INNOVATIVE METHODOLOGY FOR DETECTION OF FRACTURE-CONTROLLED SWEET SPOTS IN THE NORTHERN APPALACHIAN BASIN

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TOPICAL REPORT #3

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ABSTRACT

This Topical Report (#3 of 9) consists of the figures 3.2-6 to (and including) 3.5-52 (and appropriate figure captions) that accompany the Final Technical Progress Report entitled: "Innovative Methodology for Detection of Fracture-Controlled Sweet Spots in the Northern Appalachian Basin" for DOE/NETL Award DE-AC26-00NT40698.

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FIGURE 3.3-1. **Location Map for the Soil Gas Analyses in Figure 3.3-2.**
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FIGURE 3.3-2. **Soil Gas Analyses Along the N-S Seneca Lake Traverse.**
Soil gas samples were collected and analyzed every 10 m. Anomalous concentrations of soil gas are shown as spikes along the traverse. Spike length is proportional to the soil gas concentration measured at that location. High concentrations show up as bars orthogonal to the traverse. Location shown in figure 3.3-1.

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In the upper panel, averaged (1 km window) fracture frequency is displayed for E- and ENE-striking fractures. In the middle panel the number lineaments that trend E and ENE are averaged over 1.32 km. In the lower panel the number of soil gas significant anomalies ("spikes") are averaged over a 1 km window. For location of the transect, see Figure 2.1-4.

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FIGURE 3.4-1. **Interpretation of Part of Seismic Line #1 Across the Glodes Corners Road Field.**

Note the well-imaged graben in the Trenton/Black River section. Arrows indicate selected paleo-cuestas (hogbacks) onlapped by the basal Cambrian (?) reflector. G indicates Glodes Corners Road graben. For approximate location of seismic line, see Figure 2.4-1 (exact location not revealed to preserve the proprietary nature of the data).

FIGURE 3.4-2. **Interpretation of Part of Seismic Line #1 Across the Muck Farm Field.**
Note the well-imaged graben in the Trenton/Black River section. For approximate location of seismic line, see Figure 2.4-1 (exact location not revealed to preserve the proprietary nature of the data).

FIGURE 3.4-3. **Interpretation of Seismic Line #2.**
Reflector offsets on the various faults are compiled in Table 1. Note the well-imaged grabens in the Trenton/Black River section (e.g., between faults 5 and 7). Faults S1 to S5 are thrusts in the Firtree Anticline that ramp up from the salt decollement; the salt-cored anticline is observable in the Onondaga reflector. For approximate location of seismic line, see Figure 2.4-1 (exact location not revealed to preserve the proprietary nature of the data).

FIGURE 3.4-4. **Interpretation of Seismic Line #3.**
A possible Trenton/Black River graben is located at "A". For approximate location of seismic line, see Figure 2.4-1 (exact location not revealed to preserve the proprietary nature of the data).

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FIGURE 3.5-1. **Sample of Part of Seismic Line 2, Interpreted.**
Line overlaps with Figure 3.5-2. Complete seismic line with shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-2. **Sample of Part of Seismic Line 2, Interpreted.**
Line overlaps with Figure 3.5-1. Complete seismic line with shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

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Model based on logs from a Black River test well in the study region, and seismic picks, used for inversion of seismic line 2. Shot points and depths not shown in order to preserve the proprietary nature of the data.

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FIGURE 3.5-41. **Close-up of Inversion Results on Part of Seismic Line 2.**
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FIGURE 3.5-42. **Close-up of Inversion Results on Part of Seismic Line 2.**
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FIGURE 3.5-43. **Flattened Inversion Results for Part of Seismic Line 2.**
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FIGURE 3.5-44. **Inversion Results for Part of Seismic Line 2.**
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FIGURE 3.5-45. **Comparison of Borehole Image Log and Acoustic Impedance Log.**

Data collected at a T/BR test well in the region. Depths not shown in order to preserve the proprietary nature of the data.

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FIGURE 3.5-47. **Close-up of Inversion Results for Part of Seismic Line 2.**
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FIGURE 3.5-48. **Inversion Results for Part of Seismic Line 2.**
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FIGURE 3.5-49. **Time-Depth Calibration, Acoustic Impedance and Borehole Image Logs, Upper Black River Section.**
Data from one of the T/BR test wells in the region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-50. **Time-Depth Calibration, Acoustic Impedance and Borehole Image Logs, Middle Shaly Black River Section.**
Data from one of the T/BR test wells in the region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-51. **Close-up of Inversion Results for Part of Seismic Line 2 with FMI Log and AI overlay.**
Focus is on the porous interval. This part of seismic line 2 is shown in Figure 3.5-48. Shot points and depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-52. **Close-up of Inversion Results for Part of Seismic Line 2.**
Log overlay focuses on the middle Black River shaly interval. This part of seismic line 2 is shown in Figure 3.5-48. Shot points and depths not shown in order to preserve the proprietary nature of the data.

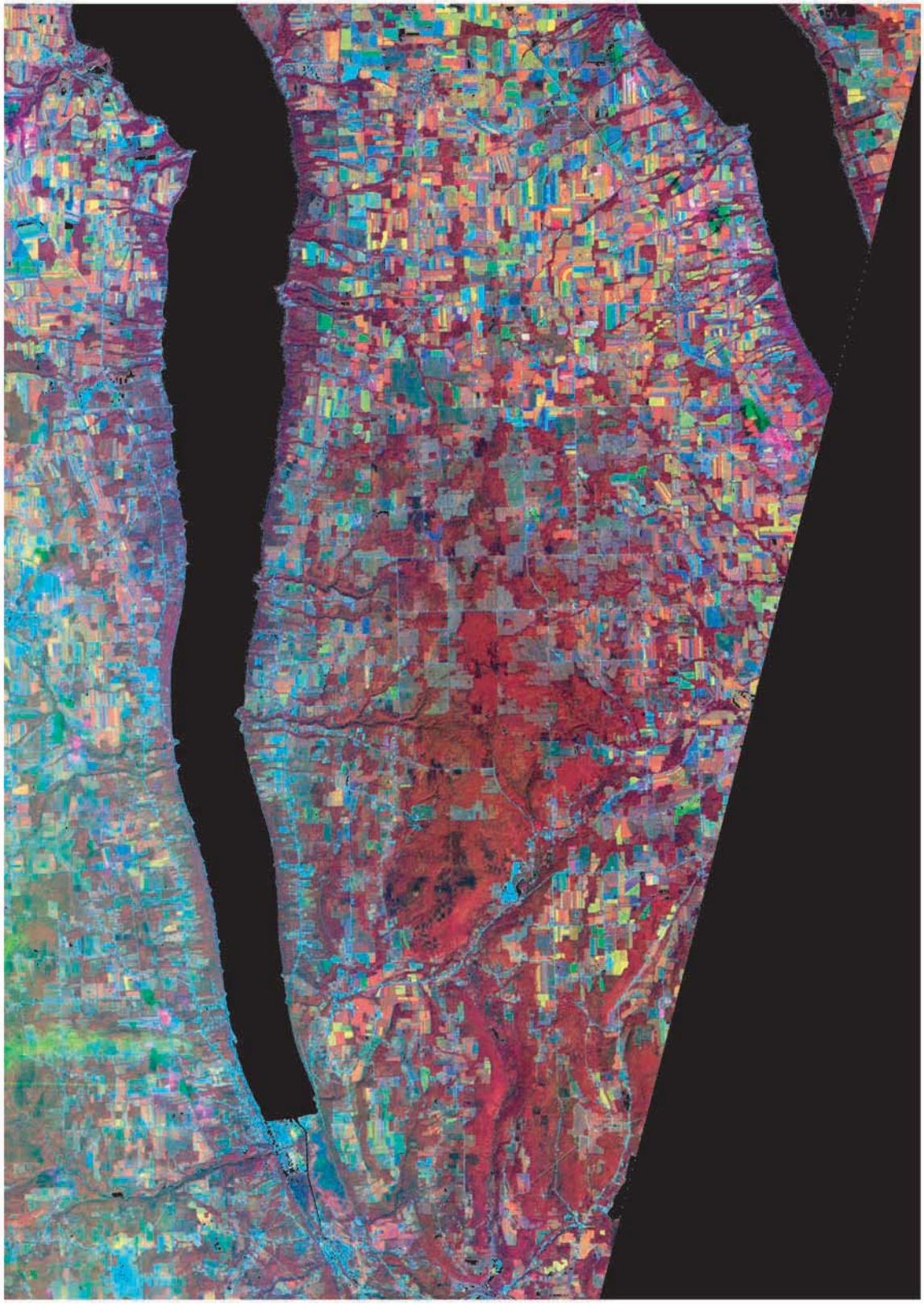


FIGURE 3.2-6a

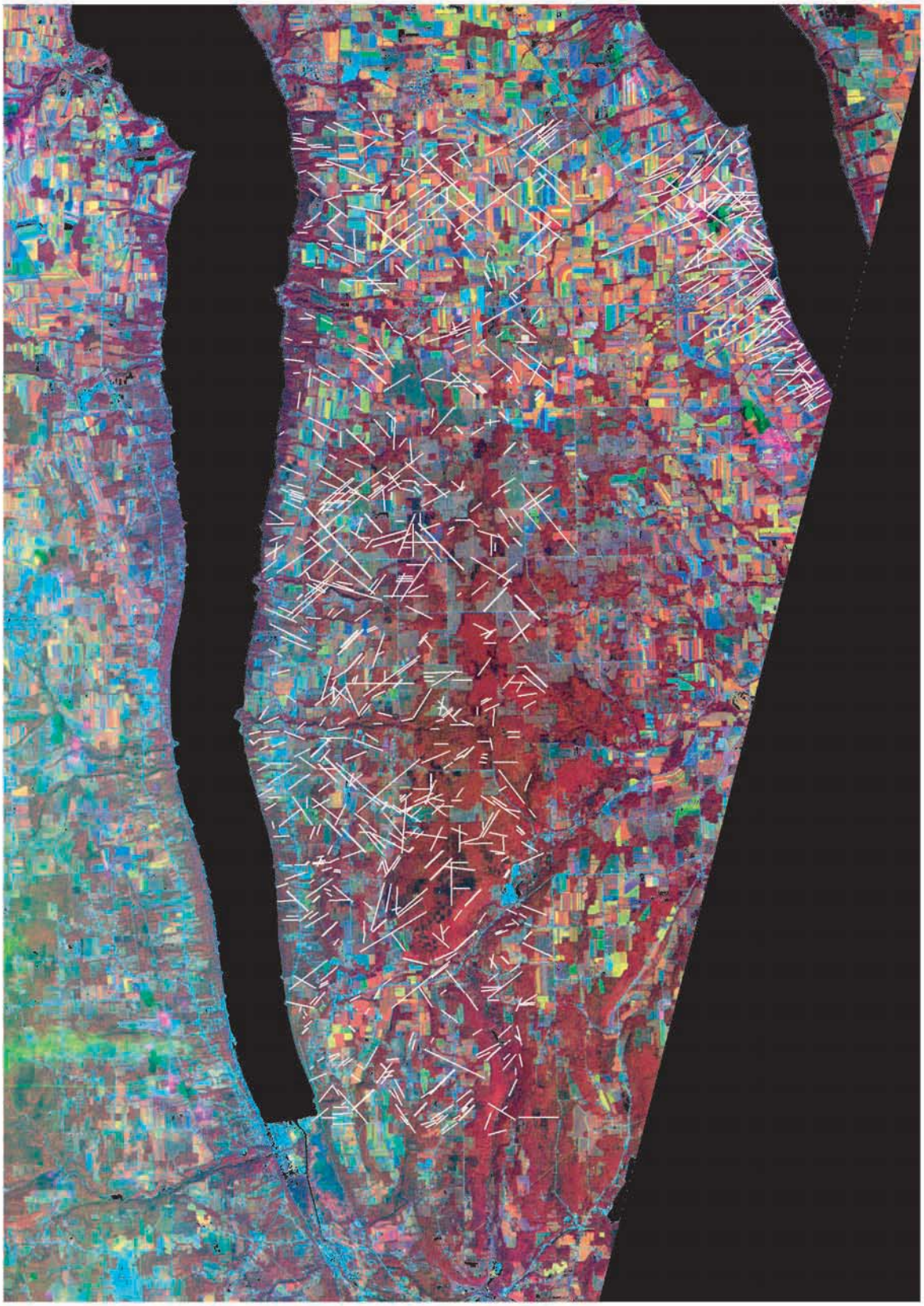


FIGURE 3.2-6b

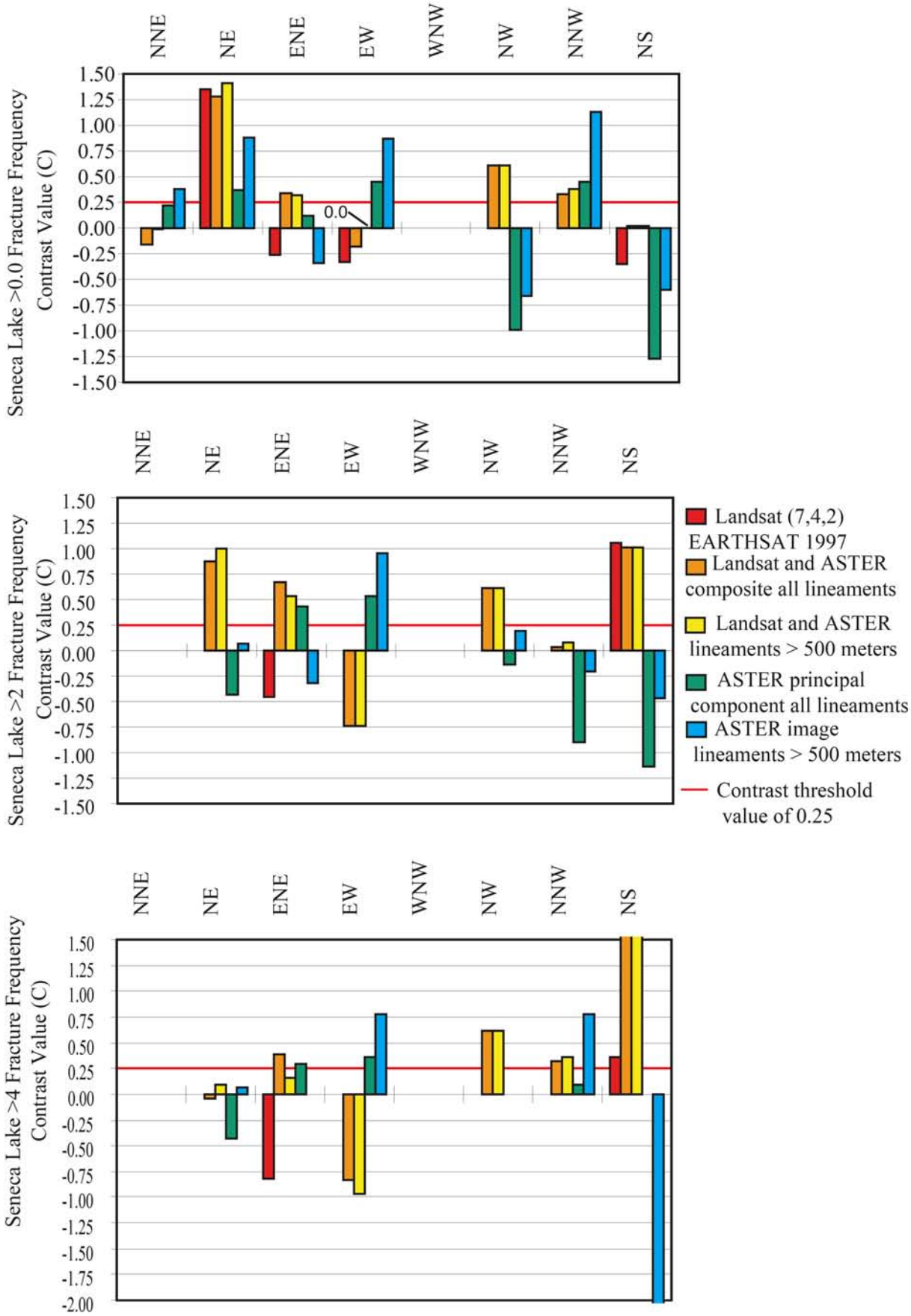

NNE
NE
ENE
EW
WNW
NW
NNW
NS
Seneca Lake >0.0 Fracture Frequency Contrast Value (C)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
-1.25
-1.50
0.0
Seneca Lake >2 Fracture Frequency Contrast Value (C)
Landsat (7,4,2) EARTHSAT 1997
Landsat and ASTER composite all lineaments
Landsat and ASTER lineaments > 500 meters
ASTER principal component all lineaments
ASTER image lineaments > 500 meters
Contrast threshold value of 0.25
Seneca Lake >4 Fracture Frequency Contrast Value (C)
-1.75
-2.00

FIGURE 3.2-7

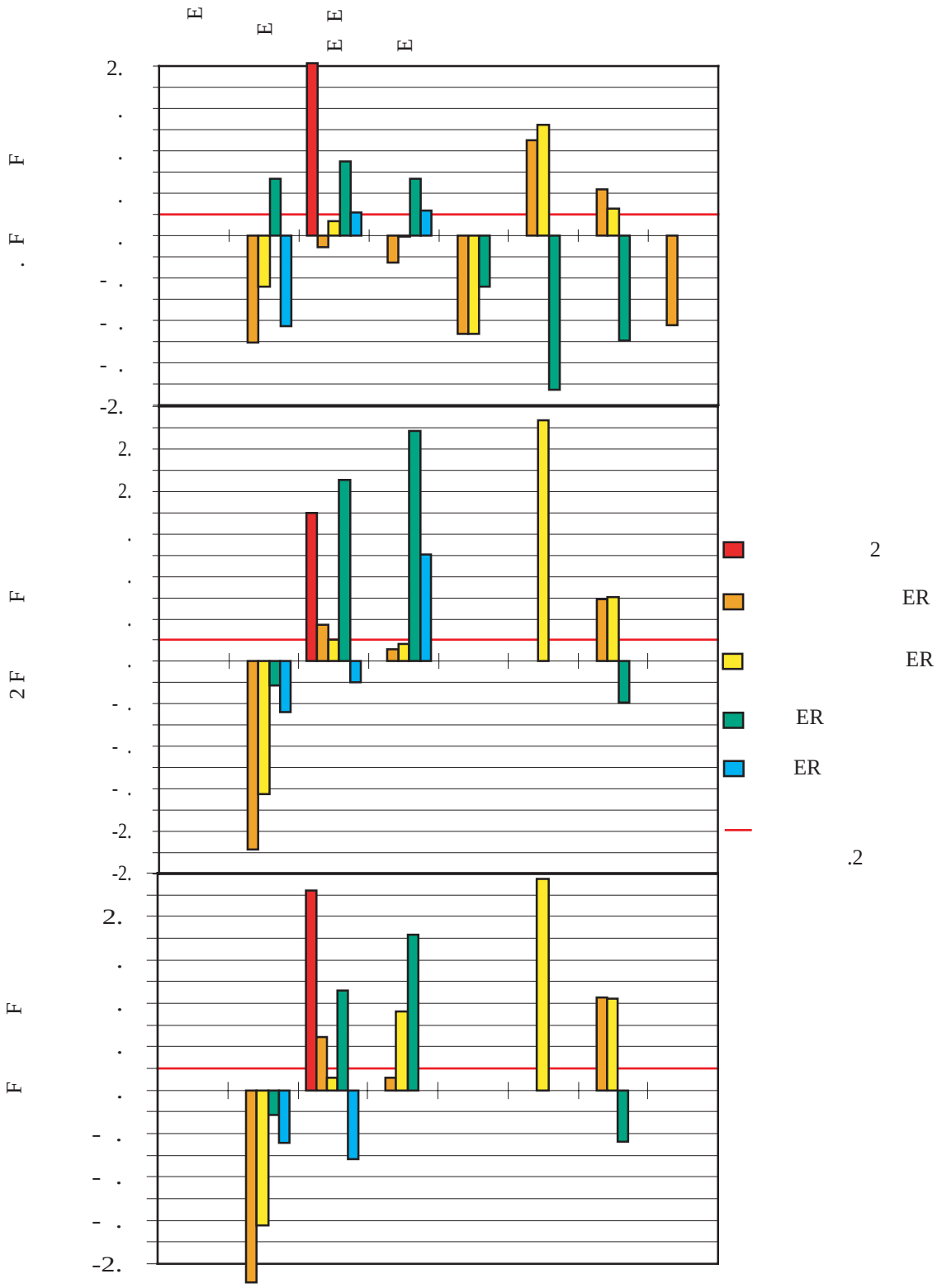


FIGURE 3.2-

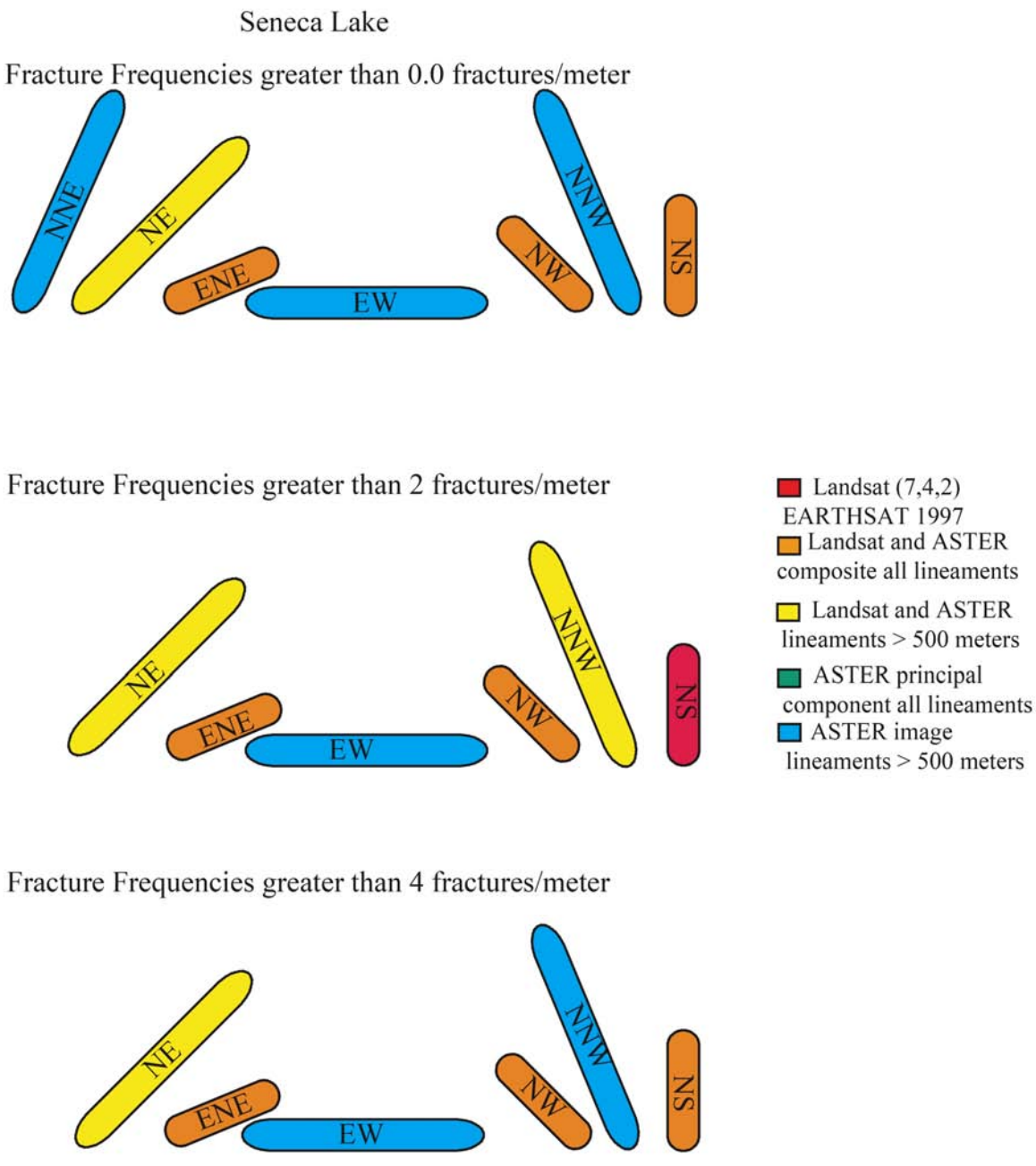
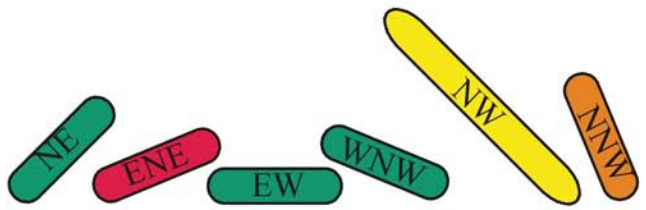

Seneca Lake
Fracture Frequencies greater than 0.0 fractures/meter
NNE
NE
ENE
EW
NW
NNW
NS
Fracture Frequencies greater than 2 fractures/meter
NE
ENE
EW
NW
NNW
NS
Fracture Frequencies greater than 4 fractures/meter
NE
ENE
EW
NW
NNW
NS
Landsat (7,4,2) EARTHSAT 1997
Landsat and ASTER composite all lineaments
Landsat and ASTER lineaments > 500 meters
ASTER principal component all lineaments
ASTER image lineaments > 500 meters

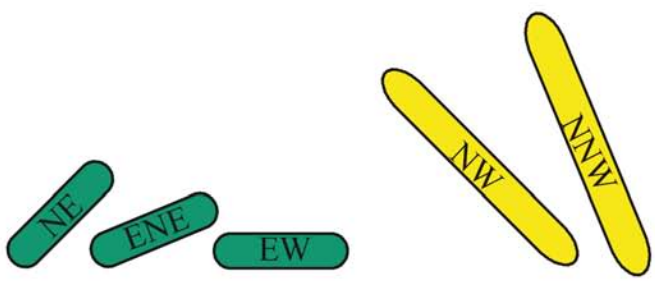
FIGURE 3.2-9a

Cayuga Lake

Fracture Frequencies greater than 0.0 fractures/meter



Fracture Frequencies greater than 2 fractures/meter



Landsat (7,4,2) EARTHSAT 1997

Landsat and ASTER composite all lineaments

Landsat and ASTER lineaments > 500 meters

ASTER principal component all lineaments

ASTER image lineaments > 500 meters

Fracture Frequencies greater than 4 fractures/meter

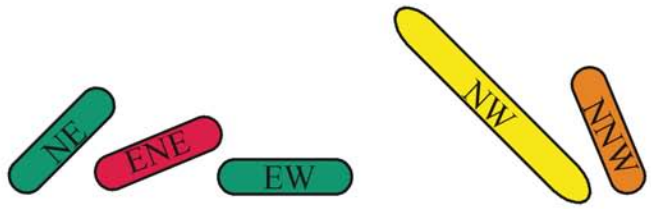


FIGURE 3.2- b

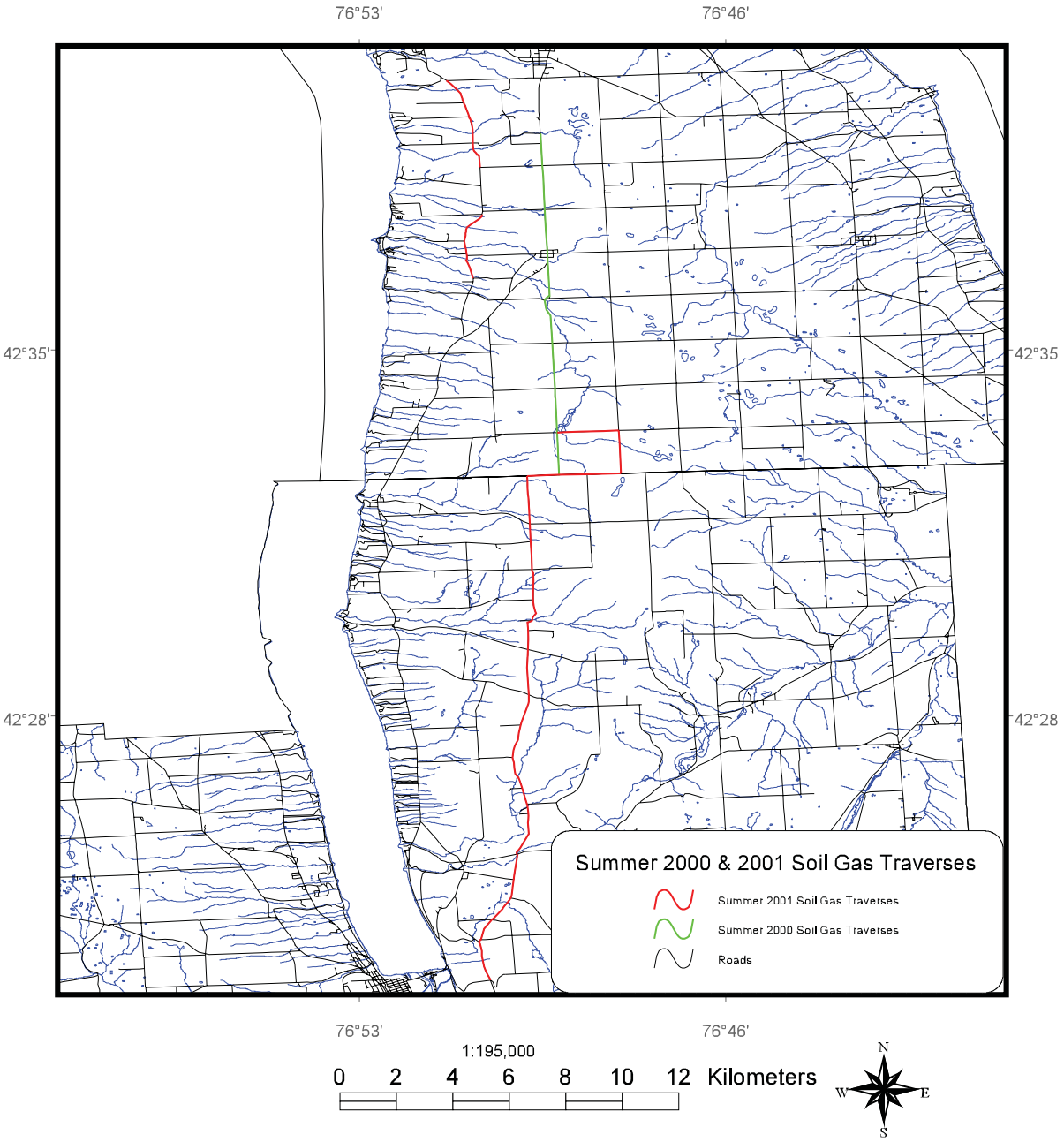

76°53'
76°46'
42°35'
42°35
42°28'
42°28
Summer 2000 & 2001 Soil Gas Traverses
Summer 2001 Soil Gas Traverses
Summer 2000 Soil Gas Traverses
Roads
76°53'
76°46'
1:195,000
0 2 4 6 8 10 12 Kilometers
N
W
E
S

FIGURE 3.3-1

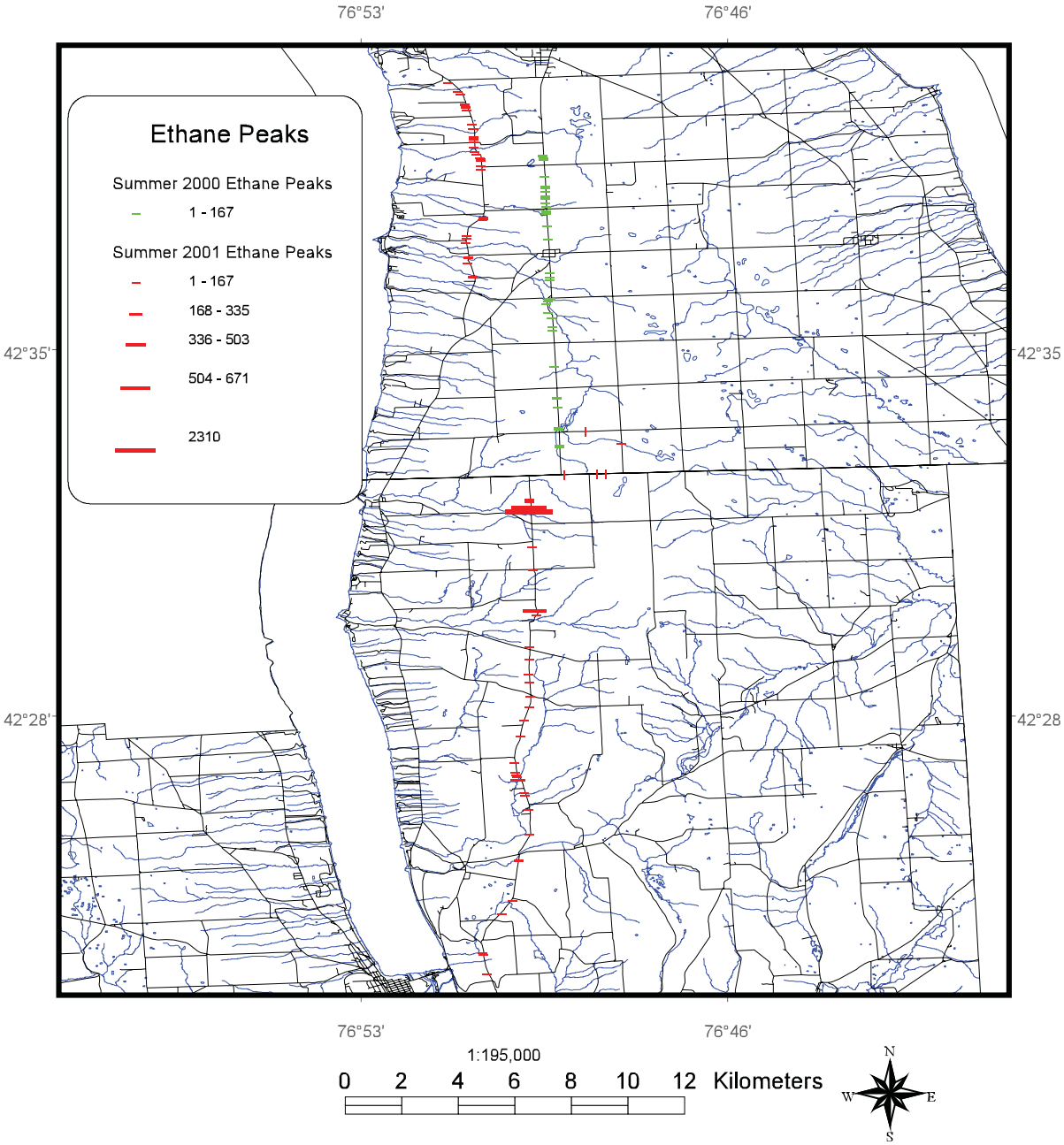

76°53'
76°46'
Ethane Peaks
Summer 2000 Ethane Peaks
1 - 167
Summer 2001 Ethane Peaks
1 - 167
168 - 335
336 - 503
504 - 671
2310
42°35'
42°28'
1:195,000
0 2 4 6 8 10 12 Kilometers
N
W
E
S

FIGURE 3.3-2

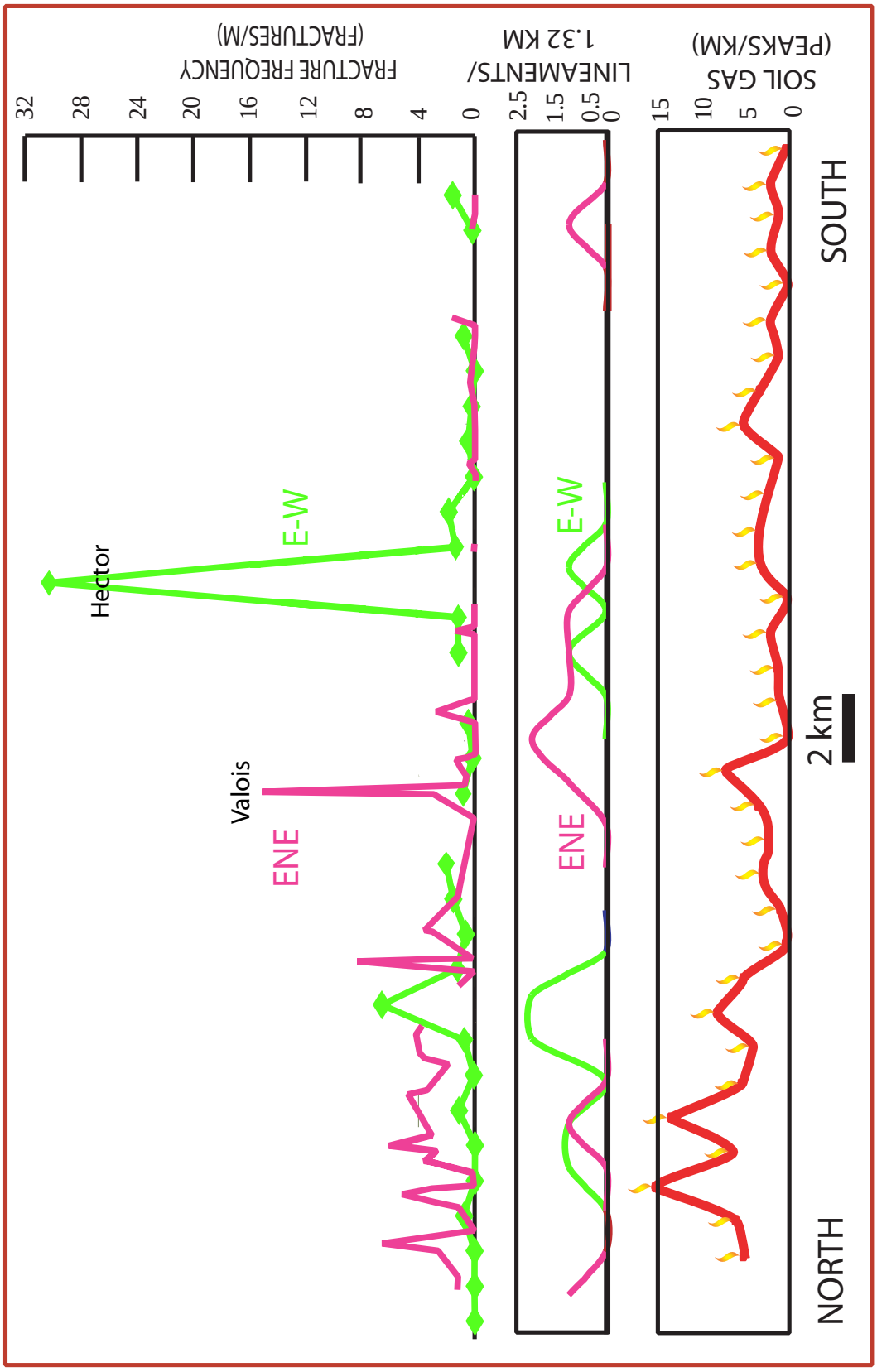

Hector
E-W
Valois
ENE
FRACTURE FREQUENCY
(FRACTURES/M)
32
28
24
20
16
12
8
4
0
LINEAMENTS/
1.32 KM
2.5
1.5
0.5
0
E-W
ENE
SOIL GAS
(PEAKS/KM)
15
10
5
0
NORTH
2 km
SOUTH

