

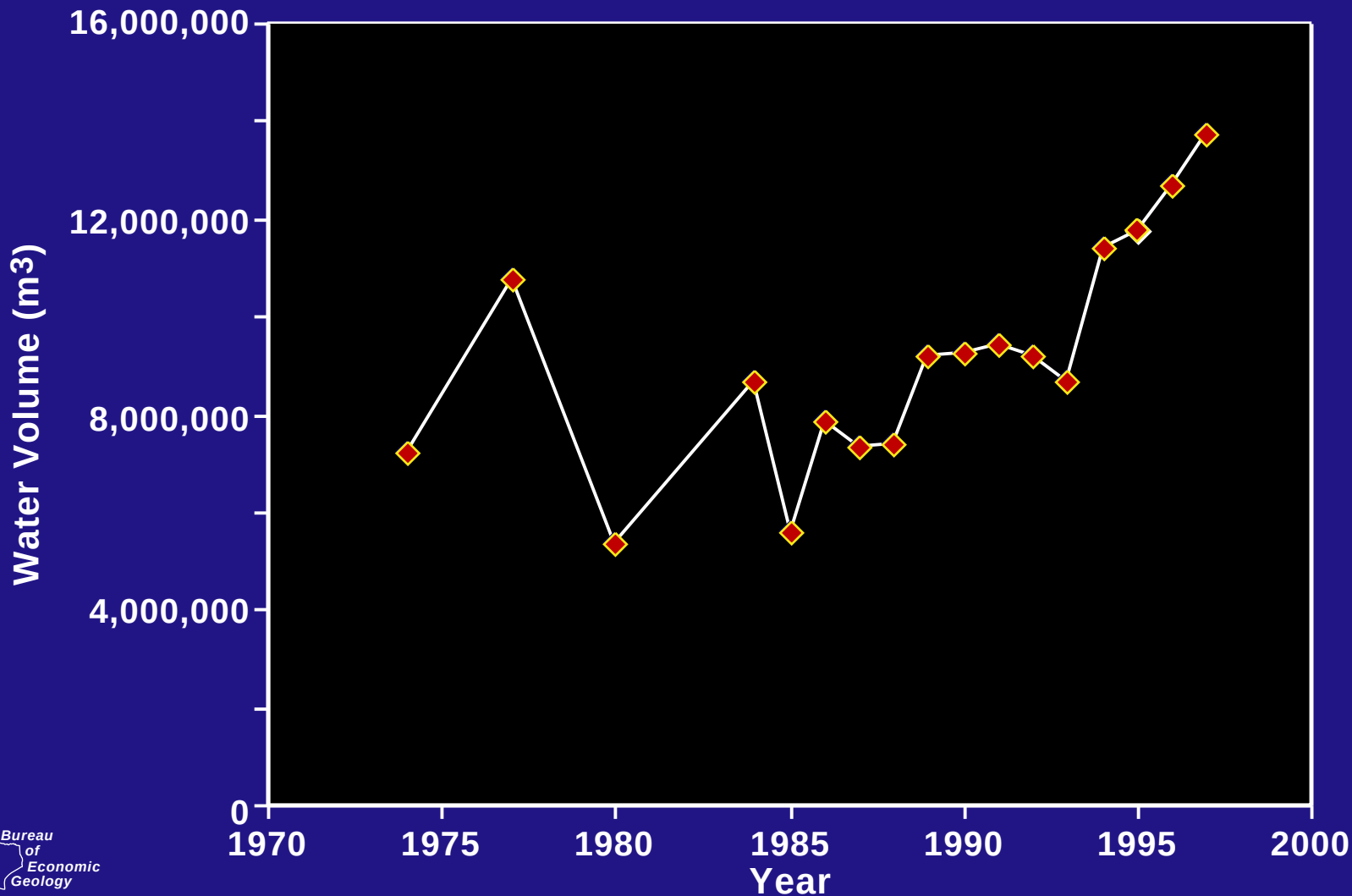


IDENTIFYING AND ASSESSING GROUND WATER IN THE LOWER RIO GRANDE VALLEY, TEXAS USING AIRBORNE ELECTROMAGNETIC INDUCTION

Jeffrey G. Paine
Bureau of Economic Geology
The University of Texas at Austin

Edward S. Angle and Rima Petrossian
Texas Water Development Board

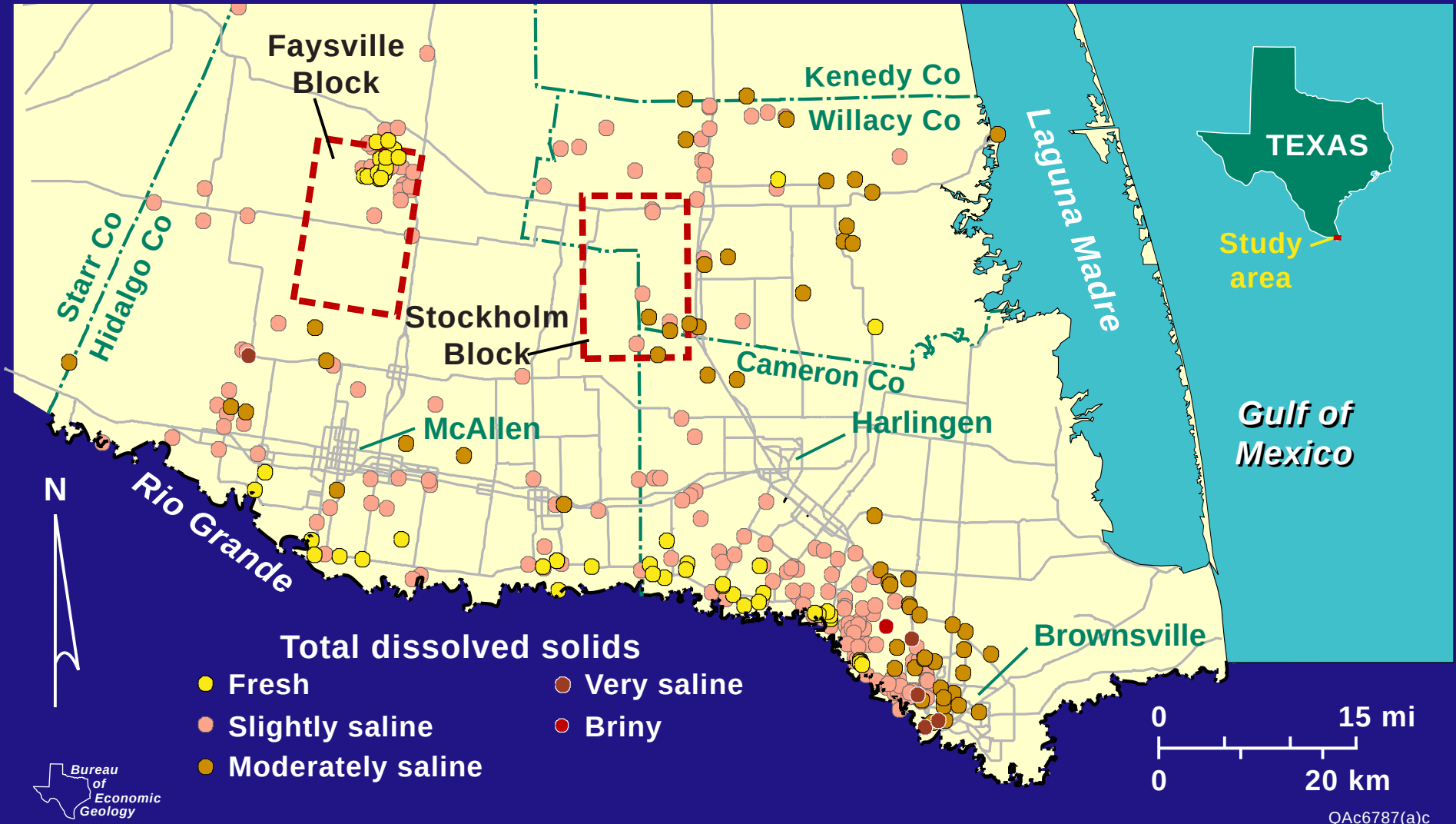
LRGV MUNICIPAL WATER USAGE, 1974-1997



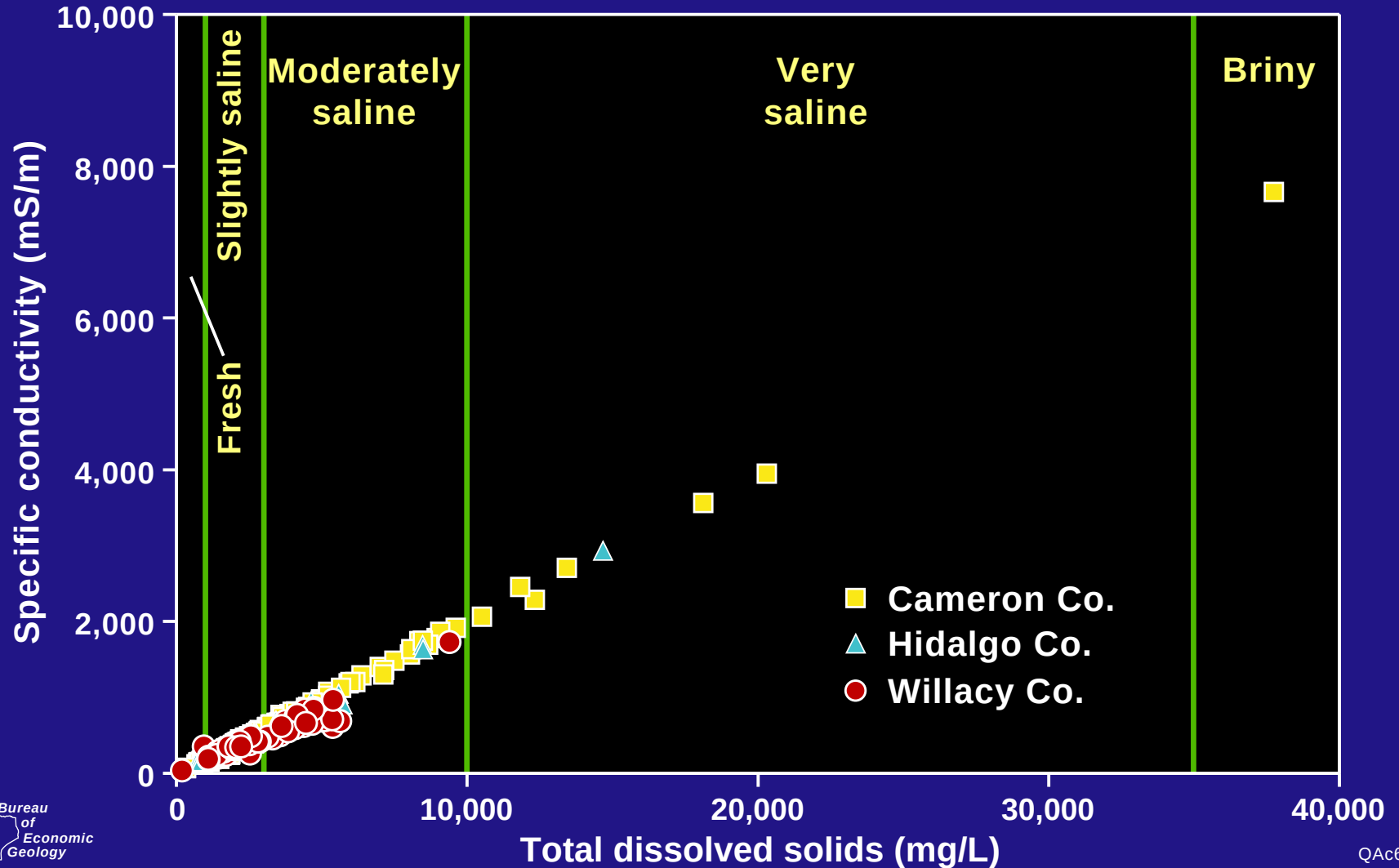
LRGV AIRBORNE SURVEYS



TOTAL DISSOLVED SOLIDS IN WATER WELLS



LRGV WATER QUALITY AND CONDUCTIVITY



ENVIRONMENTAL GEOLOGY

BROWNSVILLE- HARLINGEN AREA

POSSIBLE SIGNATURES AND RESOURCE QUALITY

Fluvial/Deltaic System

Anomaly	Depositional Environment	Water quality	Resource quality
Low conductivity, sinuous	Coarse channel deposits (sand or gravel)	Fresh	Good (abundant, good water)
Low conductivity, nonsinuuous	Several possibilities	Fresh	Fair (good water, unknown quantity)
High conductivity, sinuous	Coarse channel deposits (sand or gravel)	Saline	Poor (abundant, poor water)
High conductivity, sinuous	Fine channel-fill deposits (silt or clay)	Fresh or saline	Poor (limited water, unknown salinity)

POSSIBLE SIGNATURES AND TARGET QUALITY

Fluvial/Deltaic Environments

ANOMALY	GEOLOGIC UNIT	WATER QUALITY	TARGET QUALITY
Low conductivity, sinuous	Coarse channel deposits (sand or gravel)	Fresh	Good (abundant good water)
Low conductivity, non-sinuous	Several possibilities	Fresh	Fair (good water; unknown quantity)
High conductivity, sinuous	Coarse channel deposits (sand or gravel)	Saline	Poor (abundant poor water)
High conductivity, sinuous	Fine channel-fill deposits (silt or clay)	Fresh or saline	Poor (limited water; unknown salinity)

LRGV FLIGHT DATA

PARAMETER	FAYSVILLE	STOCKHOLM
Company	Geoterrex	World Geoscience
Acquisition date	October 1999	August 1999
Aircraft	CASA C212 (twin engine)	Shorts Skyvan (twin engine)
Principal line spacing	400 m	400 m
Tie line spacing	4,000 m	4,000 m
Principal line direction	9 and 189 degrees	0 and 180 degrees
Tie line direction	99 and 279 degrees	90 and 270 degrees
Aircraft and transmitter height	120 m	120 m
Location	Differential GPS	Differential GPS
Flight speed	235 km/hr	240 km/hr
Area surveyed	260 km ²	260 km ²

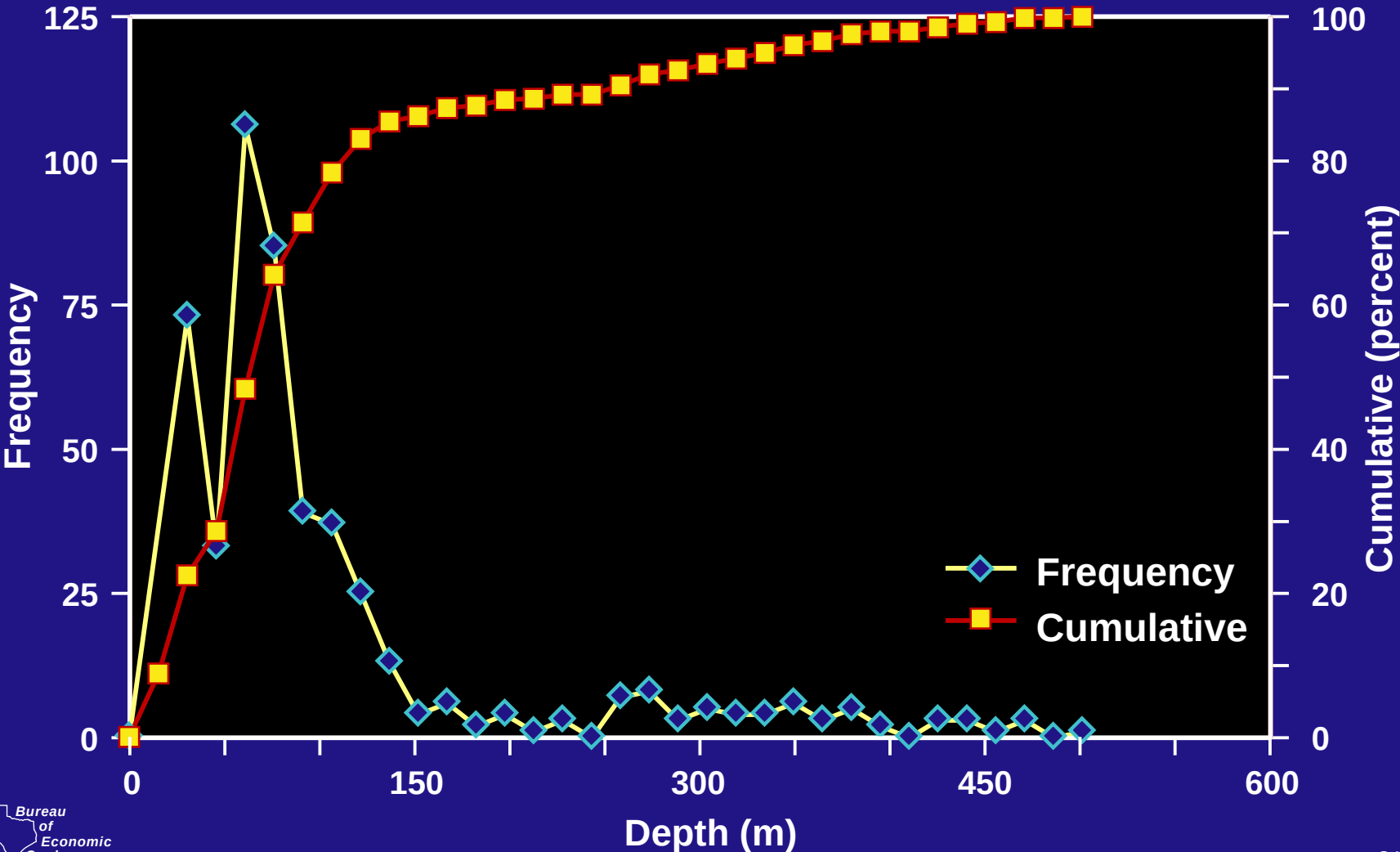
LRGV EM SURVEY

PARAMETER	FAYSVILLE	STOCKHOLM
SYSTEM	GEOTEM	QUESTEM 450
Transmitter loop area	232 m ²	186 m ²
Transmitter loop turns	6	6
Transmitter loop current	500 A	450 A
Transmitter dipole moment	696,000 A-m ²	502,200 A-m ²
Transmitter frequency	30 Hz	25 Hz
Transmitter on time	4.1 ms	4.6 ms
Receiver type	Towed 3 axis	Towed 3 axis
Receiver height	70 m	50 m
Number of recording windows	20	20
Recording time (from end of pulse)	-3.9 to 11.3 ms	0.2 to 15.4 ms
Sample rate	4 Hz	5 Hz
Sample interval	~16 m	~14 m

