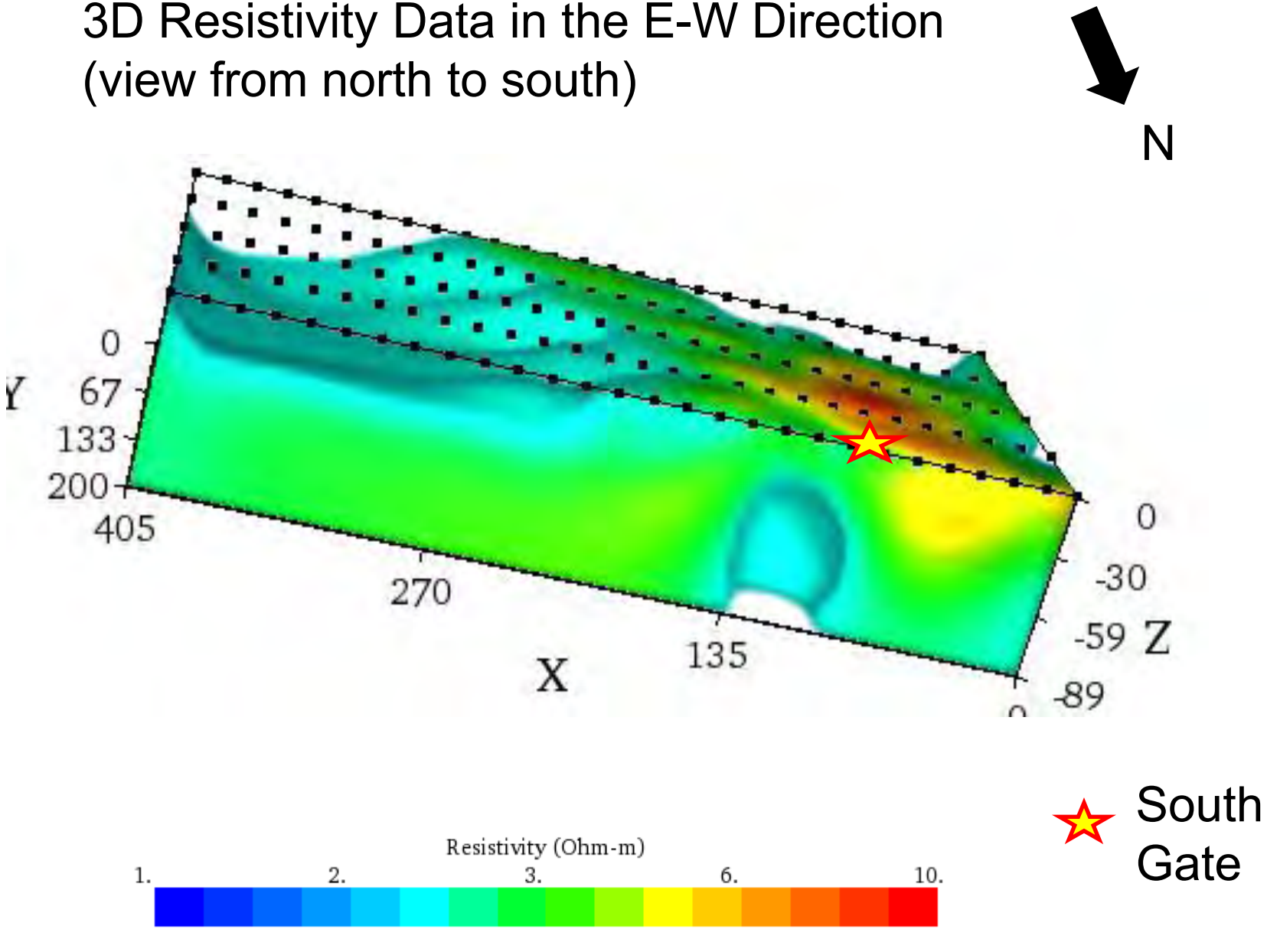
Correlation of an NP anomaly taken along Line 8 on a dry day and on a day after a stormy rain


Extra Resistivity Line

Resistivity Imaging Data



3D Resistivity Data in the E-W Direction (view from north to south)