FIGURE 3.3-3

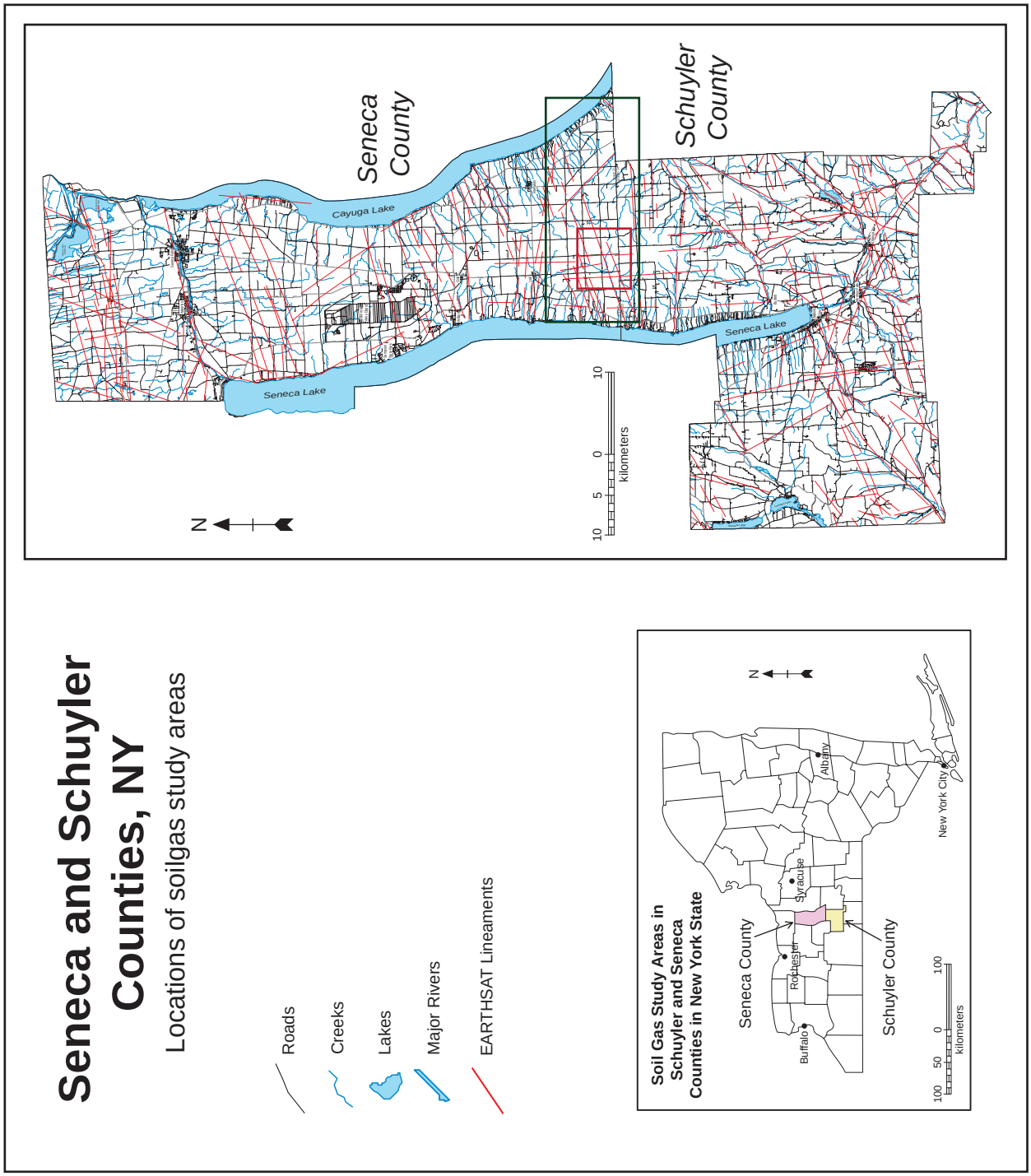

Seneca and Schuyler Counties, NY
Locations of soilgas study areas
Roads
Creeks
Lakes
Major Rivers
EARTHSAT Lineaments
Seneca County
Schuyler County
Cayuga Lake
Seneca Lake
Seneca Lake
N
10 5 0 10
kilometers
Soil Gas Study Areas in Schuyler and Seneca Counties in New York State
Seneca County
Schuyler County
Buffalo
Rochester
Syracuse
Albany
New York City
N
100 50 0 100
kilometers

FIGURE 3.3-

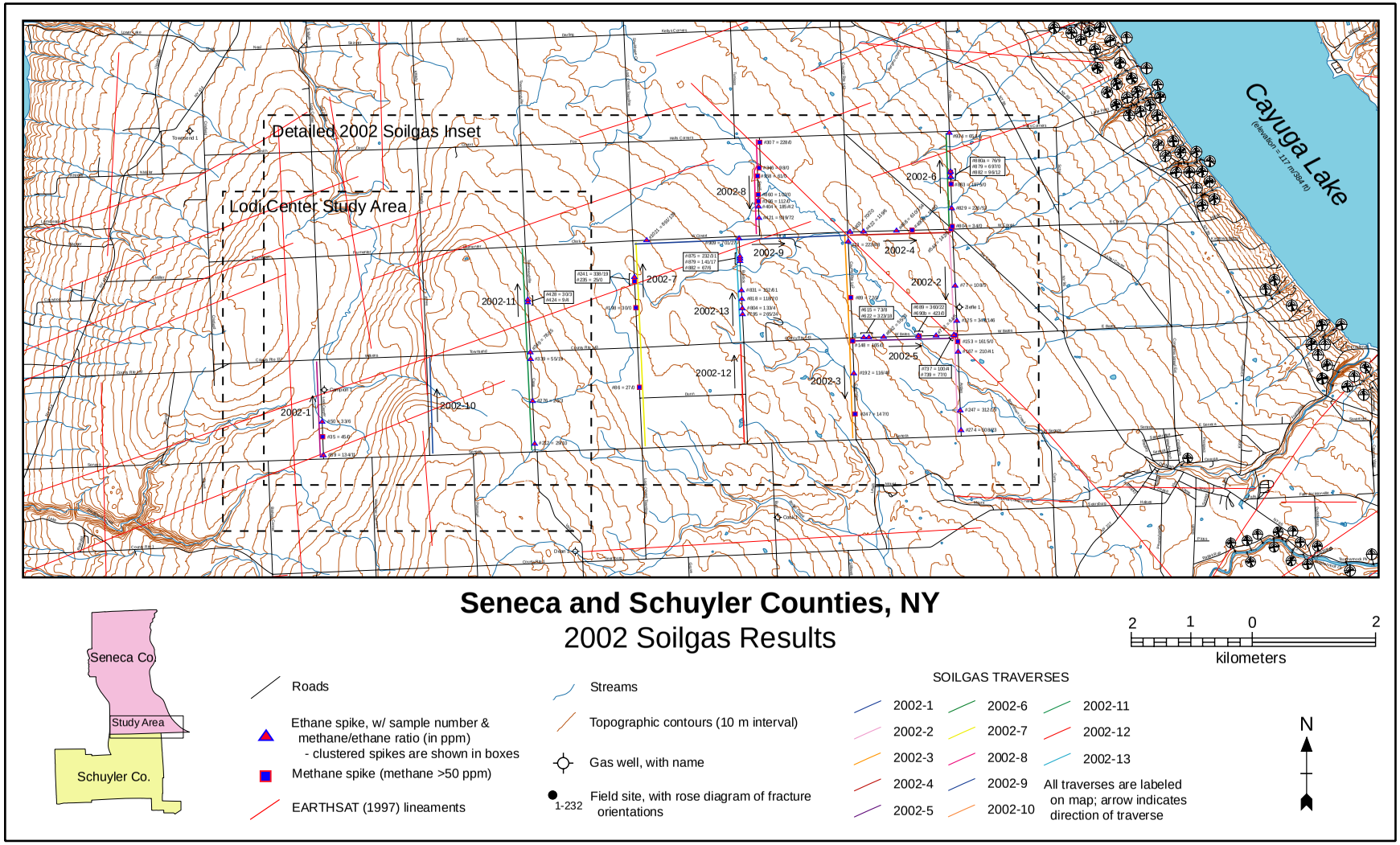
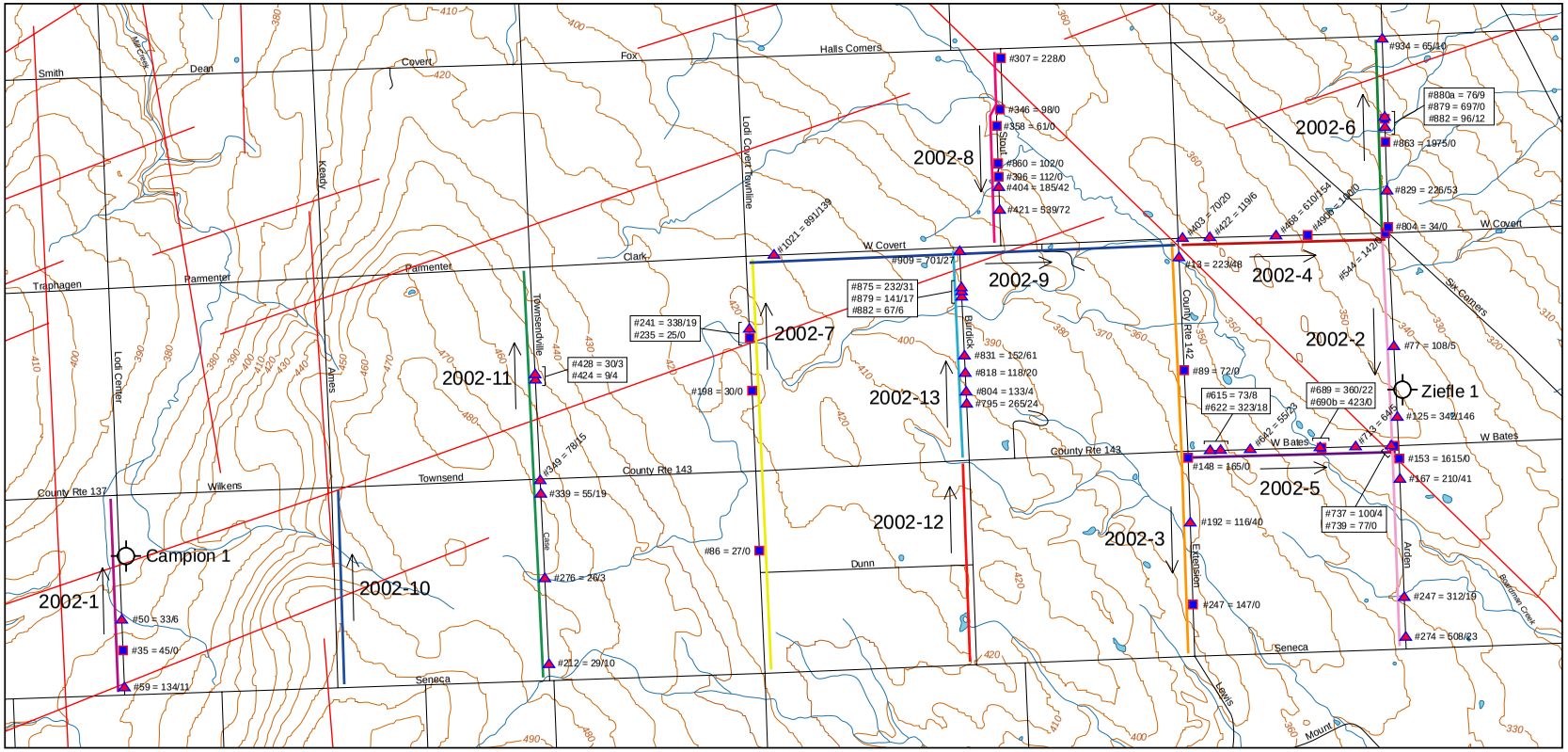
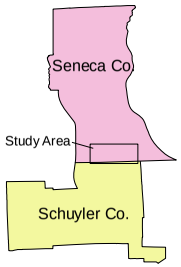

Detailed 2002 Soilgas Inset
Lodi Center Study Area
Cayuga Lake
(elevation = 117 m/384 ft)
2002-1
2002-2
2002-3
2002-4
2002-5
2002-6
2002-7
2002-8
2002-9
2002-10
2002-11
2002-12
2002-13
Seneca and Schuyler Counties, NY
2002 Soilgas Results
Seneca Co.
Study Area
Schuyler Co.
Roads
Ethane spike, w/ sample number & methane/ethane ratio (in ppm)
- clustered spikes are shown in boxes
Methane spike (methane >50 ppm)
EARTHSAT (1997) lineaments
Streams
Topographic contours (10 m interval)
Gas well, with name
1-232
Field site, with rose diagram of fracture orientations
SOILGAS TRAVERSES
2002-1
2002-2
2002-3
2002-4
2002-5
2002-6
2002-7
2002-8
2002-9
2002-10
2002-11
2002-12
2002-13
All traverses are labeled on map; arrow indicates direction of traverse
2 1 0 2
kilometers
N

FIGURE 3.3-5



Seneca and Schuyler Counties, NY

2002 Soilgas Results - Detailed Inset



Roads

Ethane spike, w/ sample number & methane/ethane ratio (in ppm)
- clustered spikes are shown in boxes

Methane spike (methane >50 ppm)

EARTHSAT (1997) lineaments

Streams

Topographic contours (10 m interval)

Gas well, with name

SOILGAS TRAVERSES

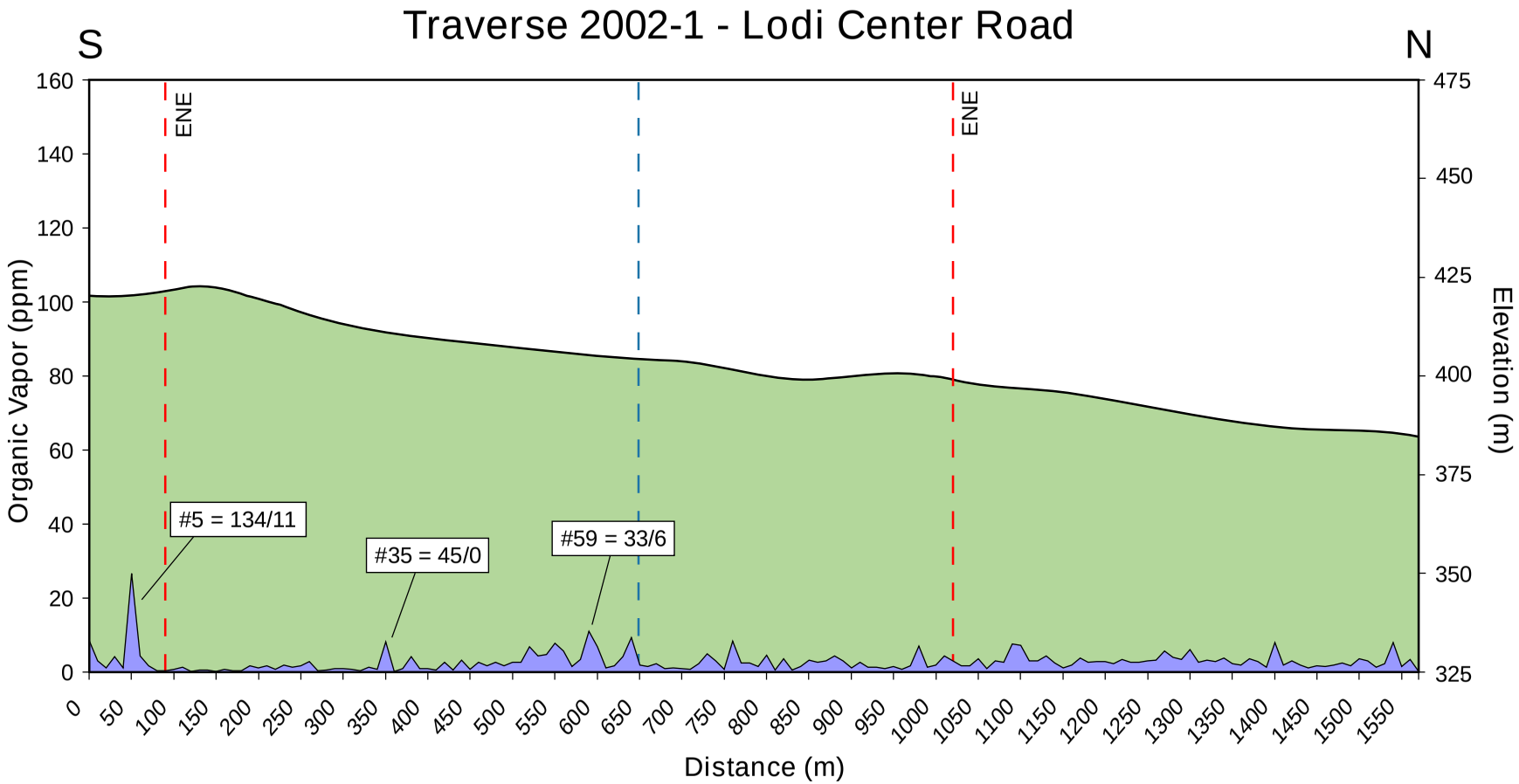
2002-1, 2002-2, 2002-3, 2002-4, 2002-5, 2002-6, 2002-7, 2002-8, 2002-9, 2002-10, 2002-11, 2002-12, 2002-13

All traverses are labeled on map; arrow indicates direction of traverse

2 1 0 2
kilometers

N

FIGURE 3.3-6



LEGEND

- Streams (with orientation, if straight)
- Lineaments (with orientation)
- Topographic profile
- Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-7

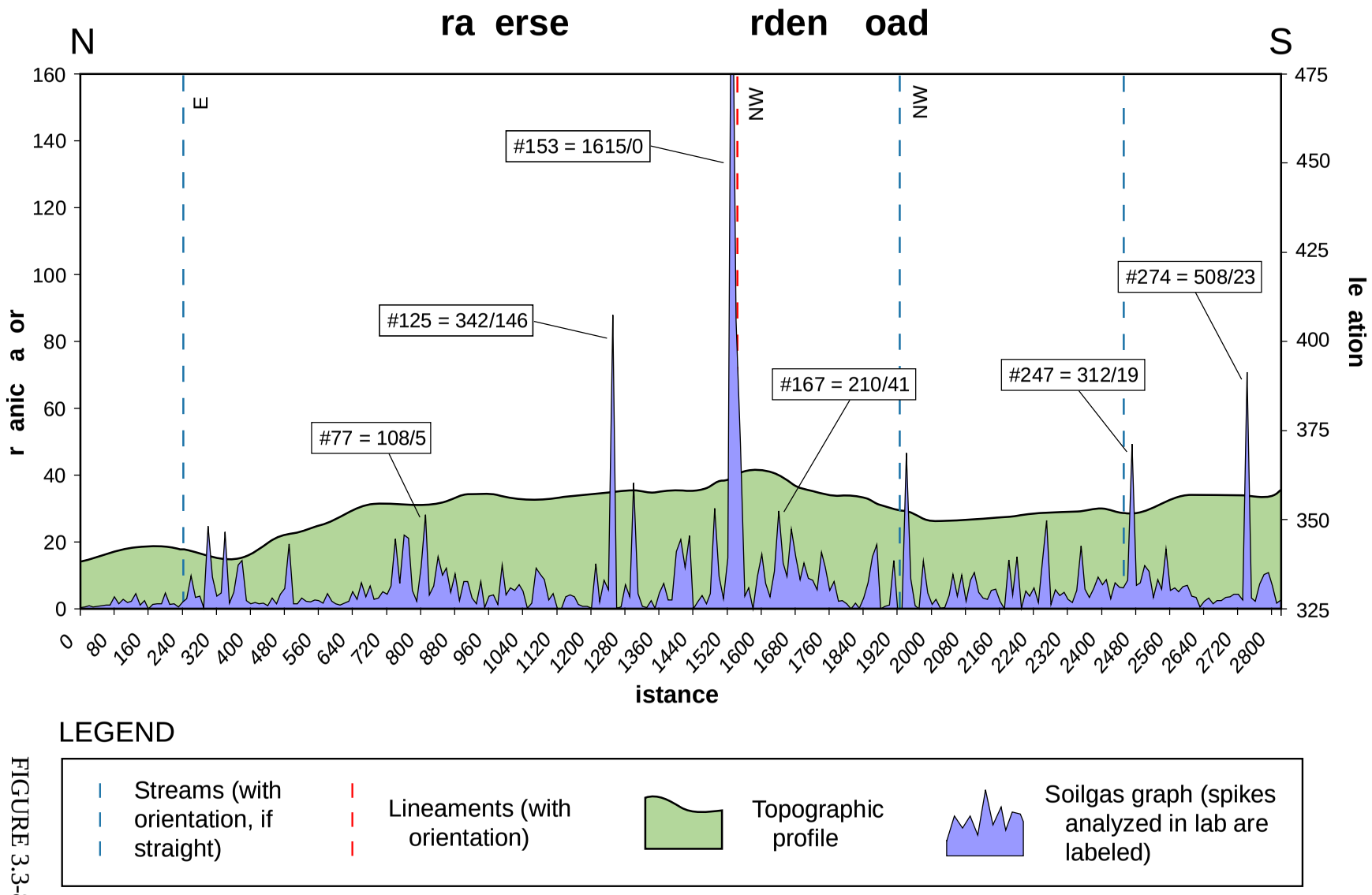

N
ra erse
rden oad
S
E
NW
NW
#153 = 1615/0
#125 = 342/146
#77 = 108/5
#167 = 210/41
#247 = 312/19
#274 = 508/23
r anic a or
le ation
istance
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-8

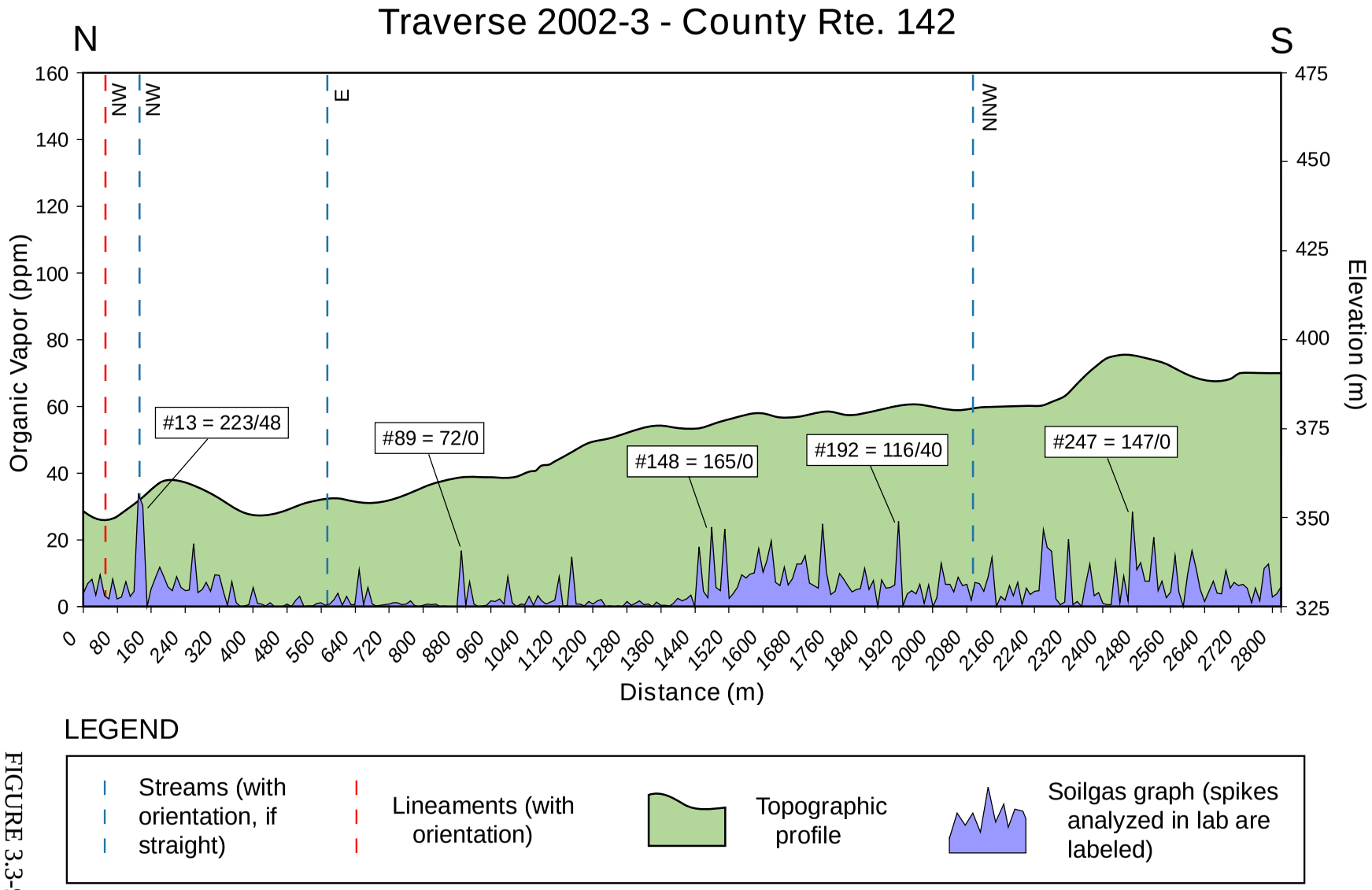

Traverse 2002-3 - County Rte. 142
N
S
NW
NW
E
NNW
#13 = 223/48
#89 = 72/0
#148 = 165/0
#192 = 116/40
#247 = 147/0
Organic Vapor (ppm)
Elevation (m)
Distance (m)
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-9

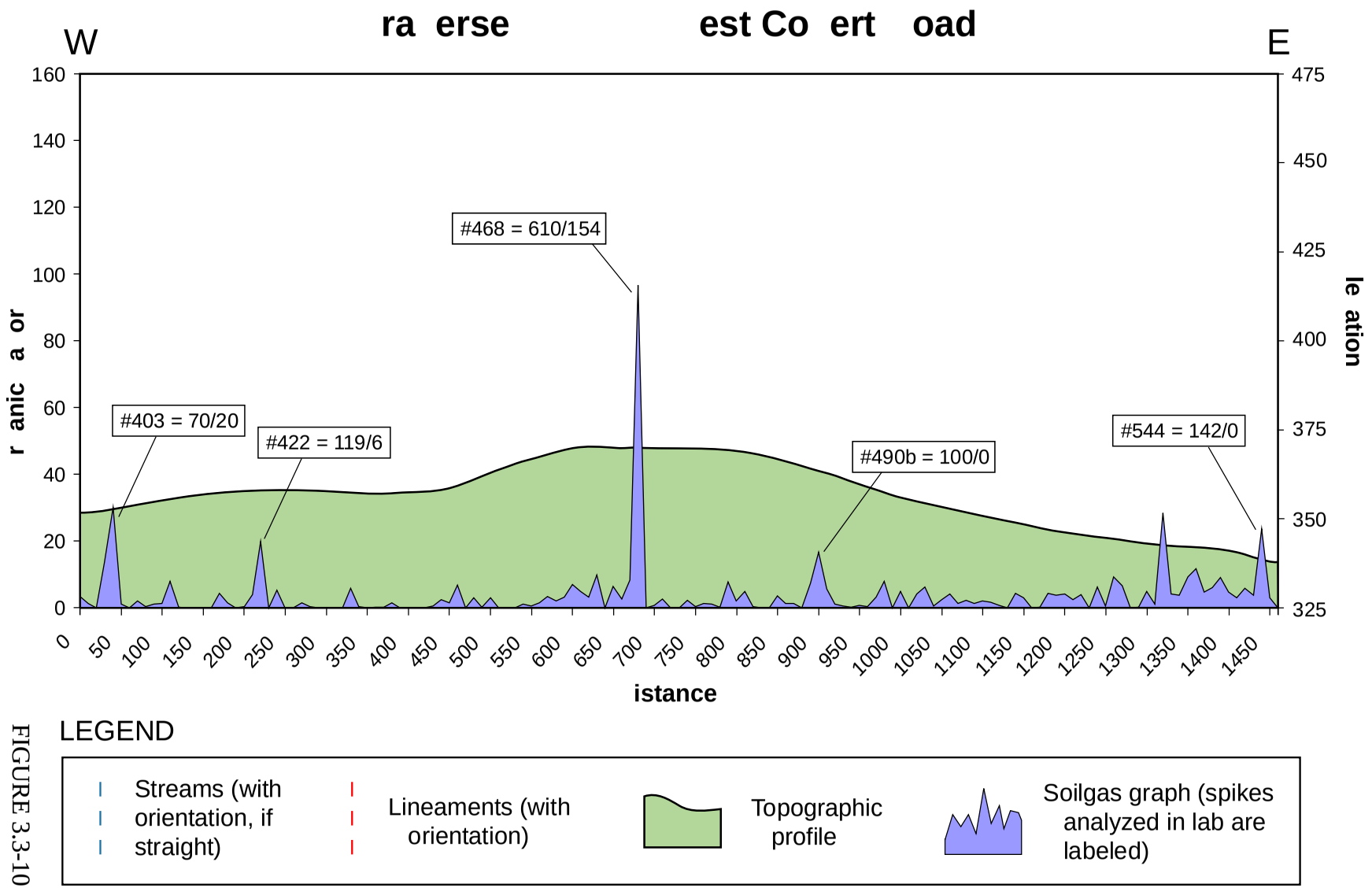

W
ra erse
est Co ert oad
E
r anic a or
le ation
istance
#403 = 70/20
#422 = 119/6
#468 = 610/154
#490b = 100/0
#544 = 142/0
0
20
40
60
80
100
120
140
160
325
350
375
400
425
450
475
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100 1150 1200 1250 1300 1350 1400 1450
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-10

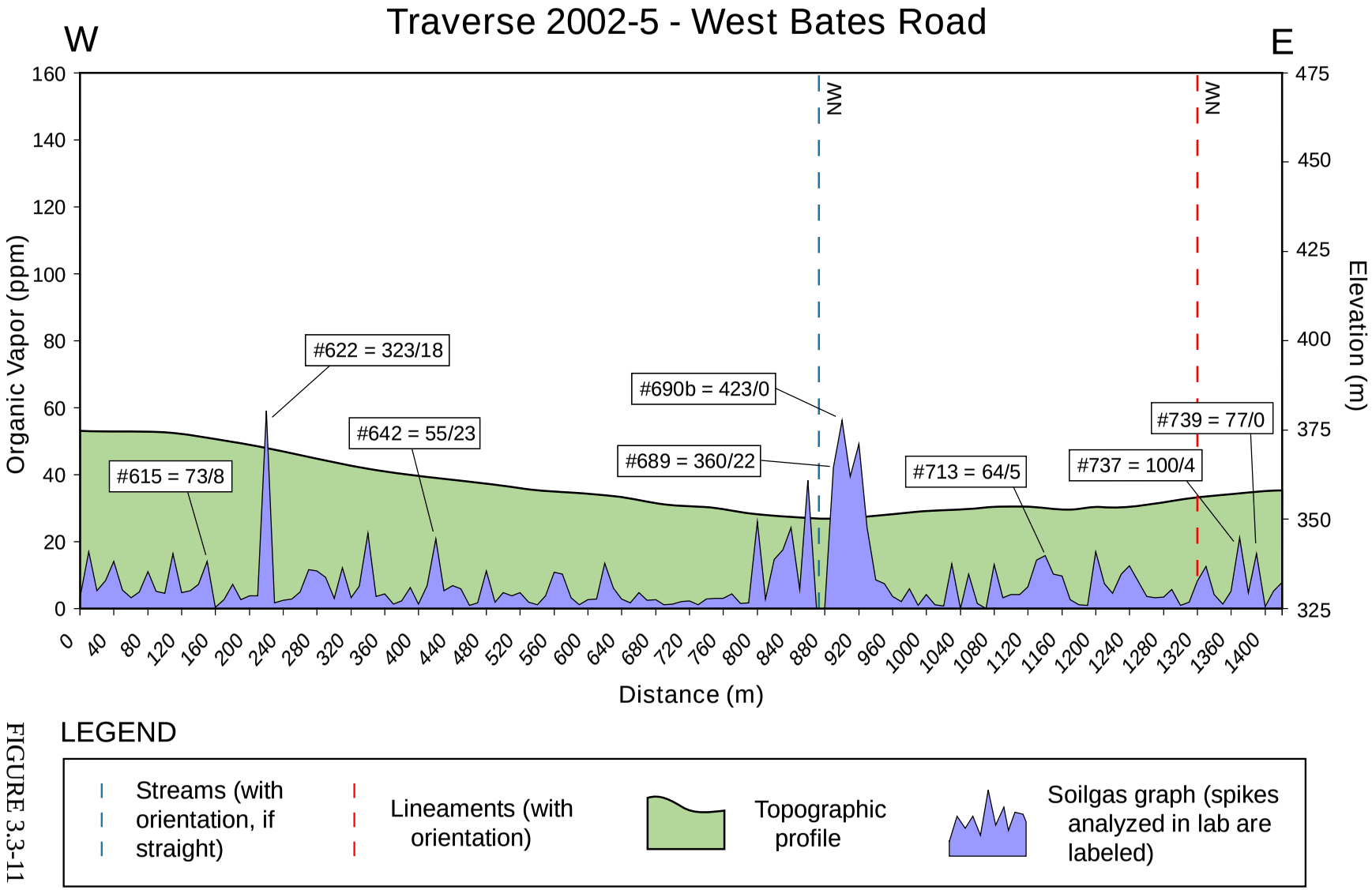

Traverse 2002-5 - West Bates Road
W
E
Organic Vapor (ppm)
Elevation (m)
Distance (m)
NW
NW
#615 = 73/8
#622 = 323/18
#642 = 55/23
#689 = 360/22
#690b = 423/0
#713 = 64/5
#737 = 100/4
#739 = 77/0
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-11

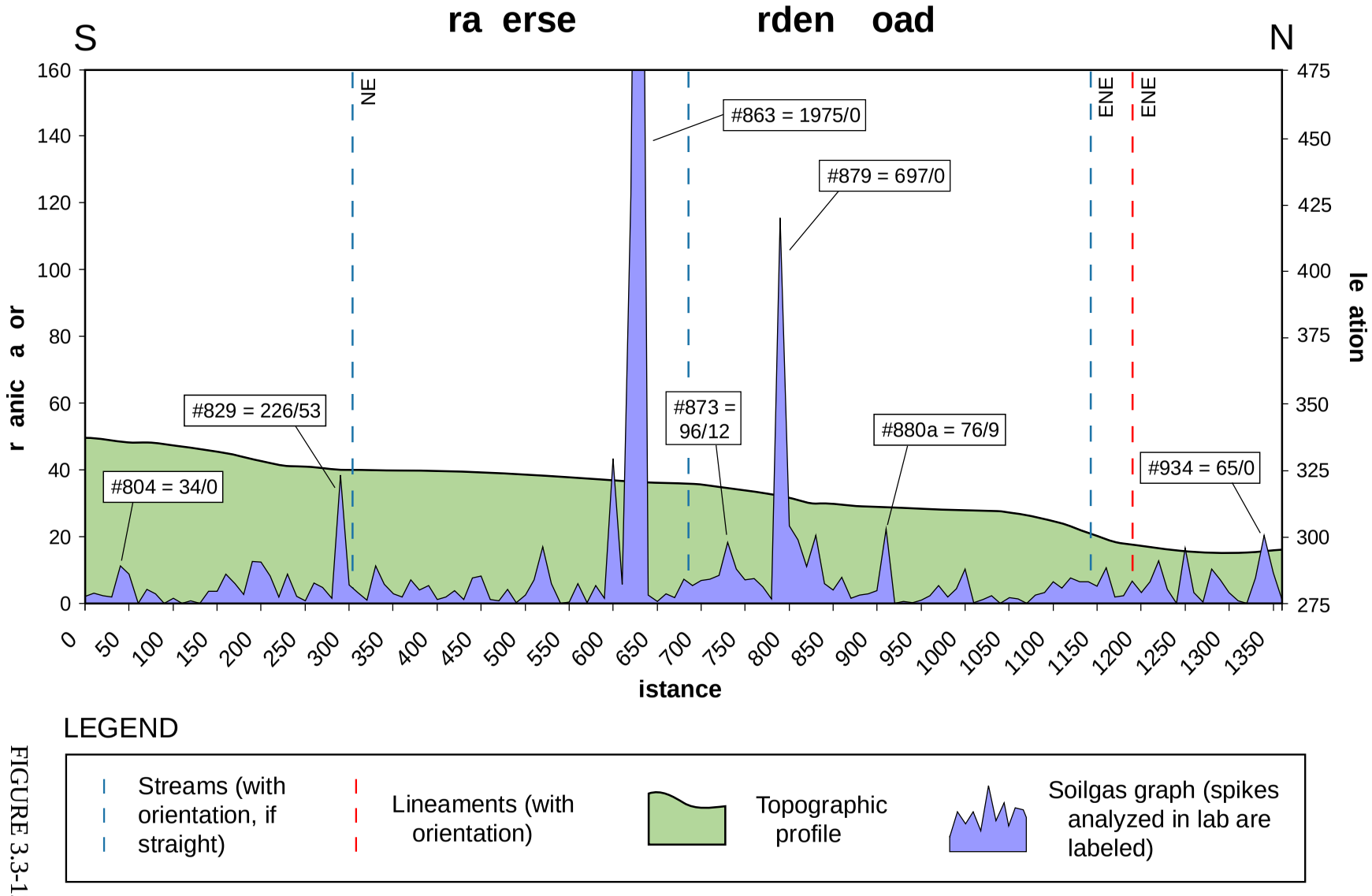
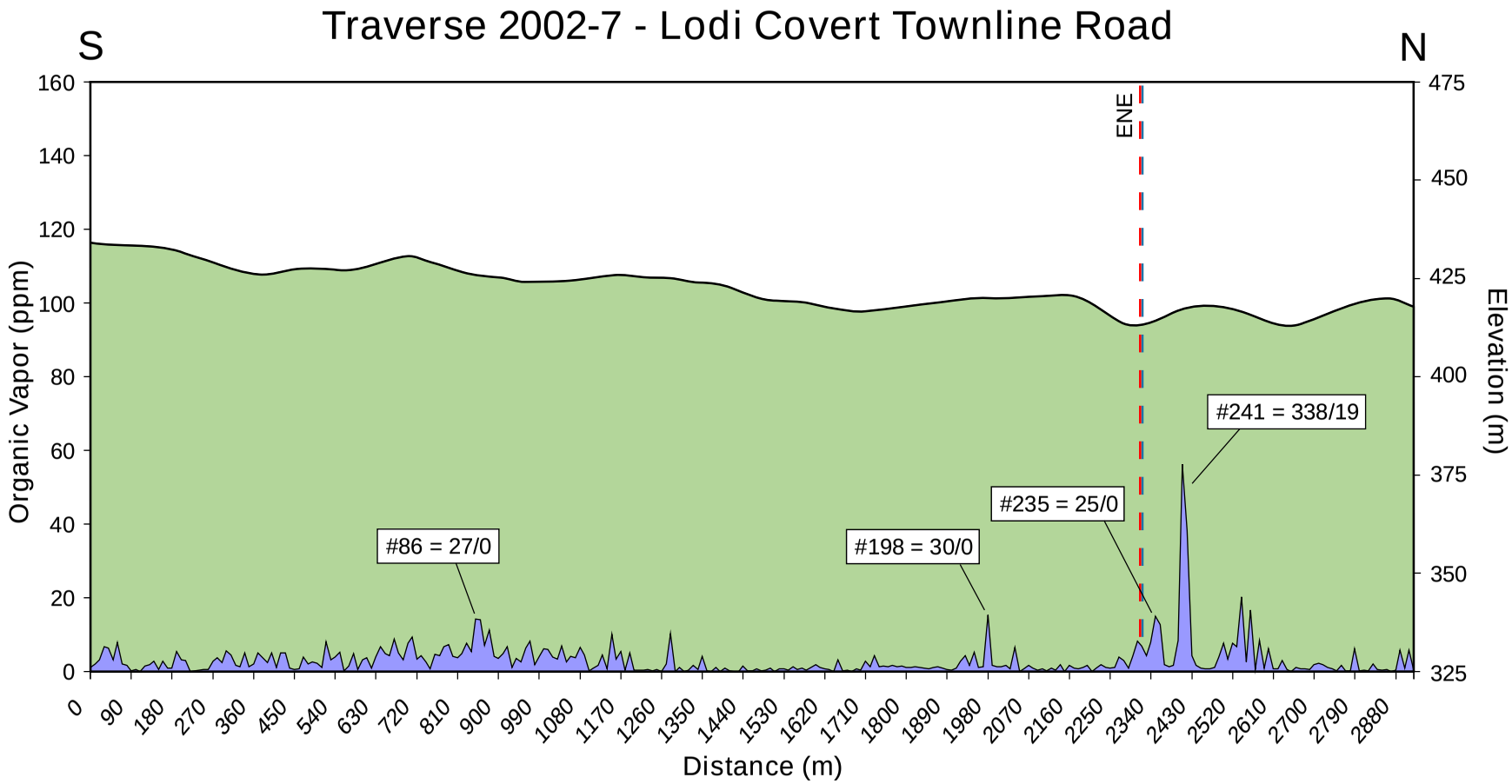

S
ra erse
rden oad
N
NE
ENE
ENE
#863 = 1975/0
#879 = 697/0
#829 = 226/53
#873 = 96/12
#880a = 76/9
#934 = 65/0
#804 = 34/0
r anic a or
le ation
istance
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-12



LEGEND

- Streams (with orientation, if straight)
- Lineaments (with orientation)
- Topographic profile
- Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-13