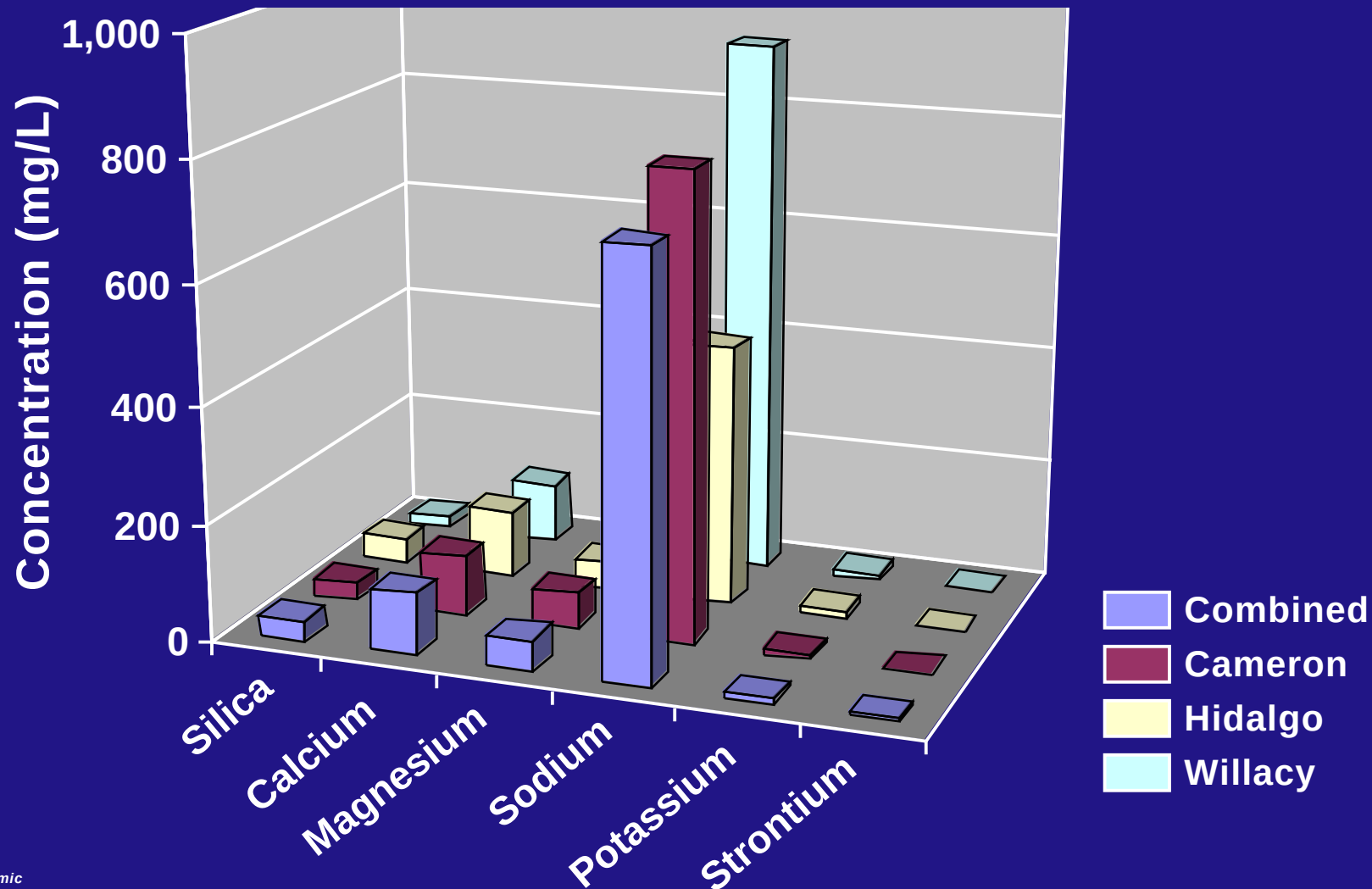
LRGV MAGNETIC SURVEY

PARAMETER	FAYSVILLE	STOCKHOLM
Magnetometer	Towed cesium vapor	Tail-mount cesium vapor
Magnetometer height	73 m	120 m
Sample rate	10 Hz	5 Hz
Sample interval	~7 m	~14 m
Sensitivity	0.01 nT	0.01 nT