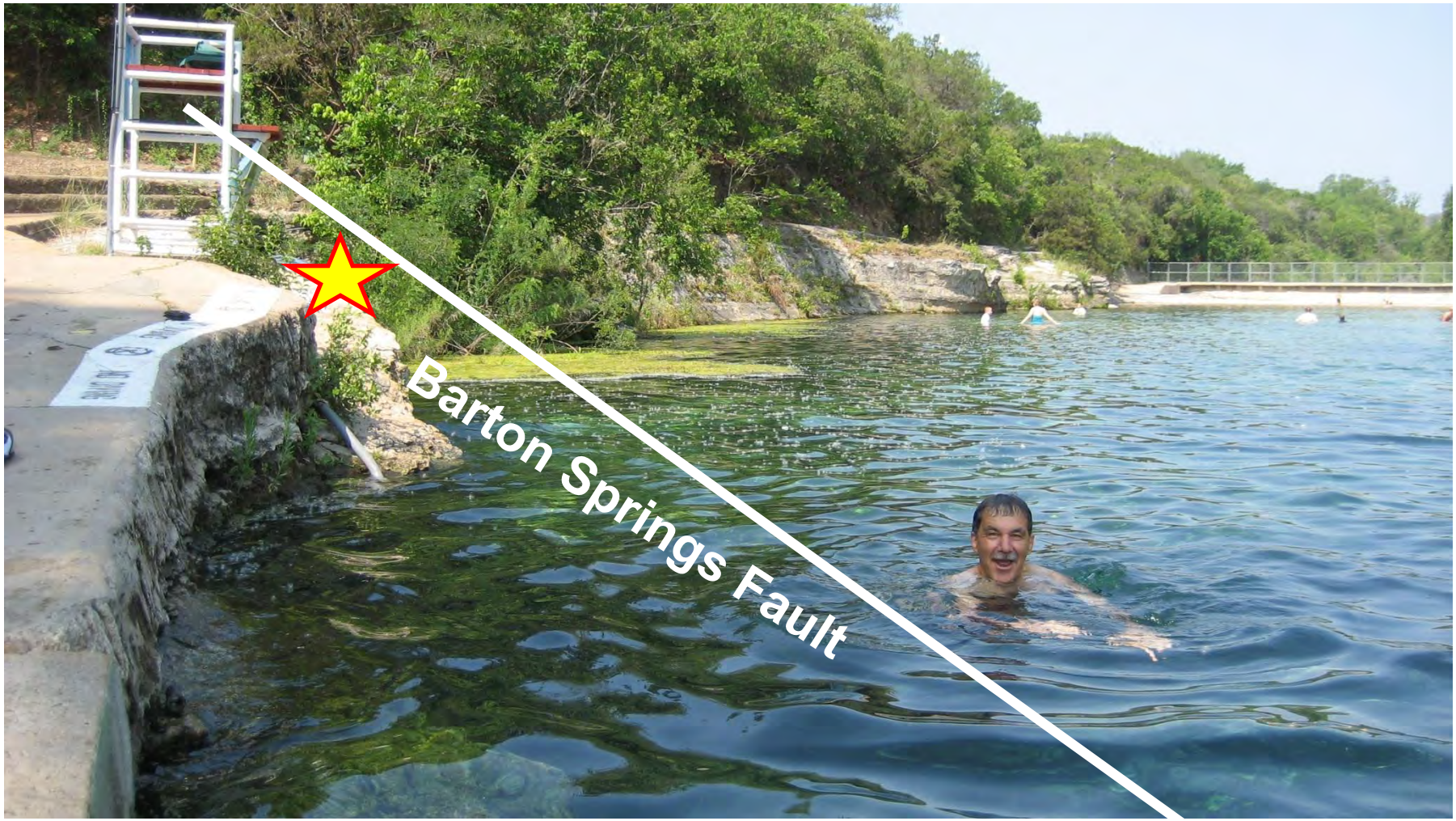


Concluding Remarks

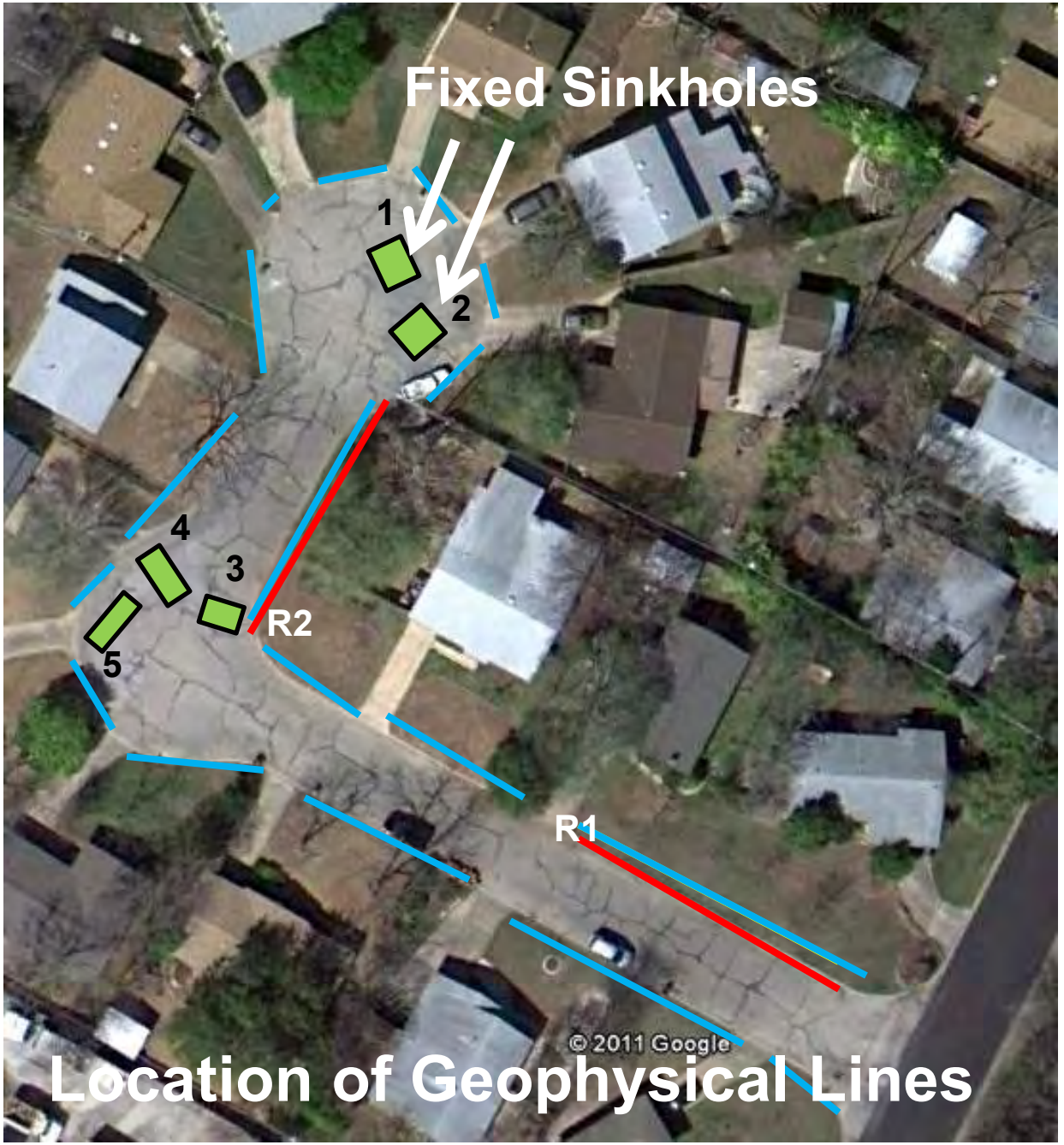
- We think we located number of conduits and caves in the Barton Springs area;

- We also think that we located a significant fracture or fault that appears to control the flow of the water into the pool.

Now, it is pool time!