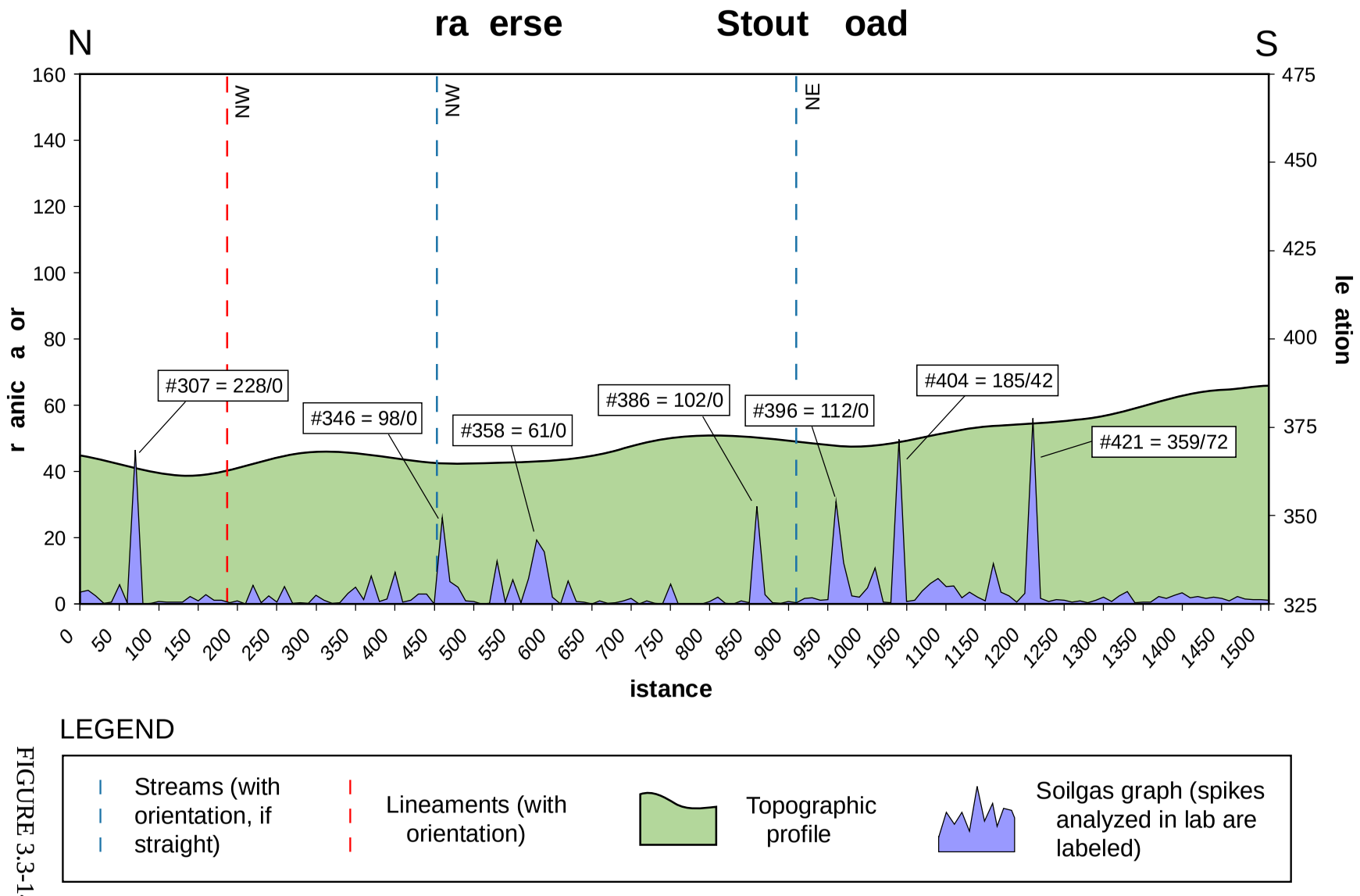

ra erse
Stout oad
N
S
NW
NW
NE
#307 = 228/0
#346 = 98/0
#358 = 61/0
#386 = 102/0
#396 = 112/0
#404 = 185/42
#421 = 359/72
r anic a or
le ation
istance
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-14

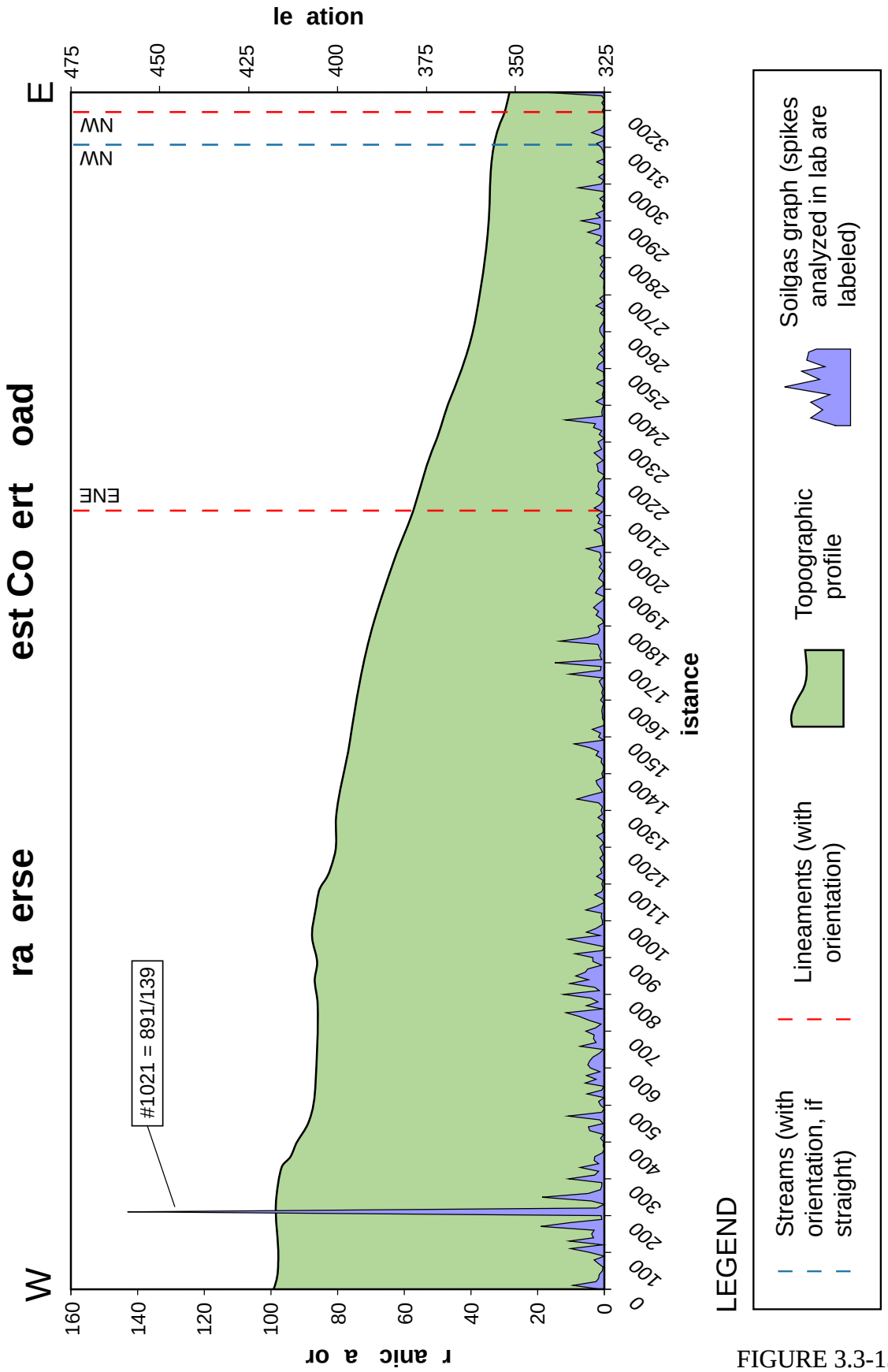
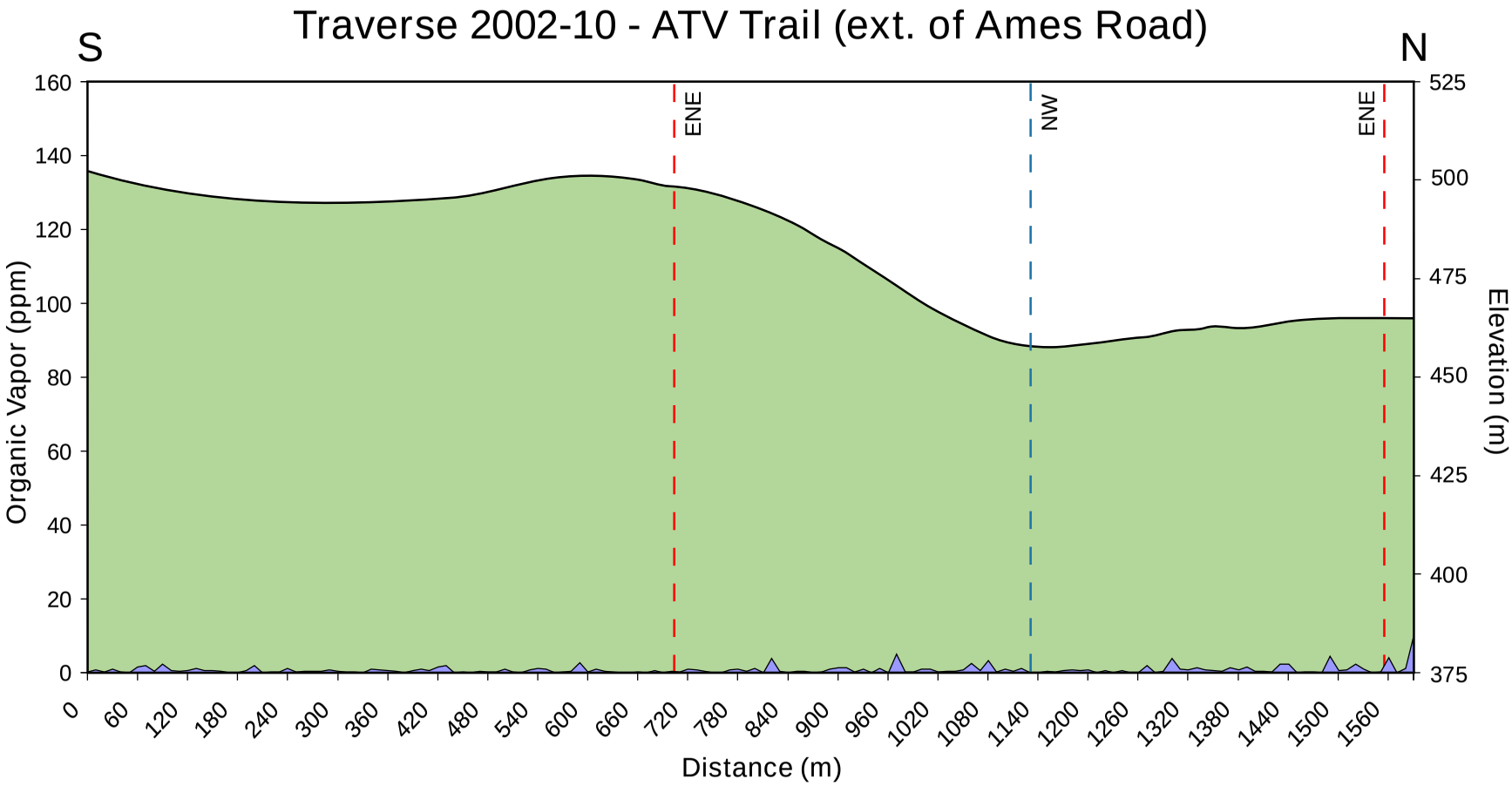

W
E
ra erse
est Co ert oad
le ation
475
450
425
400
375
350
325
NW
NW
ENE
#1021 = 891/139
160
140
120
100
80
60
40
20
0
r anic a or
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200
istance
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-15



LEGEND

Streams (with orientation, if straight)

Lineaments (with orientation)

Topographic profile

Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-16

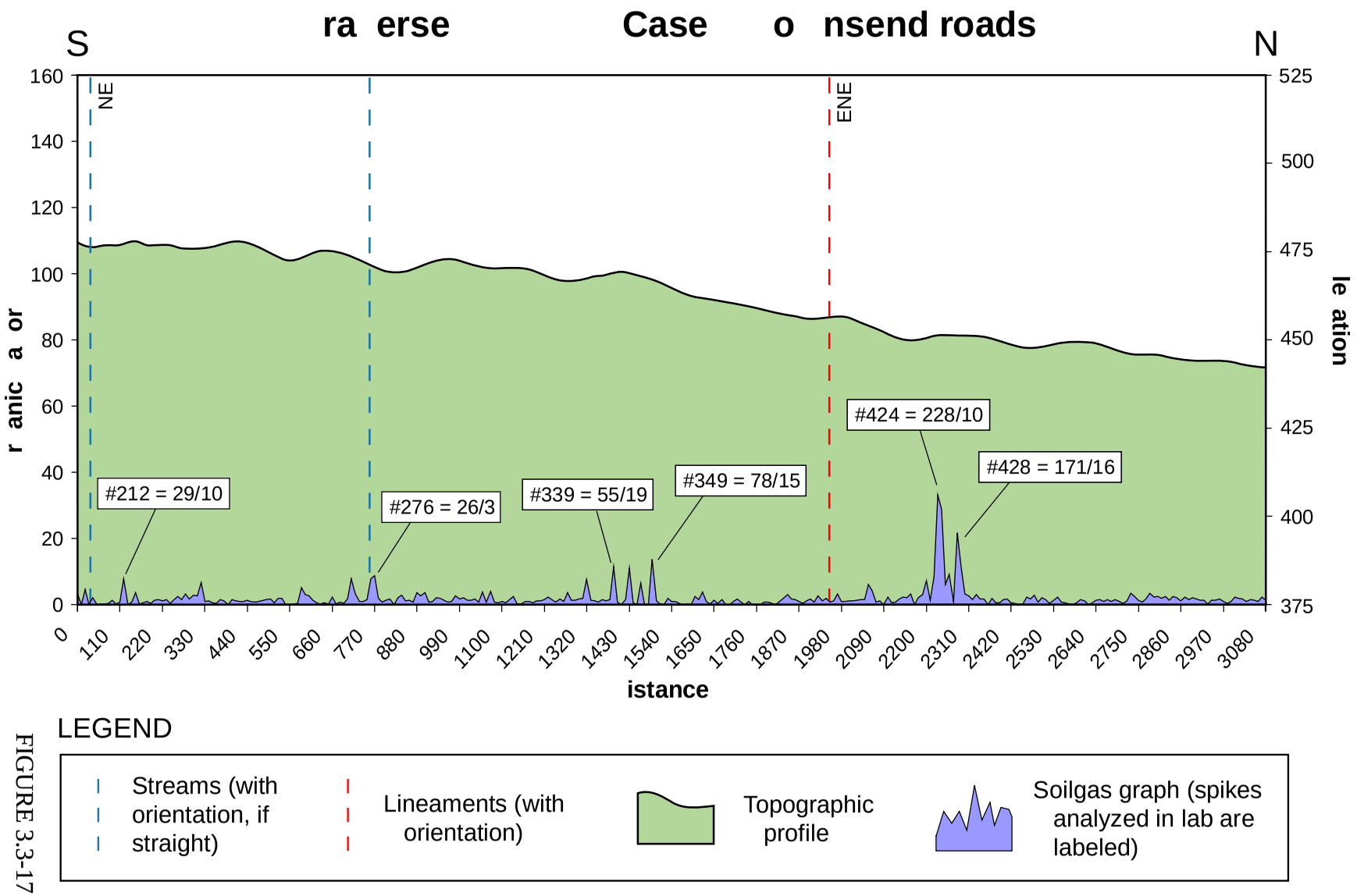
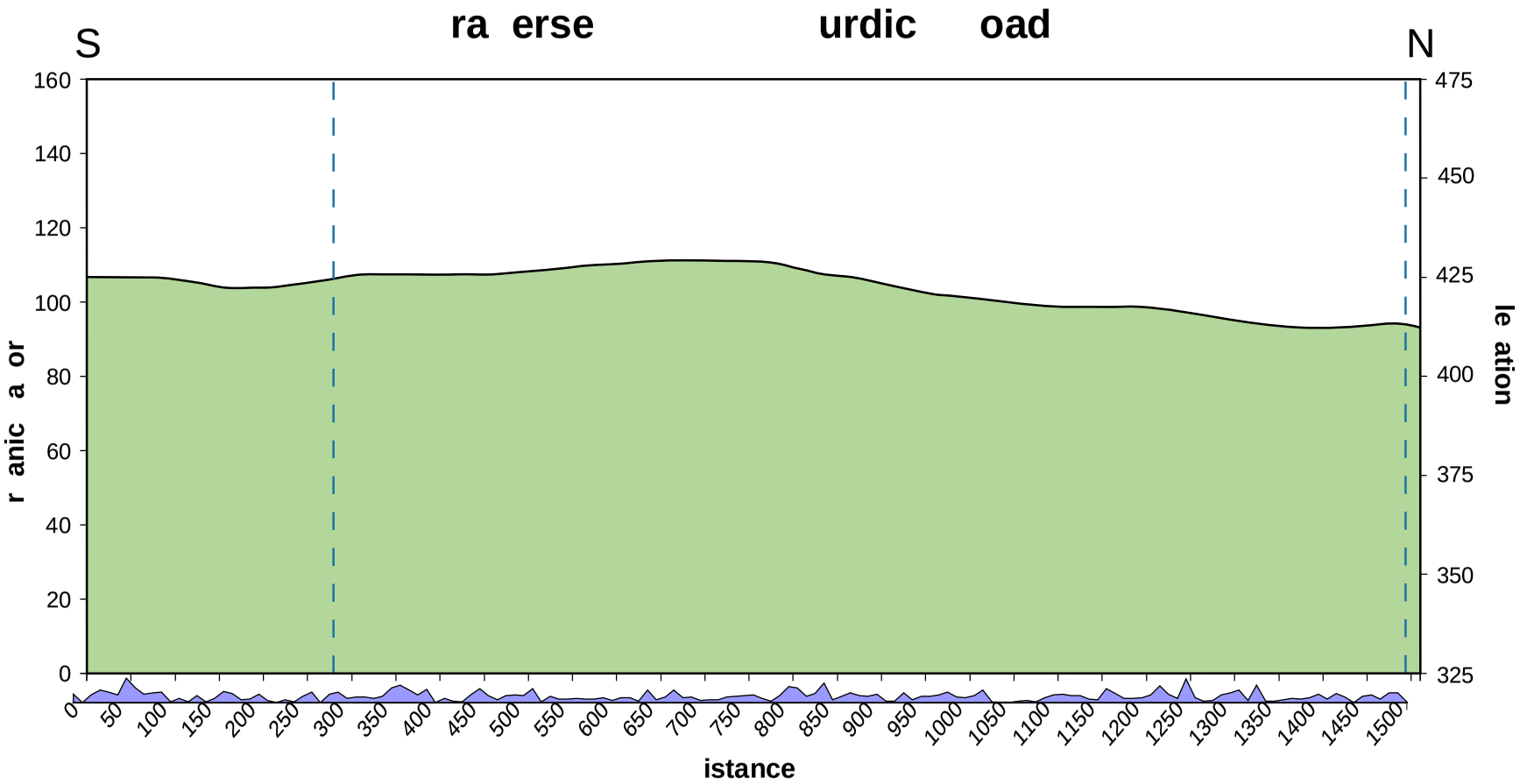

ra erse Case o nsend roads
S
N
NE
ENE
#212 = 29/10
#276 = 26/3
#339 = 55/19
#349 = 78/15
#424 = 228/10
#428 = 171/16
r anic a or
le ation
istance
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-17



LEGEND

- Streams (with orientation, if straight)
- Lineaments (with orientation)
- Topographic profile
- Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-18

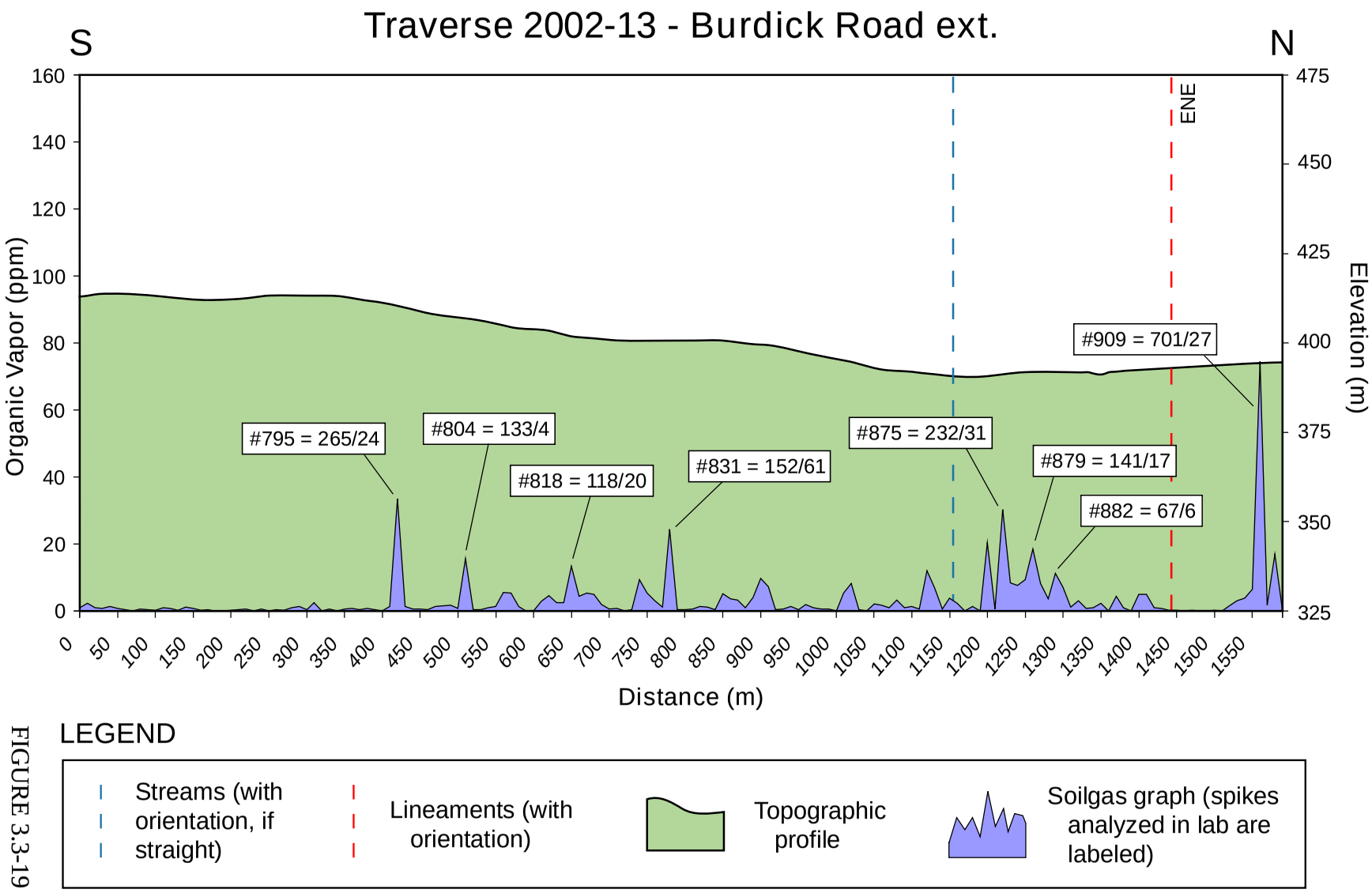

Traverse 2002-13 - Burdick Road ext.
S
N
Organic Vapor (ppm)
Elevation (m)
Distance (m)
ENE
#795 = 265/24
#804 = 133/4
#818 = 118/20
#831 = 152/61
#875 = 232/31
#879 = 141/17
#882 = 67/6
#909 = 701/27
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-19

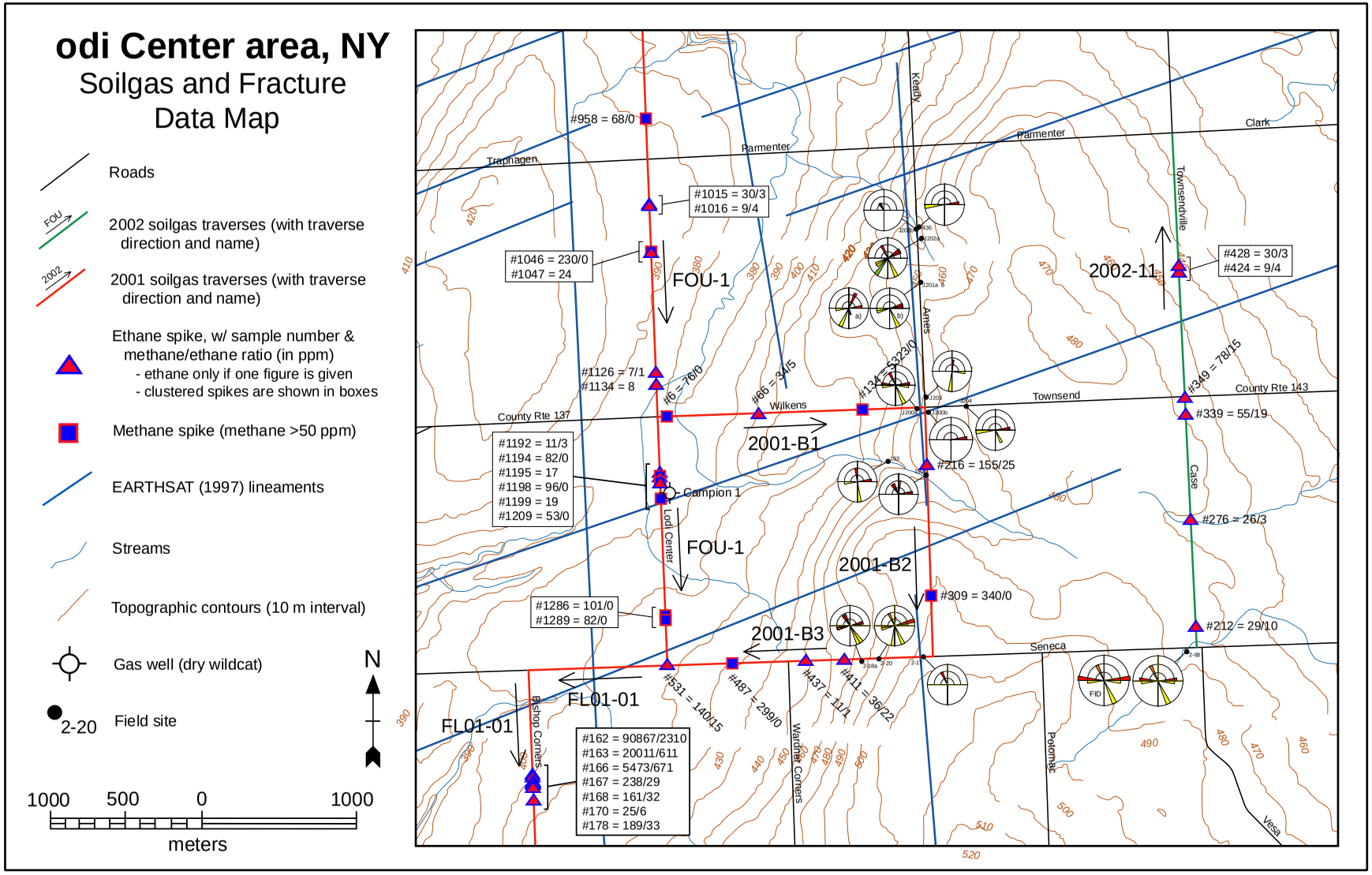
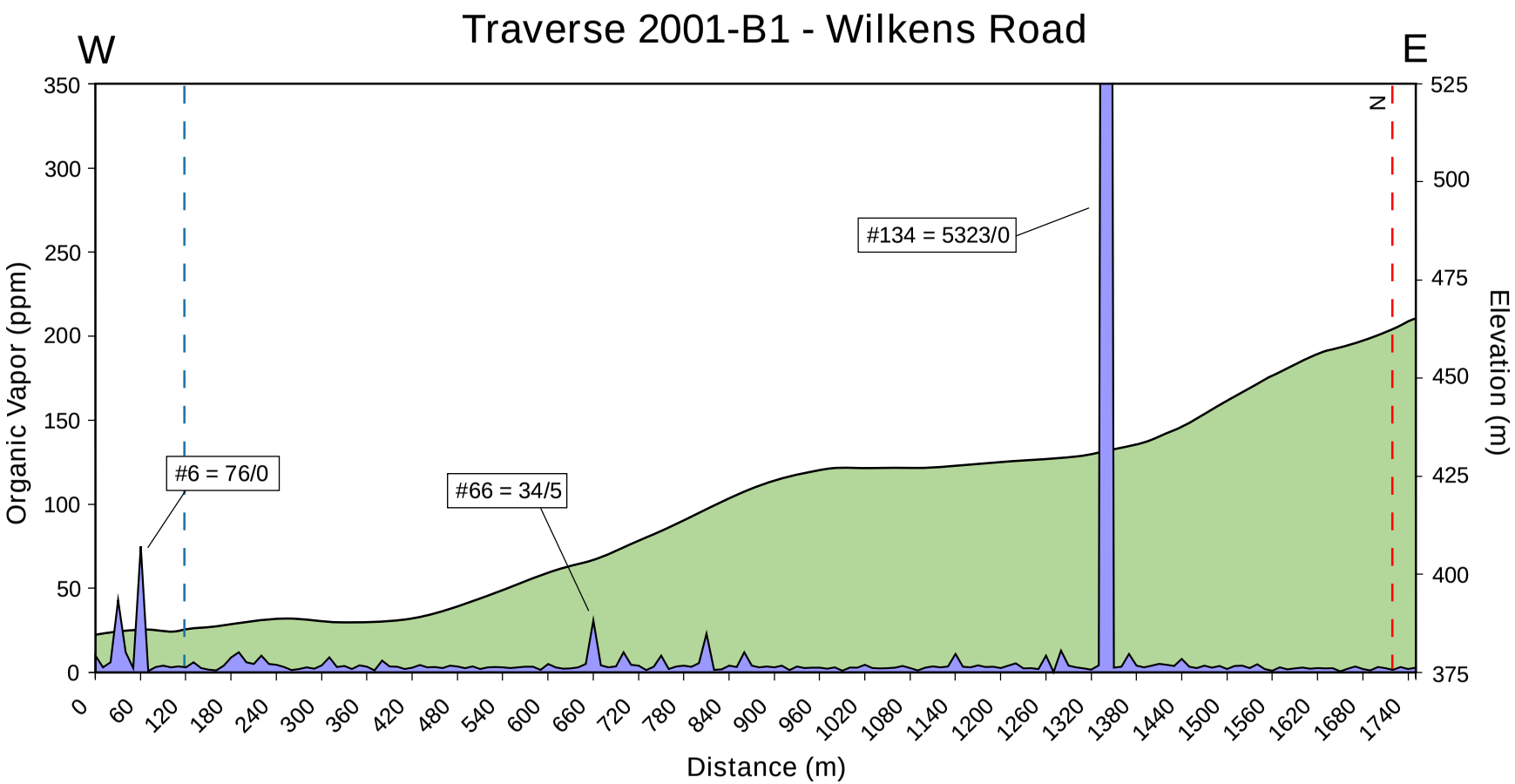

odi Center area, NY
Soilgas and Fracture Data Map
Roads
2002 soilgas traverses (with traverse direction and name)
2001 soilgas traverses (with traverse direction and name)
Ethane spike, w/ sample number & methane/ethane ratio (in ppm)
- ethane only if one figure is given
- clustered spikes are shown in boxes
Methane spike (methane >50 ppm)
EARTHSAT (1997) lineaments
Streams
Topographic contours (10 m interval)
Gas well (dry wildcat)
Field site
N
1000 500 0 1000
meters
#958 = 68/0
#1015 = 30/3
#1016 = 9/4
#1046 = 230/0
#1047 = 24
FOU-1
#1126 = 7/1
#1134 = 8
#6 = 76/0
#66 = 34/5
#134 = 5323/0
2001-B1
#216 = 155/25
#1192 = 11/3
#1194 = 82/0
#1195 = 17
#1198 = 96/0
#1199 = 19
#1209 = 53/0
Campion 1
FOU-1
2001-B2
#309 = 340/0
#1286 = 101/0
#1289 = 82/0
2001-B3
FL01-01
FL01-01
#531 = 140/15
#487 = 299/0
#437 = 11/1
#411 = 36/22
#162 = 90867/2310
#163 = 20011/611
#166 = 5473/671
#167 = 238/29
#168 = 161/32
#170 = 25/6
#178 = 189/33
2002-11
#428 = 30/3
#424 = 9/4
#349 = 78/15
#339 = 55/19
#276 = 26/3
#212 = 29/10
Traphagen
Parmenter
Parmenter
Clark
Townsendville
Keadly
Ames
Townsend
County Rte 143
County Rte 137
Wilkens
Case
Seneca
Lodi Center
Bishop Corners
Wardner Corners
Petermale
Vesa

FIGURE 3.3-20



LEGEND

- Streams (with orientation, if straight)
- Lineaments (with orientation)
- Topographic profile
- Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-21

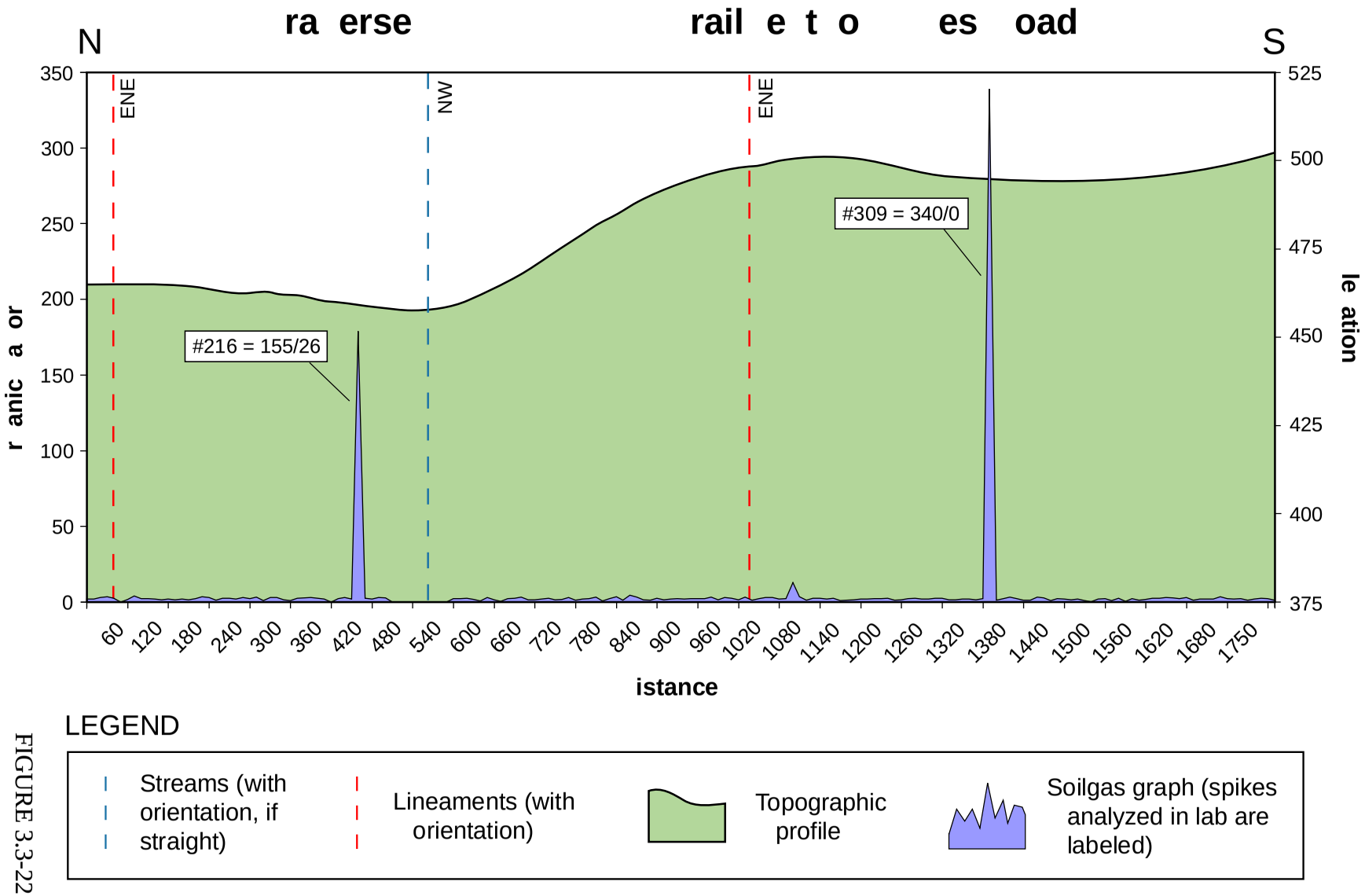
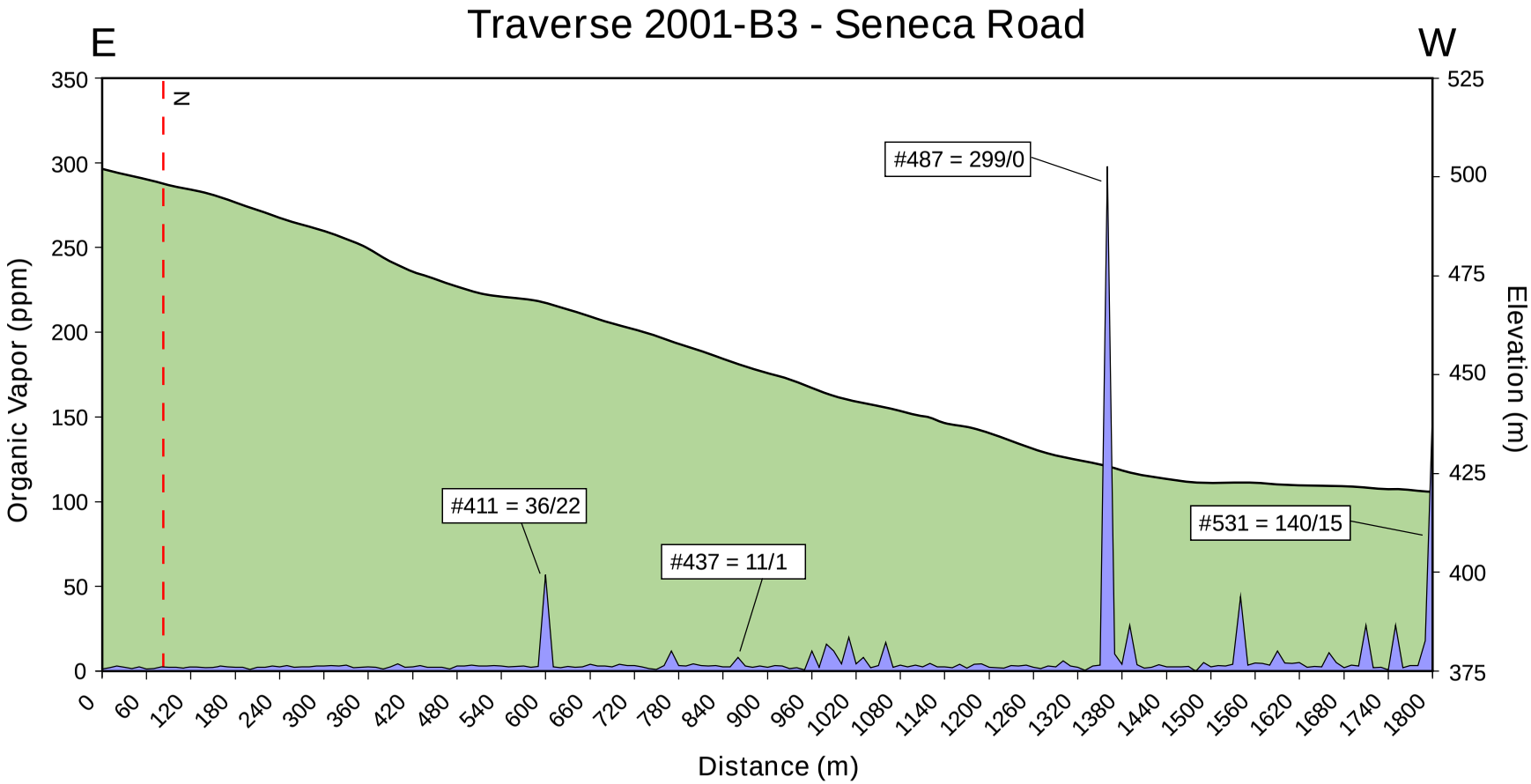