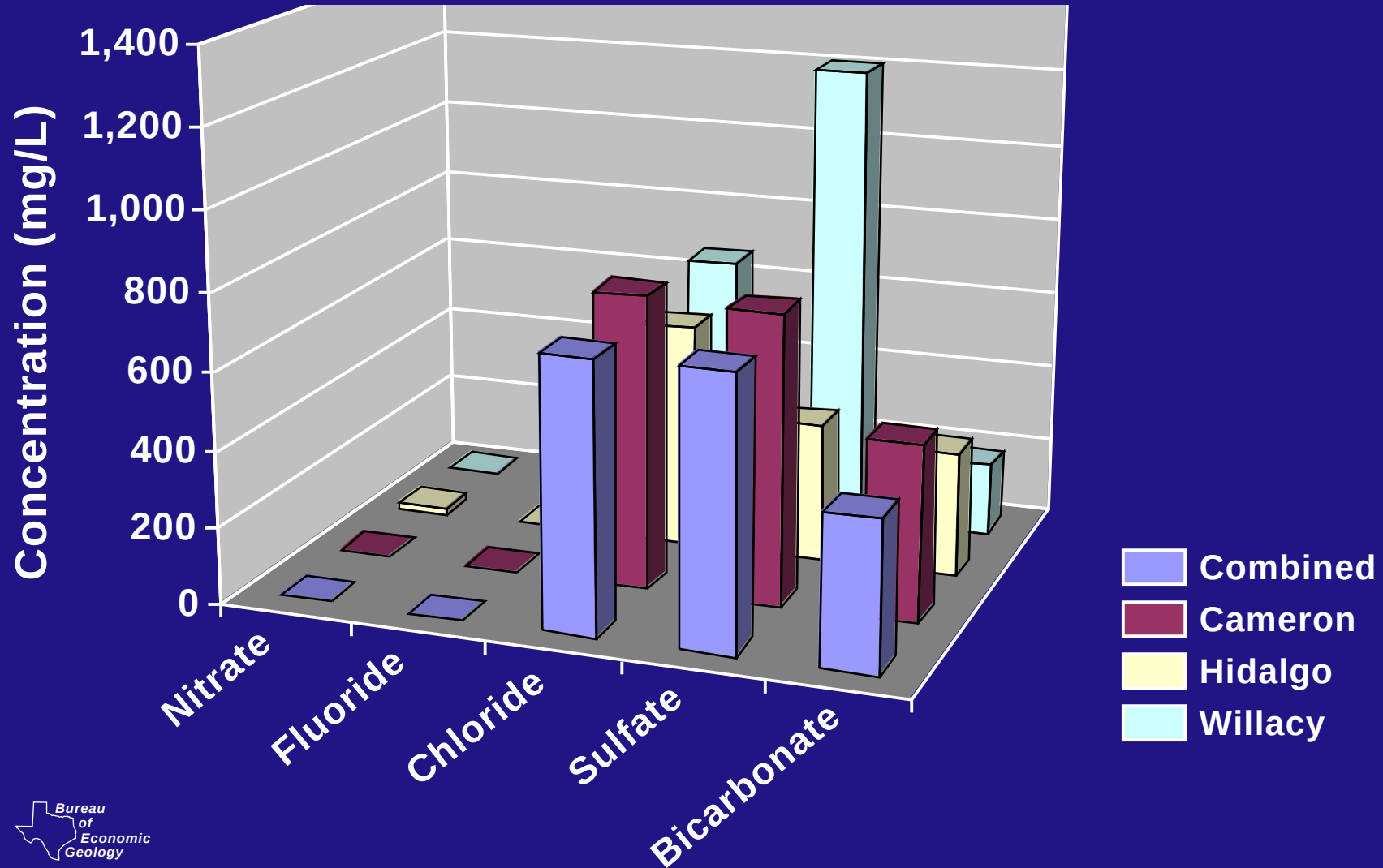
LRGV WELL DEPTHS



ANIONS IN LRGV GROUND WATER



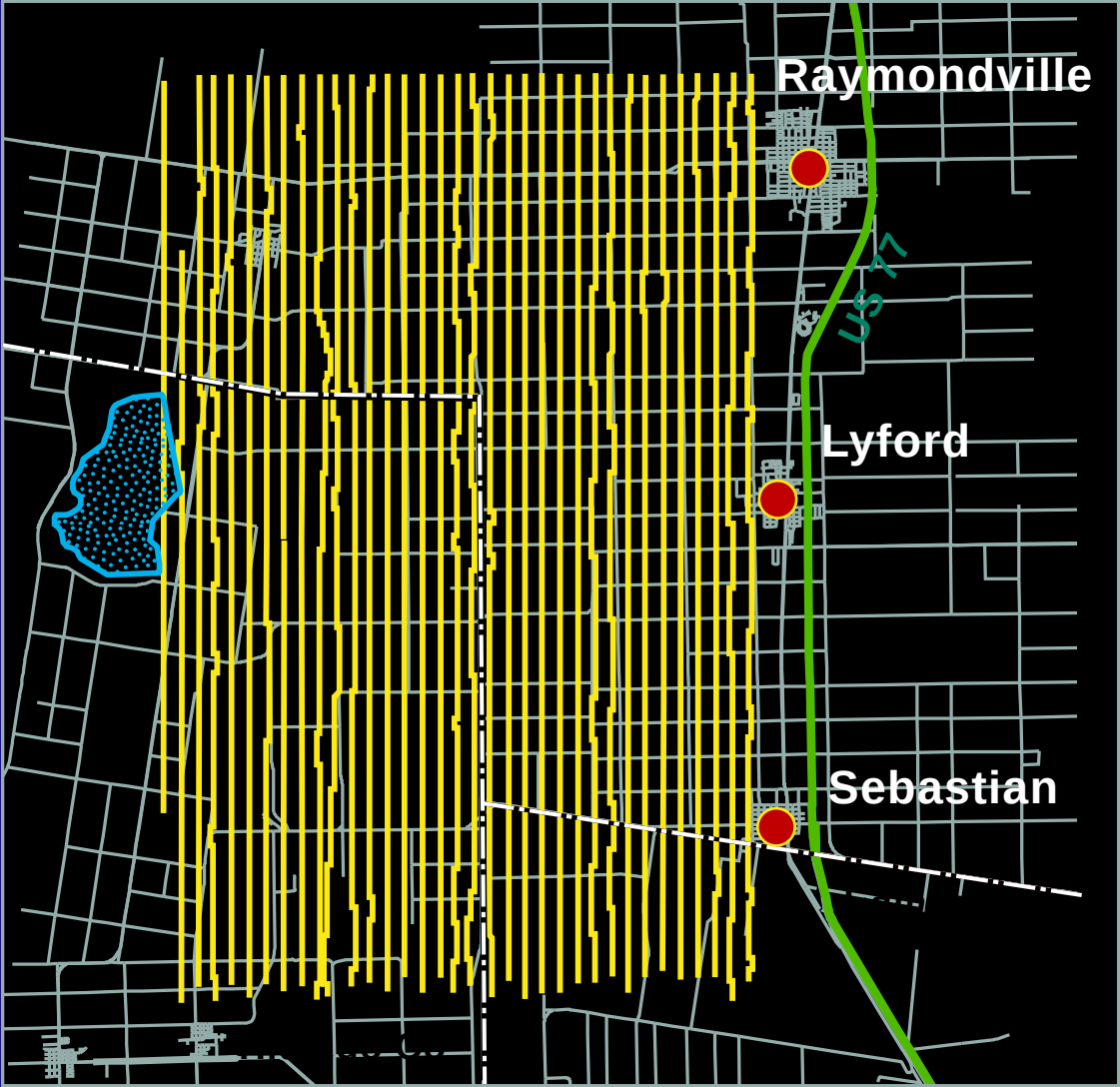
CATIONS IN LRGV GROUND WATER



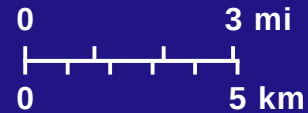
STOCKHOLM AIRCRAFT



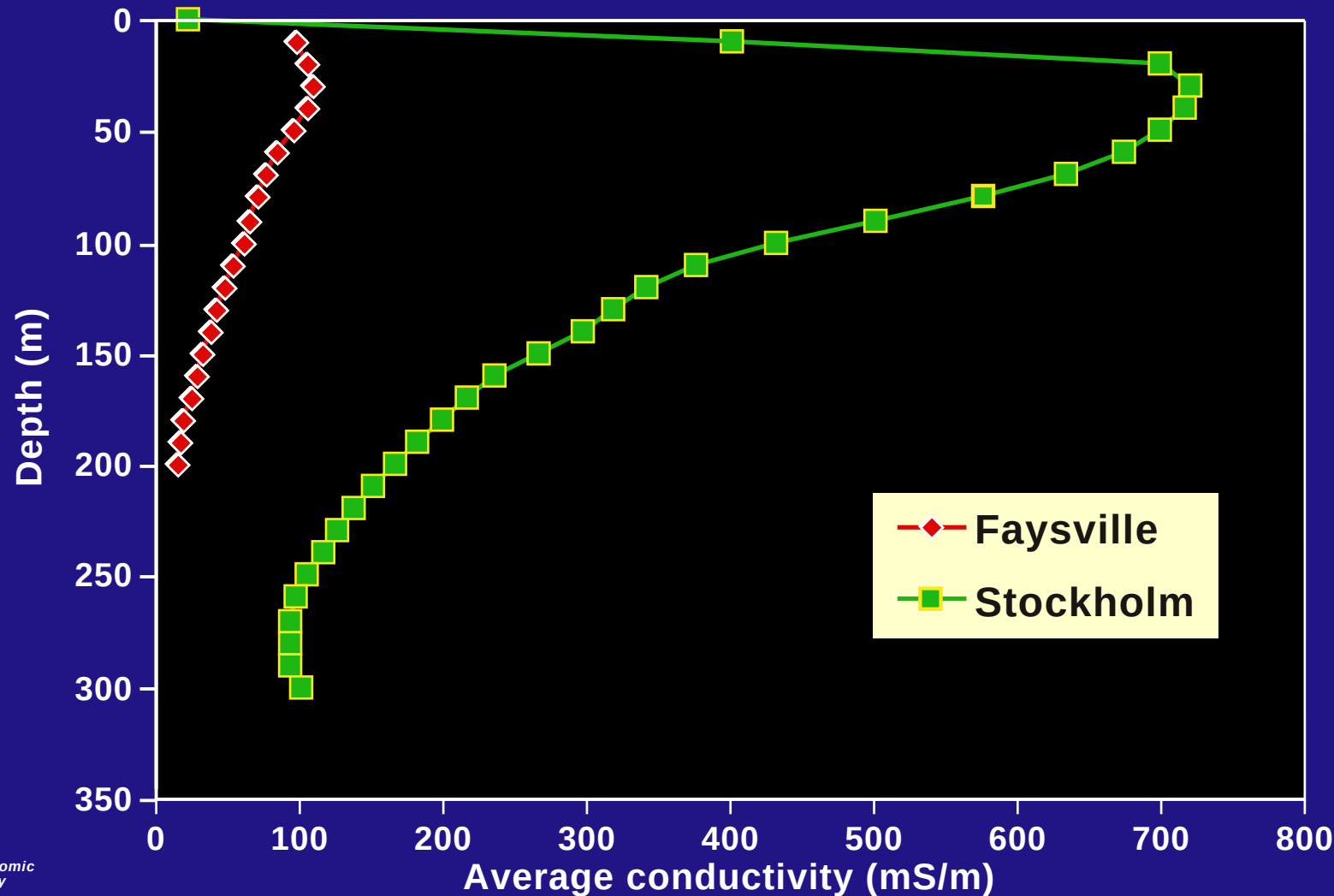