Barton Springs Fault

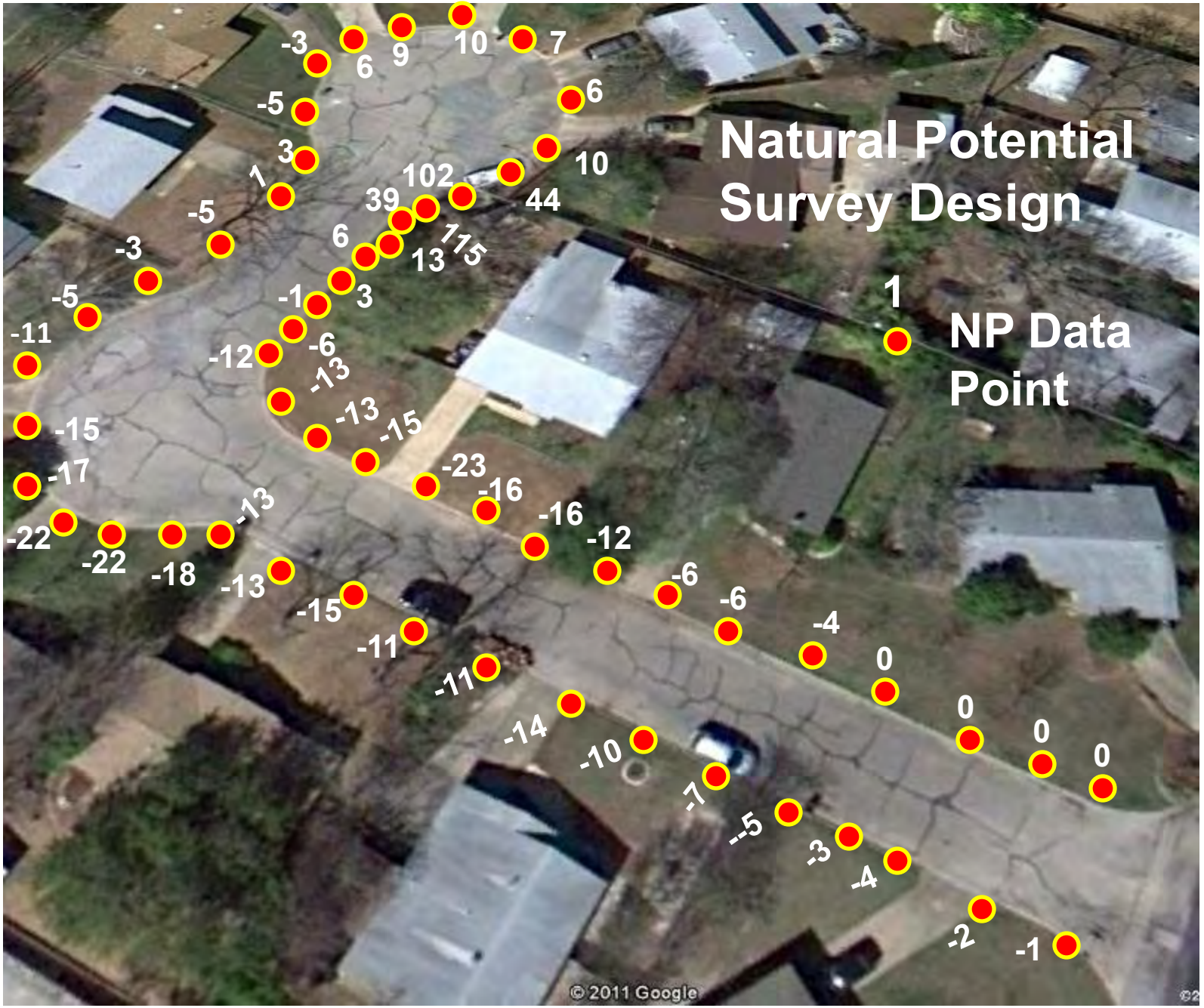
FRONT YARD GEOPHYSICS IN AUSTIN



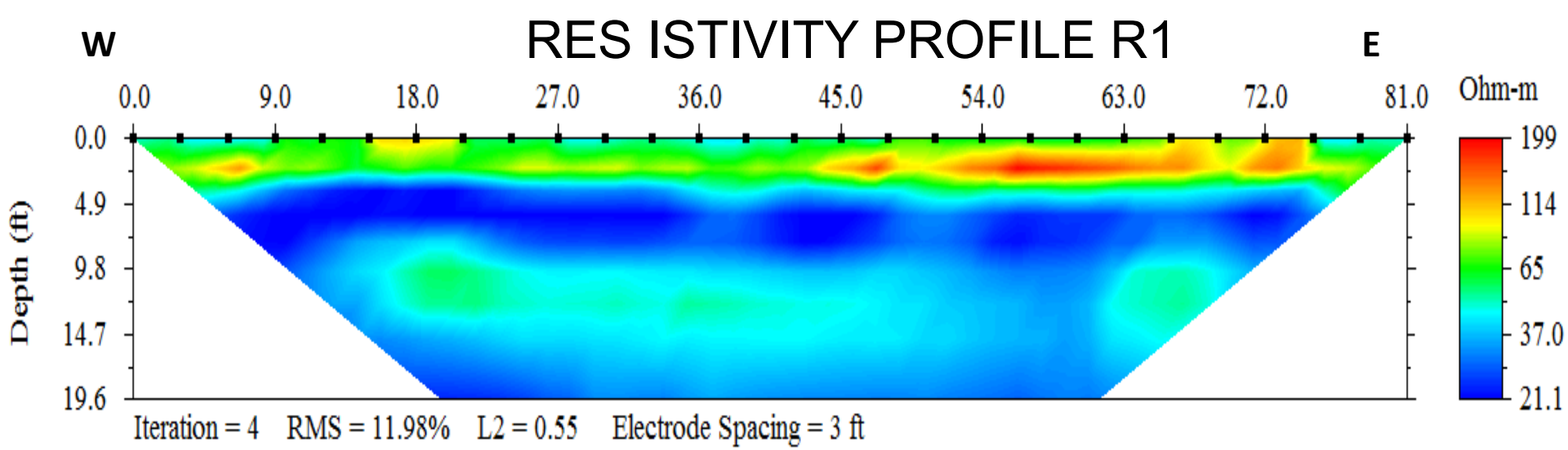
NP line

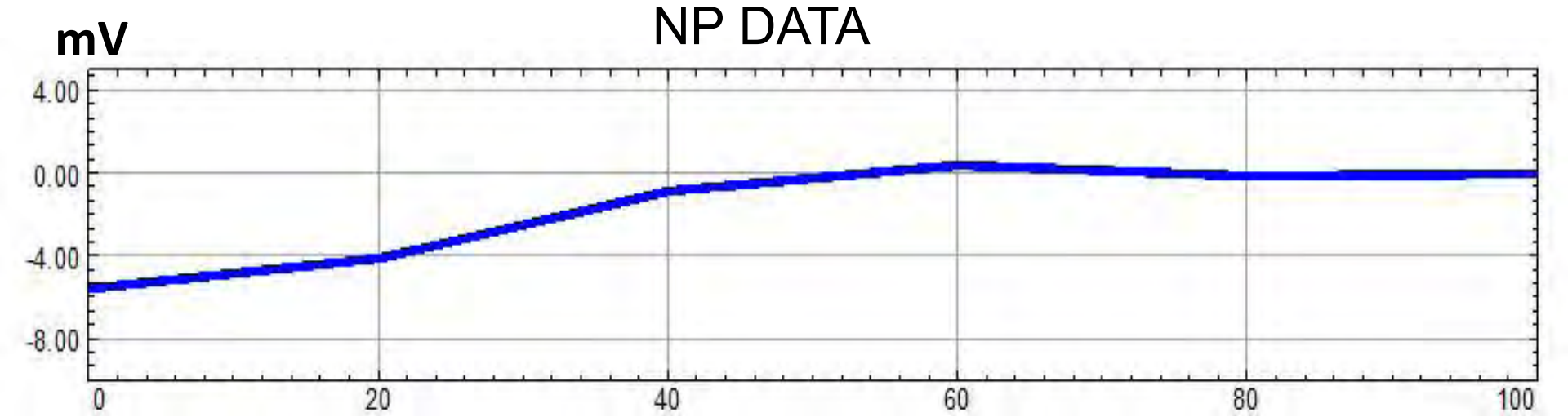
Resistivity line