N
ra erse
rail e t o es oad
S
ENE
NW
ENE
#216 = 155/26
#309 = 340/0
r anic a or
le ation
istance
350
300
250
200
150
100
50
0
525
500
475
450
425
400
375
60
120
180
240
300
360
420
480
540
600
660
720
780
840
900
960
1020
1080
1140
1200
1260
1320
1380
1440
1500
1560
1620
1680
1750
LEGEND
Streams (with orientation, if straight)
Lineaments (with orientation)
Topographic profile
Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-22



LEGEND

- Streams (with orientation, if straight)
- Lineaments (with orientation)
- Topographic profile
- Soilgas graph (spikes analyzed in lab are labeled)

FIGURE 3.3-23

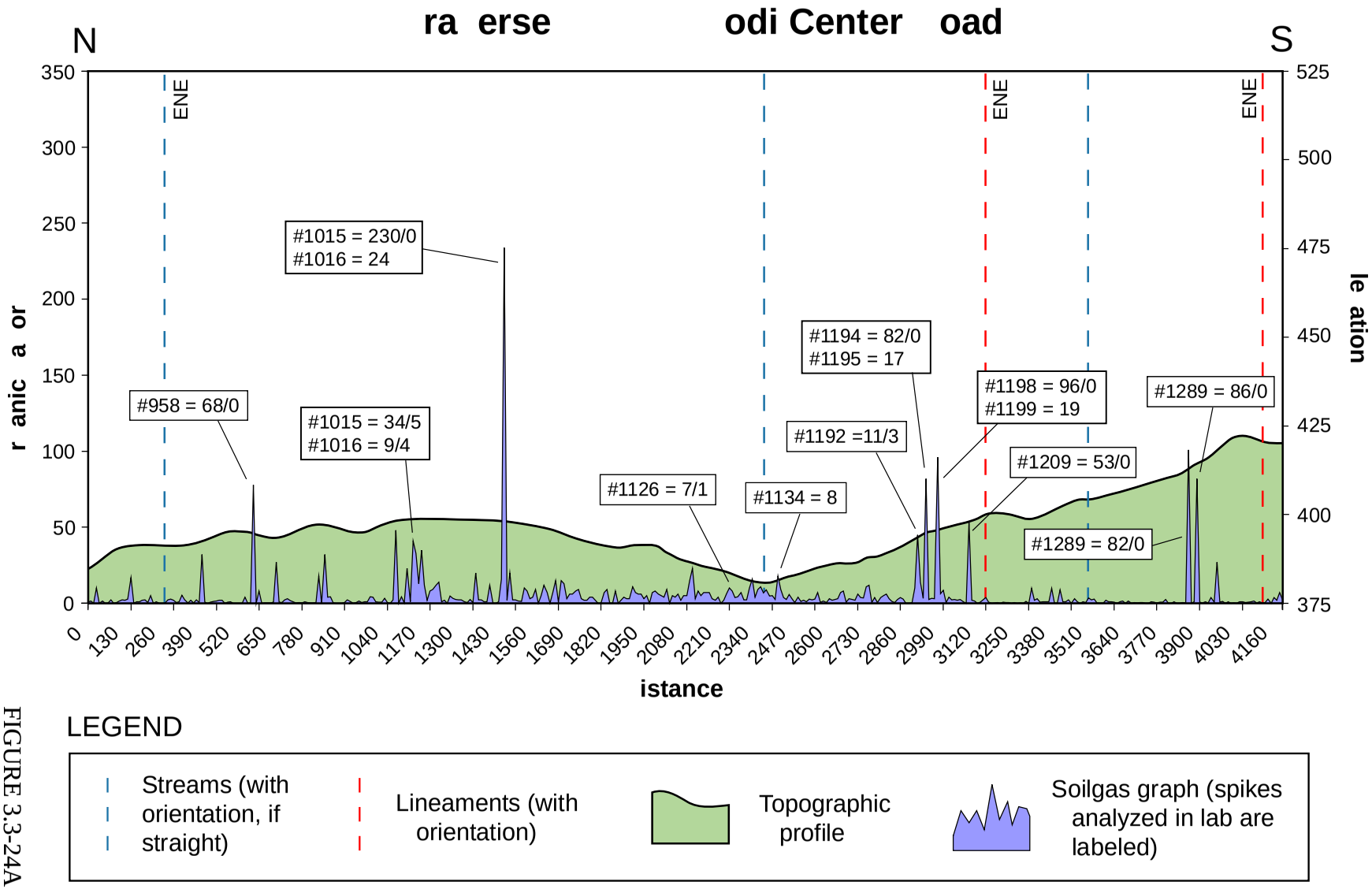


FIGURE 3.3-24A

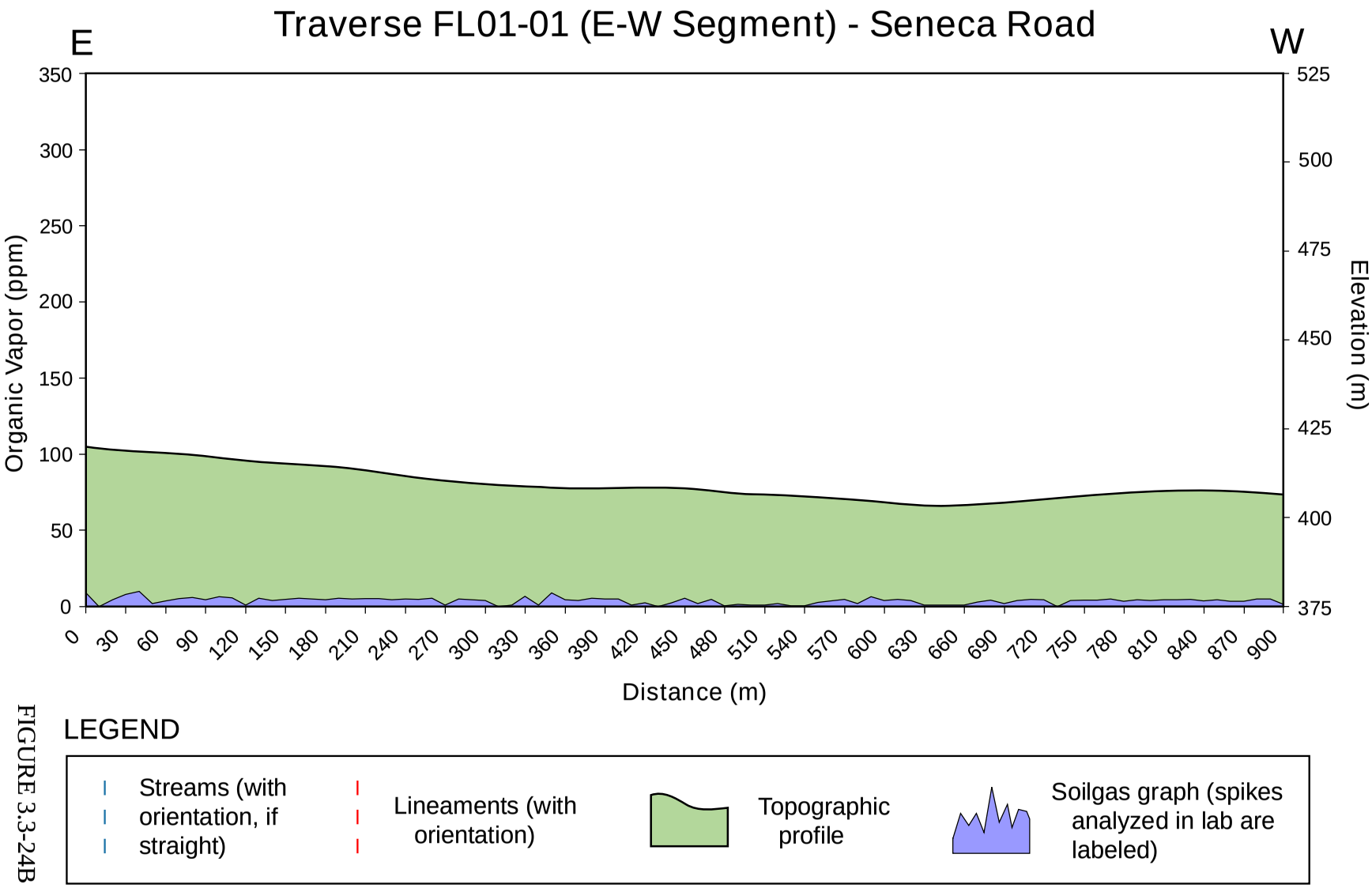


FIGURE 3.3-24B

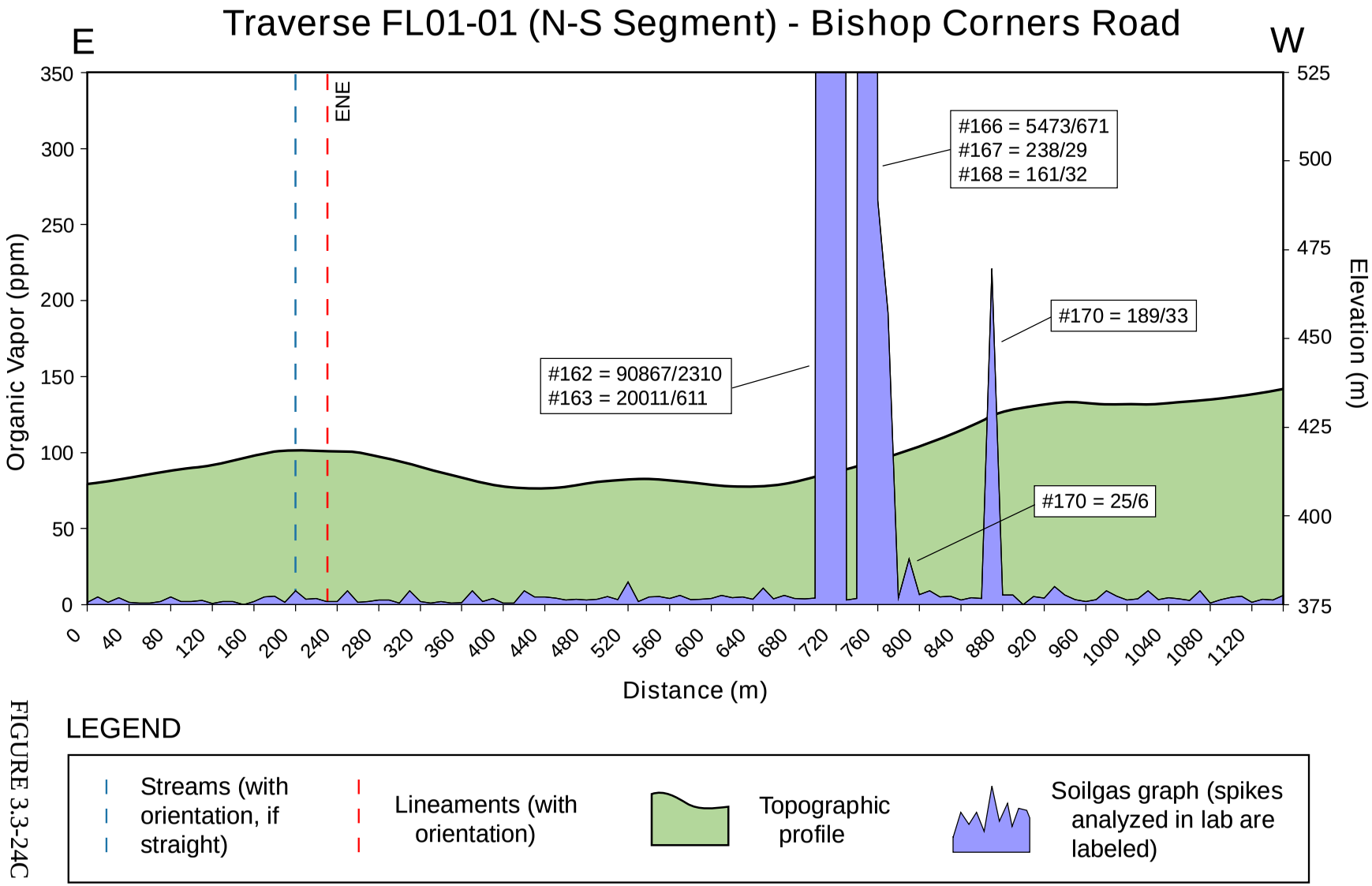


FIGURE 3.3-24C

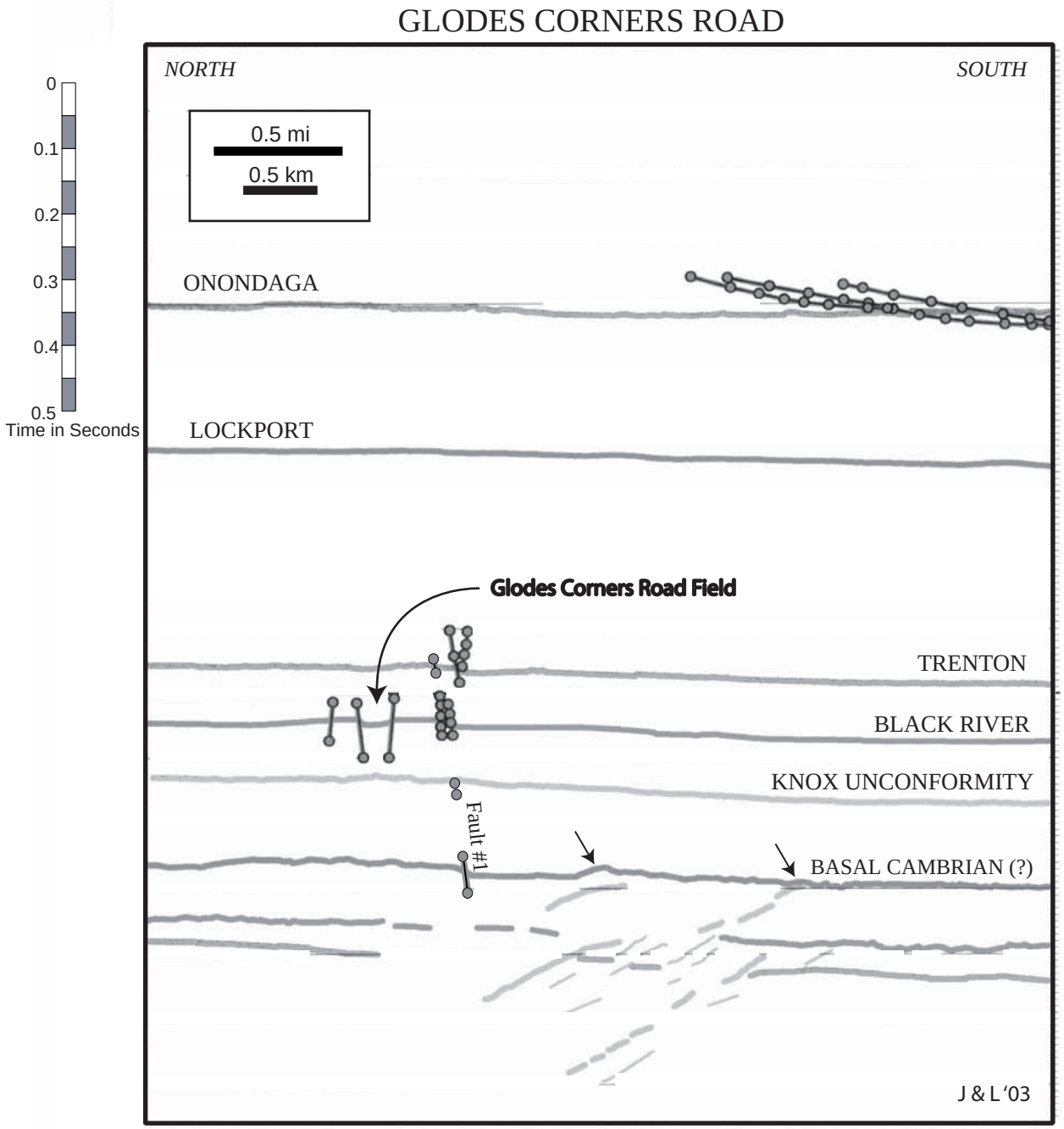

GLODES CORNERS ROAD
NORTH
SOUTH
0
0.1
0.2
0.3
0.4
0.5
Time in Seconds
0.5 mi
0.5 km
ONONDAGA
LOCKPORT
Glodes Corners Road Field
TRENTON
BLACK RIVER
KNOX UNCONFORMITY
Fault #1
BASAL CAMBRIAN (?)
J & L '03

FIGURE 3.4-1

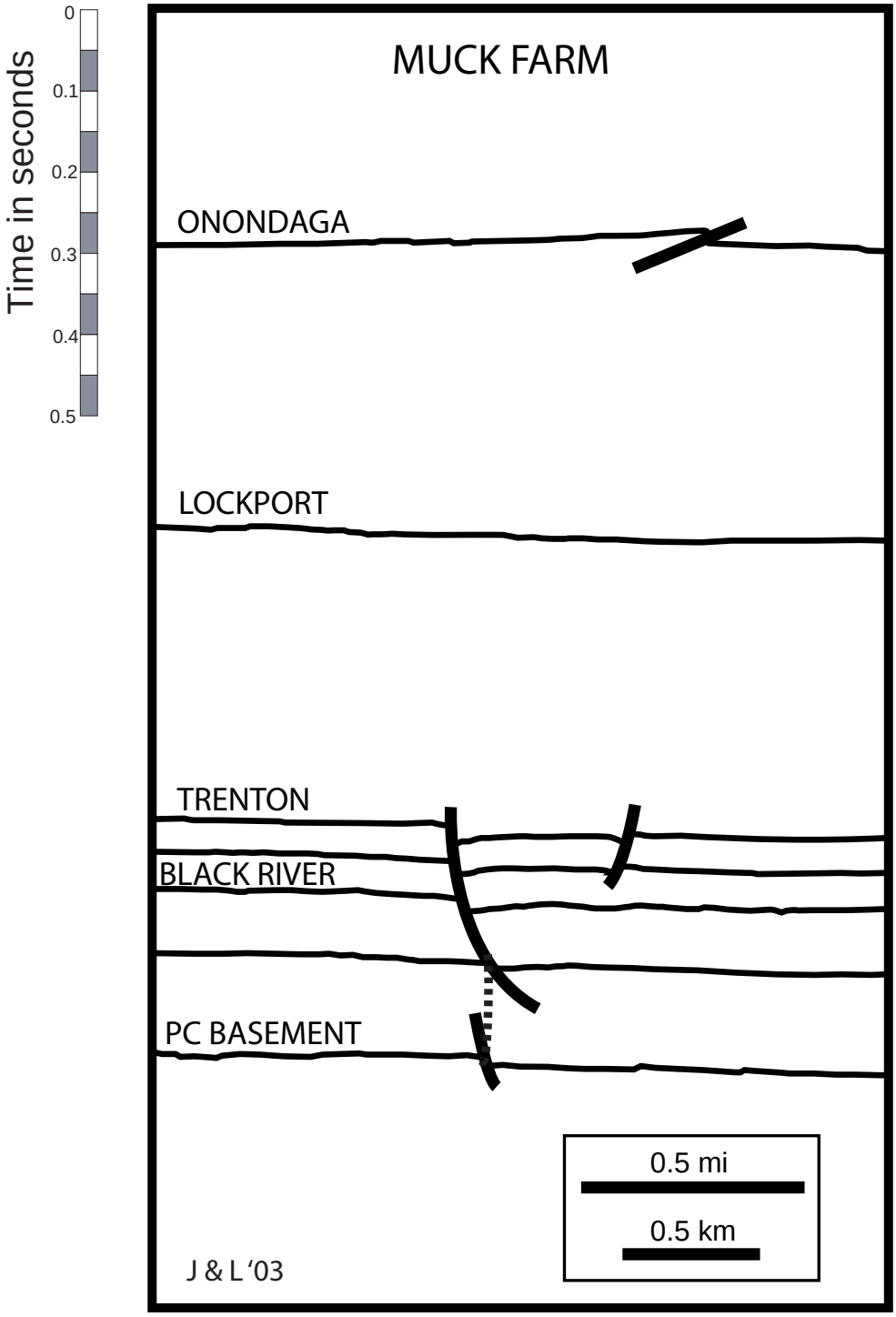

Time in seconds
0
0.1
0.2
0.3
0.4
0.5
MUCK FARM
ONONDAGA
LOCKPORT
TRENTON
BLACK RIVER
PC BASEMENT
0.5 mi
0.5 km
J & L '03

FIGURE 3.4-2

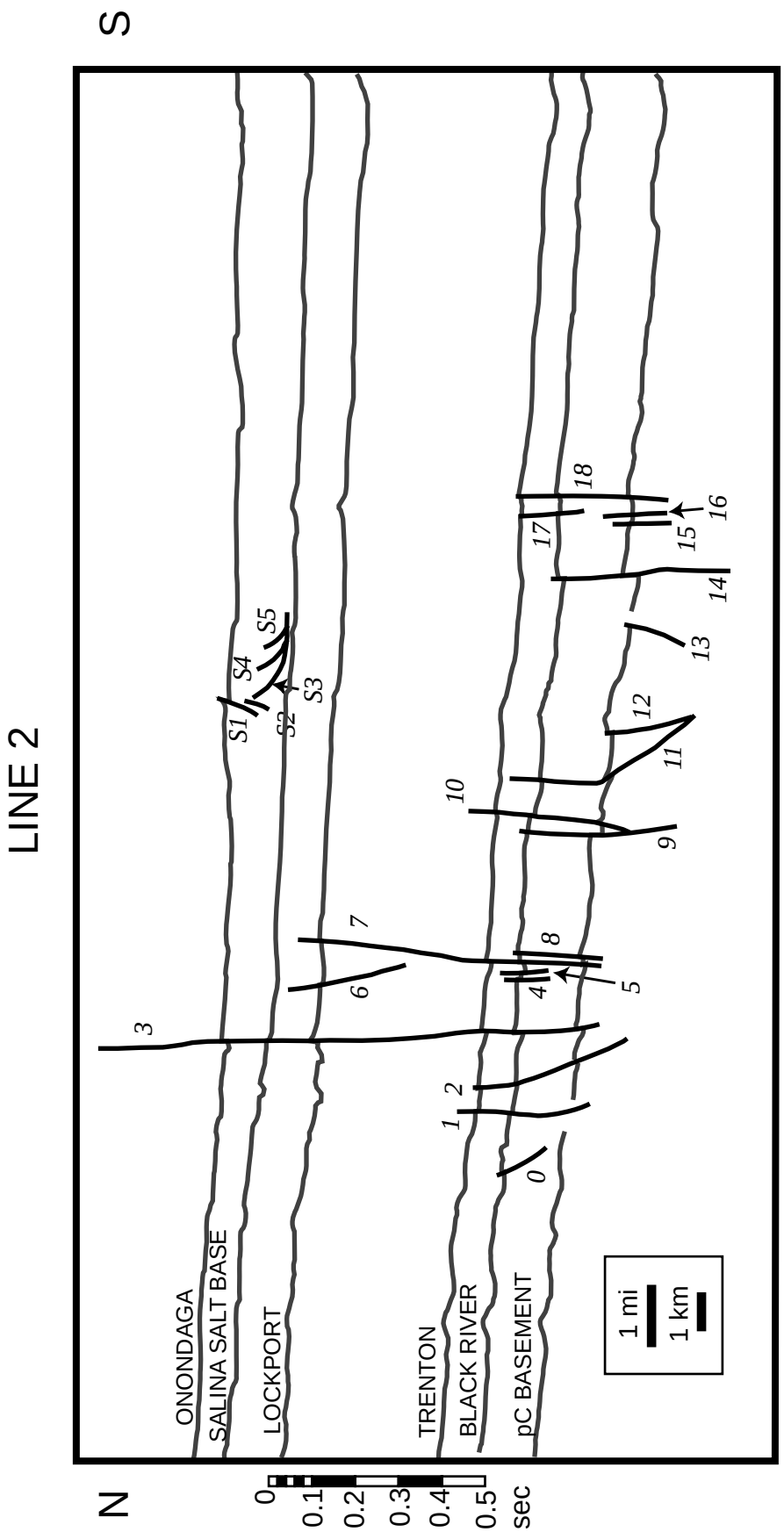

LINE 2
N
S
ONONDAGA
SALINA SALT BASE
LOCKPORT
TRENTON
BLACK RIVER
pC BASEMENT
0
0.1
0.2
0.3
0.4
0.5
sec
1 mi
1 km
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
S1
S2
S3
S4
S5

FIGURE 3.4-3

LINE 3

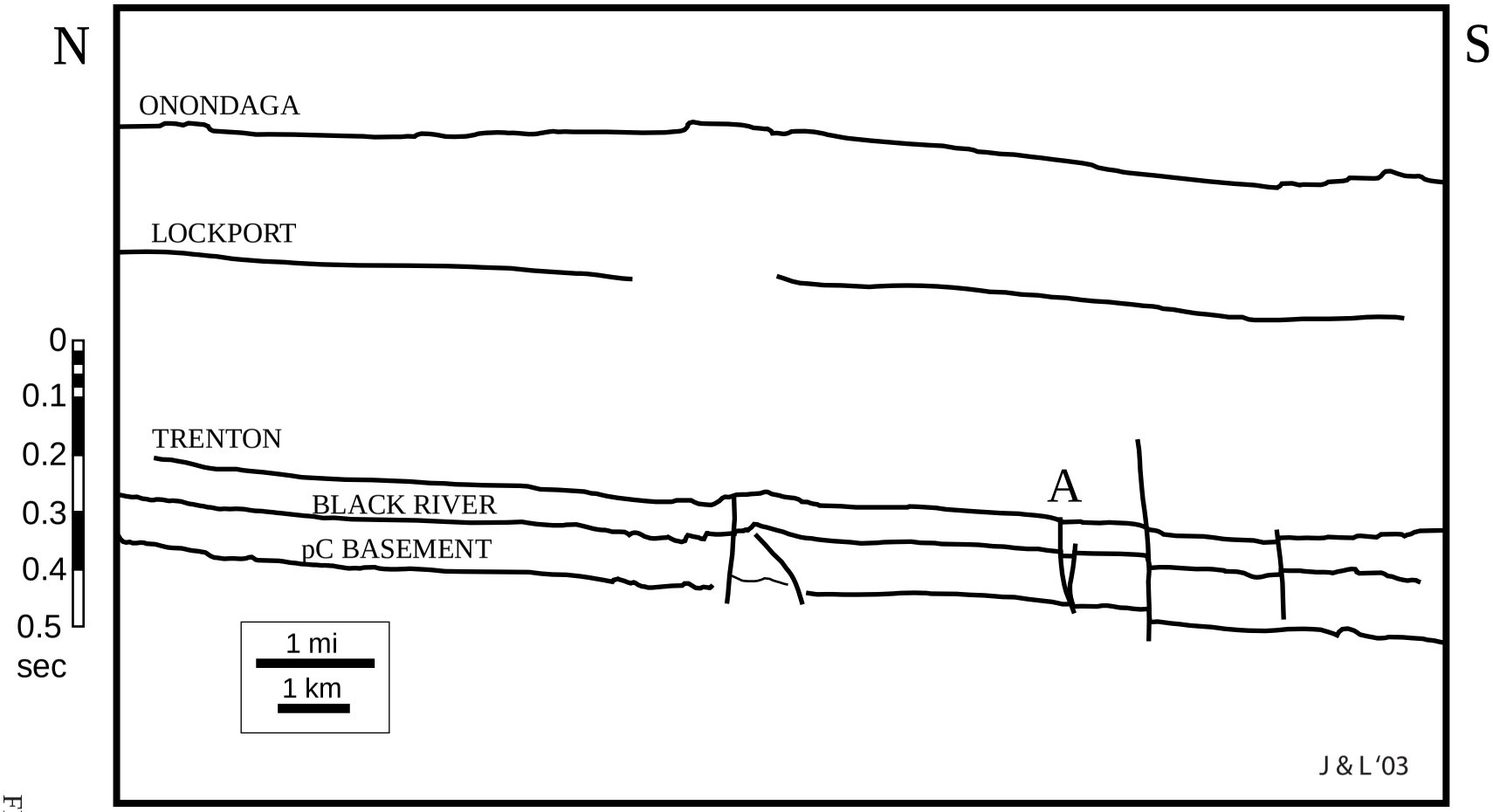


FIGURE 3.4-4

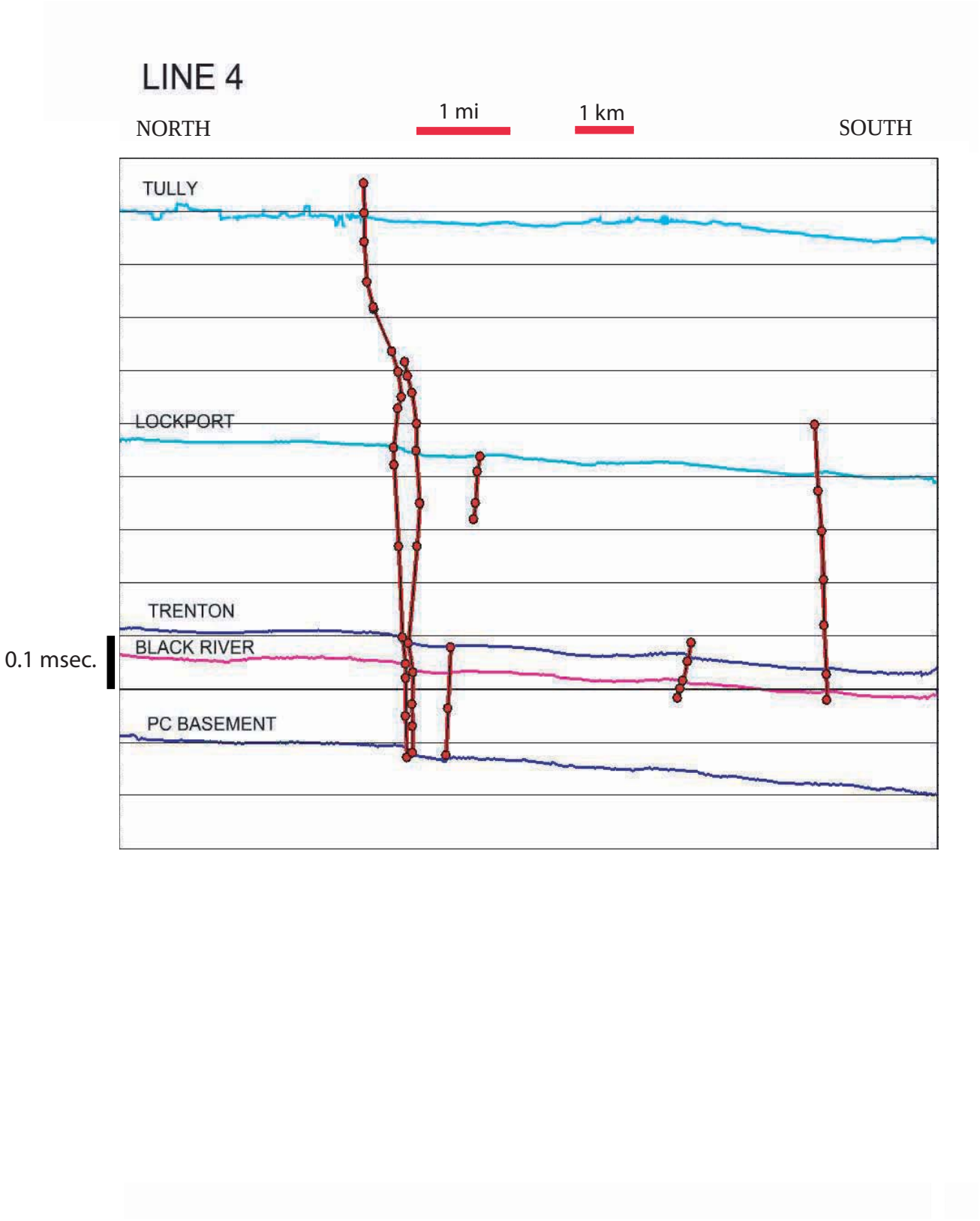

LINE 4
NORTH
1 mi
1 km
SOUTH
TULLY
LOCKPORT
TRENTON
BLACK RIVER
PC BASEMENT
0.1 msec.

FIGURE 3.4-5

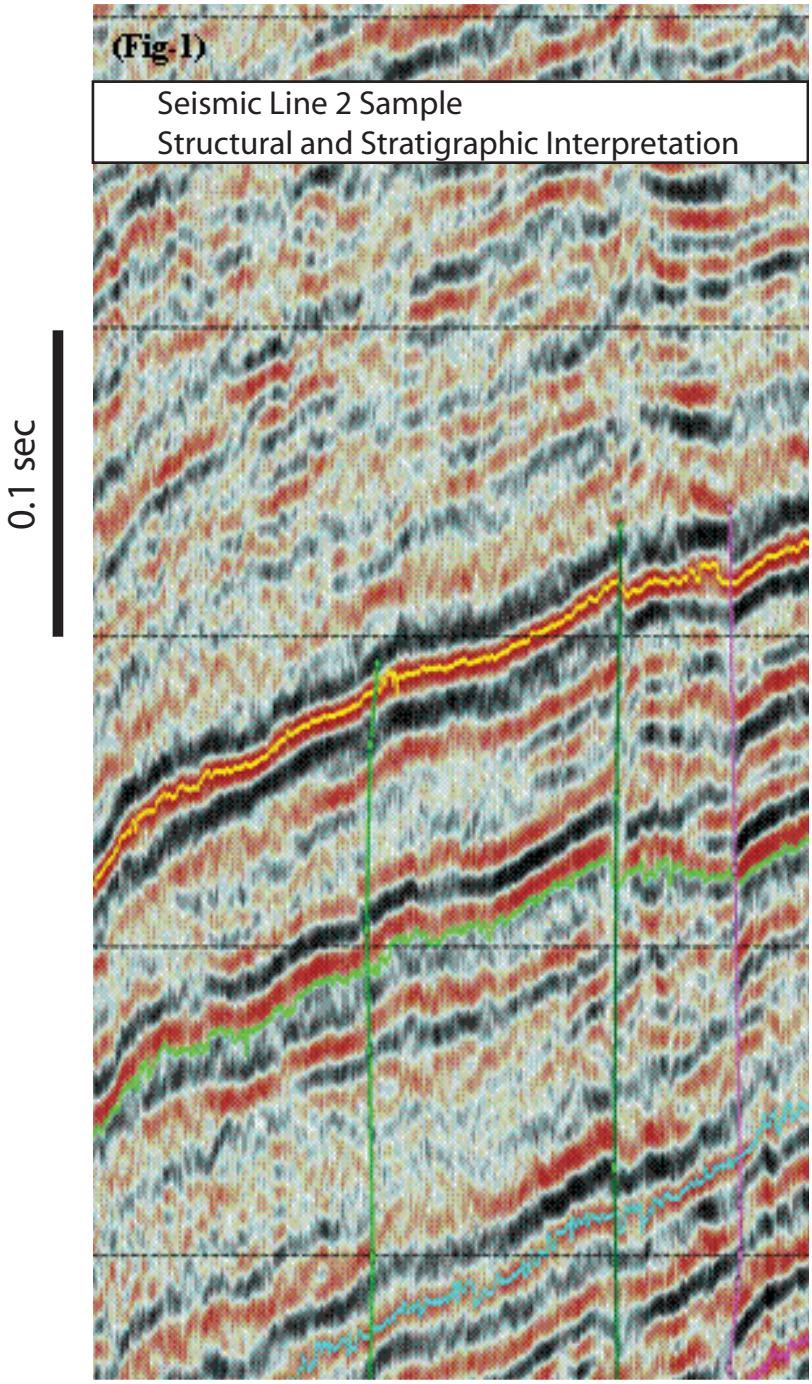

(Fig.1)
Seismic Line 2 Sample
Structural and Stratigraphic Interpretation
0.1 sec

FIGURE 3.5-1

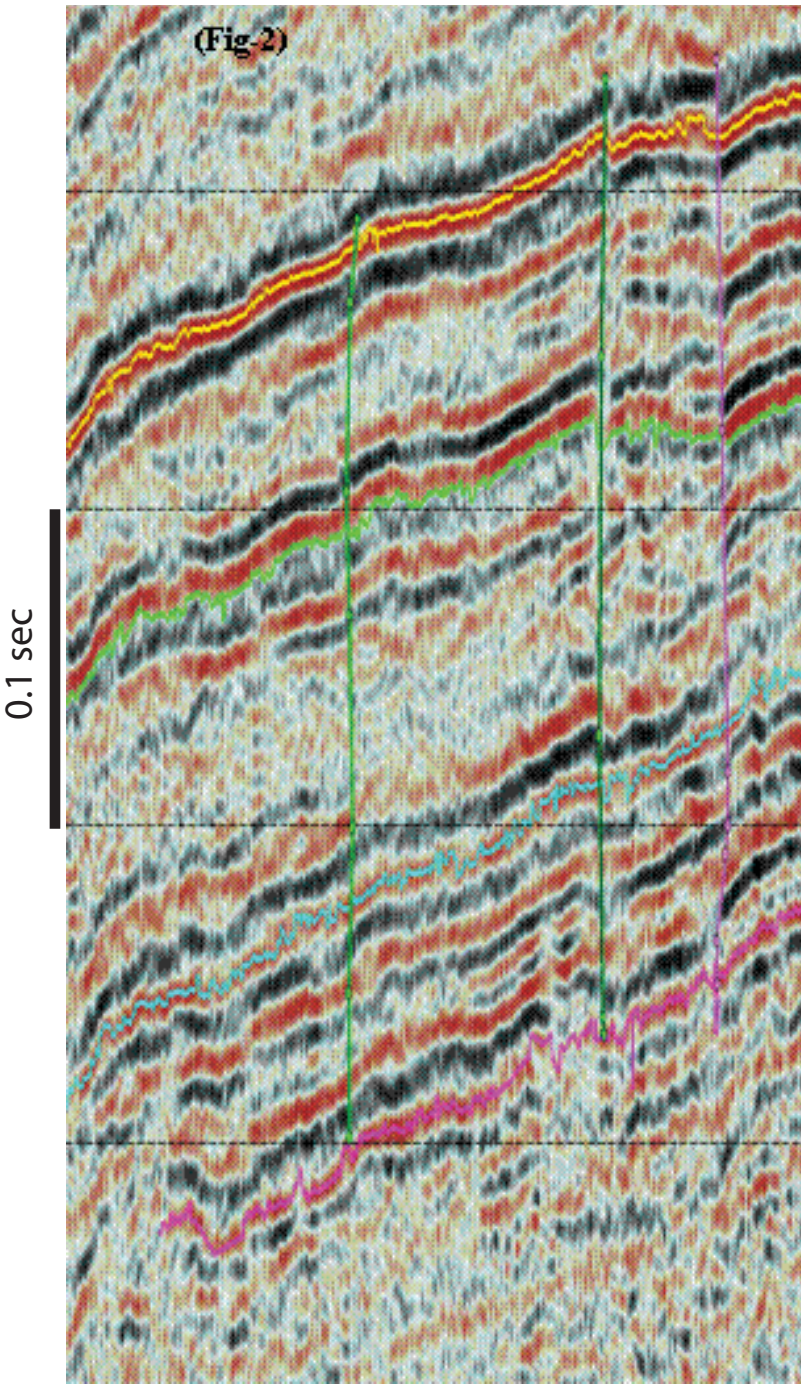


FIGURE 3.5-2

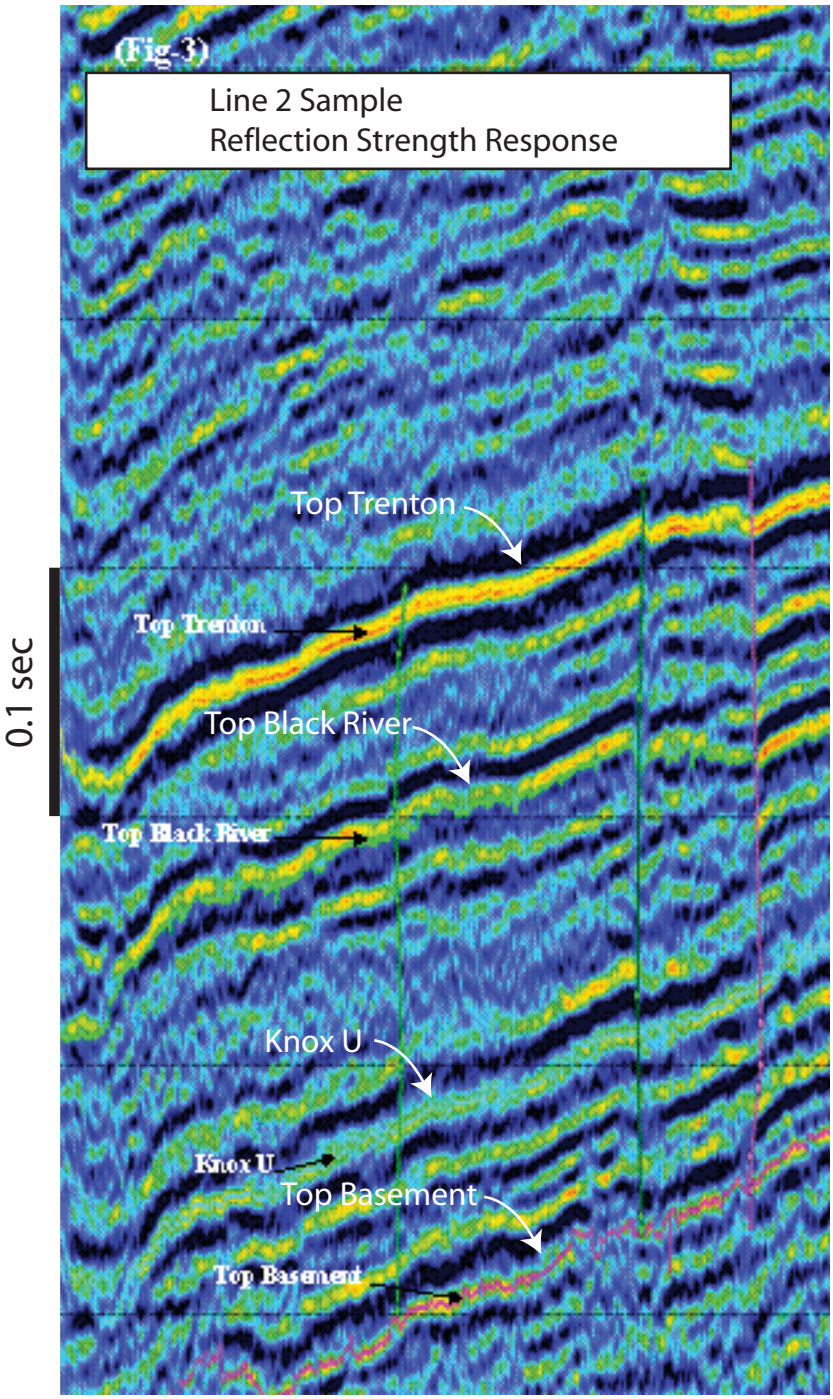

(Fig-3)
Line 2 Sample
Reflection Strength Response
Top Trenton
Top Trenton
Top Black River
Top Black River
Knox U
Knox U
Top Basement
Top Basement
0.1 sec