STOCKHOLM FLIGHT LINES



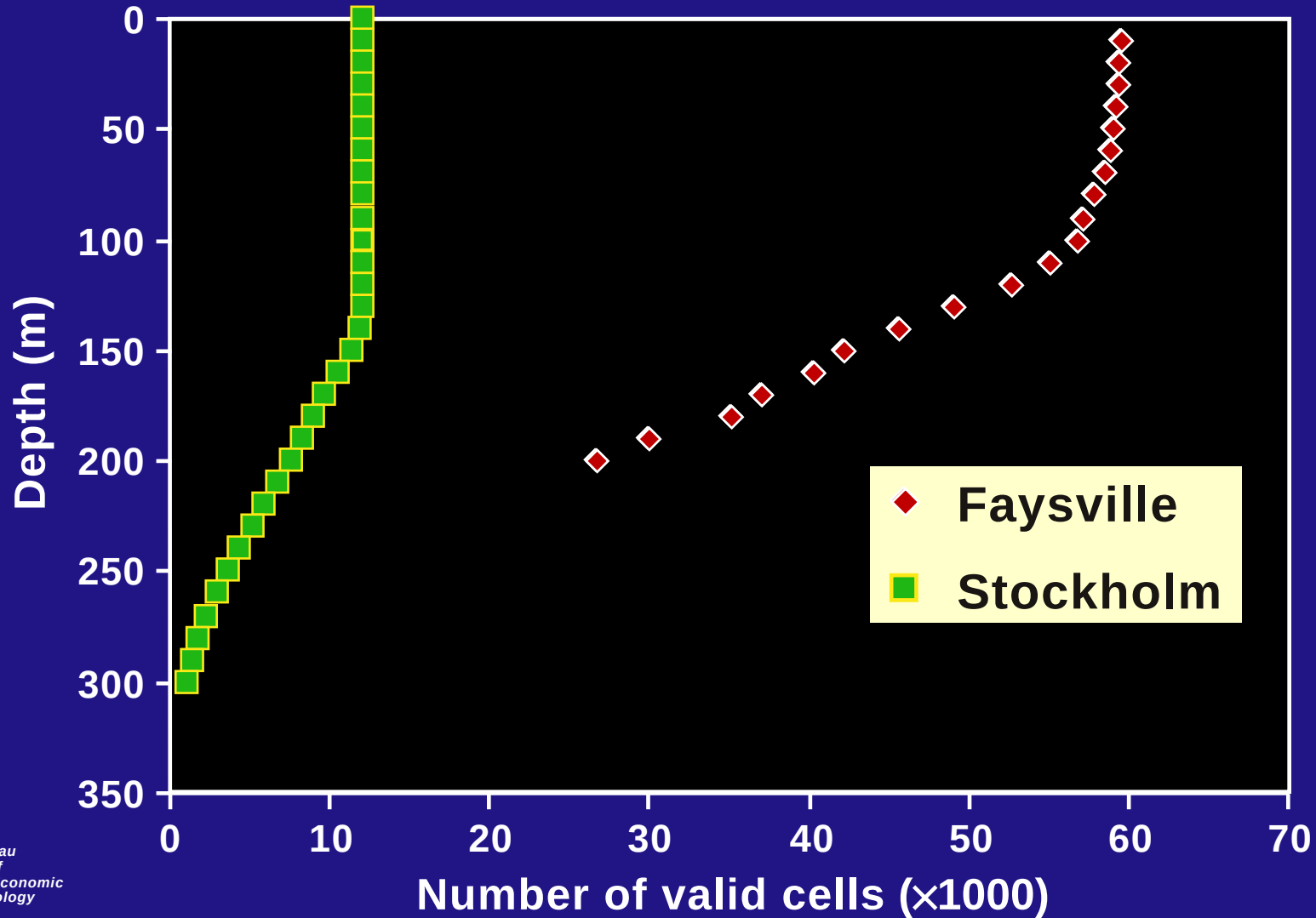
N



AVERAGE CONDUCTIVITY WITH DEPTH



EXPLORATION DEPTH



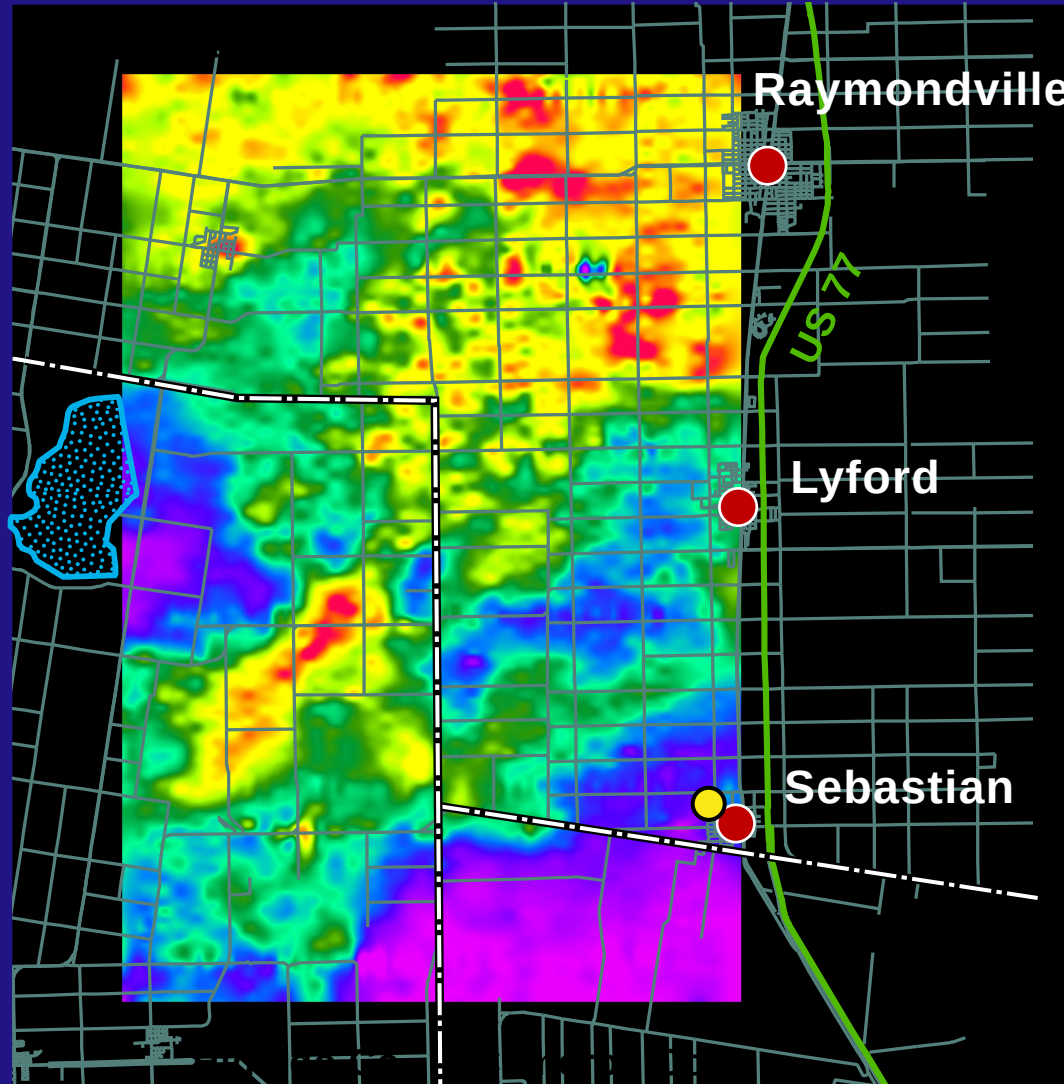
STOCKHOLM DEPTH SLICES

STOCKHOLM DEPTH-SLICE ANIMATION

(click on image to view movie)