Road patches
1

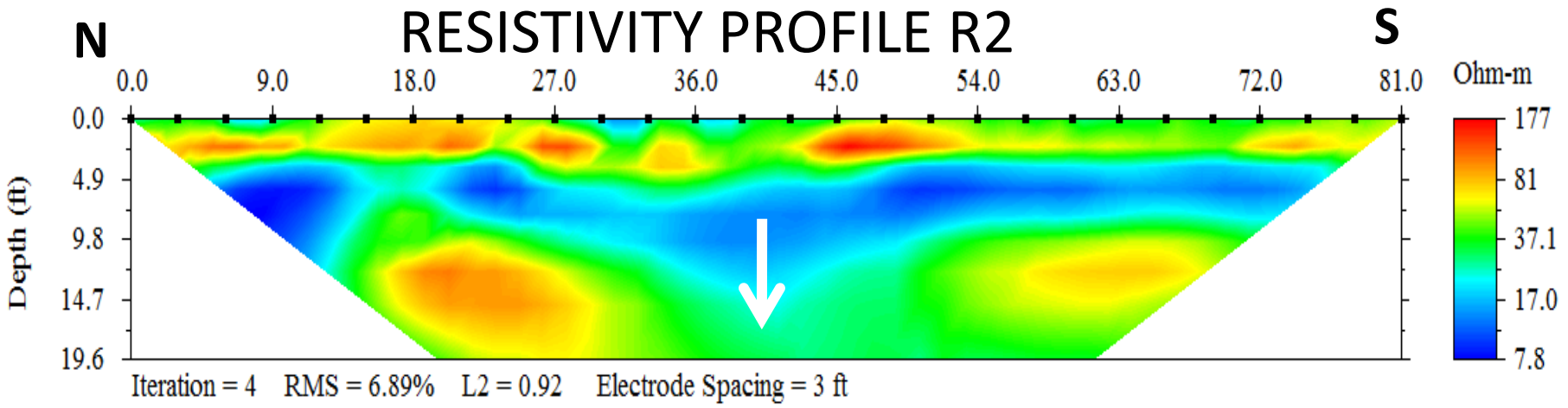

Natural Potential
Survey Design
1
NP Data
Point
-3
6
9
10
7
-5
6
3
1
102
10
39
44
-5
6
775
13
-3
-5
-1
3
-11
-12
-6
-13
-15
-13
-15
-17
-23
-16
-22