FIGURE 3.5-3

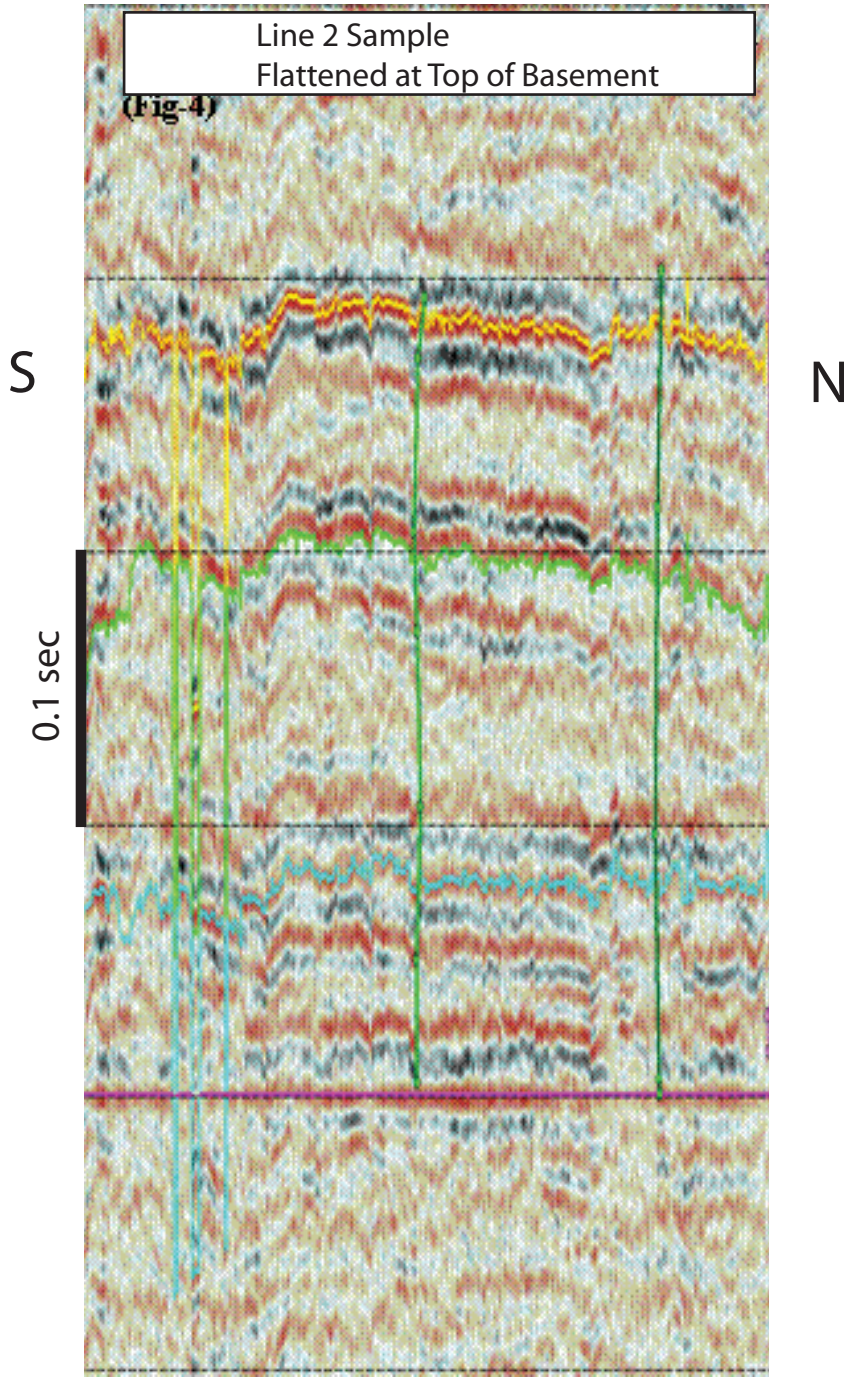


FIGURE 3.5-4

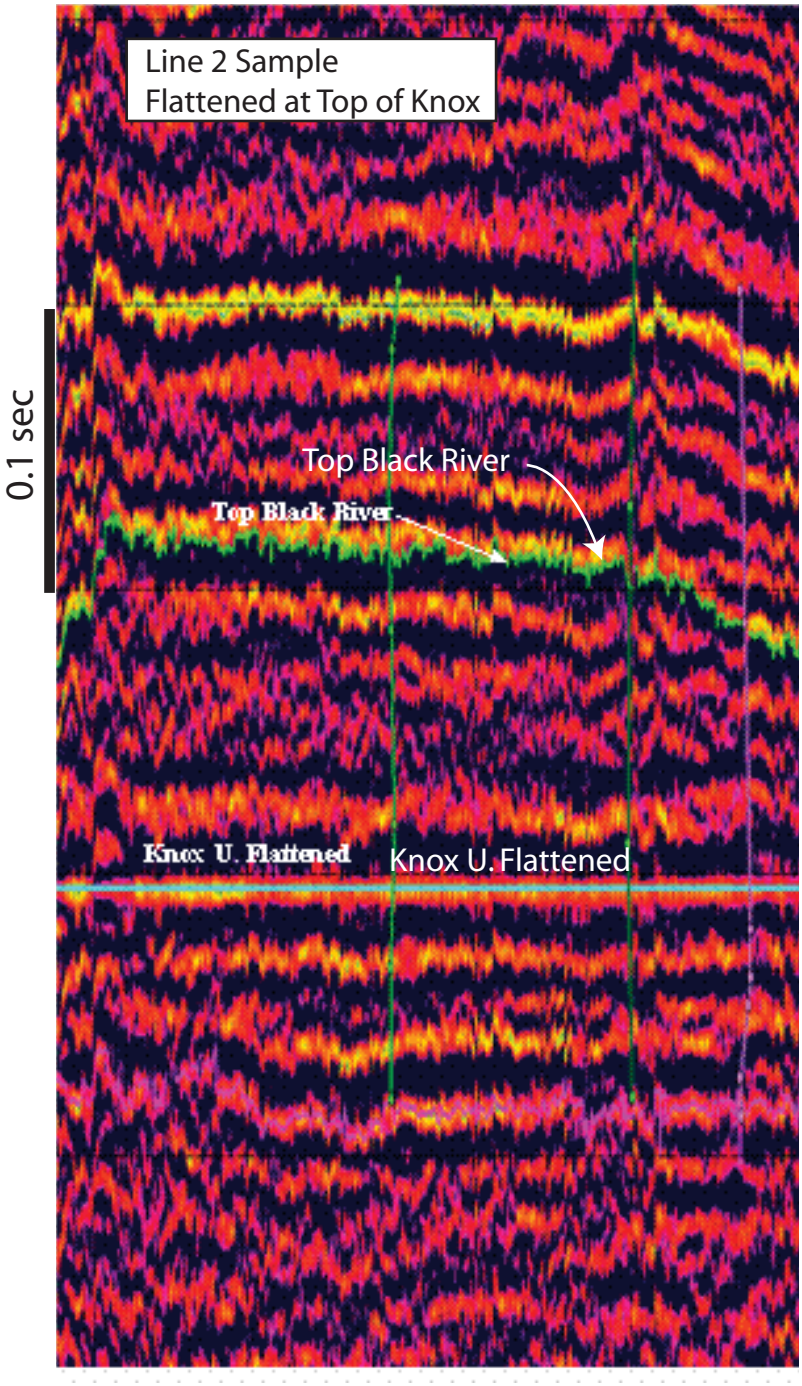

Line 2 Sample
Flattened at Top of Knox
0.1 sec
Top Black River
Top Black River
Knox U. Flattened
Knox U. Flattened

FIGURE 3.5-5

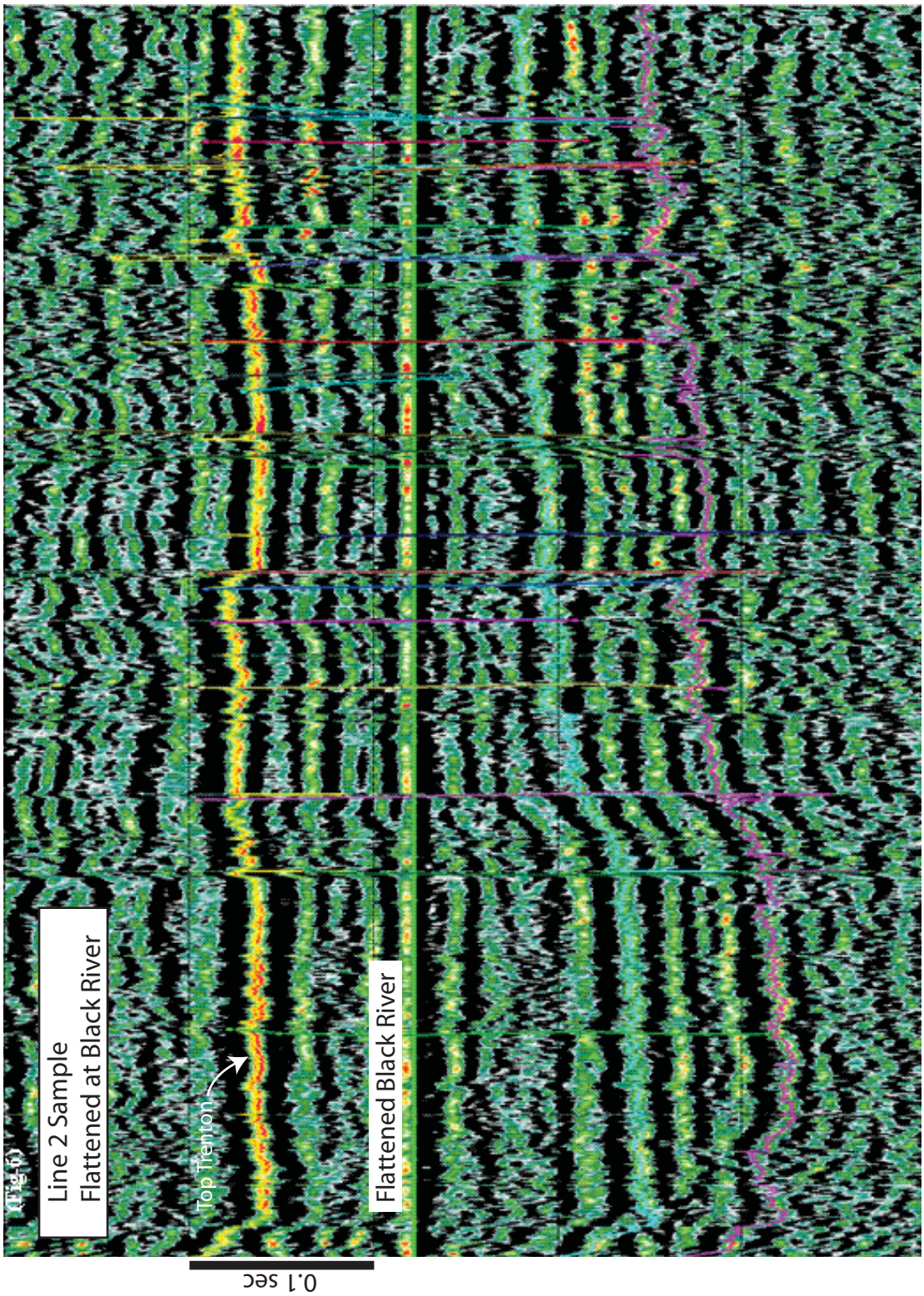

Line 2 Sample
Flattened at Black River
Top Trenton
Flattened Black River
0.1 sec

FIGURE 3.5-6

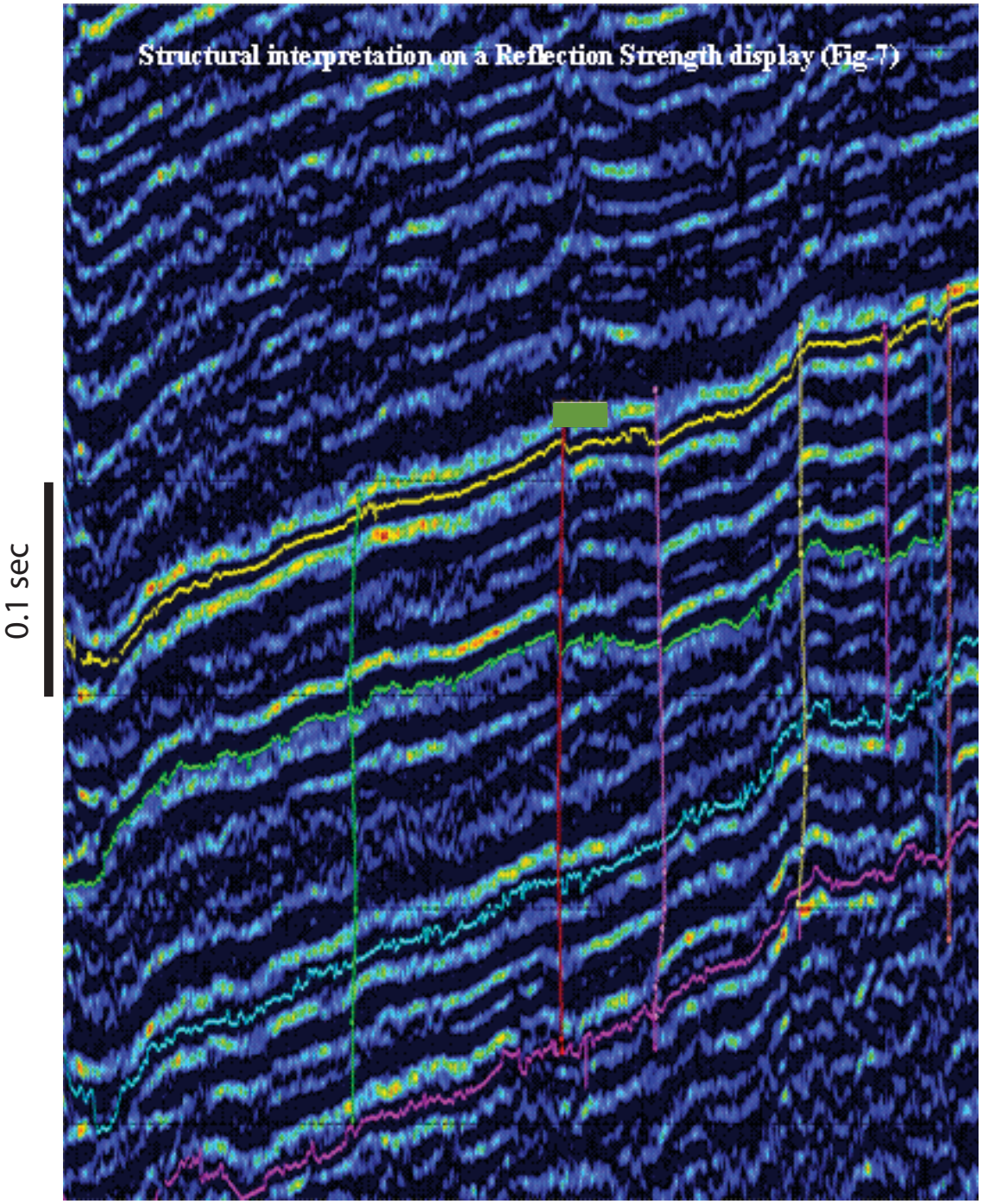

Structural interpretation on a Reflection Strength display (Fig-7)
0.1 sec

FIGURE 3.5-7

100 m
200 ft
(Fig-8)
Top Black River
Top Black River
Knox U
Knox U
0.05 seconds

FIGURE 3.5-8

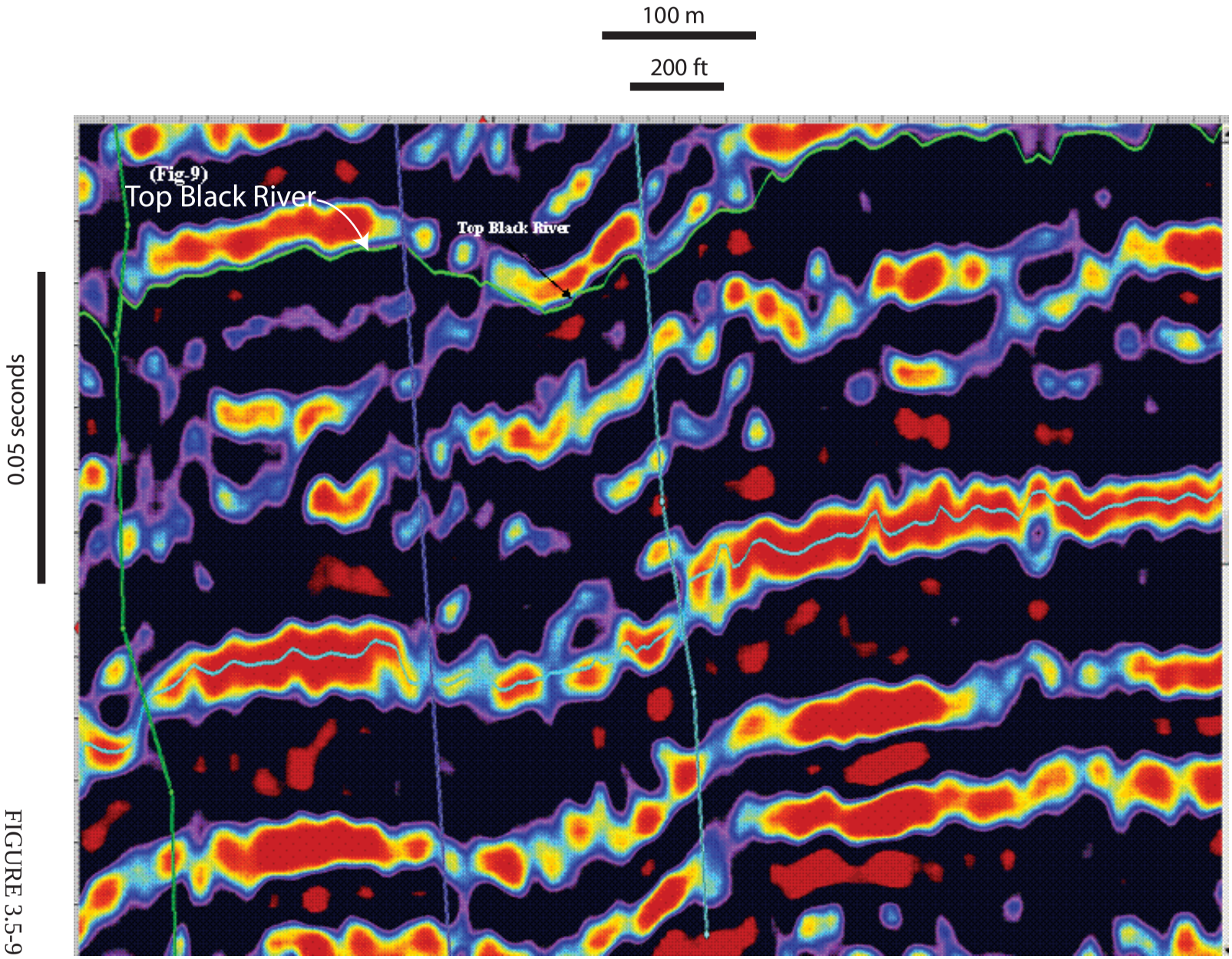


FIGURE 3.5-9

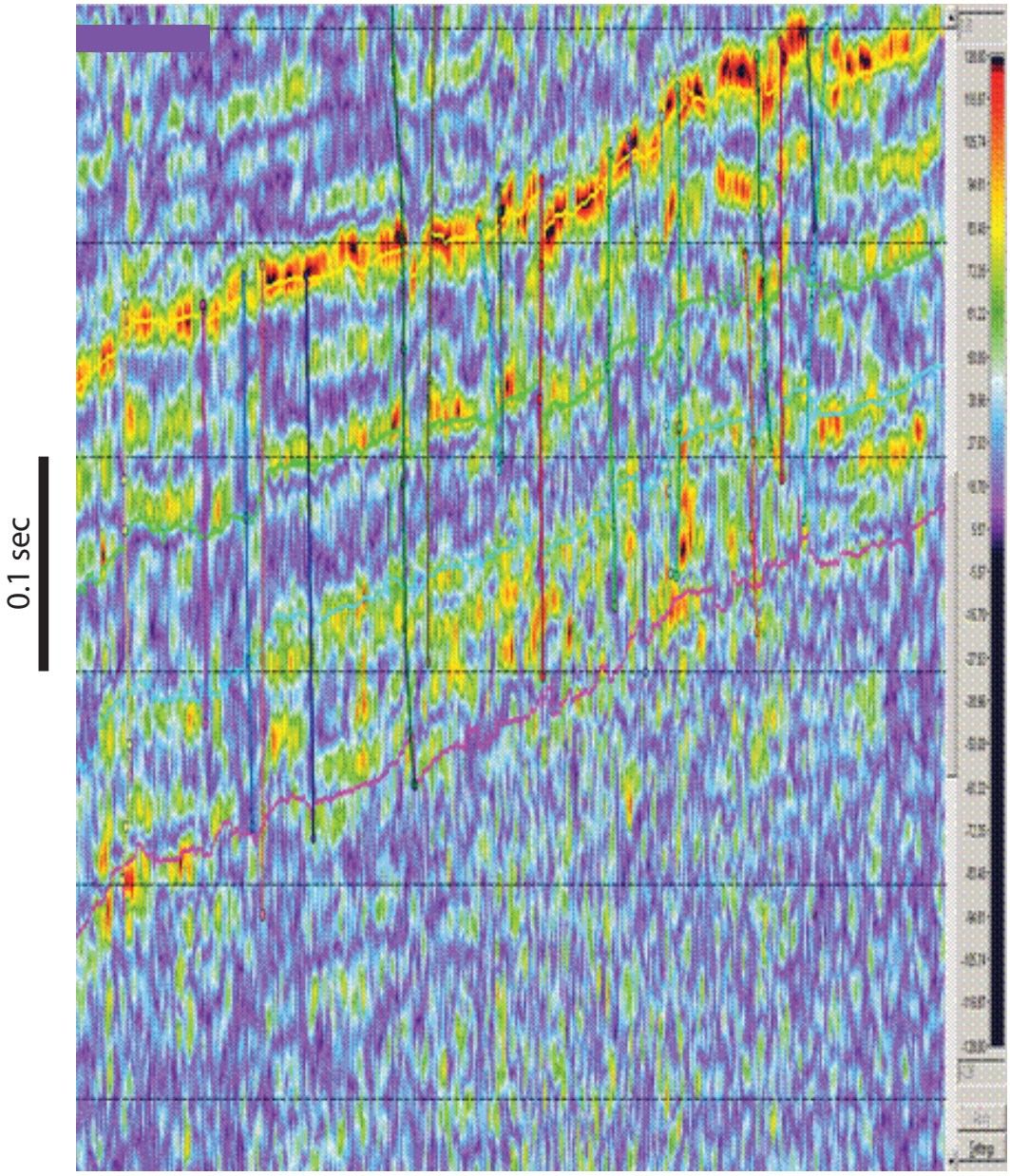


FIGURE 3.5-10

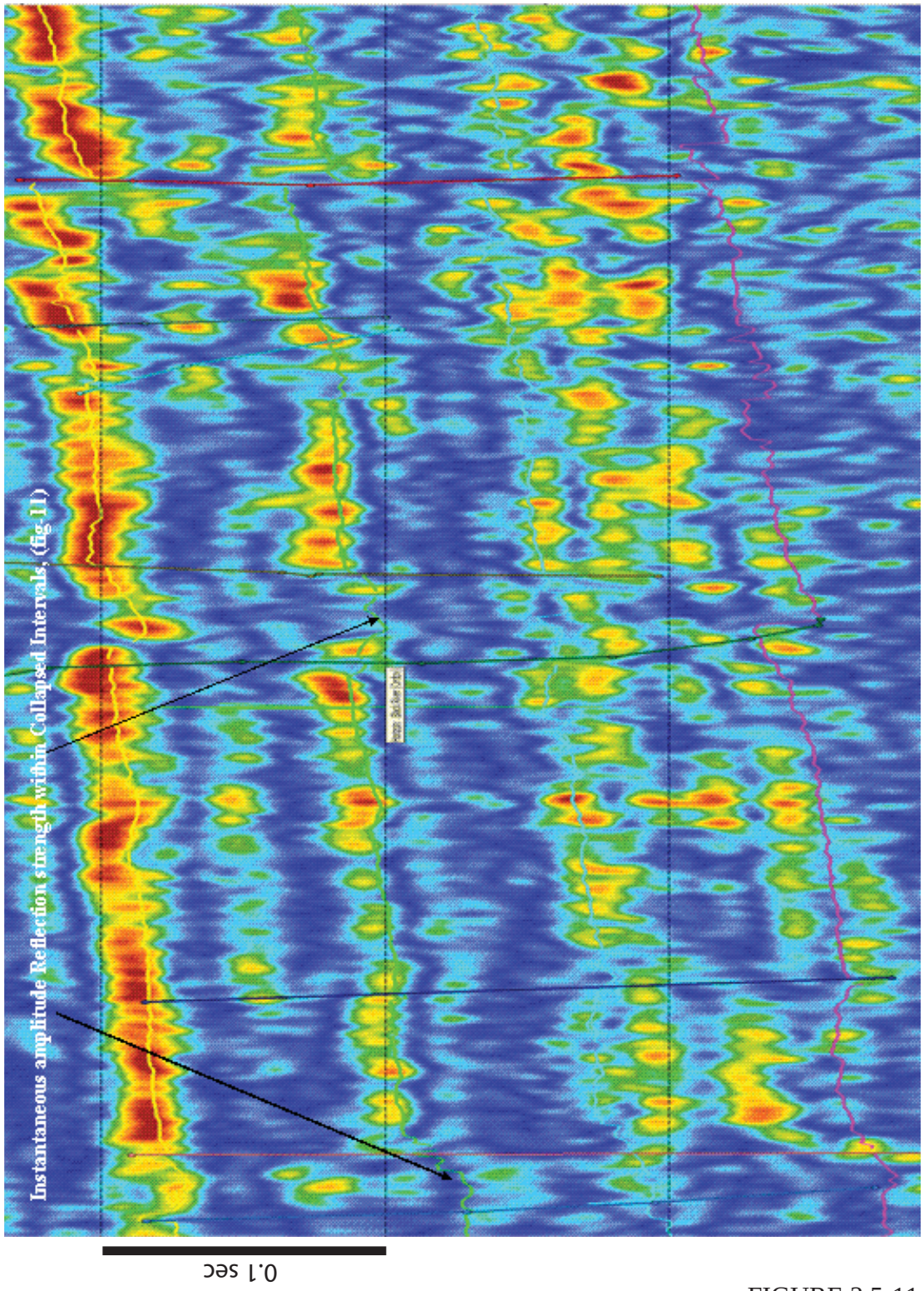

Instantaneous amplitude Reflection strength within Collapsed Intervals, (fig.11)
0.1 sec

FIGURE 3.5-11

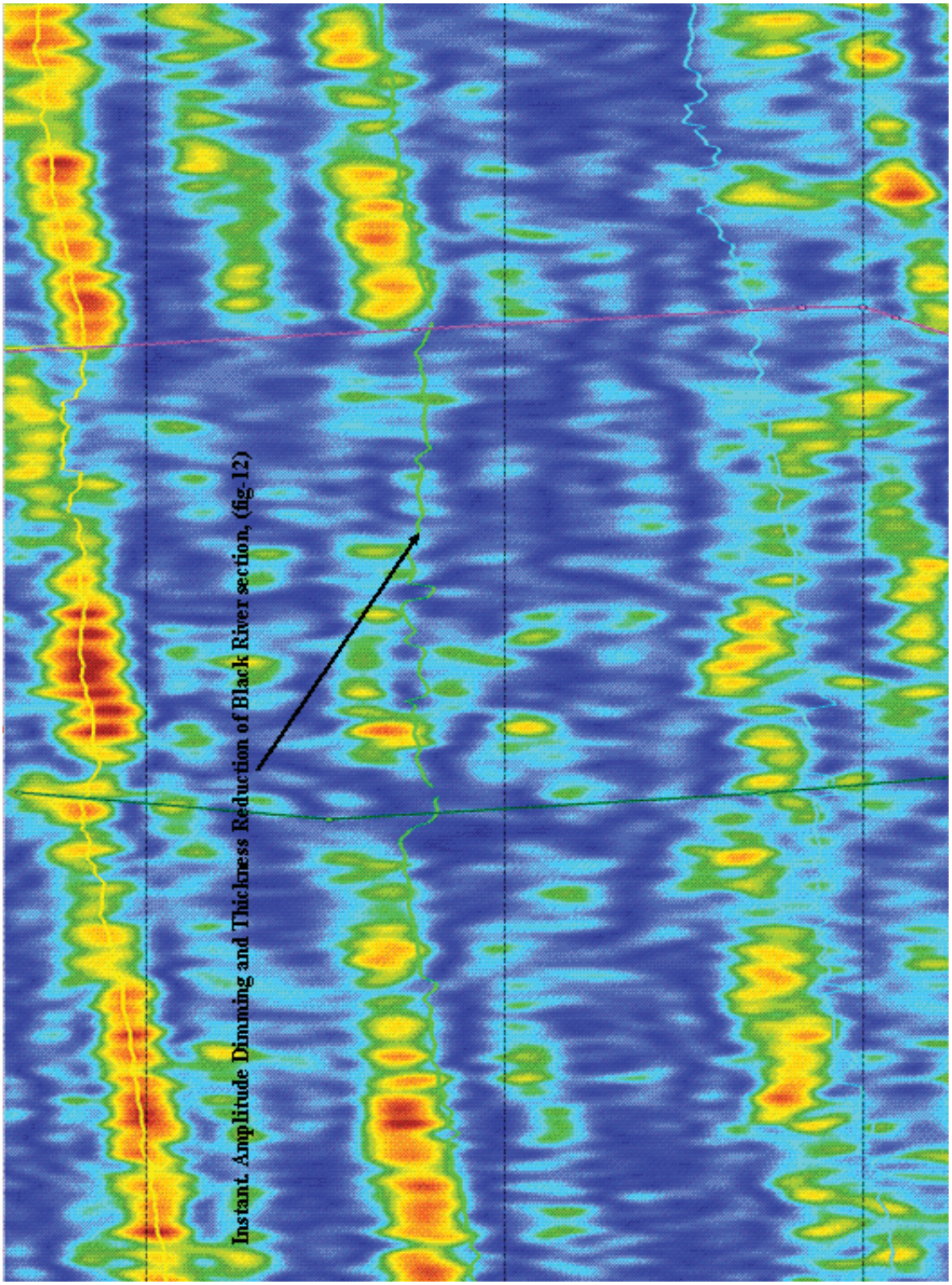

Instant. Amplitude Dimming and Thickness Reduction of Black River section, (fig-12)