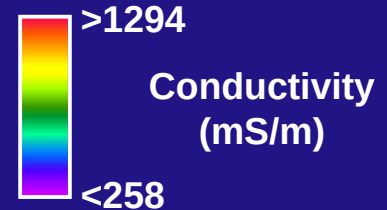
STOCKHOLM DEPTH SLICES

STOCKHOLM CONDUCTIVITY & TDS AT 30m

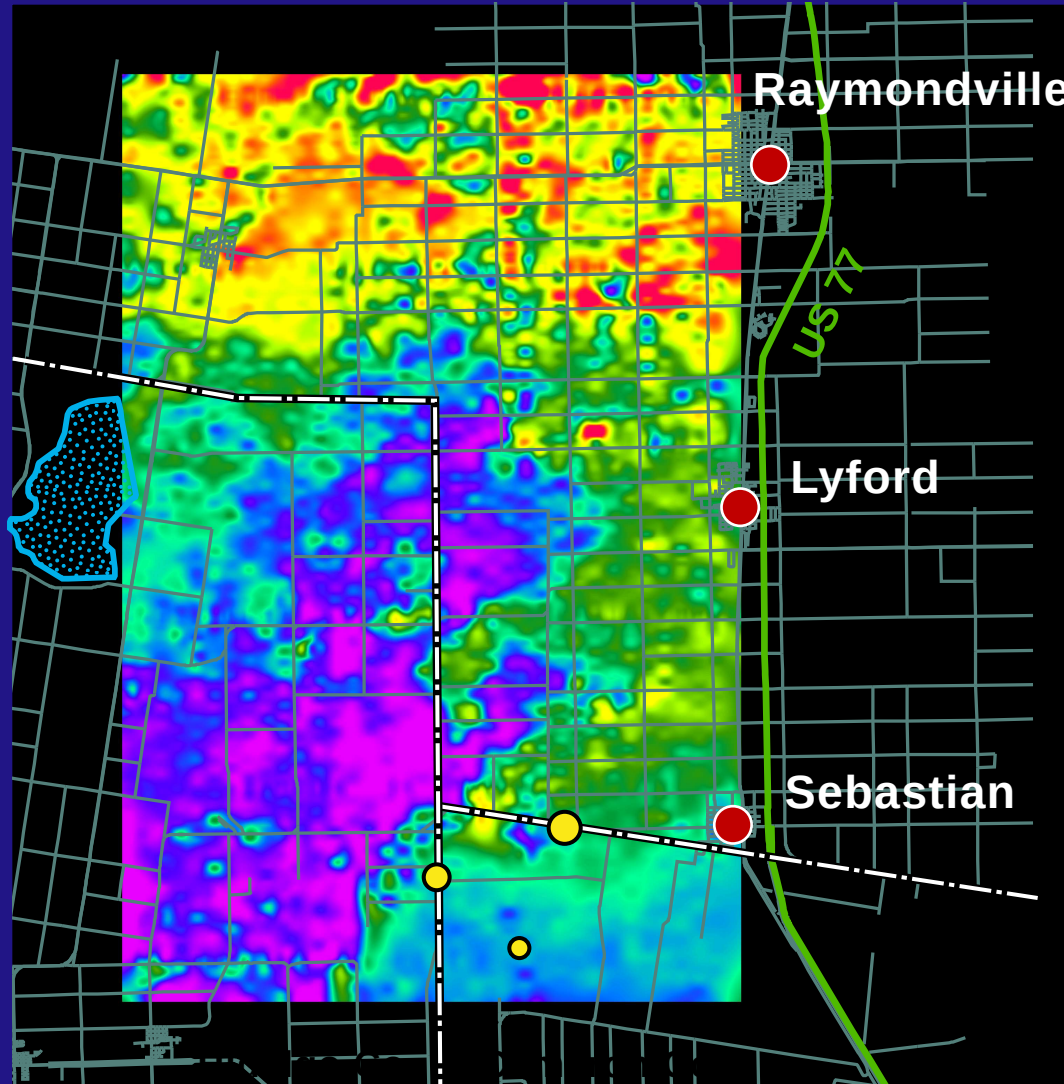


TDS
(Wells 30 to 40m deep)

- 1000 – 1200
- 1200 – 2300
- 2300 – 3200
- 3200 – 3800
- 3800 – 4800

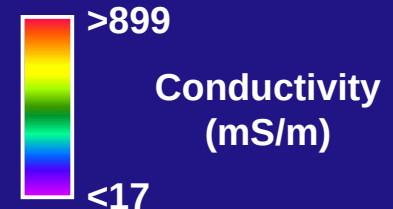


STOCKHOLM CONDUCTIVITY & TDS AT 110m

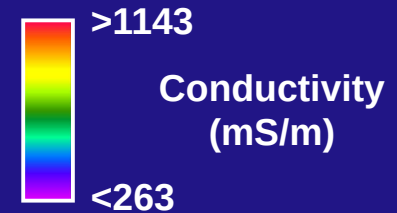
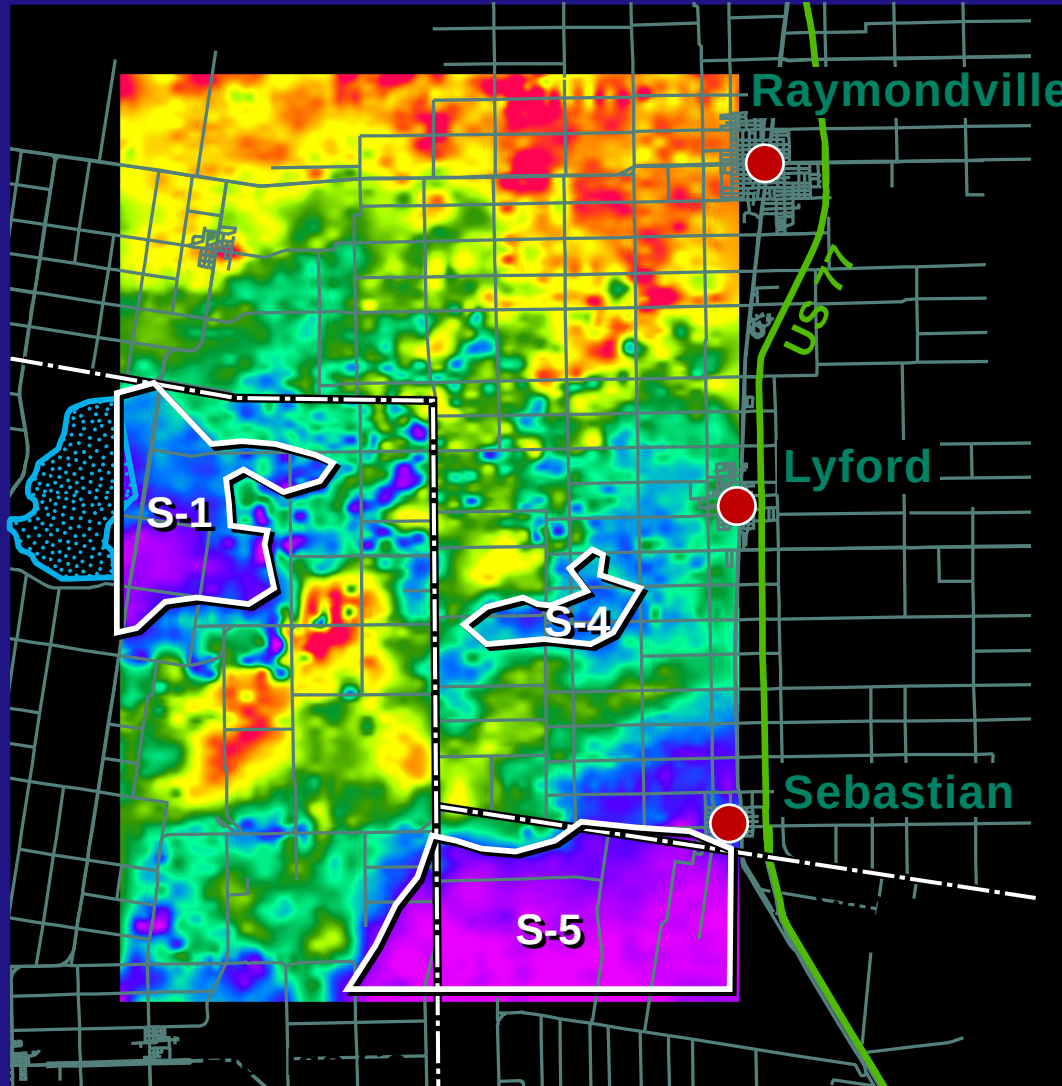


TDS
(Wells 110 to 120 m deep)