-13
-16
-12
-22
-18
-13
-6
-15
-6
-11
-4
-11
0
-14
0
-10
0
-7
-5
-3
-4
-2
-1
© 2011 Google

Location of Resistivity Line R1

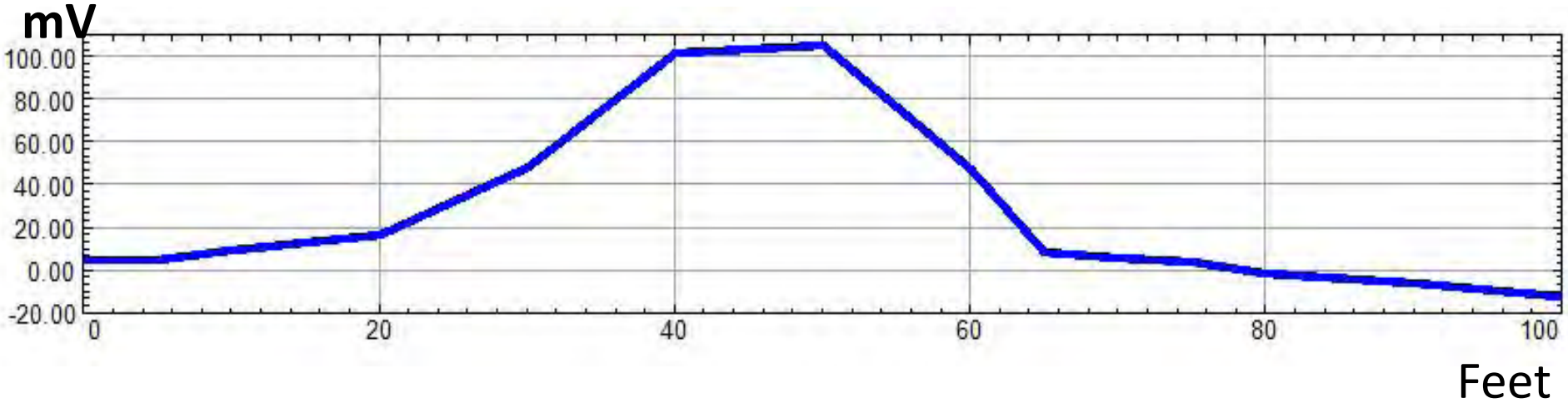




Both data sets indicate no anomaly!