FIGURE 3.5-12

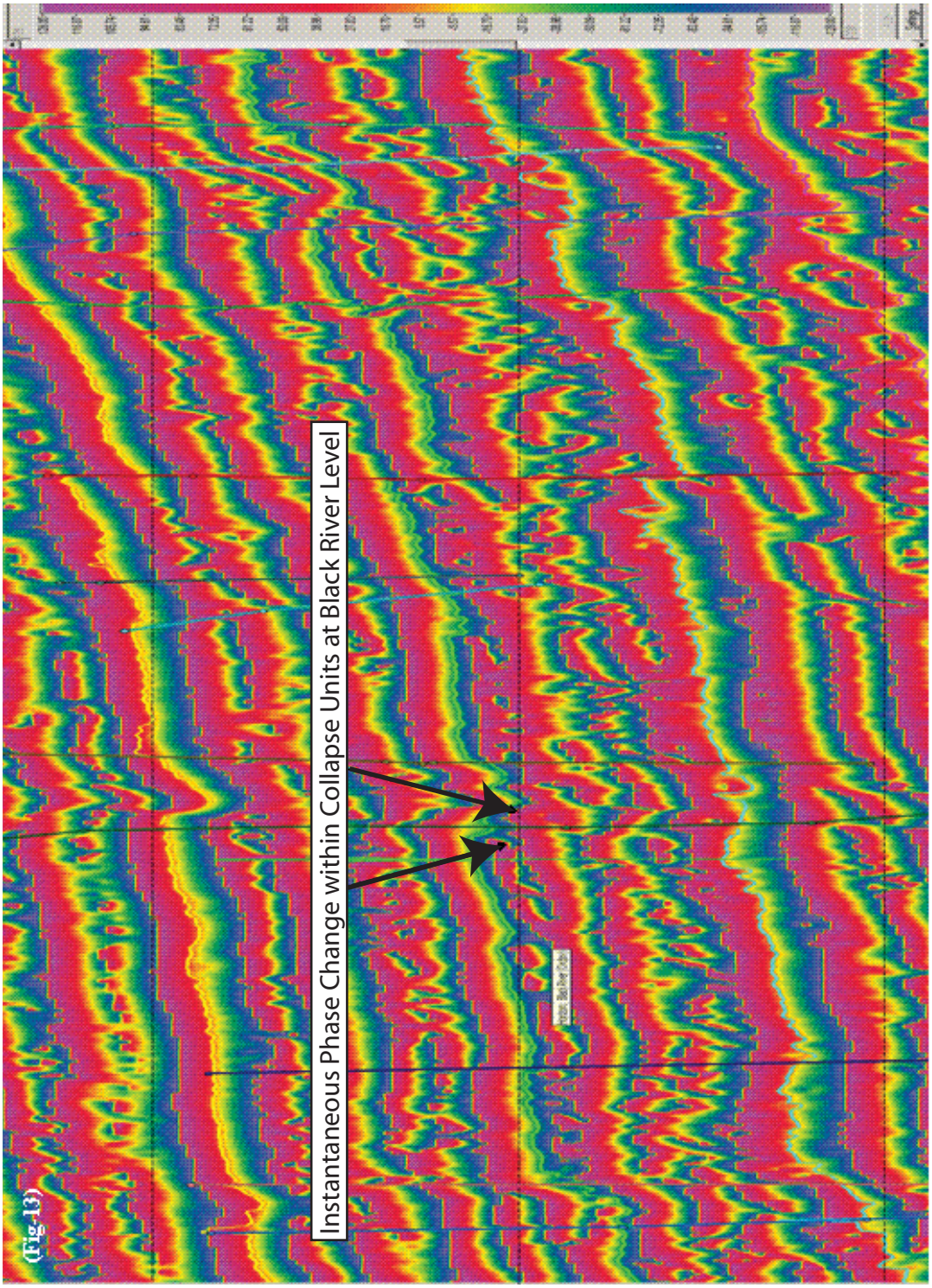

(Fig-13)
Instantaneous Phase Change within Collapse Units at Black River Level

FIGURE 3.5-13

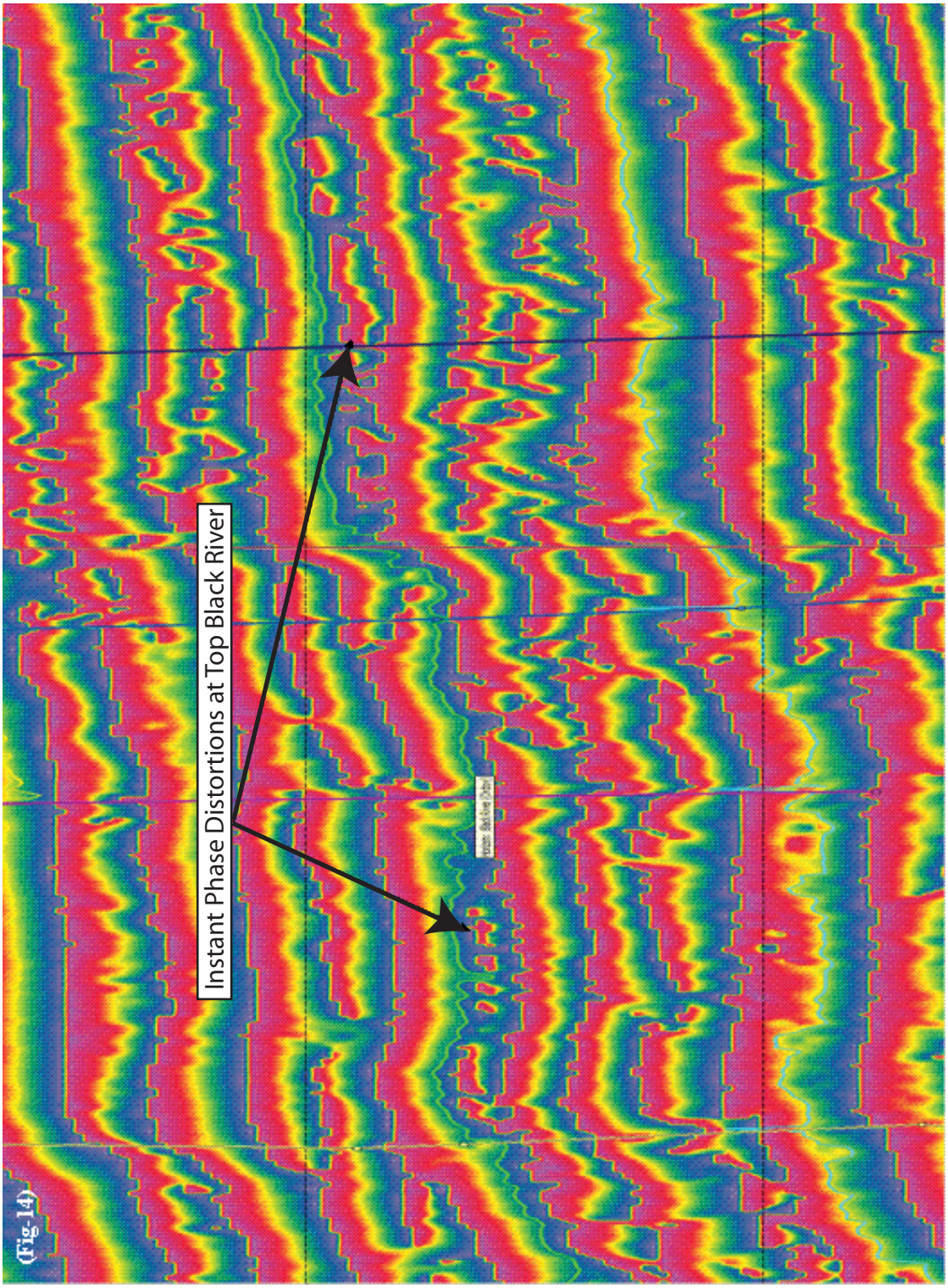


FIGURE 3.5-14

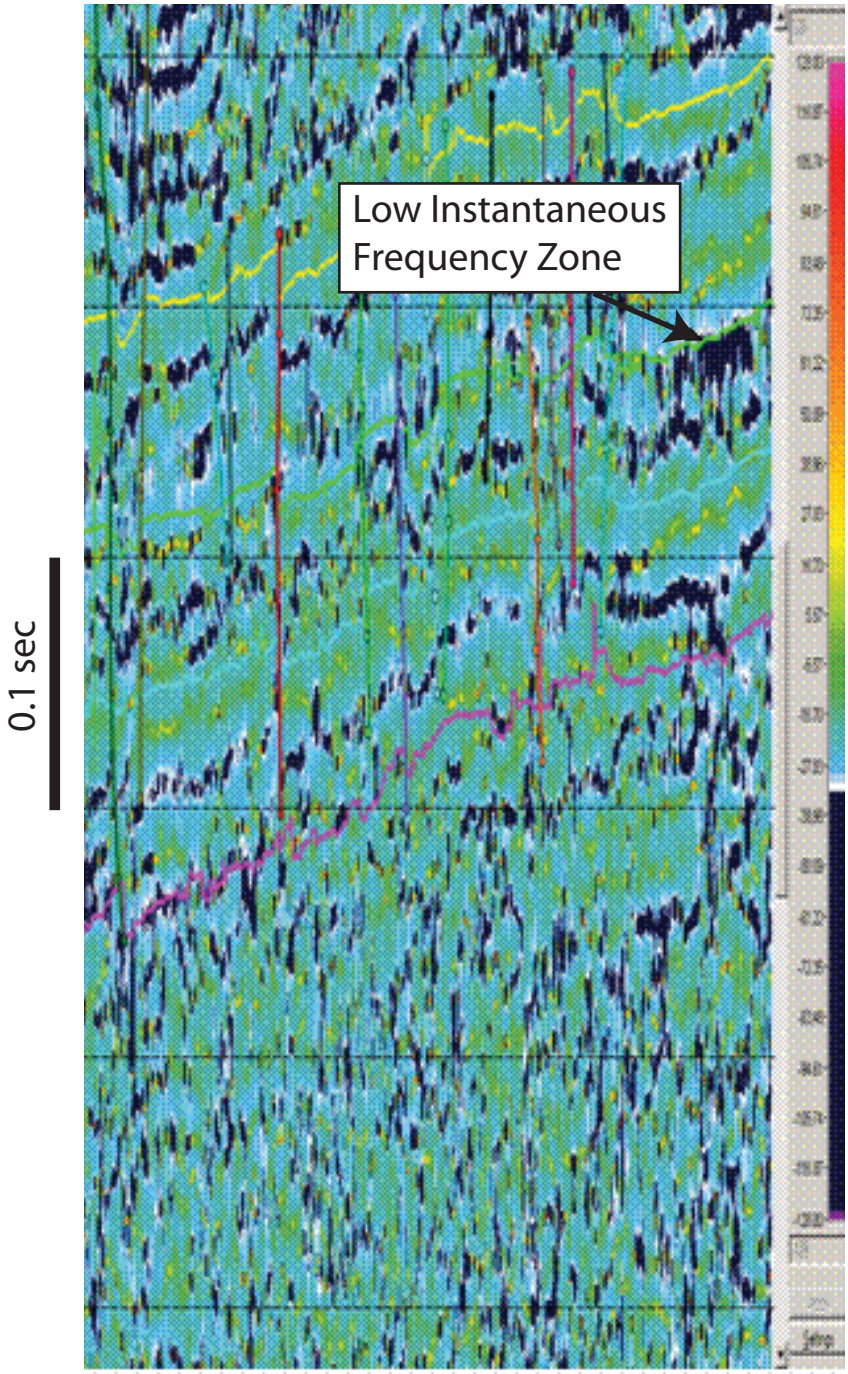


FIGURE 3.5-15

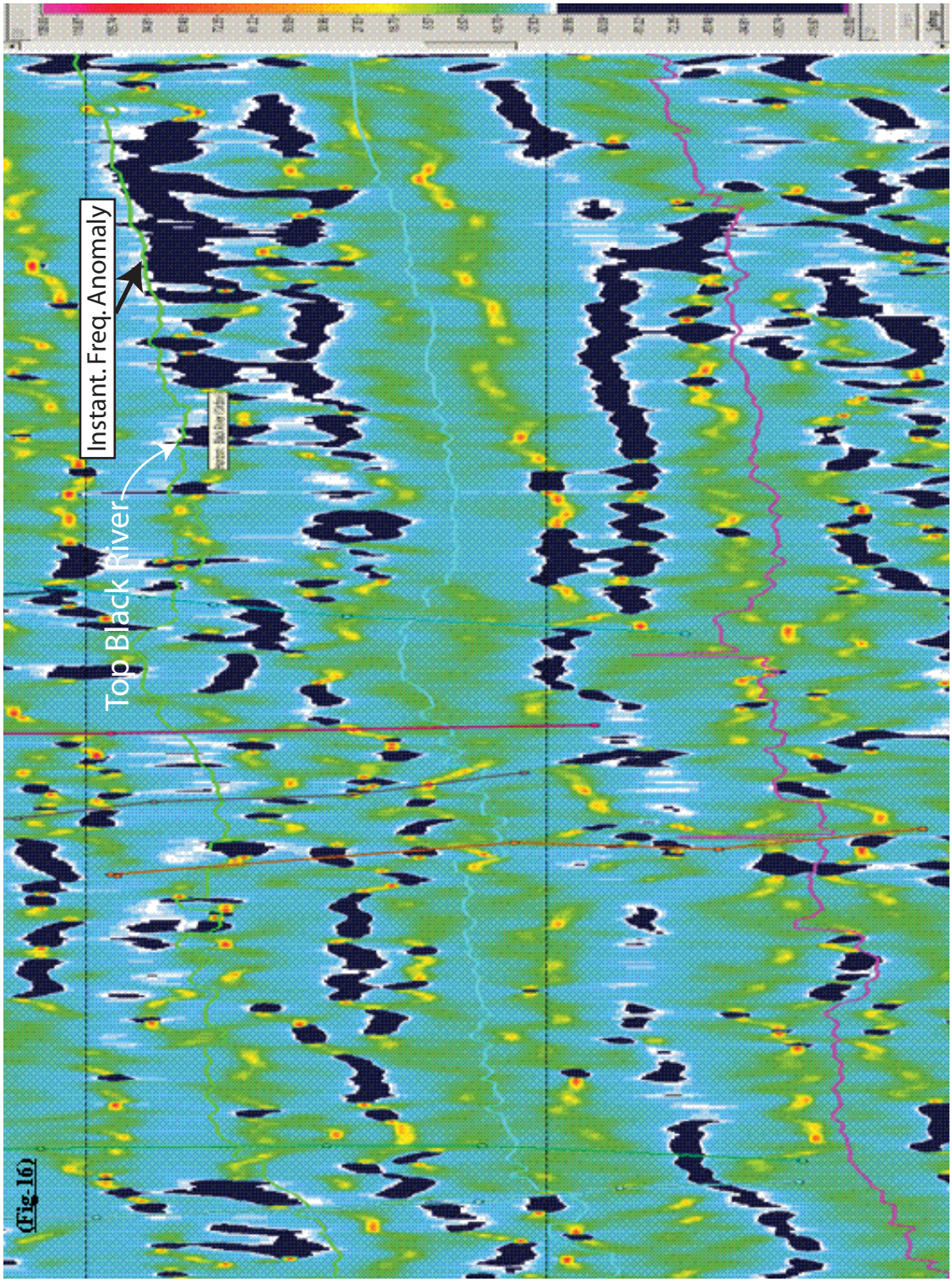


FIGURE 3.5-16

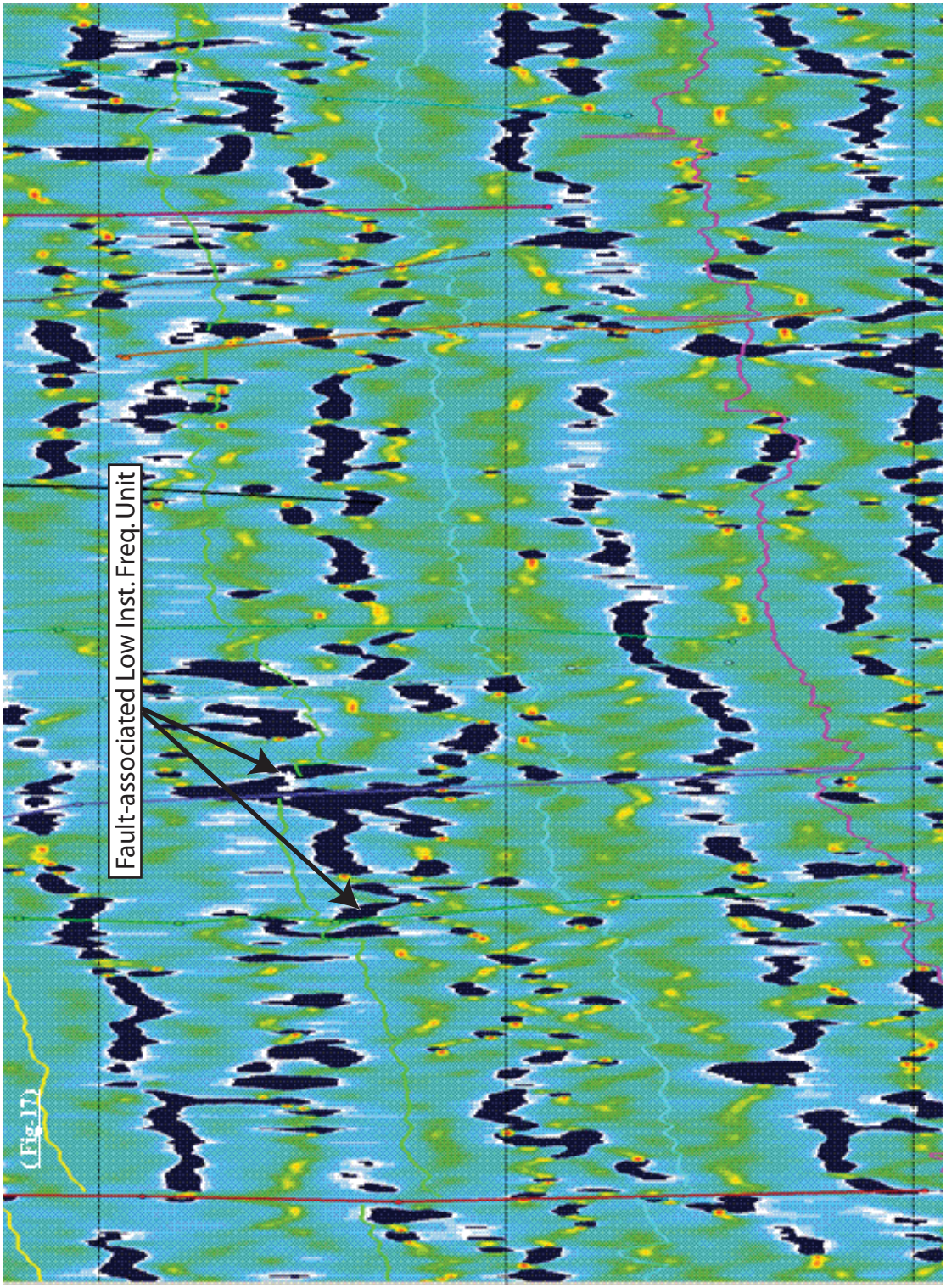


FIGURE 3.5-17

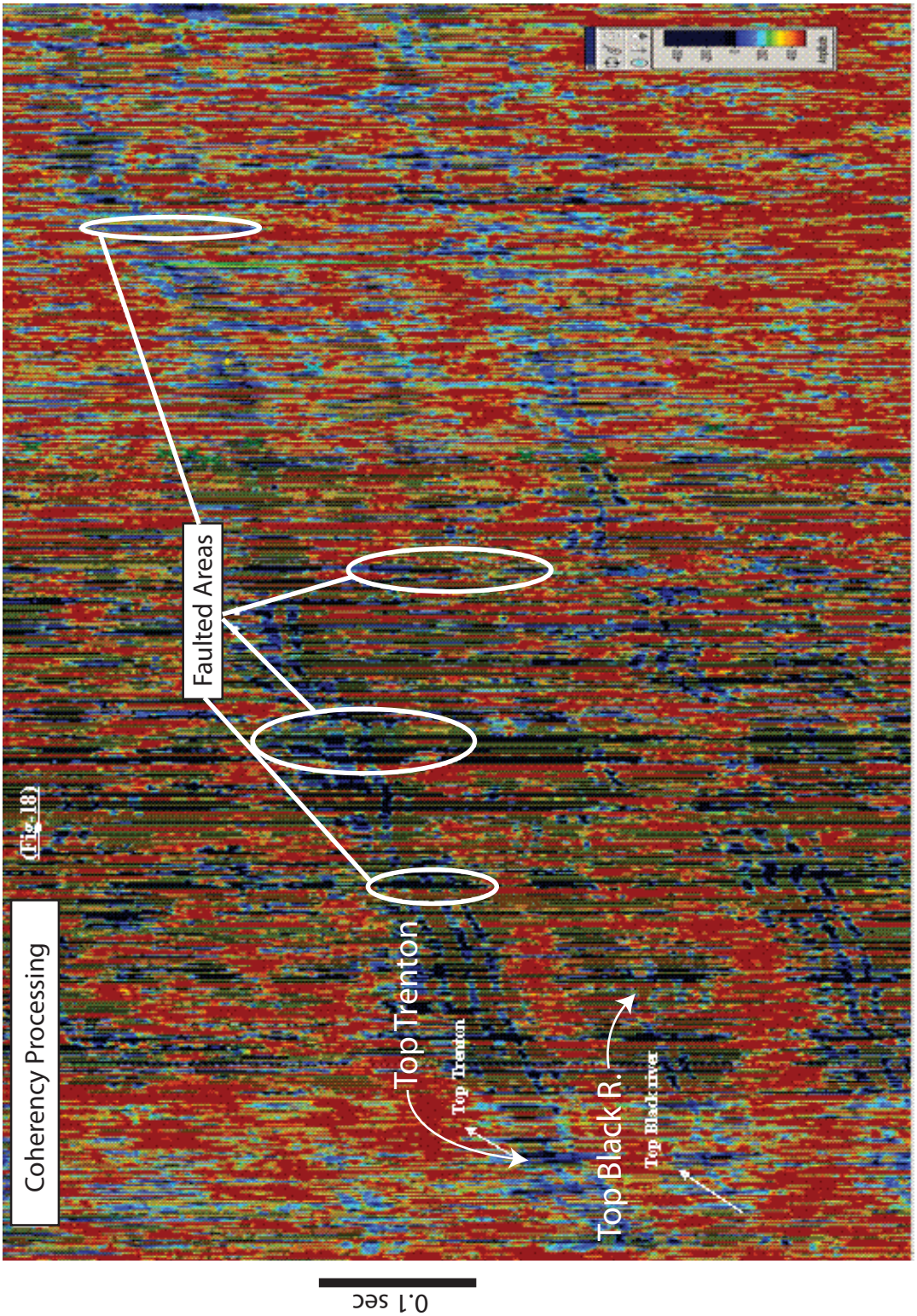

Coherency Processing
(Fig-18)
Faulted Areas
Top Trenton
Top Trenton
Top Black R.
Top Blackriver
0.1 sec

FIGURE 3.5-18

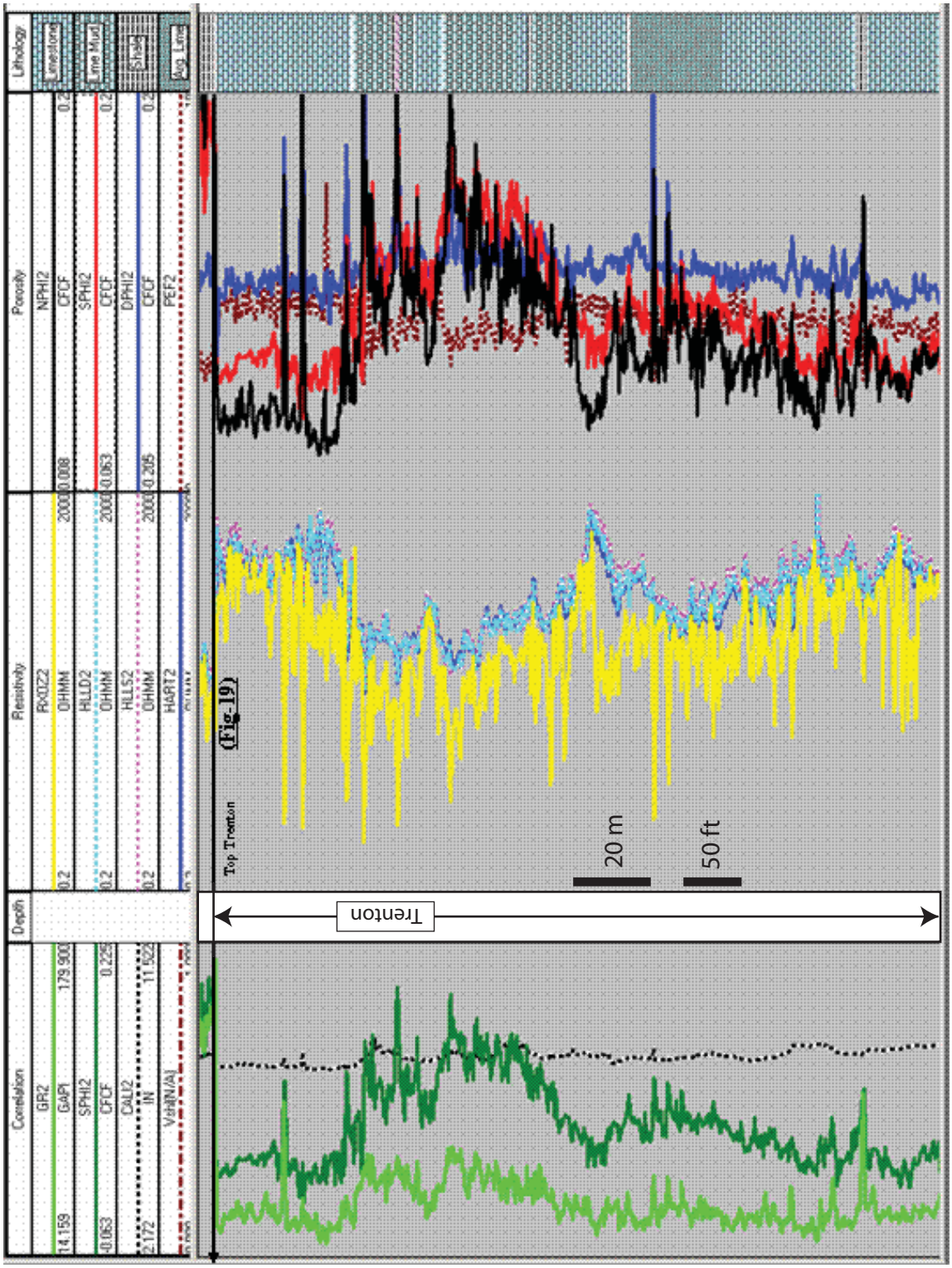

Correlation
Depth
Resistivity
Porosity
Lithology
GR2
GAPI
14.159
179.900
SPHI2
CFCF
-0.063
0.225
CALI2
IN
2.172
11.522
Vshl(N/A)
RXOZ2
OHMM
0.2
2000
HLLD2
OHMM
0.2
2000
HLLS2
OHMM
0.2
2000
HART2
NPHI2
CFCF
0.008
0.2
SPHI2
CFCF
-0.063
0.2
DPHI2
CFCF
-0.205
0.2
PEF2
Limestone
Lime Mud
Shale
Avg. Lime
Top Trenton
(Fig-19)
20 m
50 ft
Trenton

FIGURE 3.5-19

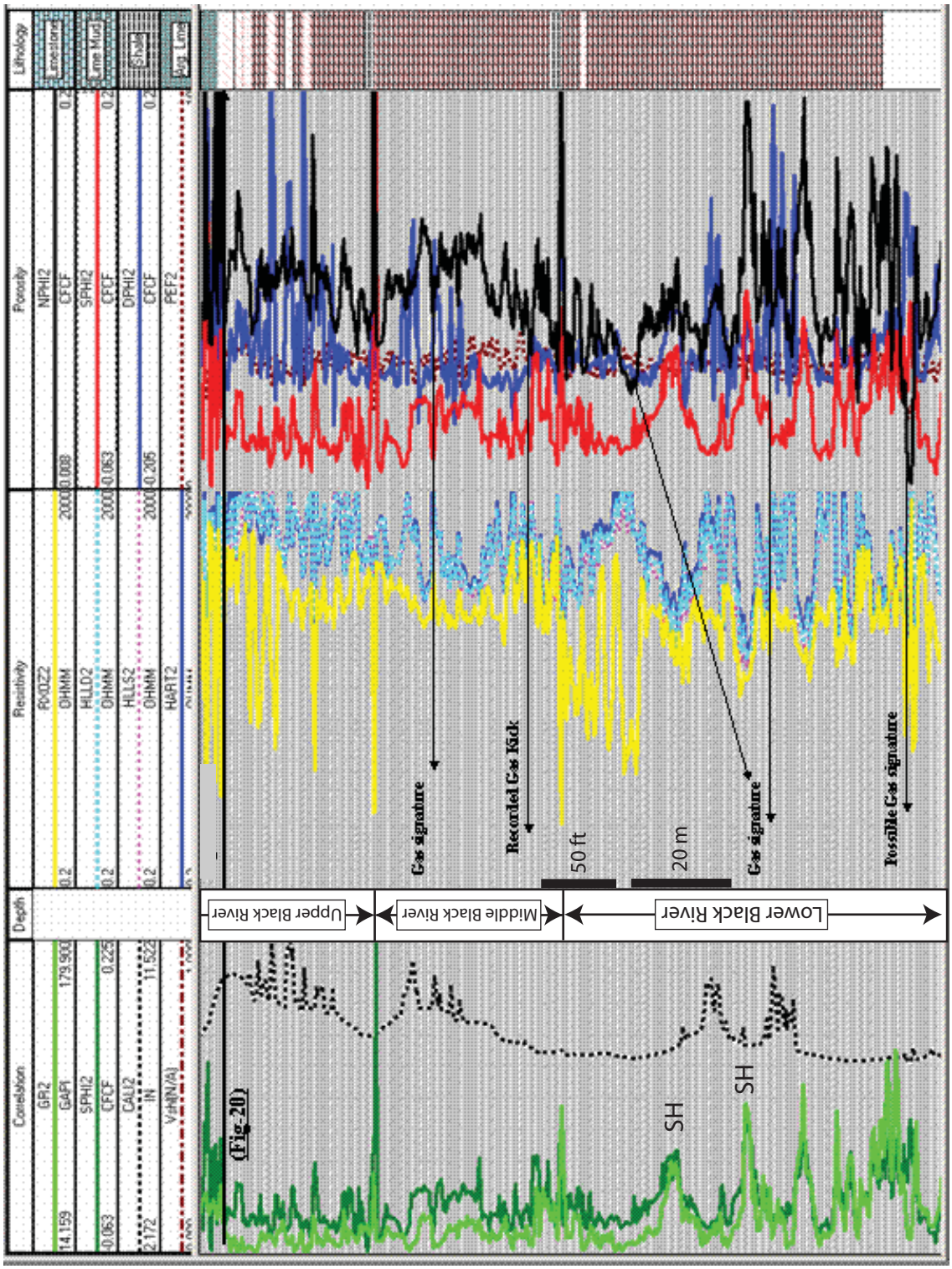

Correlation
Depth
Resistivity
Porosity
Lithology
GR2
GAPI
SPHI2
CFCF
CALI2
IN
VHNN(A)
RXOZ2
OHMM
HILLD2
HILLS2
HART2
NPHI2
DPHI2
PEF2
Limestone
Lime Mud
Shale
Arg. Lime
(Fig-20)
SH
SH
Upper Black River
Middle Black River
Lower Black River
Gas signature
Recorded Gas Kick
50 ft
20 m
Gas signature
Possible Gas signature

FIGURE 3.5-20

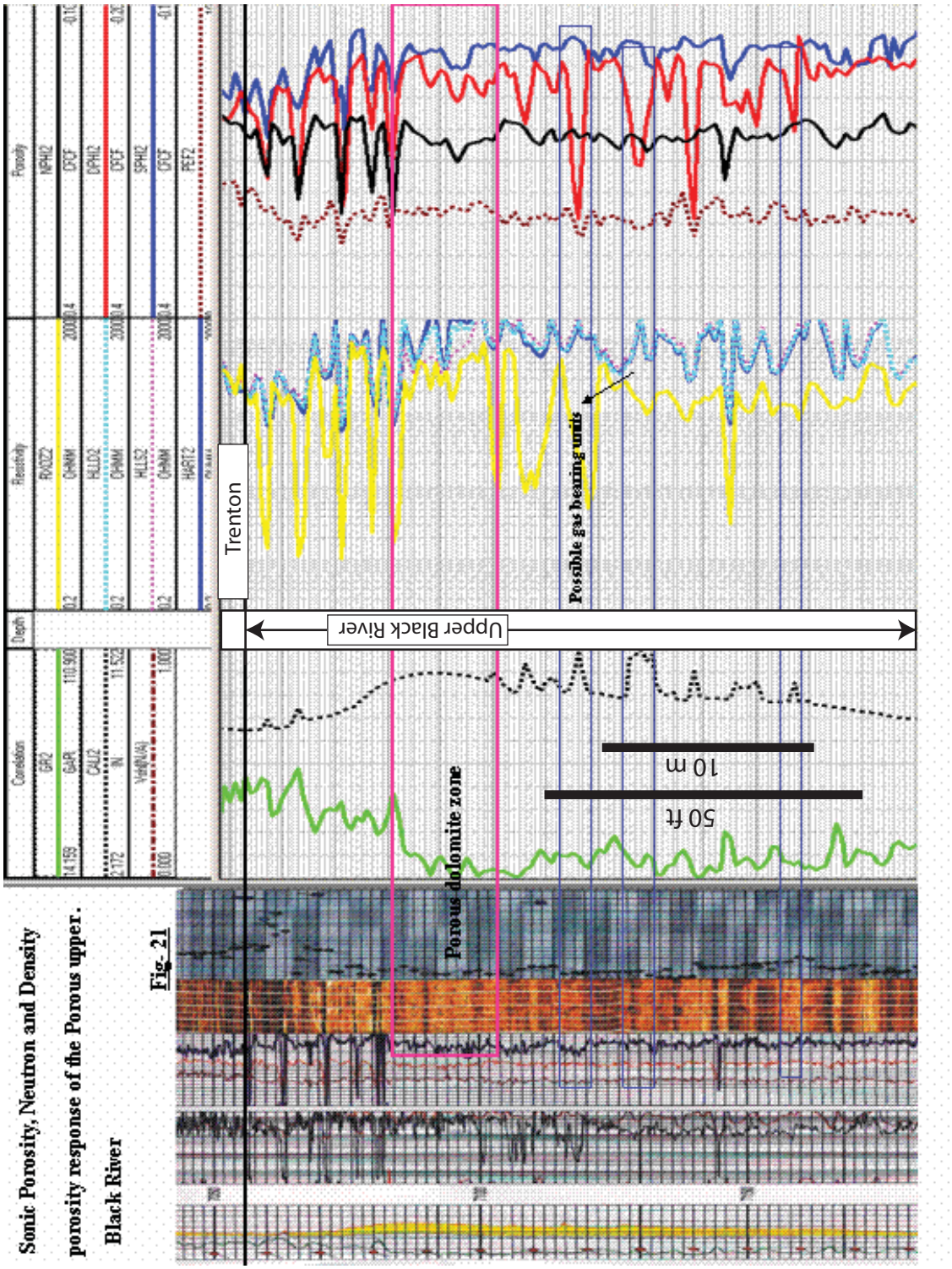

Sonic Porosity, Neutron and Density
porosity response of the Porous upper.
Black River
Fig. 21
Porous dolomite zone
50 ft
10 m
Upper Black River
Trenton
Possible gas bearing units

FIGURE 3.5-21

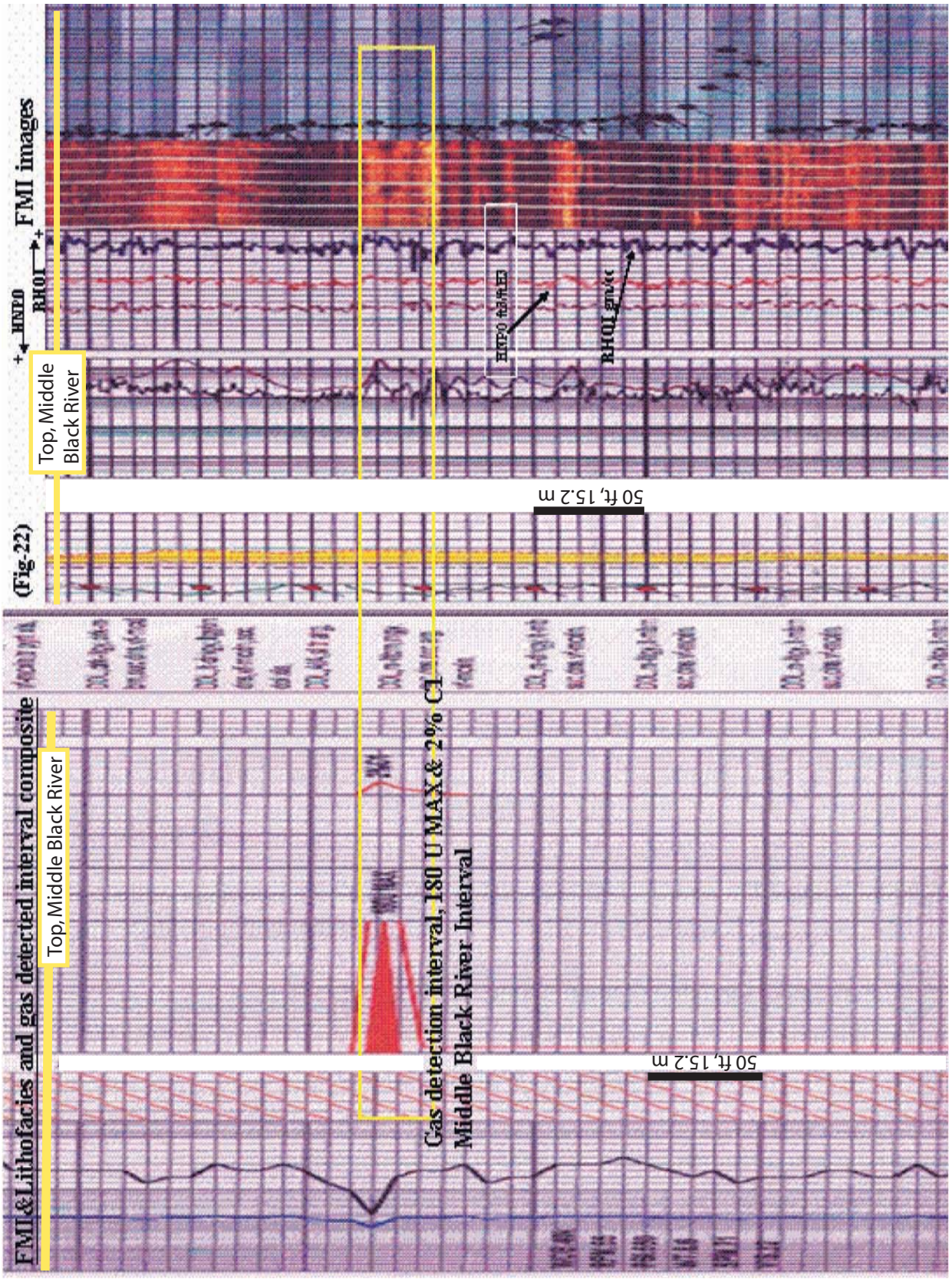

FMI&Lithofacies and gas detected interval composite
Top, Middle Black River
Gas detection interval, 180 U MAX & 2% C1
Middle Black River Interval
50 ft, 15.2 m
(Fig-22)
50 ft, 15.2 m
Top, Middle Black River
FMI images
HNPO
RHOI

FIGURE 3.5-22

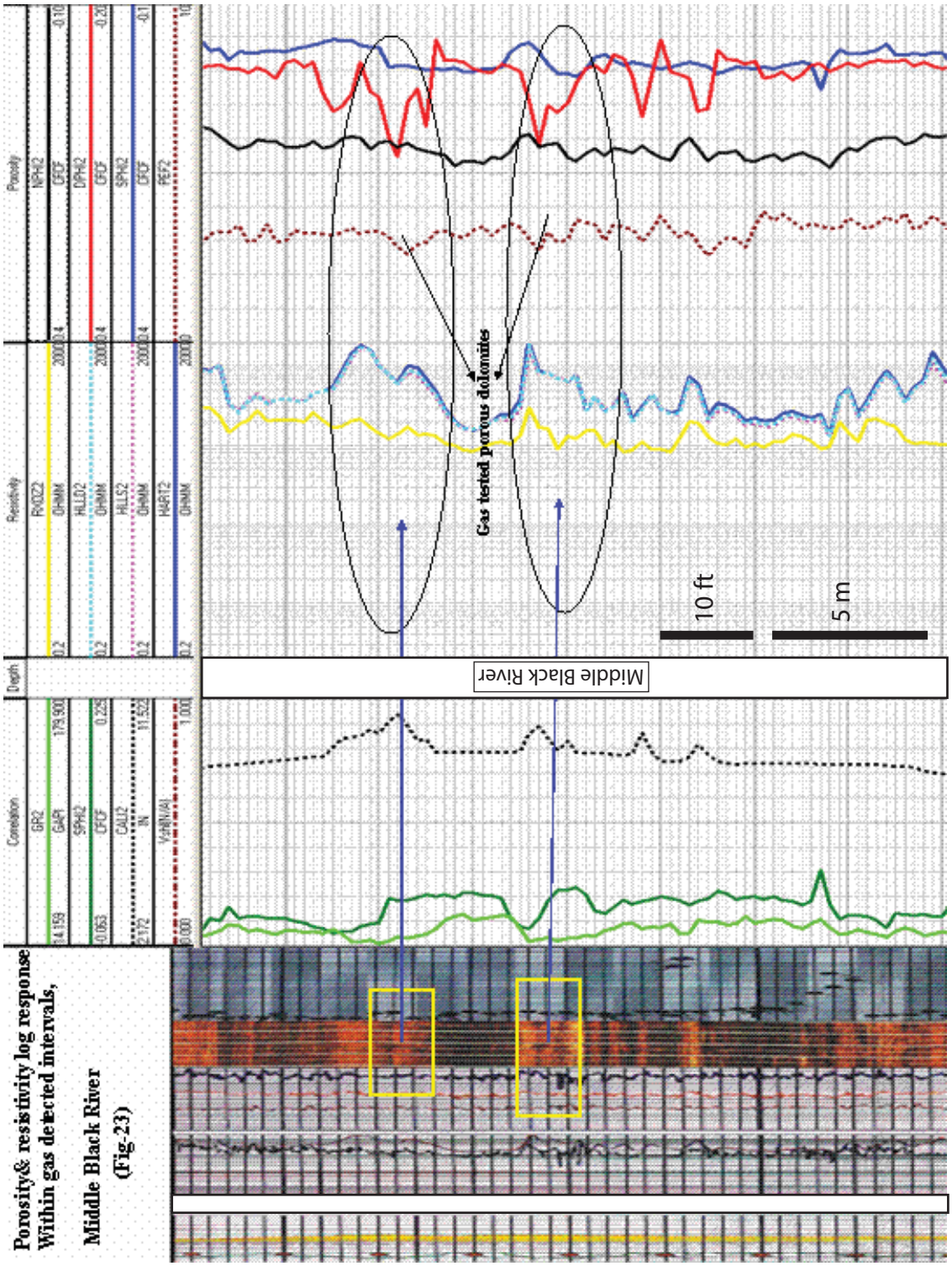

Porosity& resistivity log response
Within gas detected intervals,
Middle Black River
(Fig-23)
Correlation
Depth
Resistivity
Porosity
Gas tested porous dolomites
Middle Black River
10 ft
5 m

FIGURE 3.5-23

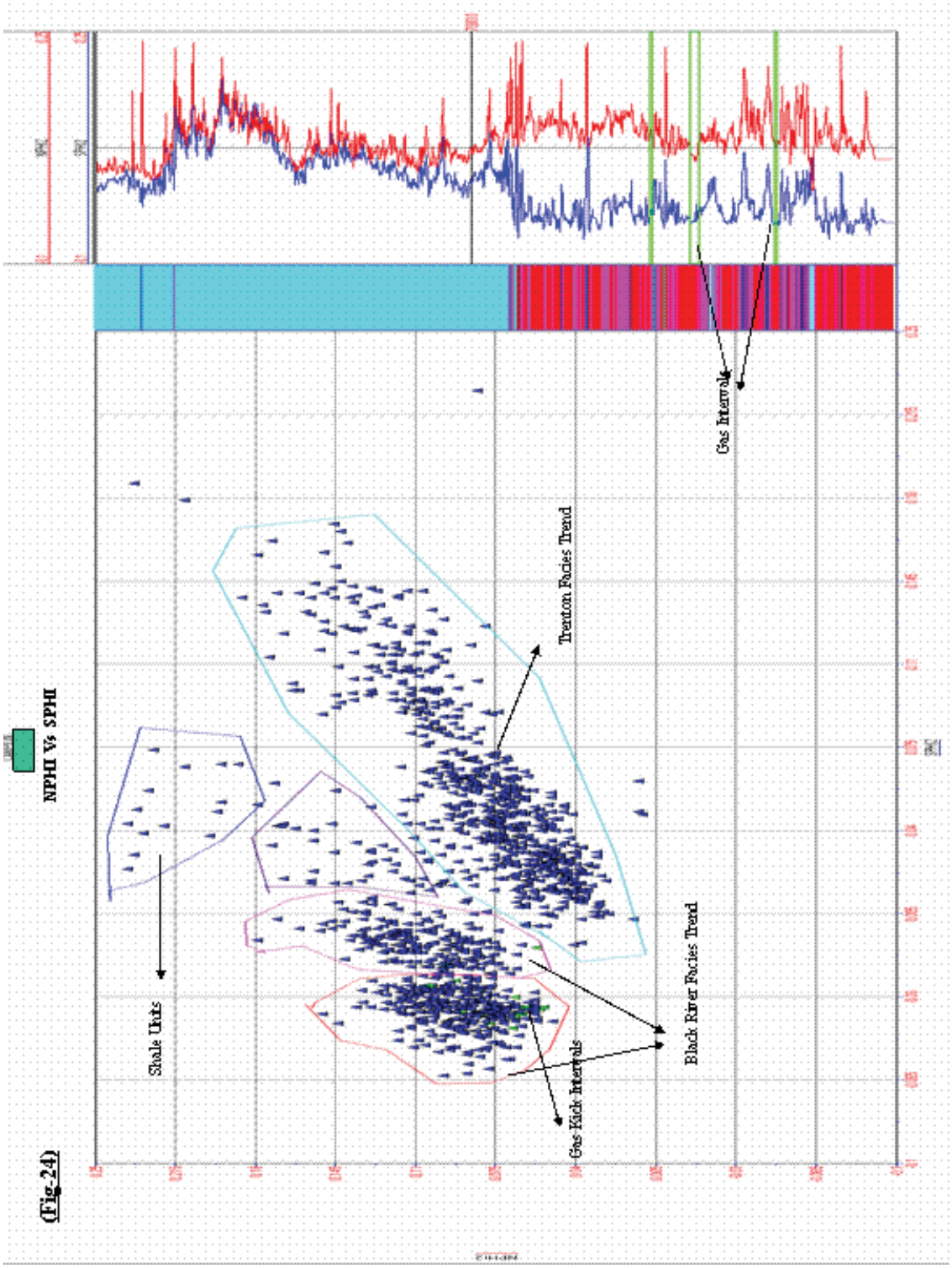

(Fig-24)
NPHI Vs SPHI
Shale Units
Gas Kick Intervals
Black River Facies Trend
Trenton Facies Trend
Gas Intervals