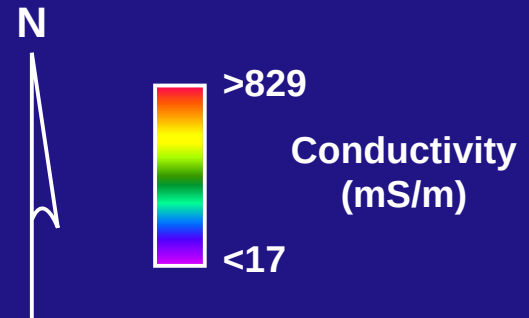
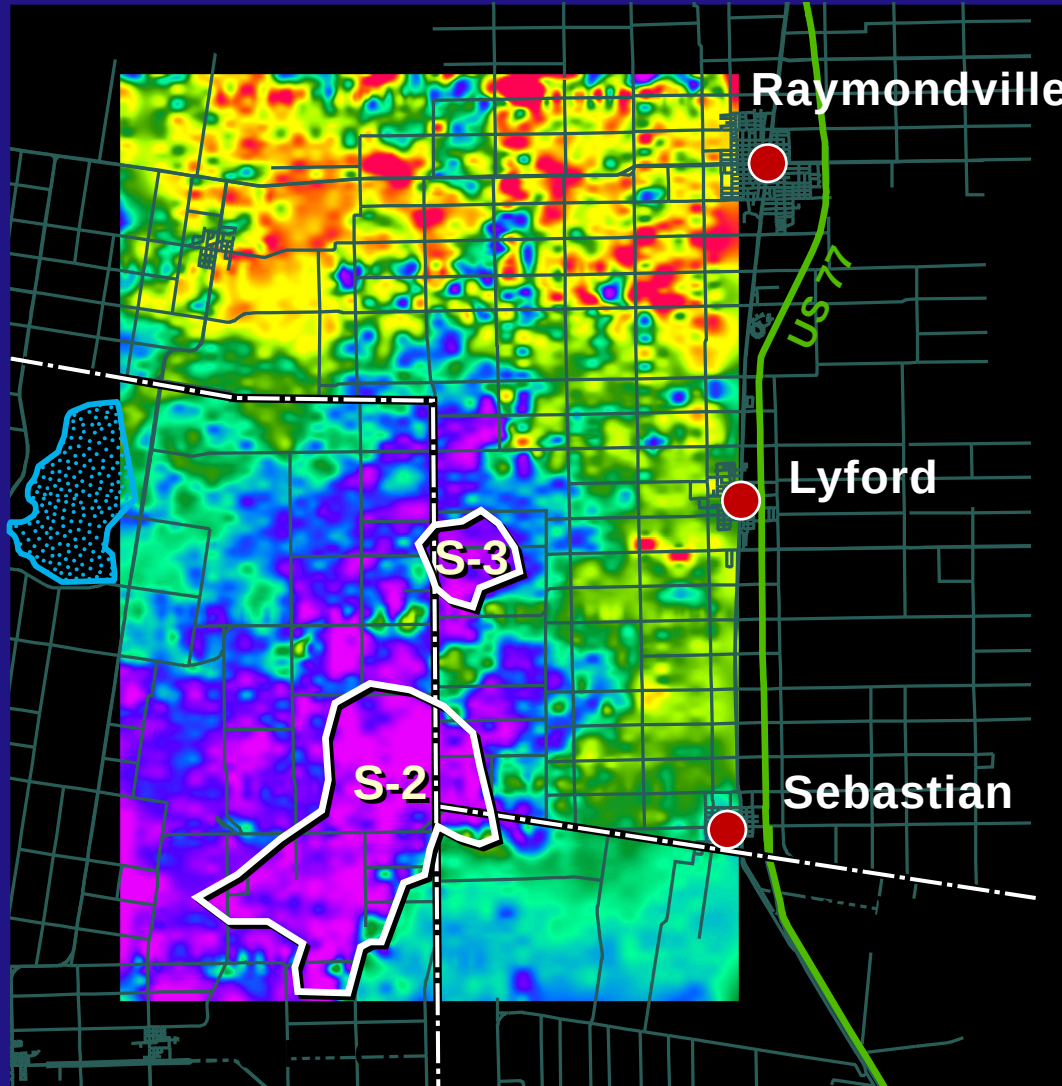
- 1000 – 1200
- 1200 – 2300
- 2300 – 3200
- 3200 – 3800
- 3800 – 4800



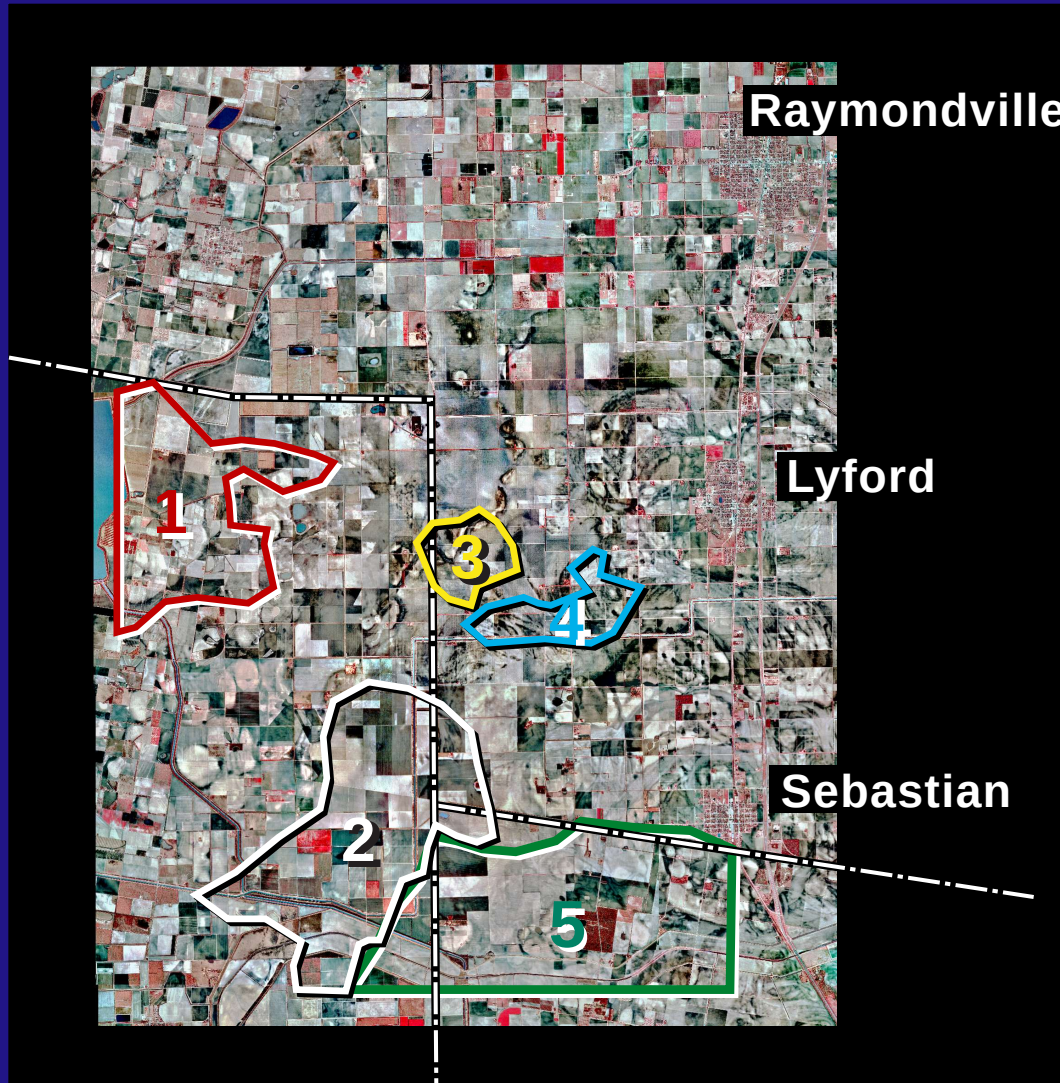
STOCKHOLM CONDUCTIVITY & DRILL SITES AT 60m



STOCKHOLM CONDUCTIVITY & DRILL SITES AT 120m



STOCKHOLM DRILLING AREAS

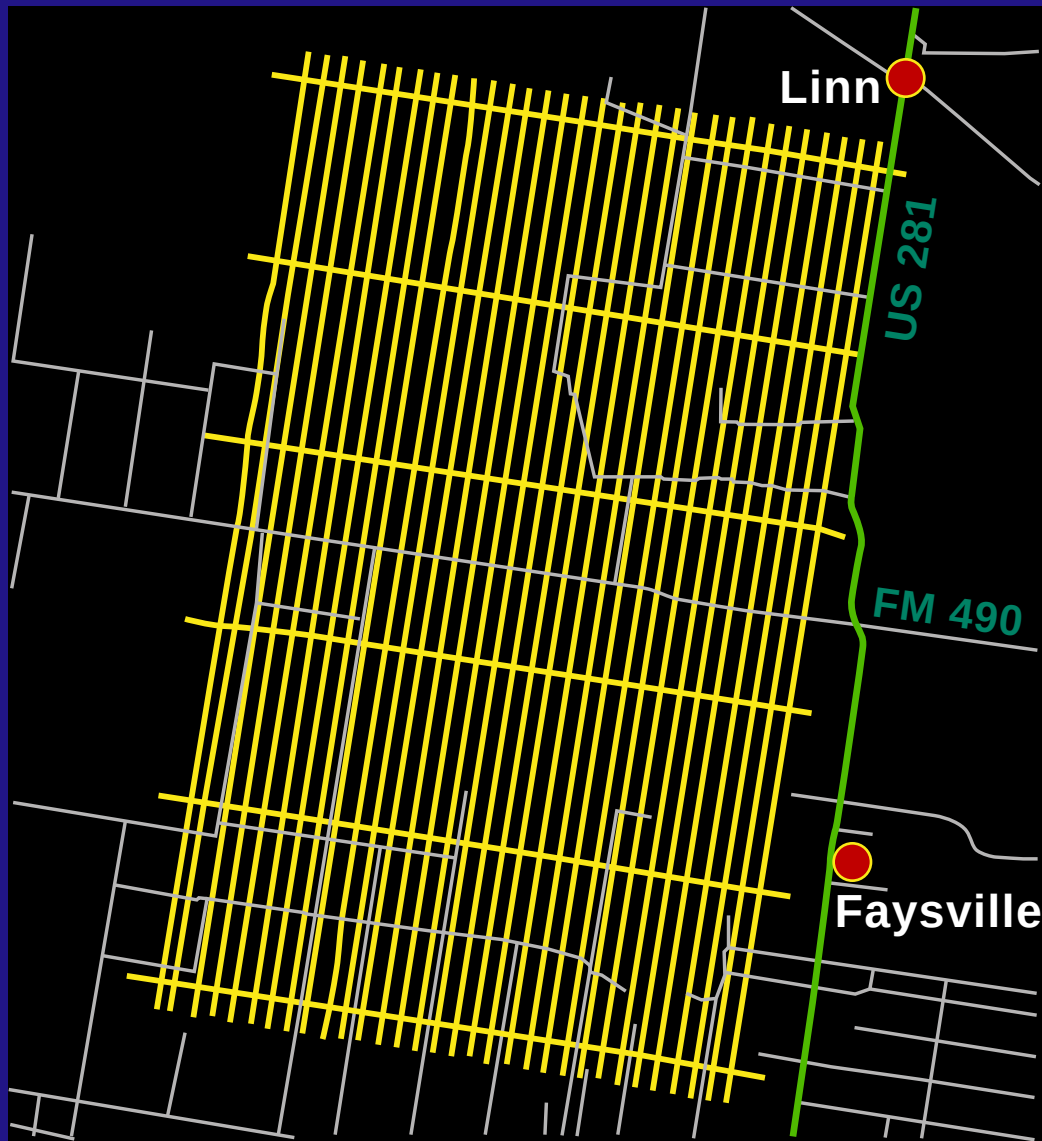


- 1** 20 to 80 m
- 2** 120 to 200 m
- 3** 100 to 200 m
- 4** 30 to 70 m
- 5** 20 to 80 m