NP DATA

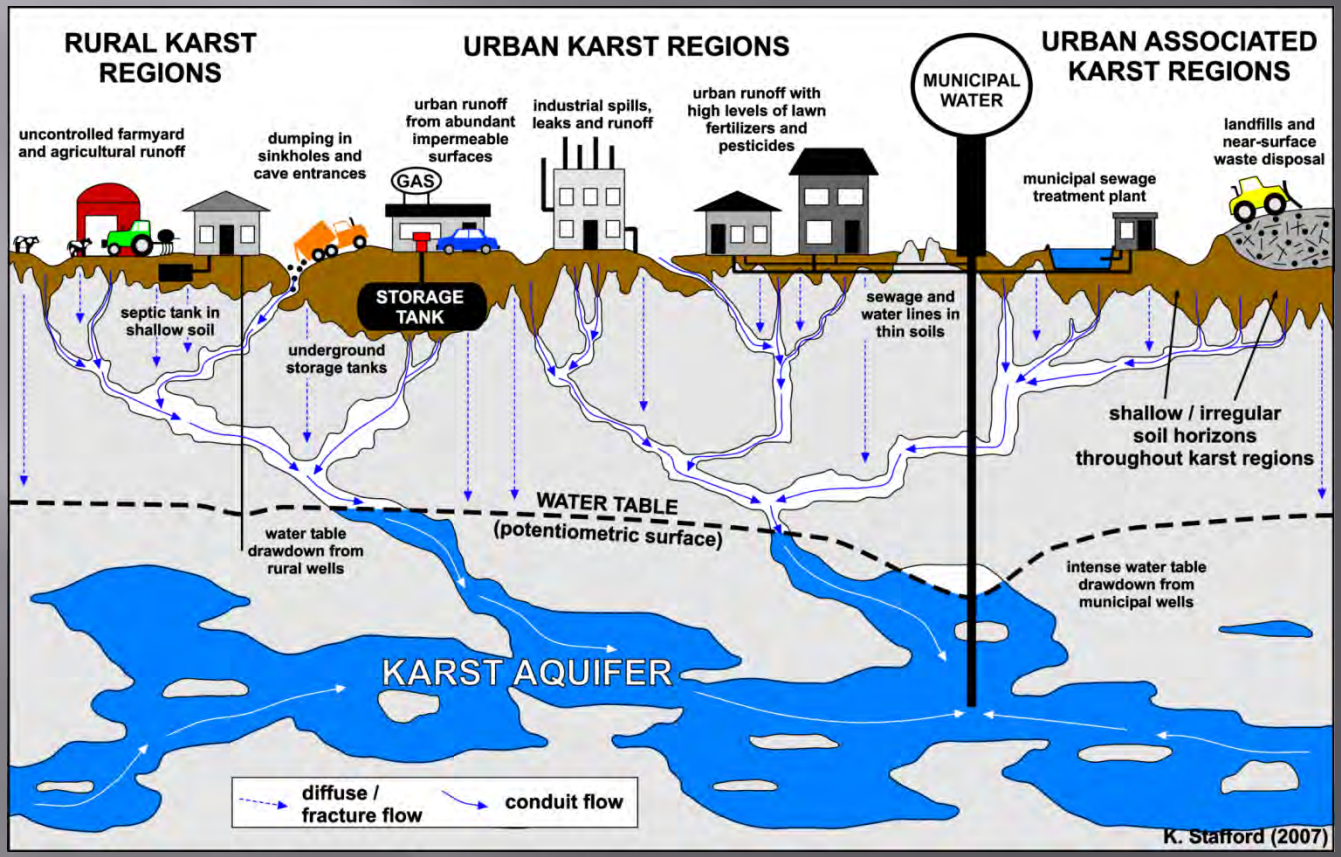


Both data sets indicate significant anomalies!

- Q: Do karstic features represent a hazard to the Austin Community?

- **Q: What do you think?**

Q: Or do we represent a hazard to the Karstic Community?



Taken from 2010 NSS Journal with permission from Dr. George Veni

Final Remarks-1

A key factor conducting a successful survey is to select the proper geophysical methods for the site conditions. There is no one geophysical tool that can be considered the proverbial “silver bullet” which can uniquely locate, delineate, and characterize all hazards.

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Final Remarks-2

- But clearly geophysics can play a role in advance in reducing the risk many hazards present to public safety and health.

- Properly planned and executed, a geophysical survey can provide a wealth of information cost effectively that could NOT be obtained otherwise, such as drilling and/or surface sampling.

EGA

- Let's remember: Geophysics is just another