FIGURE 3. -2

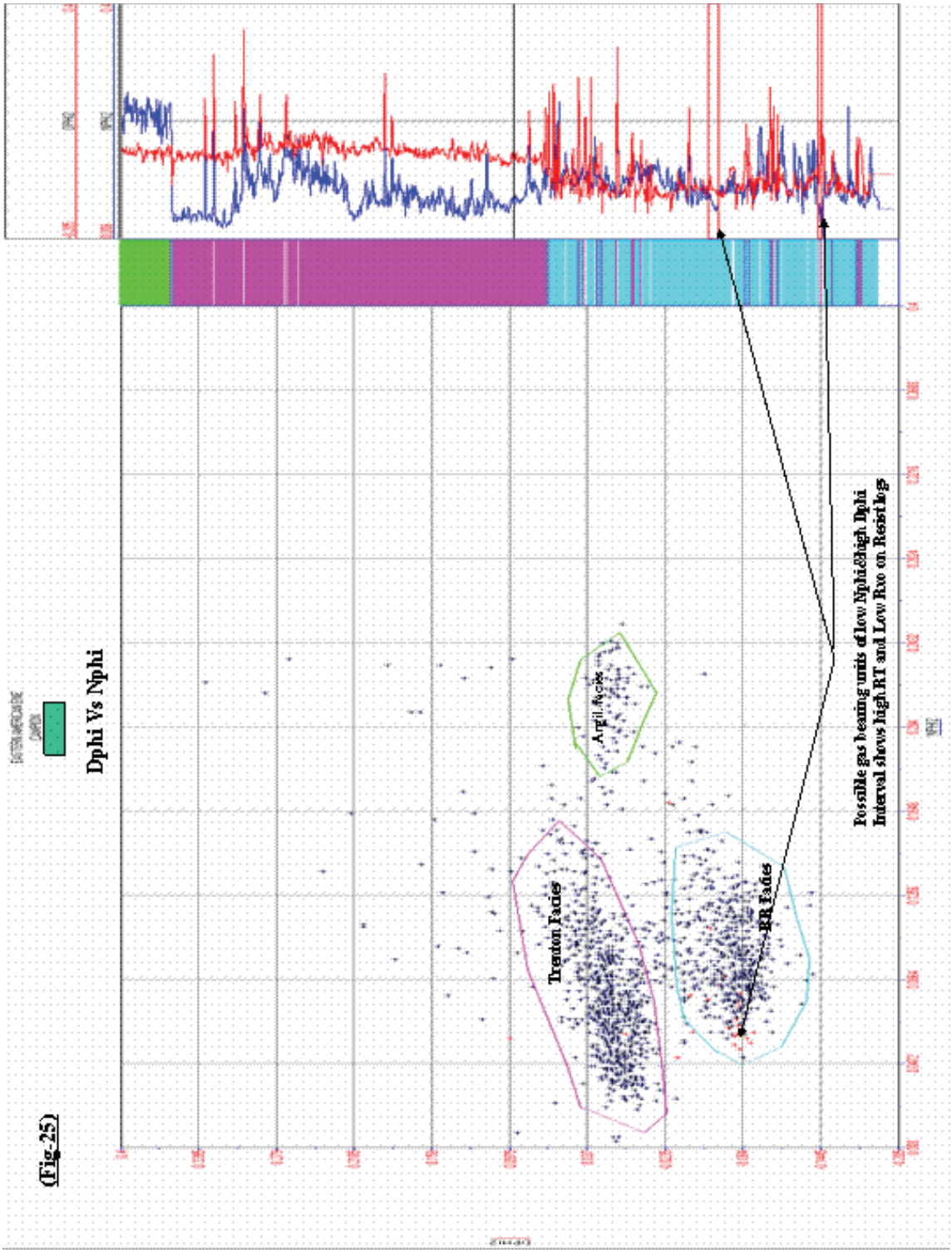

(Fig-25)
Dphi Vs Nphi
Trenton Facies
Argil. Facies
BR Facies
Possible gas bearing units of low Nphi&high Dphi
Interval shows high RT and Low Rxo on Resistlog

FIGURE 3.5-25

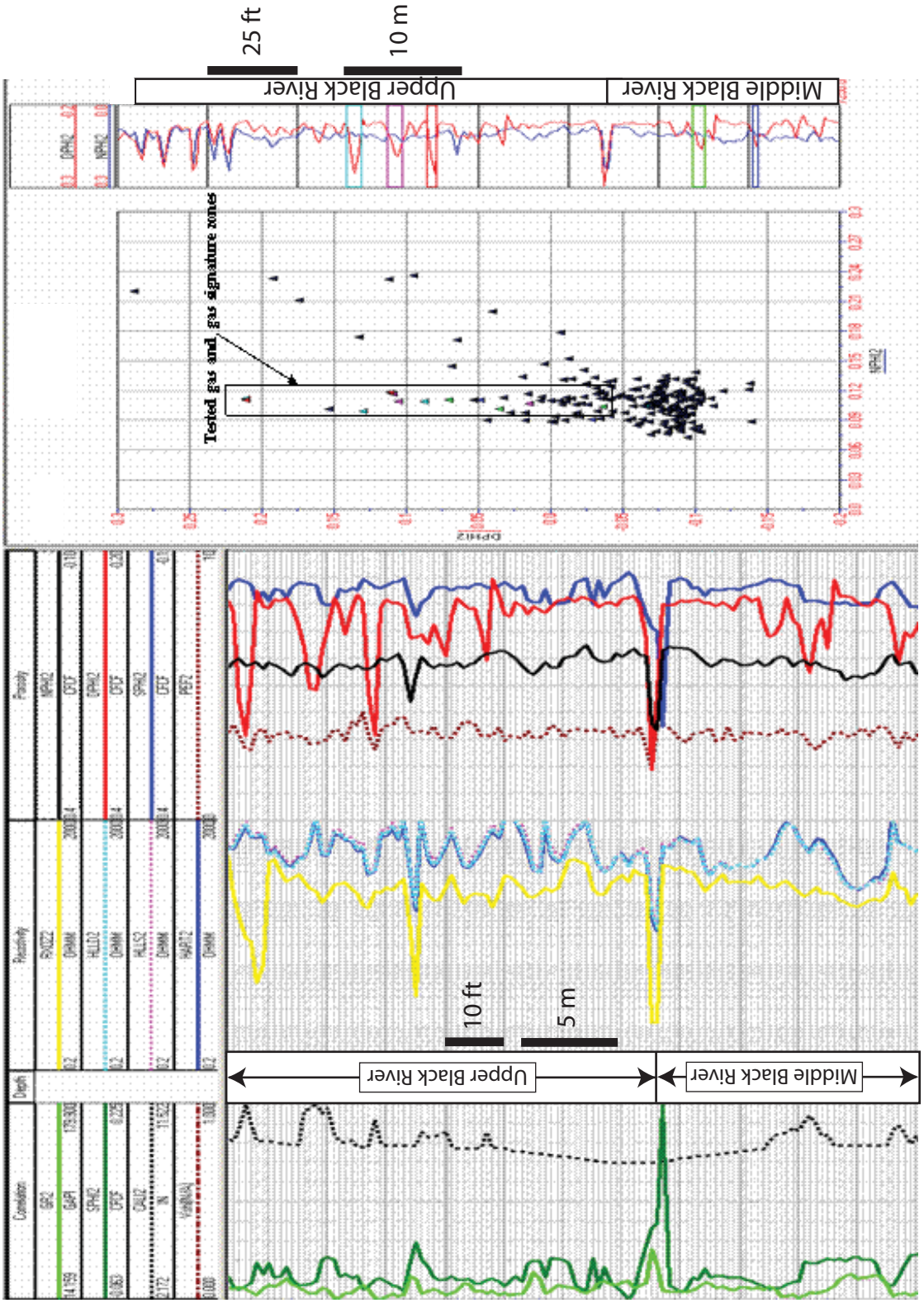

Tested gas and gas signature zones
Upper Black River
Middle Black River
25 ft
10 m
10 ft
5 m

FIGURE 3.5-26

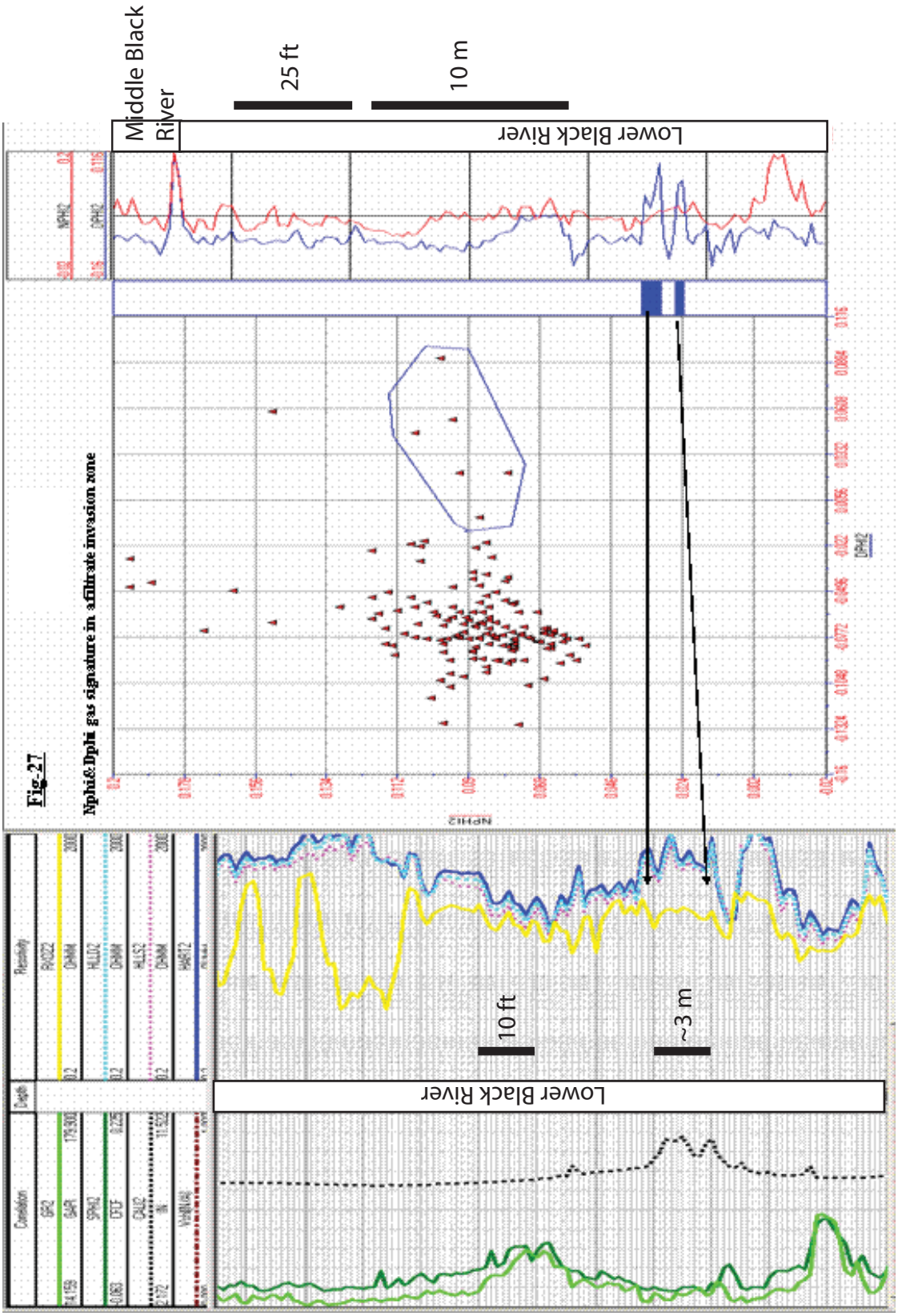


Fig-27
Nphi&Dphi gas signature in a filtrate invasion zone
Middle Black River
Lower Black River
25 ft
10 m
10 ft
~3 m
Lower Black River

FIGURE 3.5-27

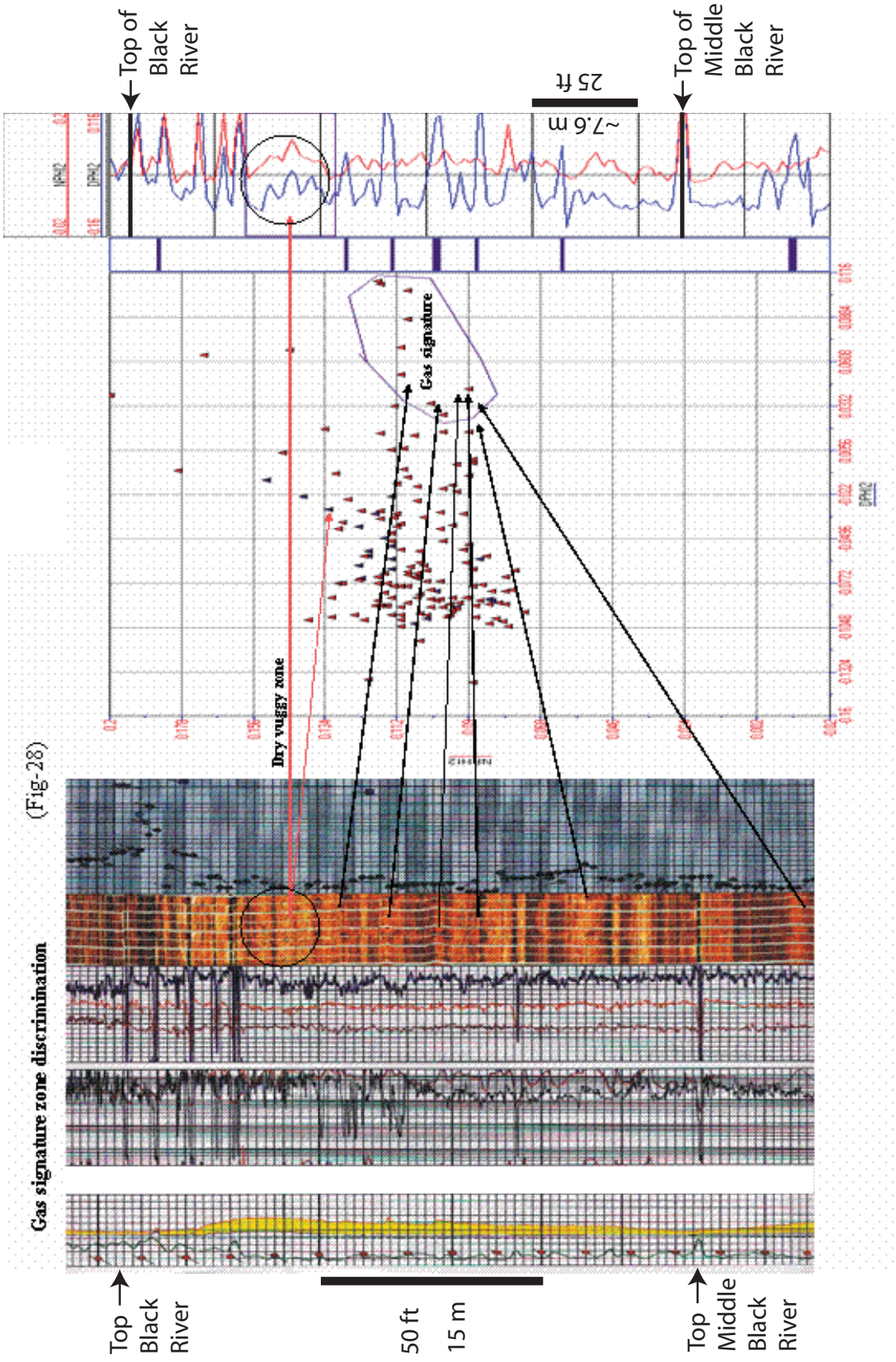

Gas signature zone discrimination
(Fig-28)
Top of Black River
Top of Middle Black River
Dry vuggy zone
Gas signature
~7.6 m
25 ft
Top Black River
50 ft
15 m
Top Middle Black River

FIGURE 3.5-28

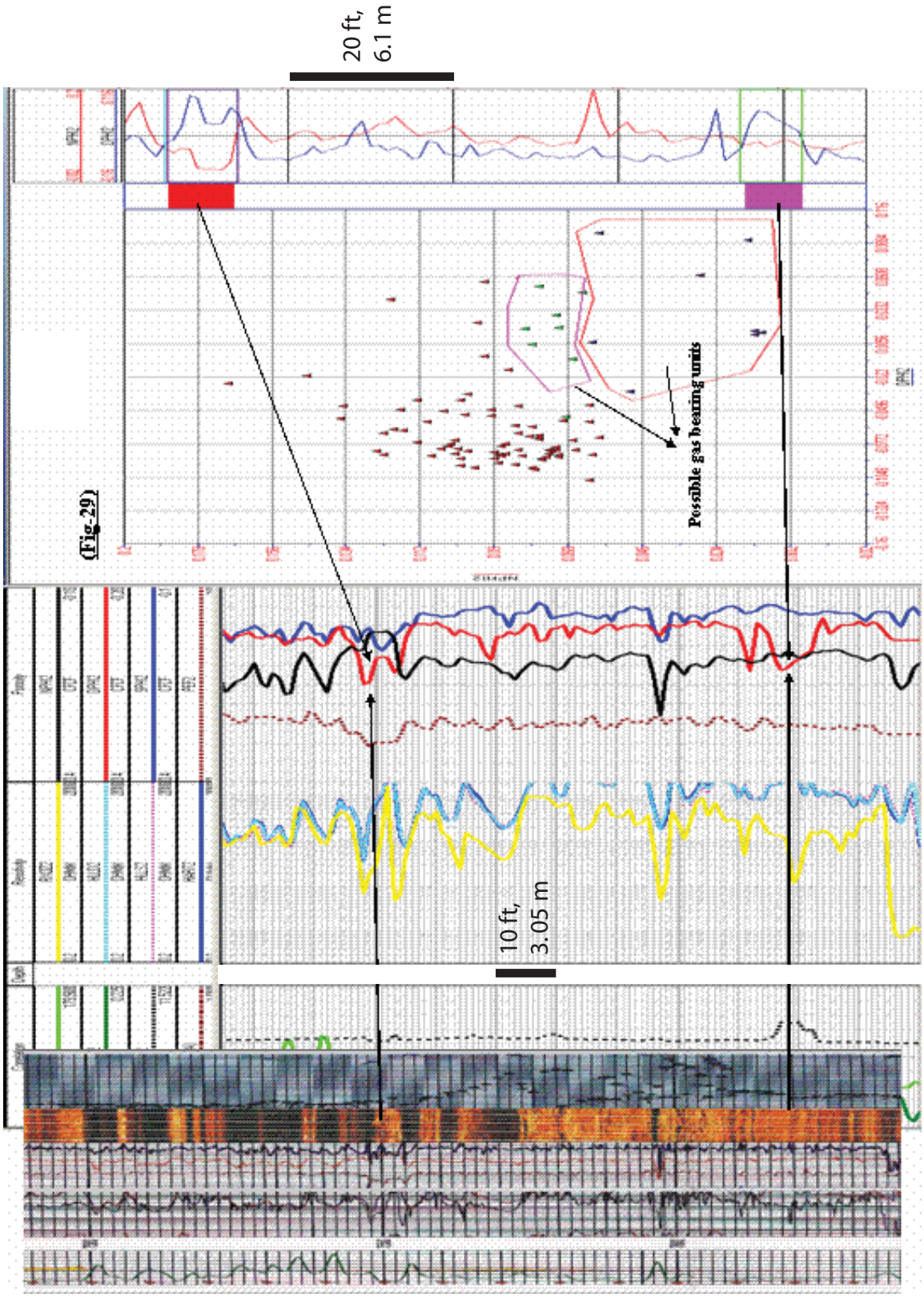


FIGURE 3.5-29

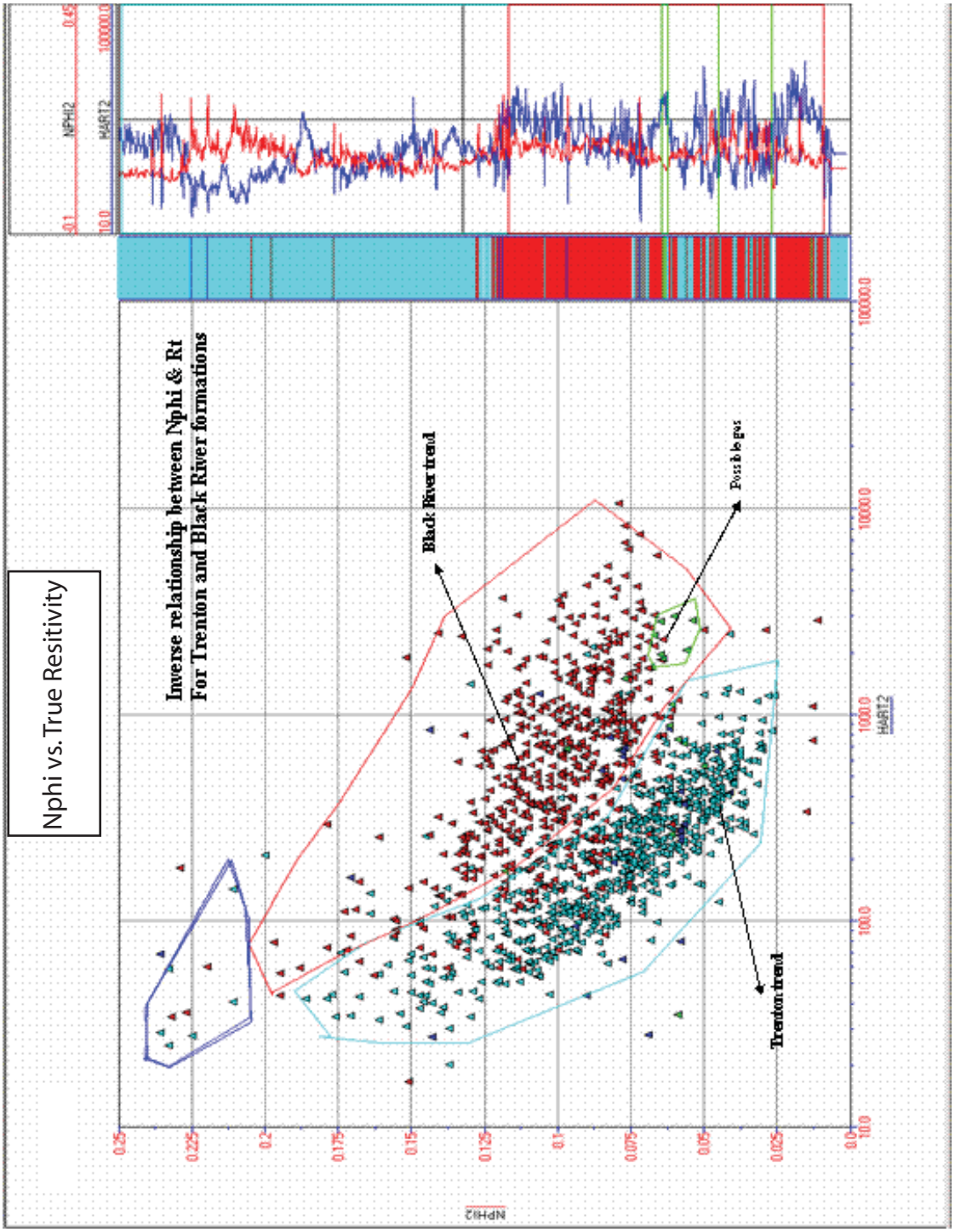

Nphi vs. True Resitivity
Inverse relationship between Nphi & Rt
For Trenton and Black River formations
Black River trend
Possible gas
Trenton trend
NPHI2
HART2
0.25
0.225
0.2
0.175
0.15
0.125
0.1
0.075
0.05
0.025
0.0
10.0
100.0
1000.0
10000.0
100000.0

FIGURE 3.5-30

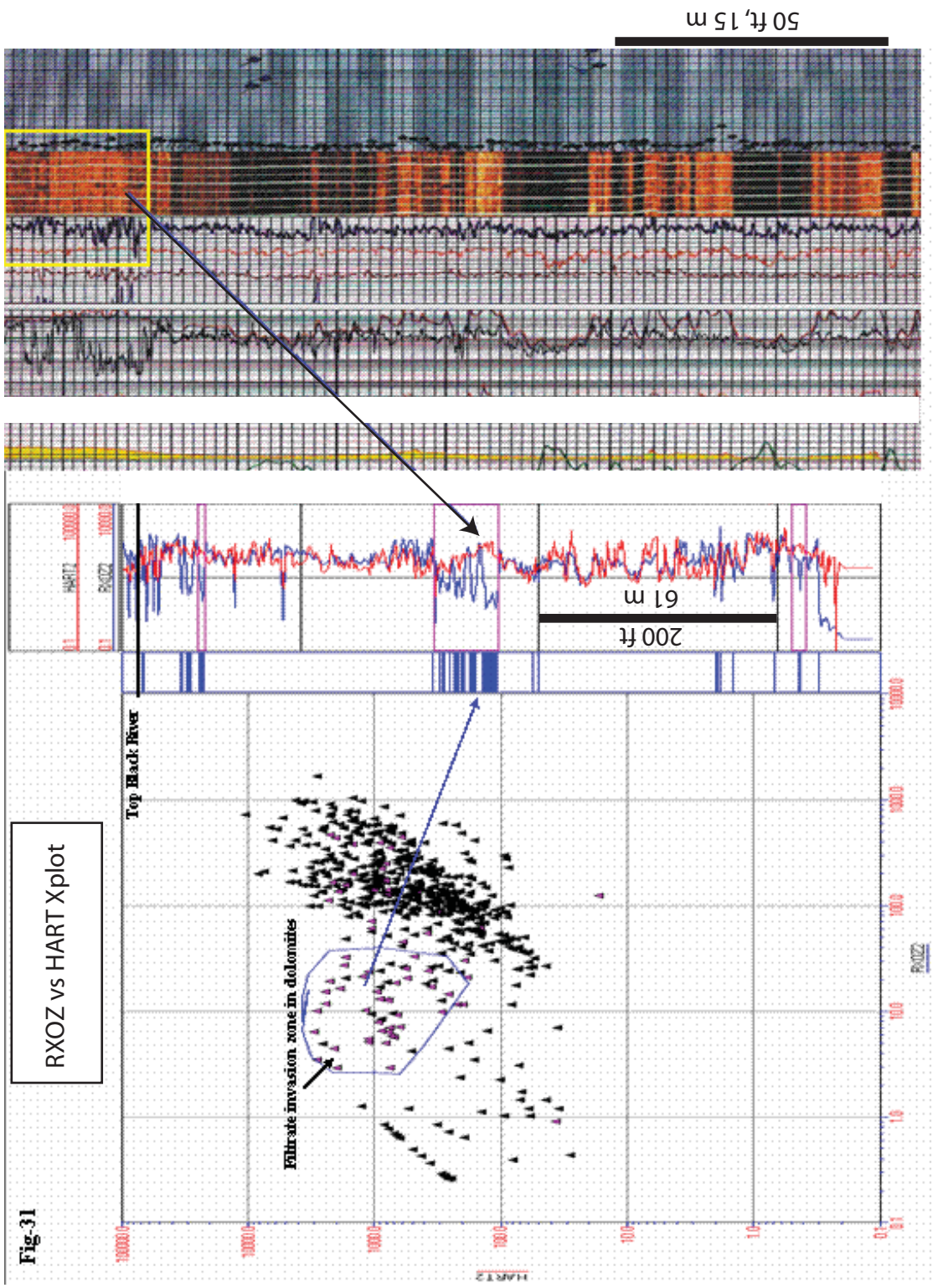


Fig.31
RXOZ vs HART Xplot
Filtrate invasion zone in dolomites
Top Black River
200 ft
61 m
50 ft, 15 m
HART2
RXOZ

FIGURE 3.5-31

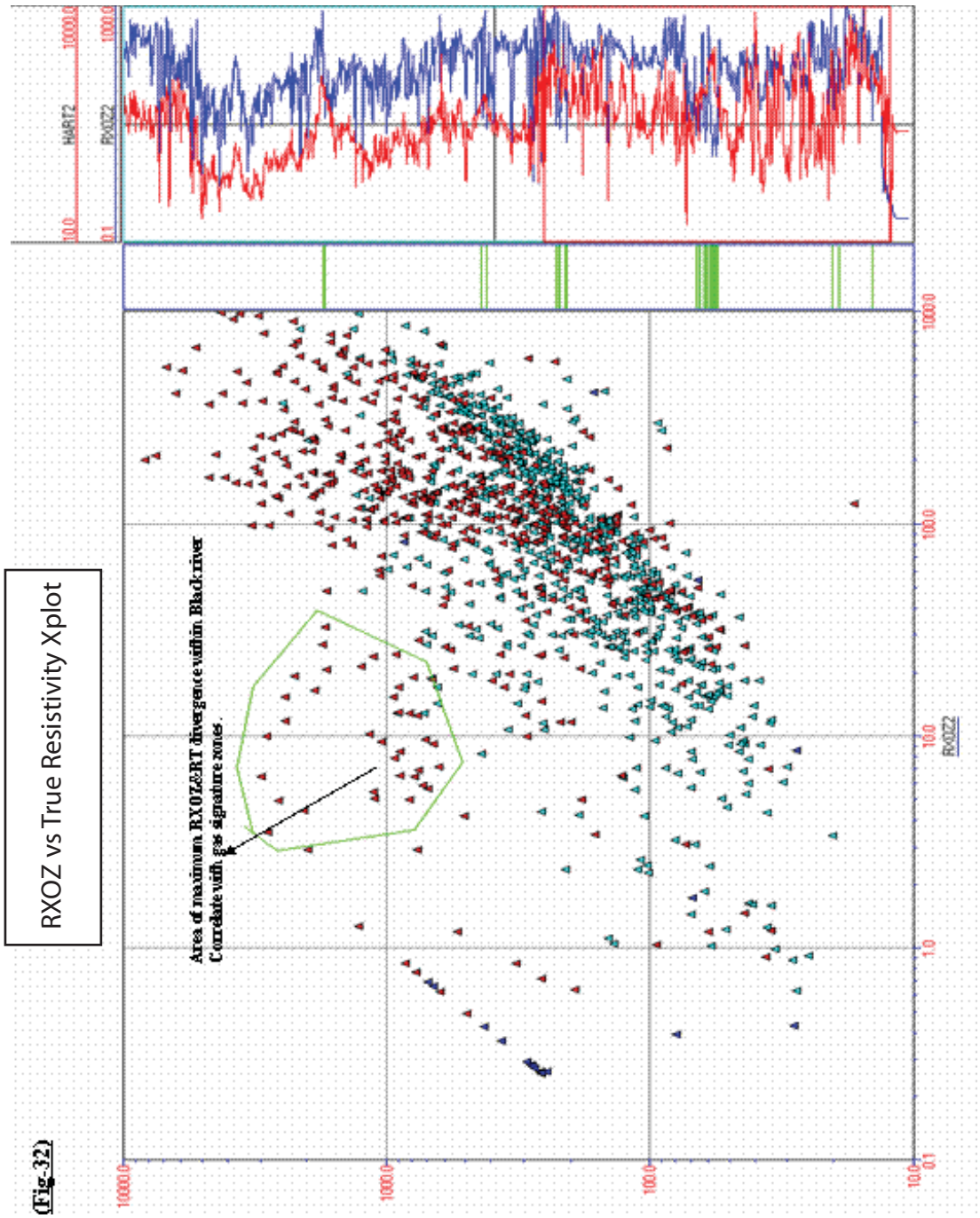

(Fig-32)
RXOZ vs True Resistivity Xplot
Area of maximum RXOZ&RT divergence within Black river
Correlate with gas signature zones.
HART2
RXOZ2
10.0
1000.0
0.1
10000.0
1000.0
100.0
10.0
1.0
0.1
RXOZ2

FIGURE 3.5-32

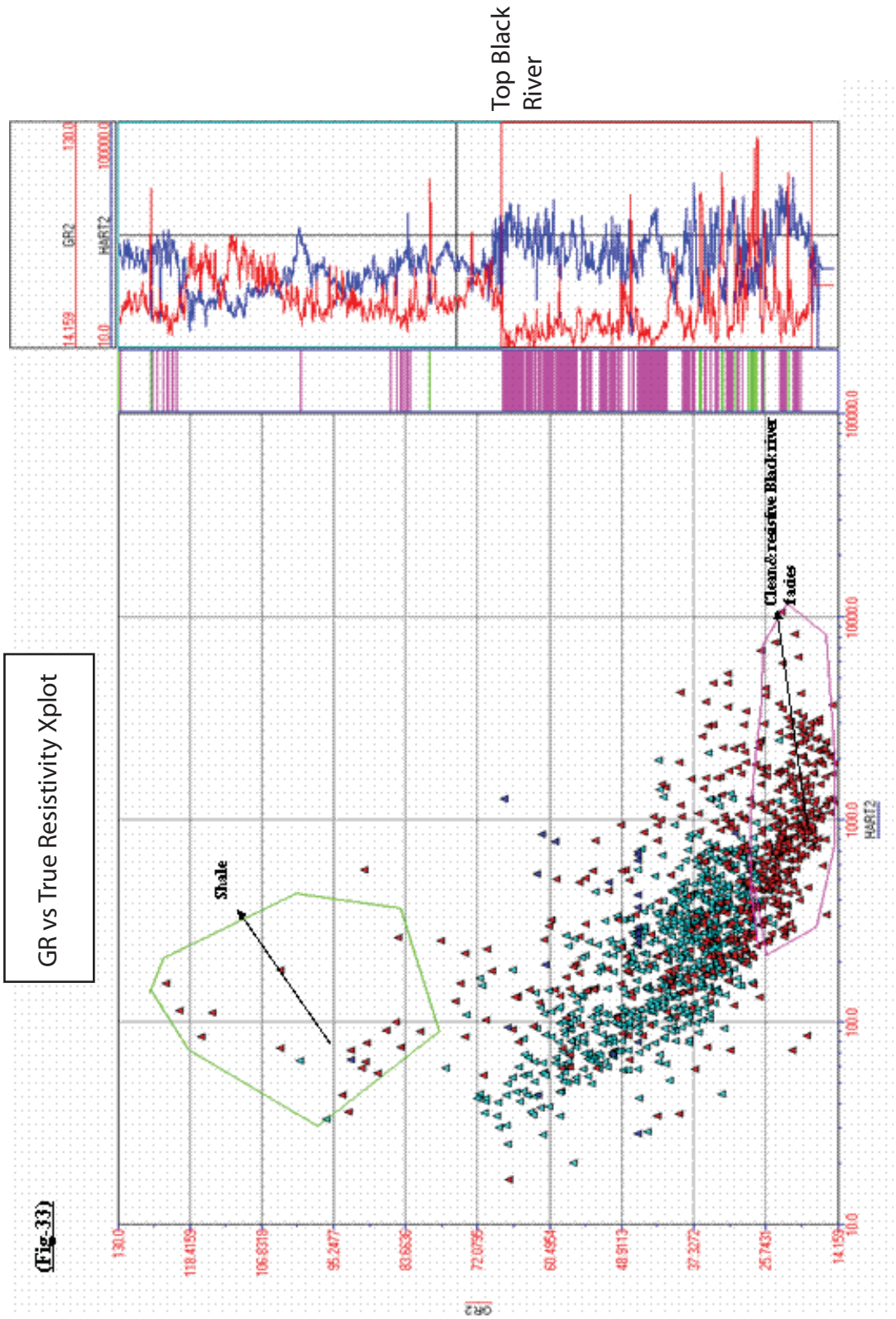

(Fig-33)
GR vs True Resistivity Xplot
Shale
Clean&resistive Black river facies
Top Black River
GR2
HART2
130.0
118.4159
106.8318
95.2477
83.6636
72.0795
60.4954
48.9113
37.3272
25.7431
14.159
10.0
100.0
1000.0
10000.0
100000.0

FIGURE 3.5-33

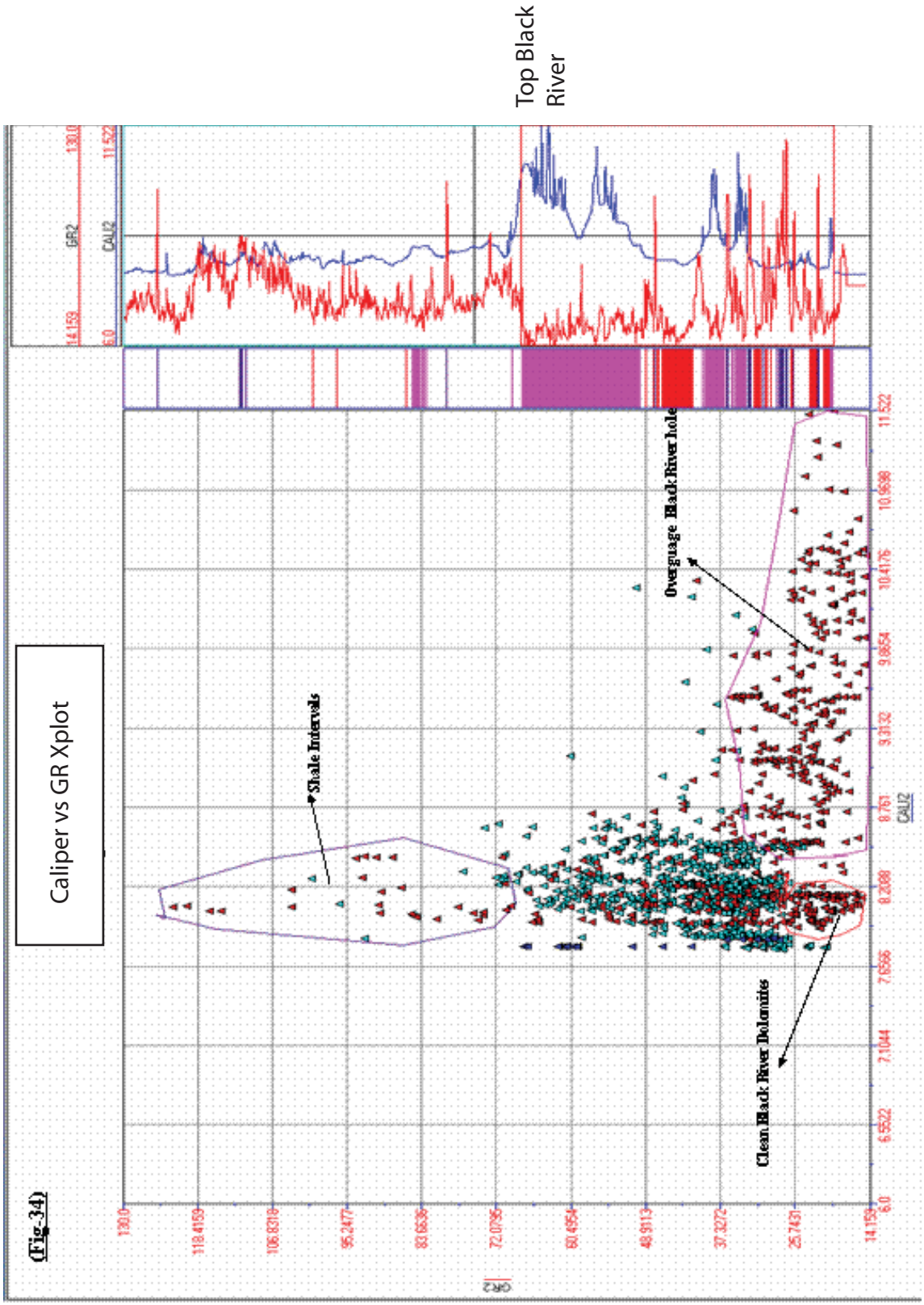

(Fig-34)
Caliper vs GR Xplot
Top Black River
Shale Intervals
Overguage Black River hole
Clean Black River Dolomite
GR2
CALI2