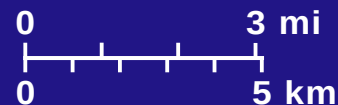


FAYSVILLE AIRCRAFT





FAYSSVILLE FLIGHT LINES

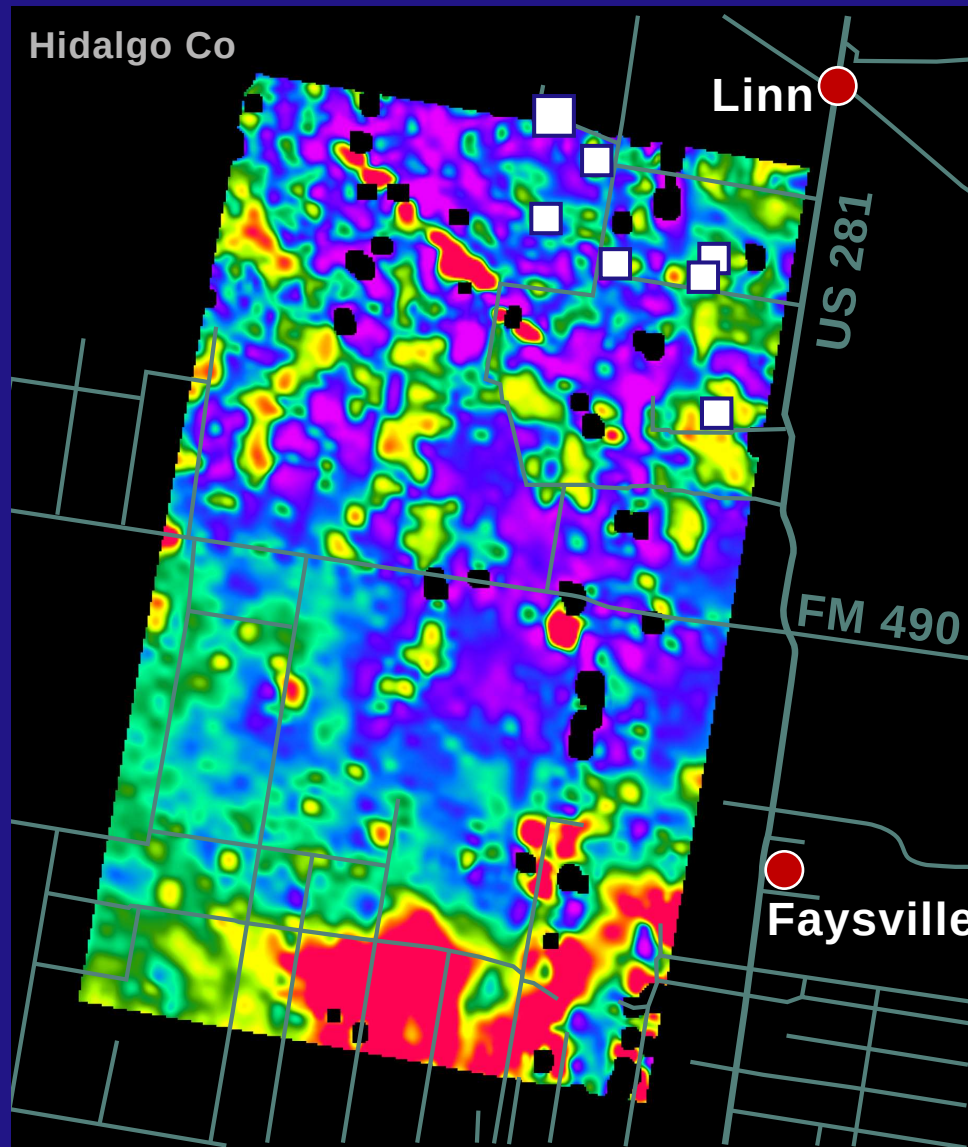


FAYSVILLE DEPTH SLICES

FAYSVILLE DEPTH-SLICE ANIMATION

(click on image to view movie)

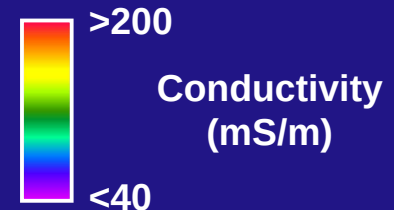
FAYSVILLE DEPTH SLICES

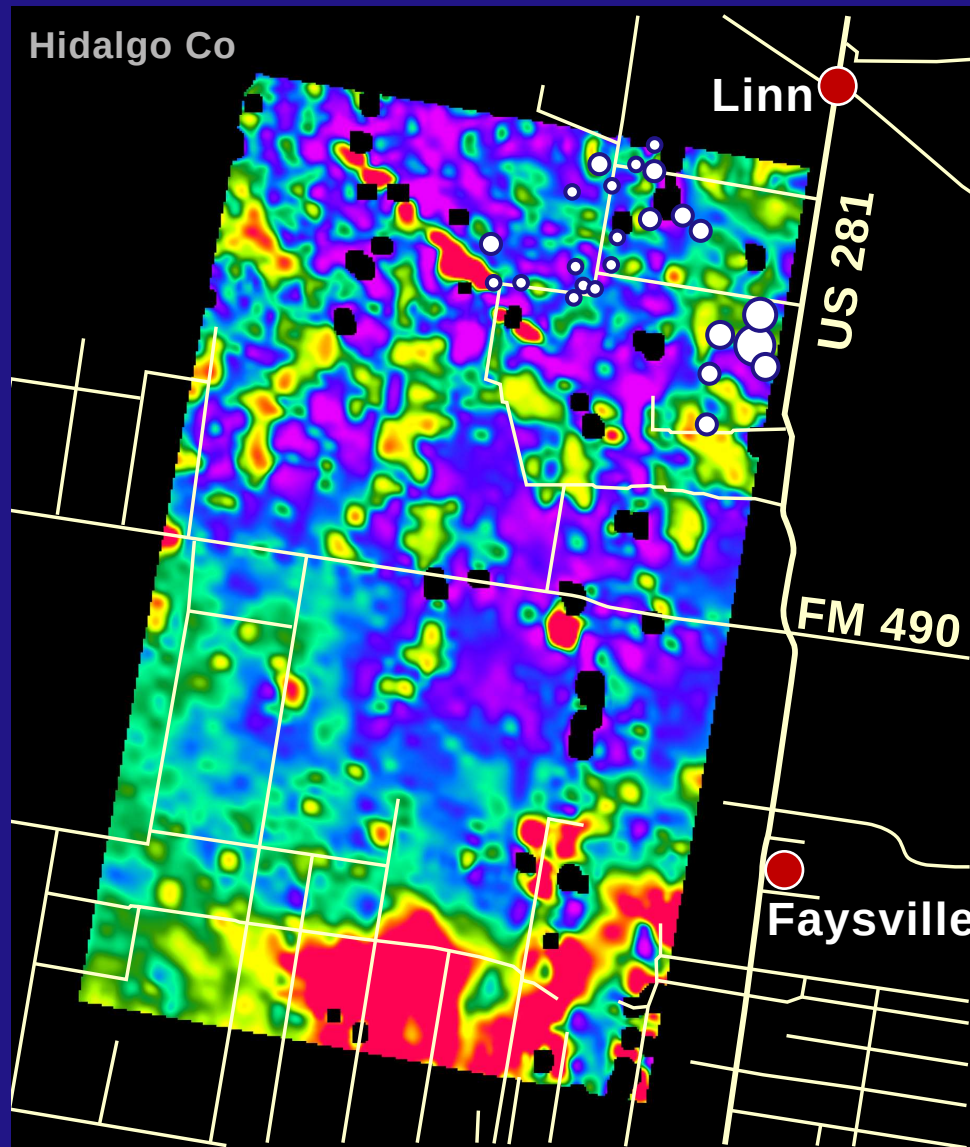


FAYSVILLE CONDUCTIVITY & TEXTURE AT 20m

Drillers log

- Clay
- Silty or sandy clay
- Silt
- Clayey or silty sand
- Sand
- Gravelly sand
- Gravel



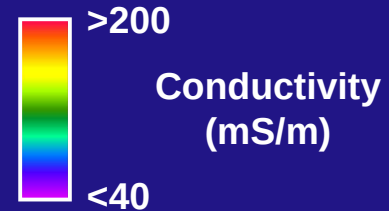


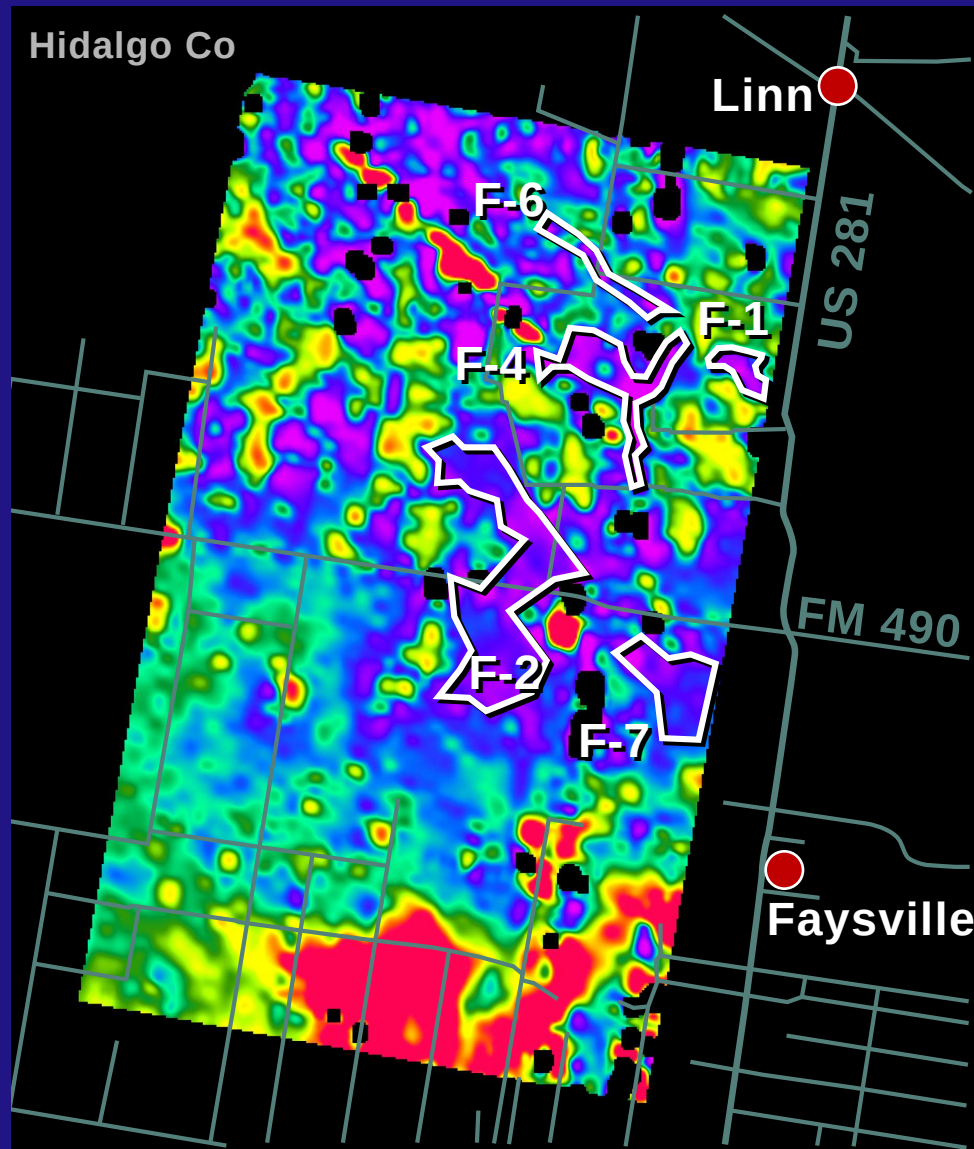
FAYSVILLE CONDUCTIVITY & TDS AT 20m

TDS

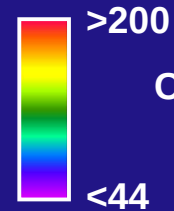
(Wells 20 to 30m deep)

- 650 – 1000
- 1000 – 1200
- 1200 – 1400
- 1400 – 1600
- 1600 – 1900





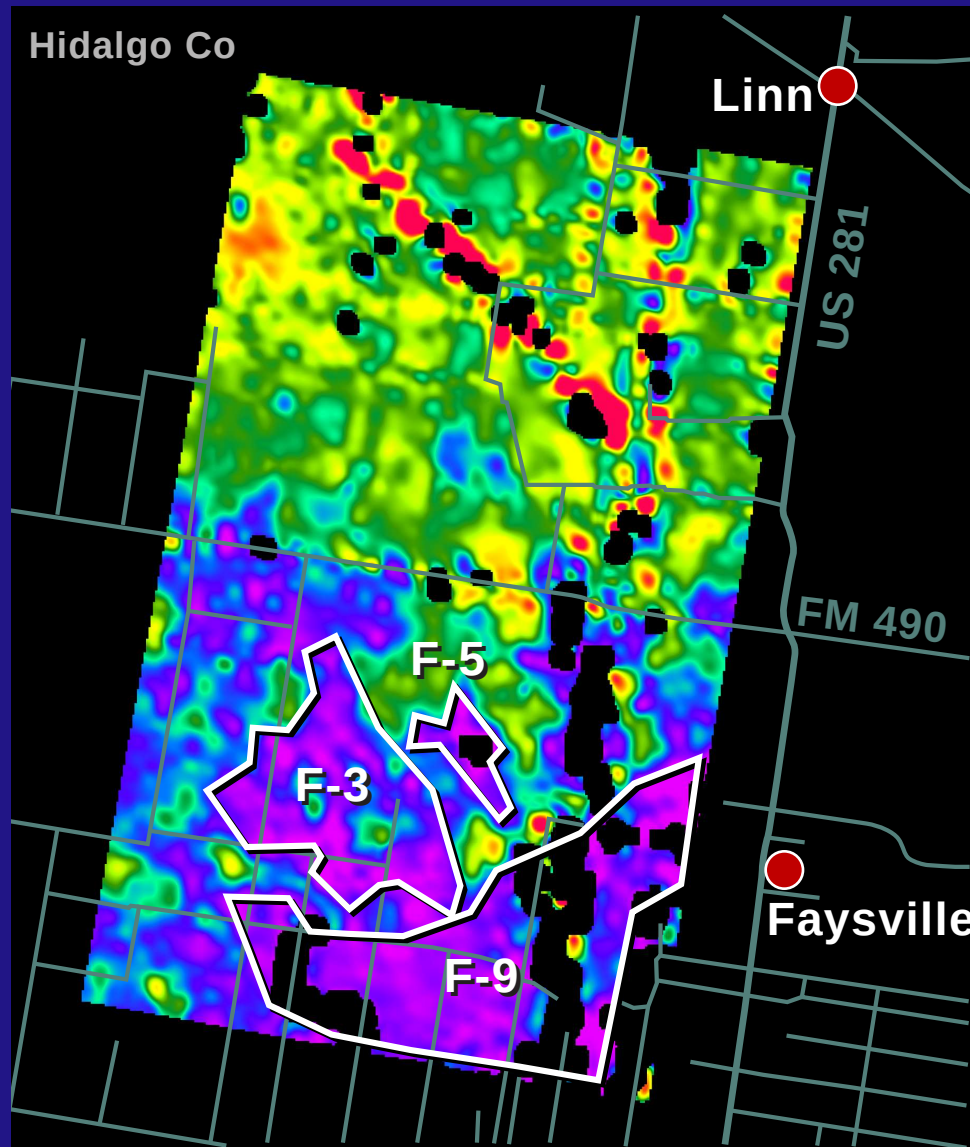
FAYSVILLE CONDUCTIVITY & DRILL SITES AT 30m



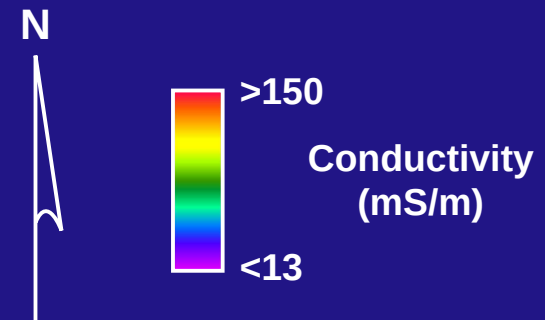
Conductivity
(mS/m)



QAc6794c



FAYSVILLE CONDUCTIVITY & DRILL SITES AT 90m



Hidalgo Co



Linn

Faysville

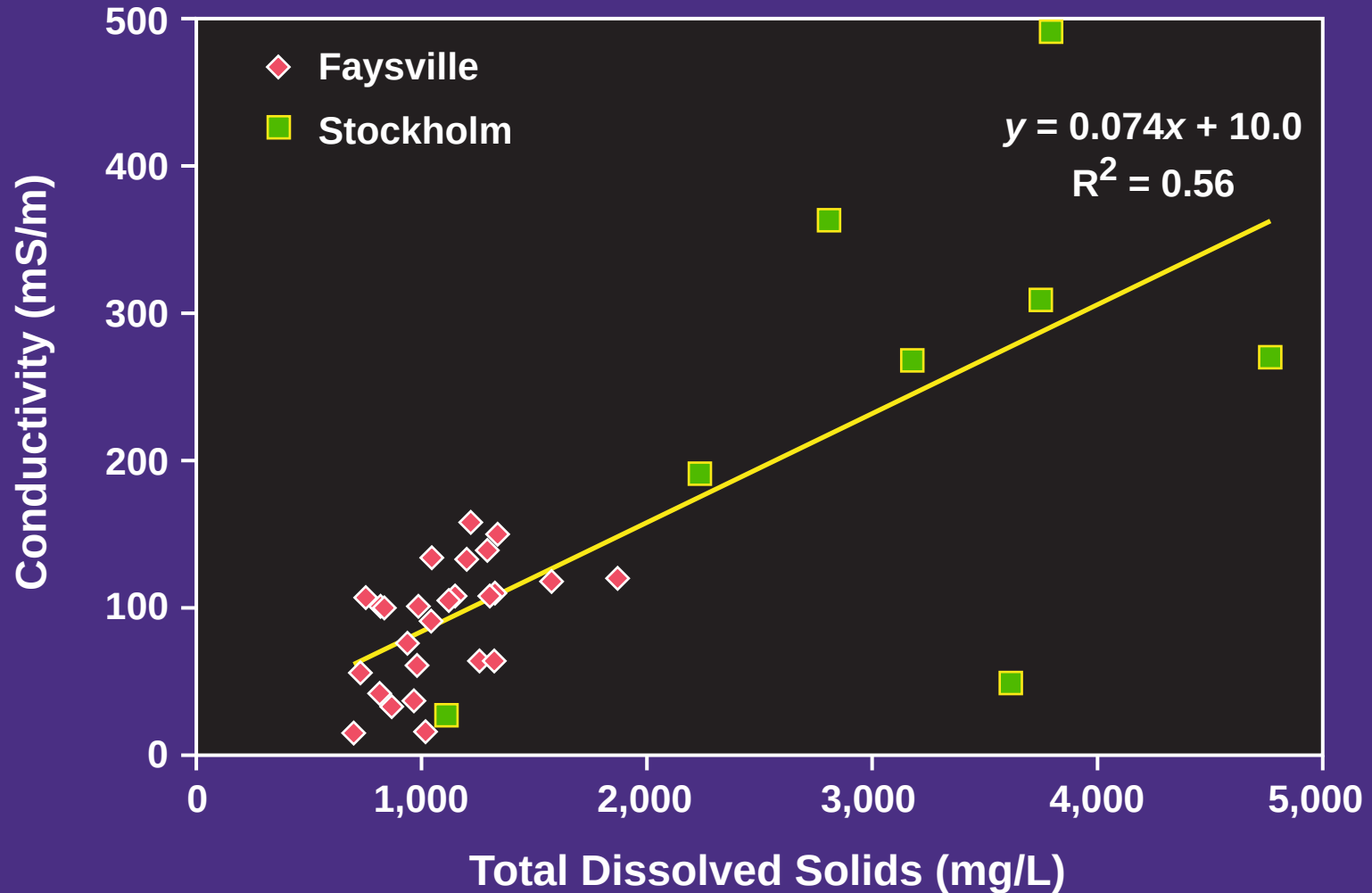
FAYSVILLE DRILLING AREAS

- | | |
|---|---------------|
| 1 | 10 to 50 m |
| 2 | 10 to 50 m |
| 3 | 50 to >130 m |
| 4 | 20 to 50 m |
| 5 | 50 to >130 m |
| 6 | 10 to 60 m |
| 7 | 10 to 60 m |
| 8 | 100 to >180 m |
| 9 | 70 to >140 m |



QAc6796c

TDS vs. AIRBORNE CONDUCTIVITY



SUMMARY

- Airborne EM can be used to explore to depths of 150 to 300m in fresh to moderately saline coastal plain aquifers
- Depositional patterns can be detected and environments inferred from airborne EM if the surveys are flown at appropriate line spacing and orientation
- Ground-water quality (as measured by TDS) appears to correlate to conductivity derived from airborne EM data
- Anomaly shapes and conductivity contrasts can be used to interpret likely water-resource quality by combining geological and hydrological concepts
- Airborne EM surveys are a realistic alternative to drilling and seismic surveys to investigate Quaternary depositional systems