FIGURE 3.5-34

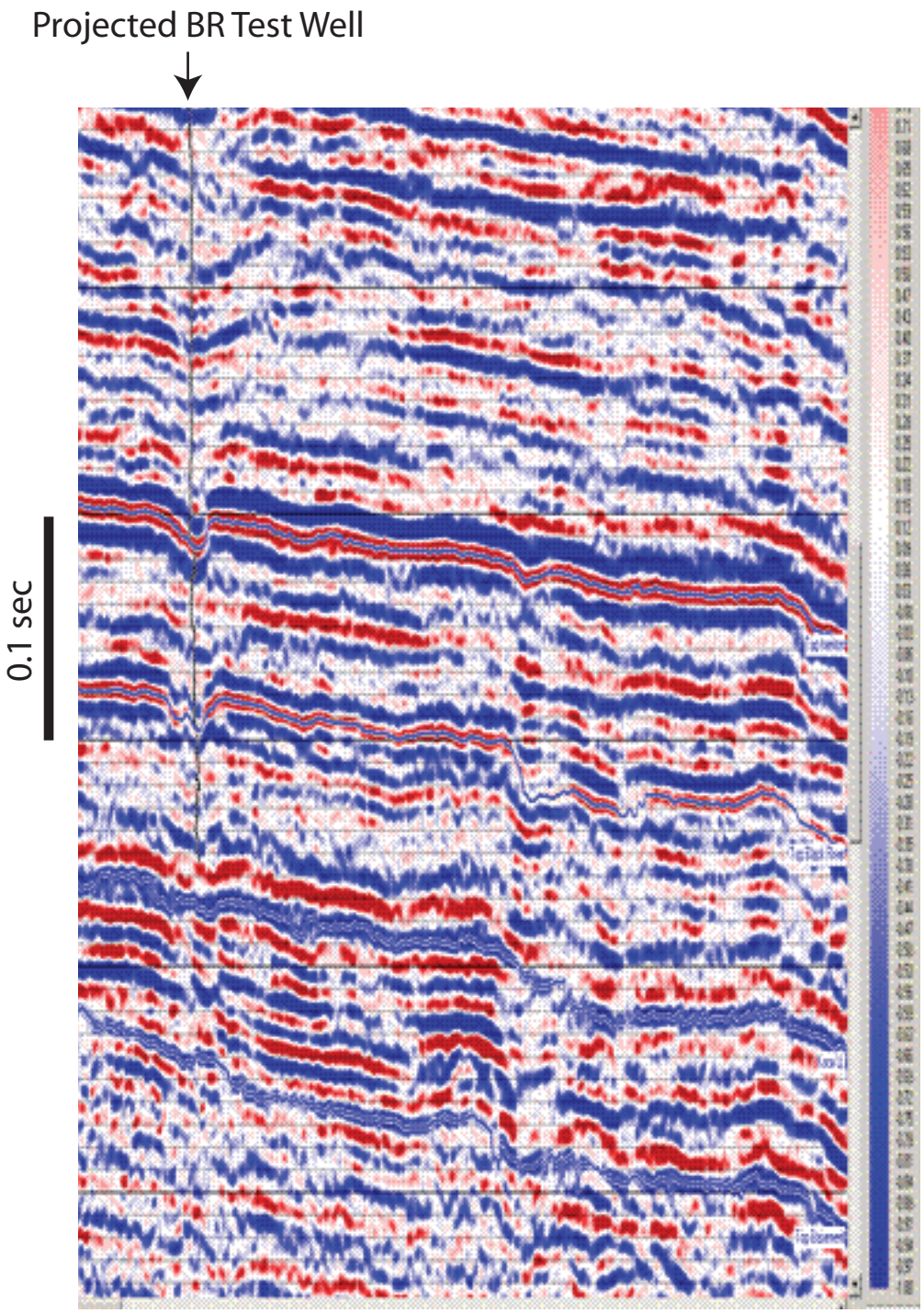


FIGURE 3.5-35

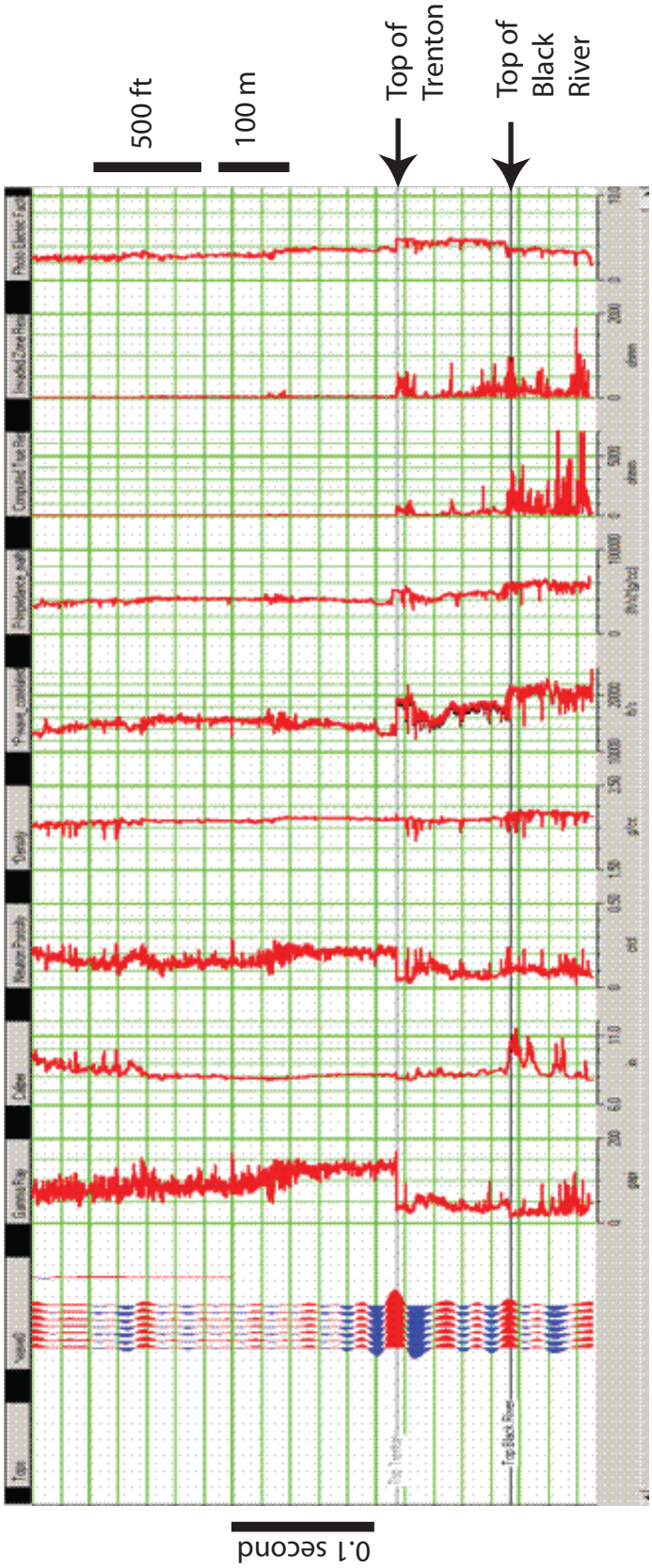


FIGURE 3.5-36

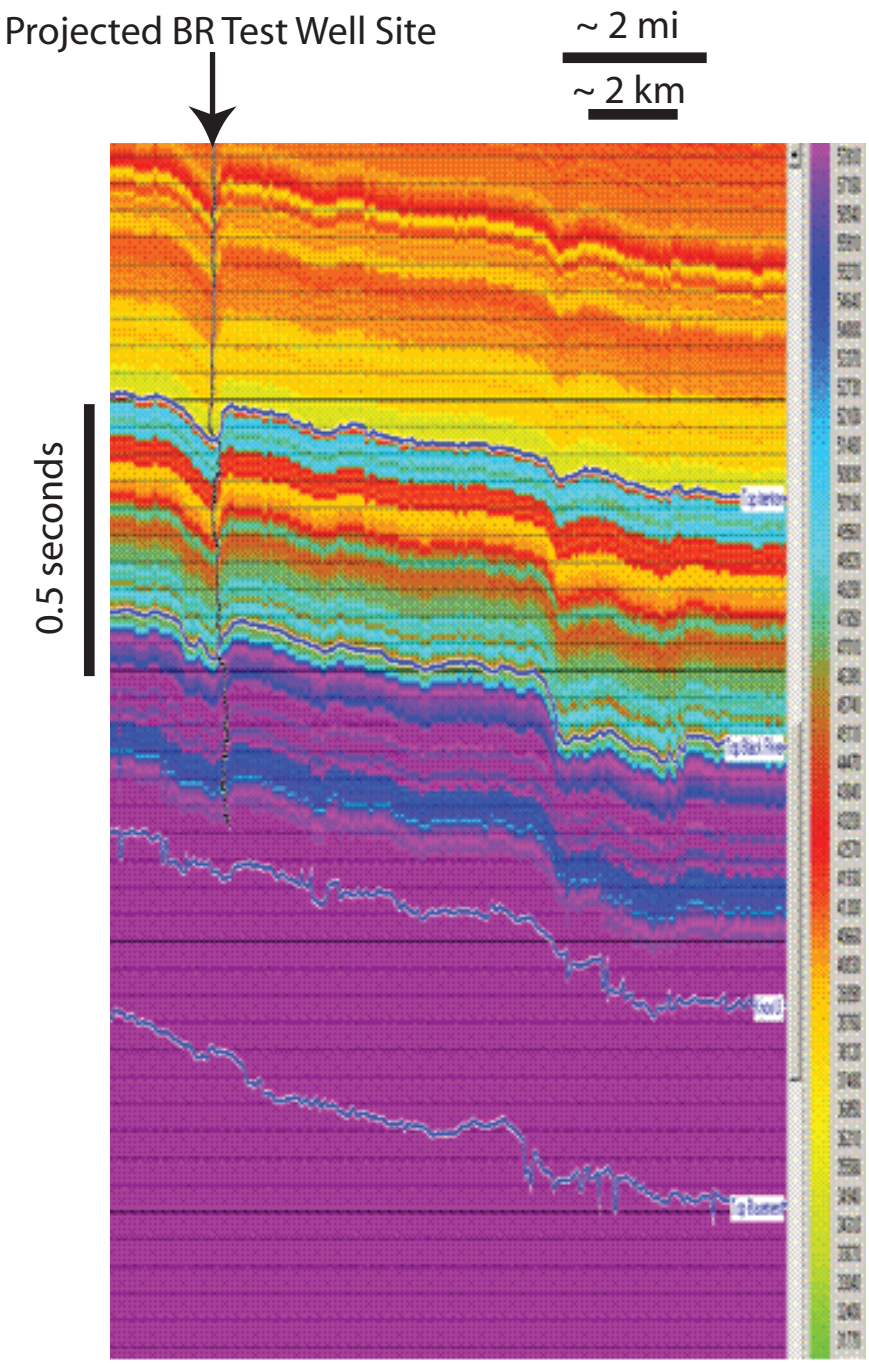


FIGURE 3.5-37

Projected BR
Test Well

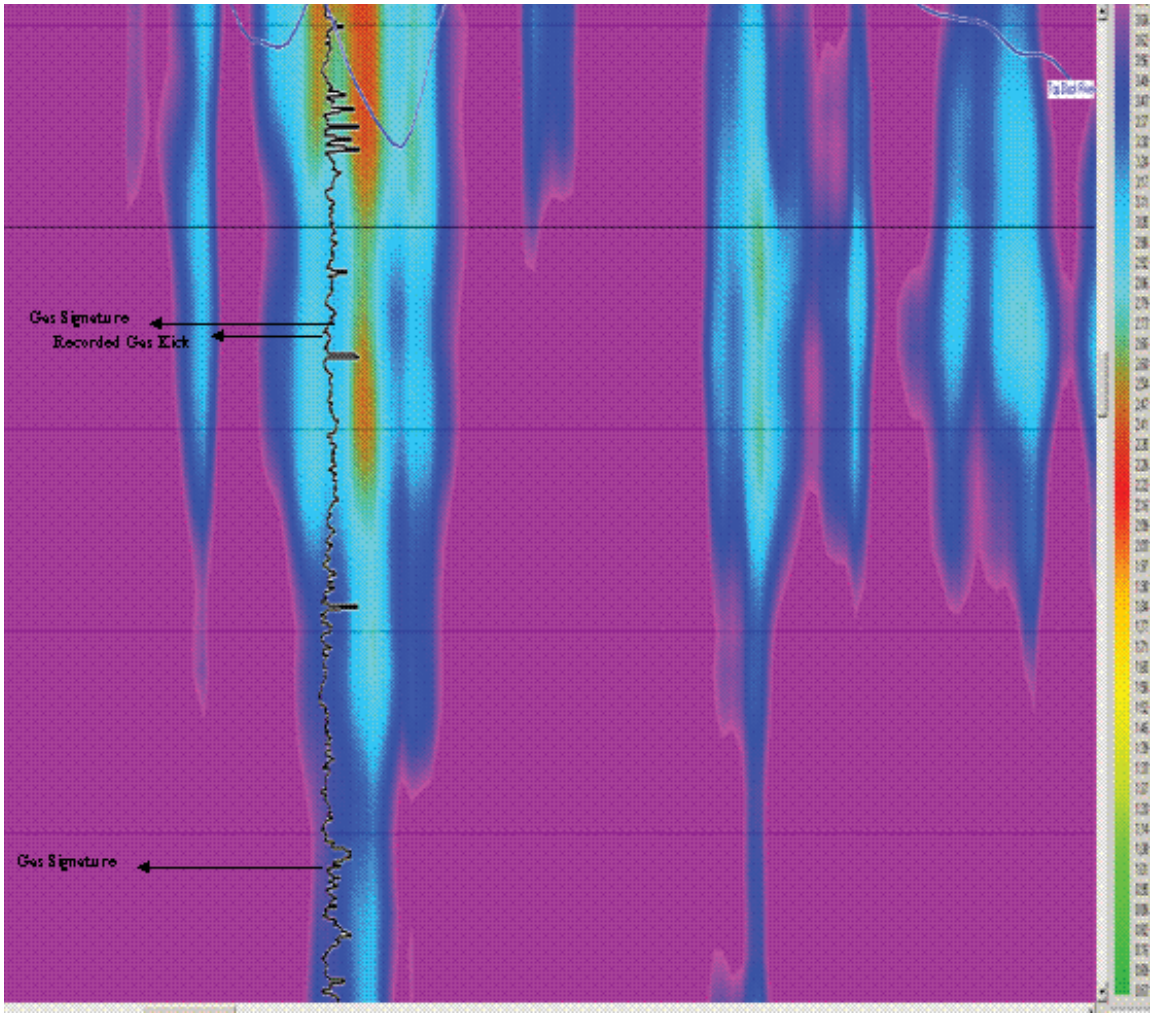


FIGURE 3.5-38

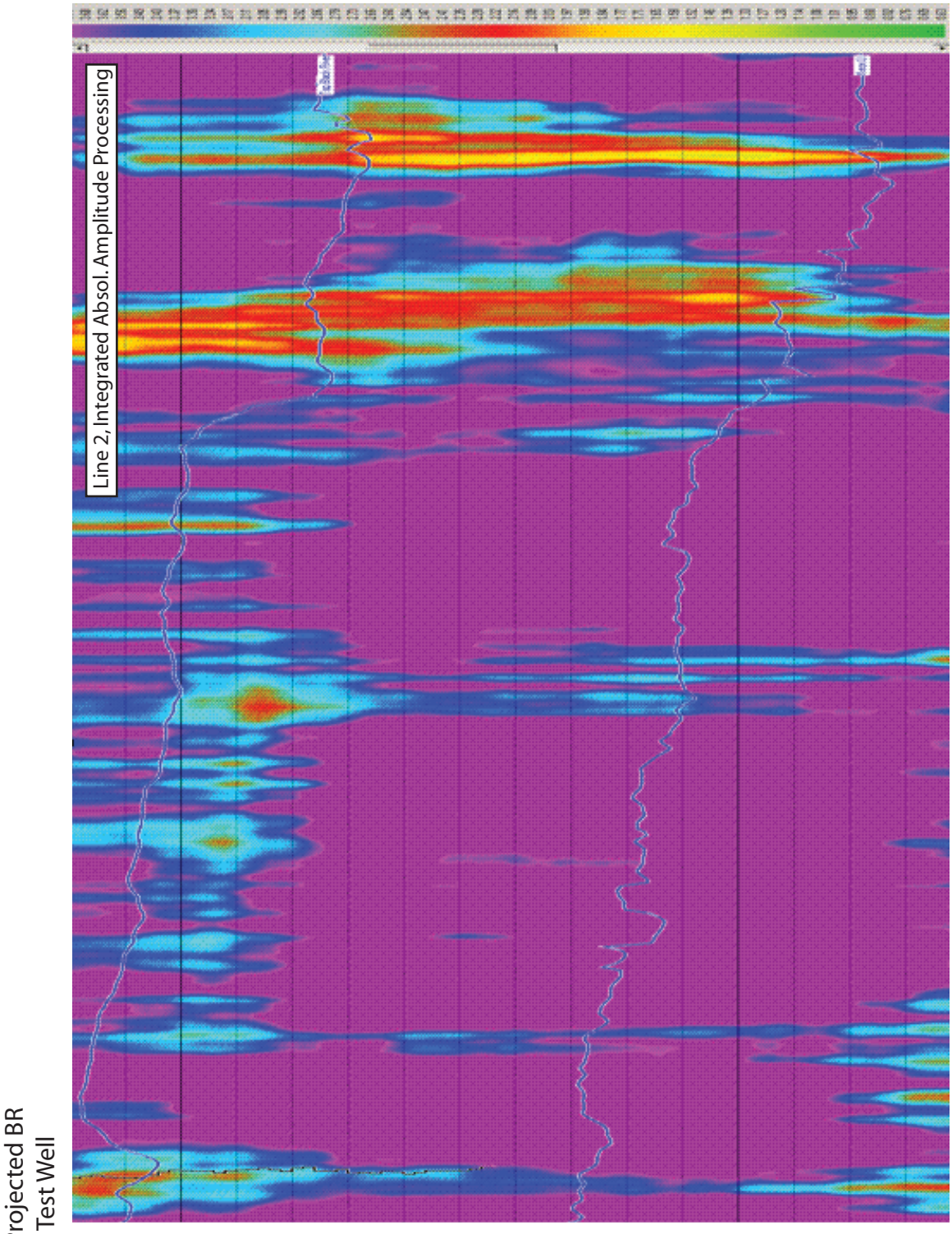

Line 2, Integrated Absol. Amplitude Processing
Projected BR
Test Well

FIGURE 3.5-39

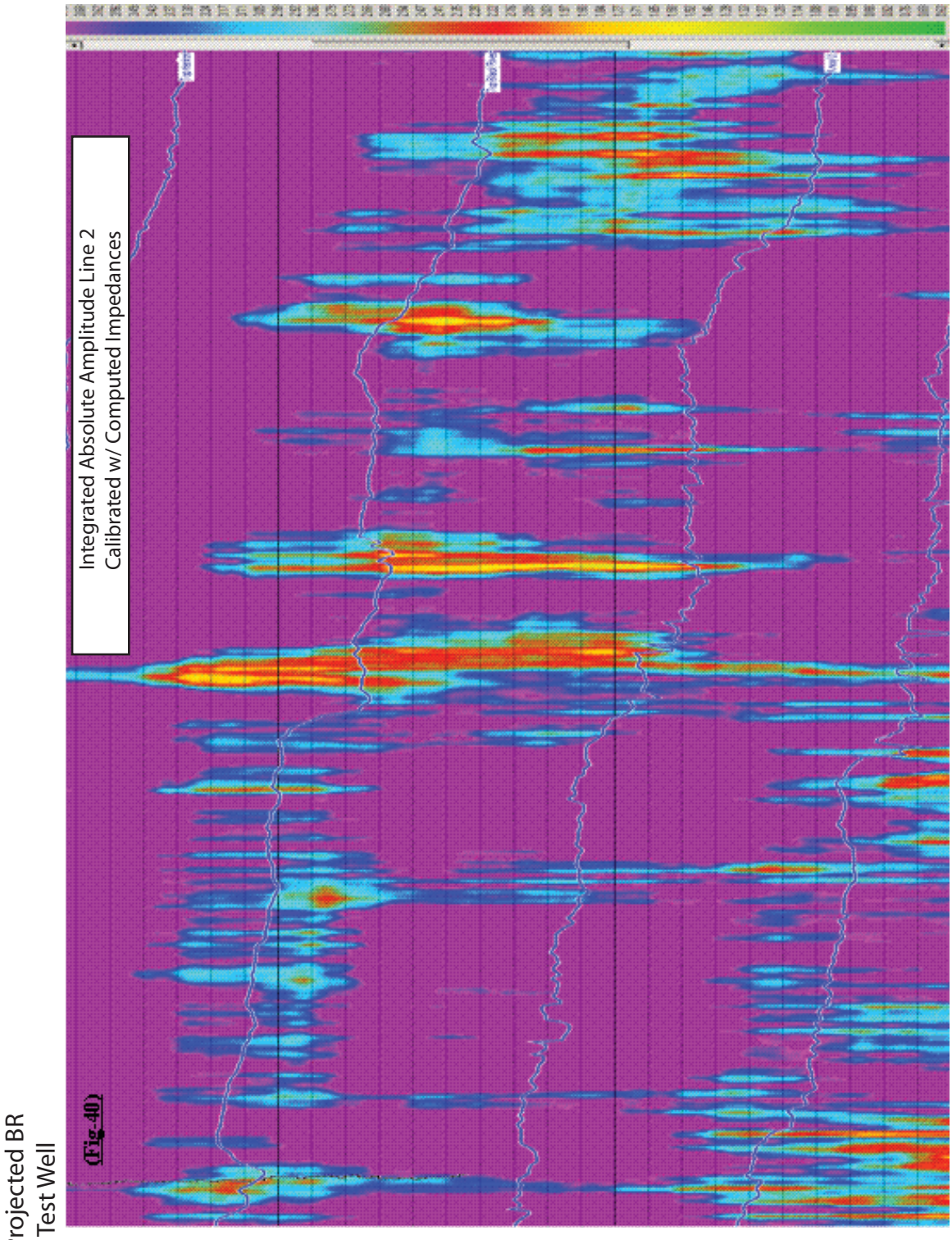

Projected BR
Test Well
(Fig-40)
Integrated Absolute Amplitude Line 2
Calibrated w/ Computed Impedances

FIGURE 3.5-40

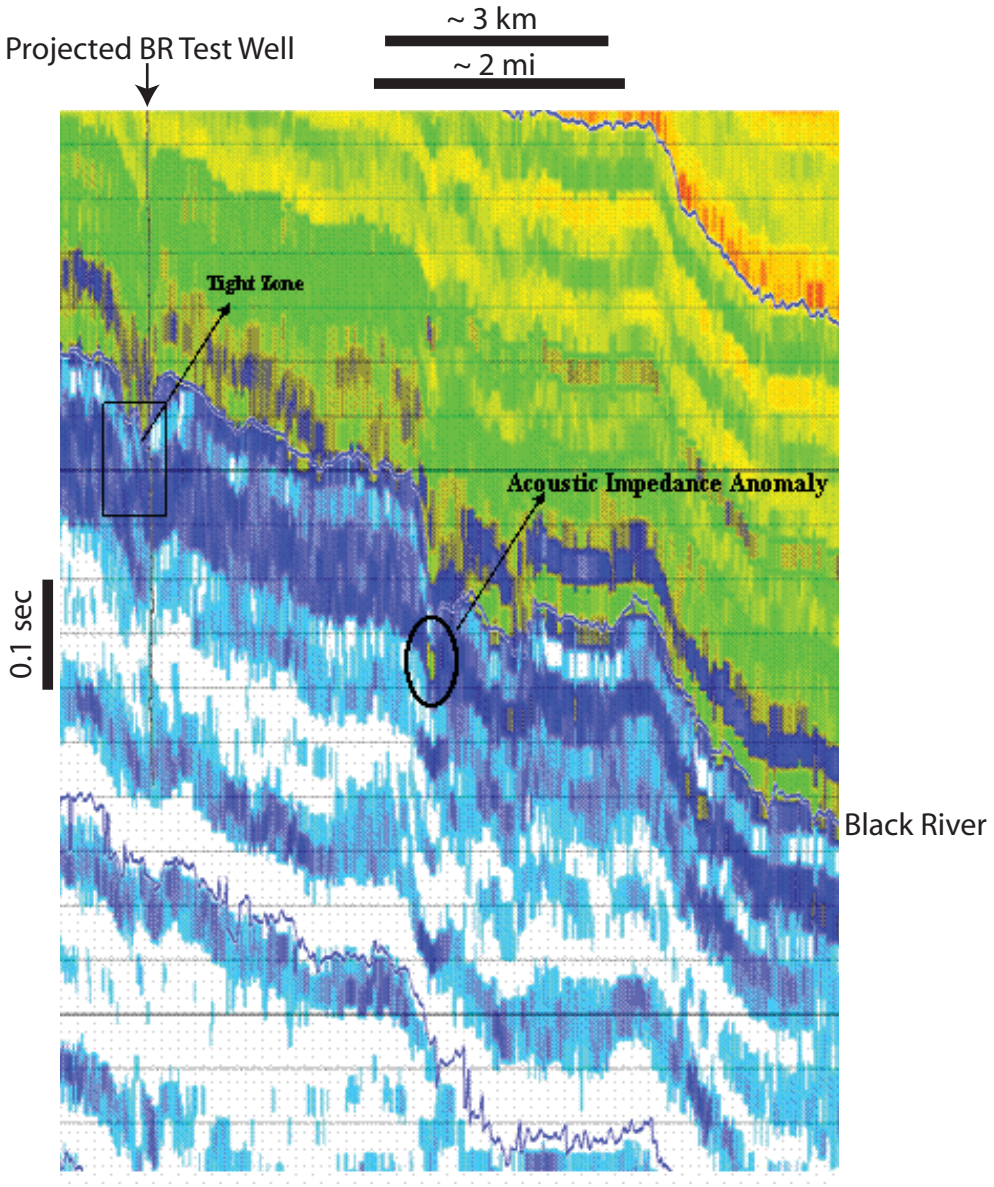

~ 3 km
~ 2 mi
Projected BR Test Well
Tight Zone
Acoustic Impedance Anomaly
0.1 sec
Black River

FIGURE 3.5-41

Projected BR
Test Well

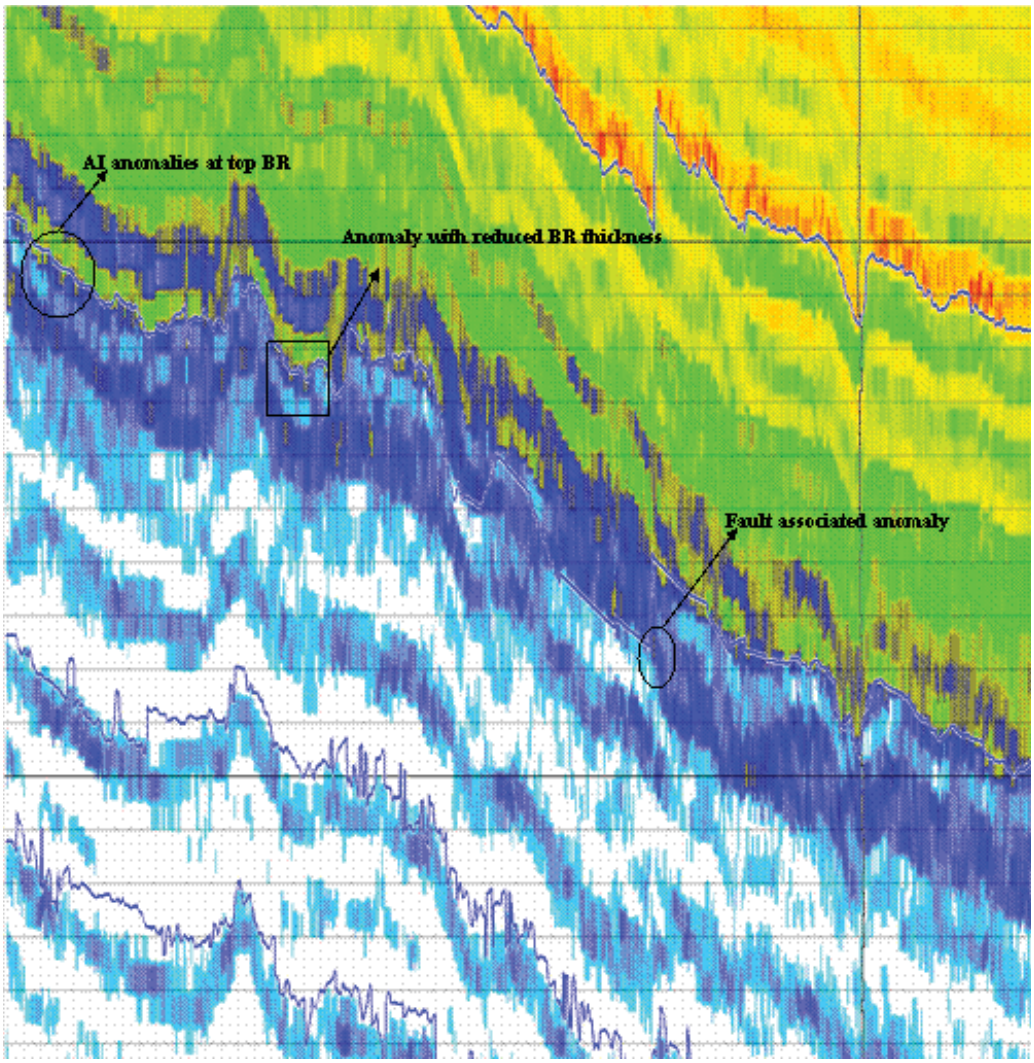


FIGURE 3.5-42

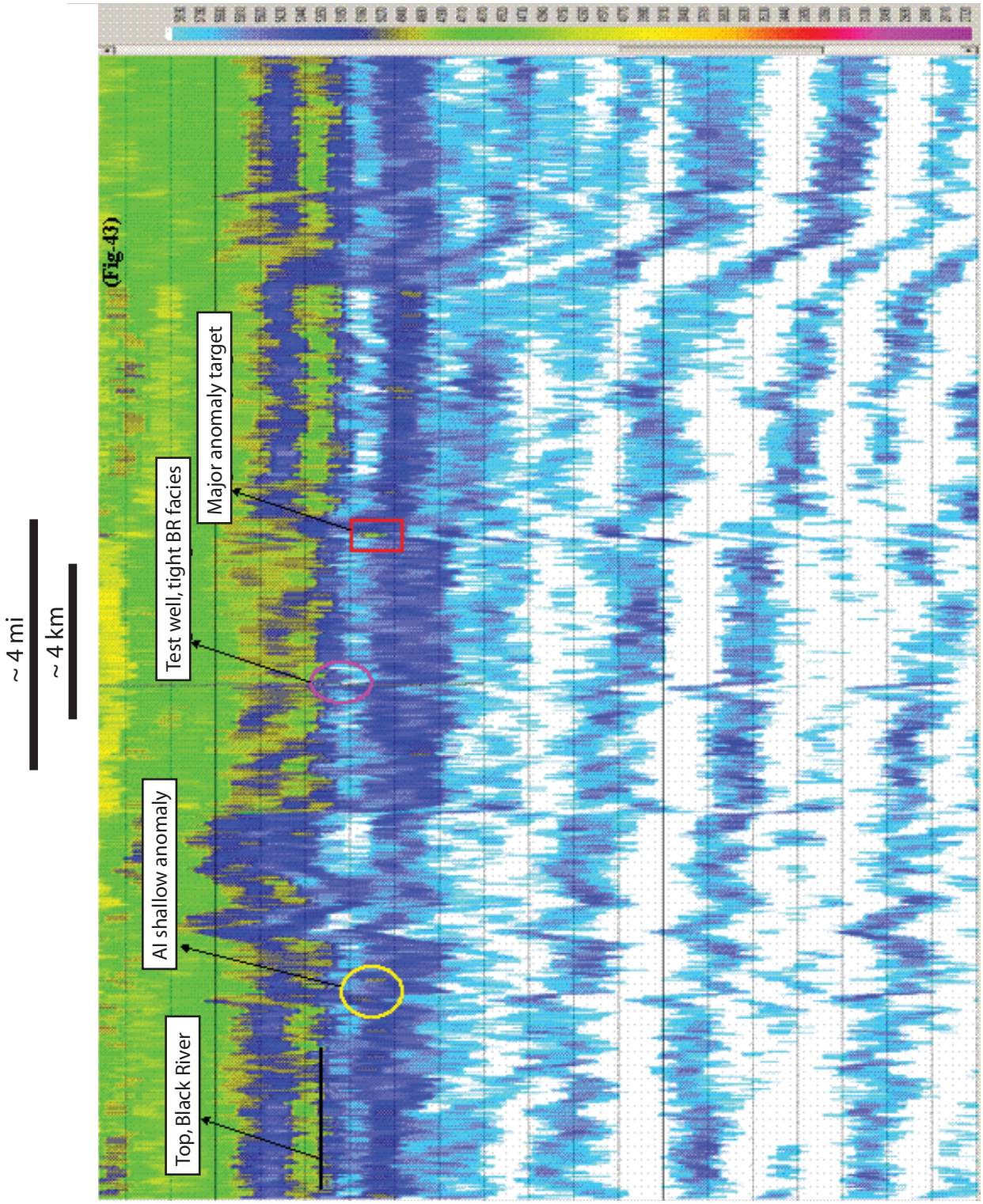

~ 4 mi
~ 4 km
(Fig-43)
Top, Black River
AI shallow anomaly
Test well, tight BR facies
Major anomaly target

FIGURE 3.5-43

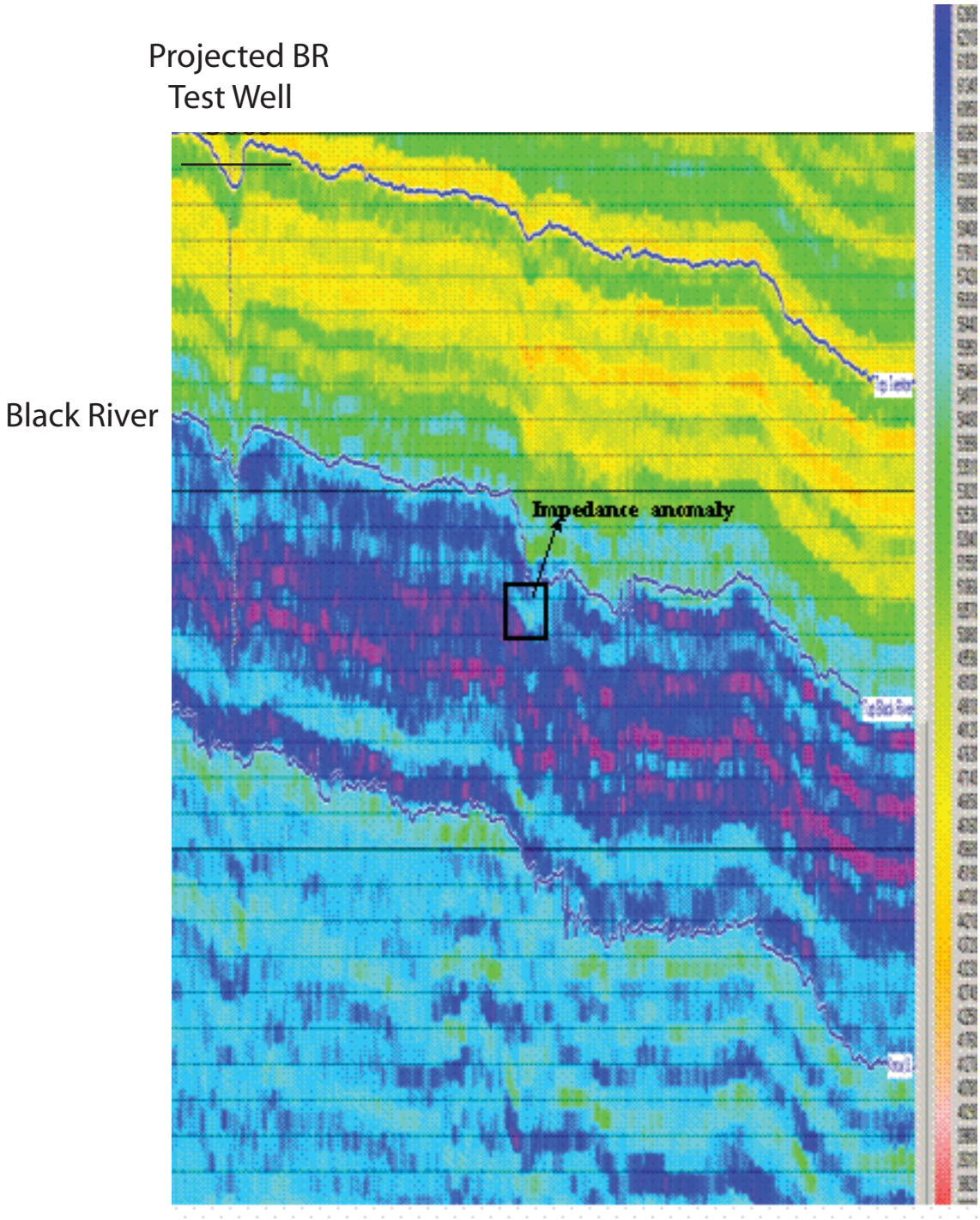


FIGURE 3.5-44

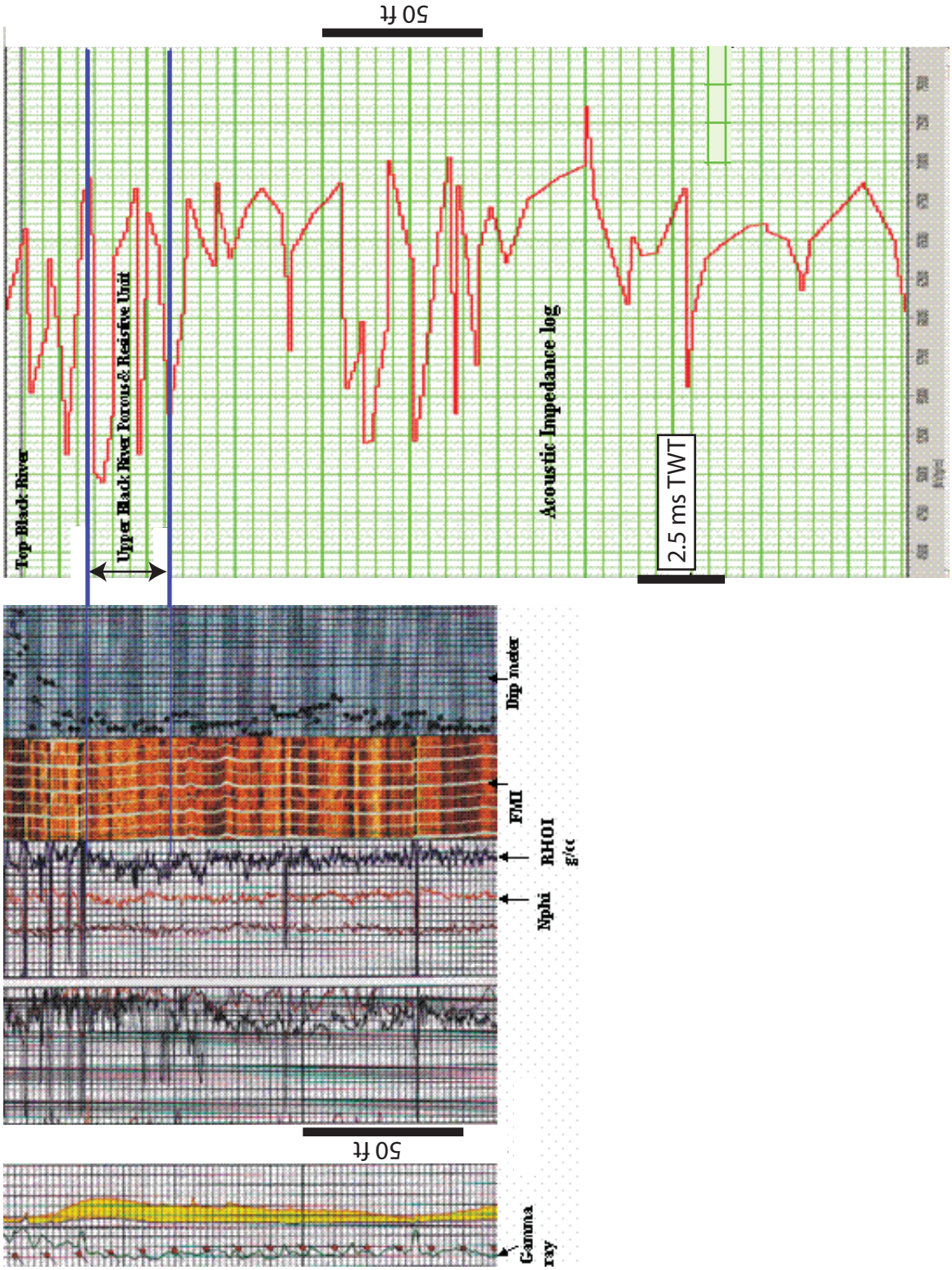

Top Black River
Upper Black River Porous & Resistive Unit
Acoustic Impedance log
2.5 ms TWT
50 ft
Dip meter
FMI
RHOI
g/cc
Nphi
50 ft
Gamma
ray

FIGURE 3.5-45

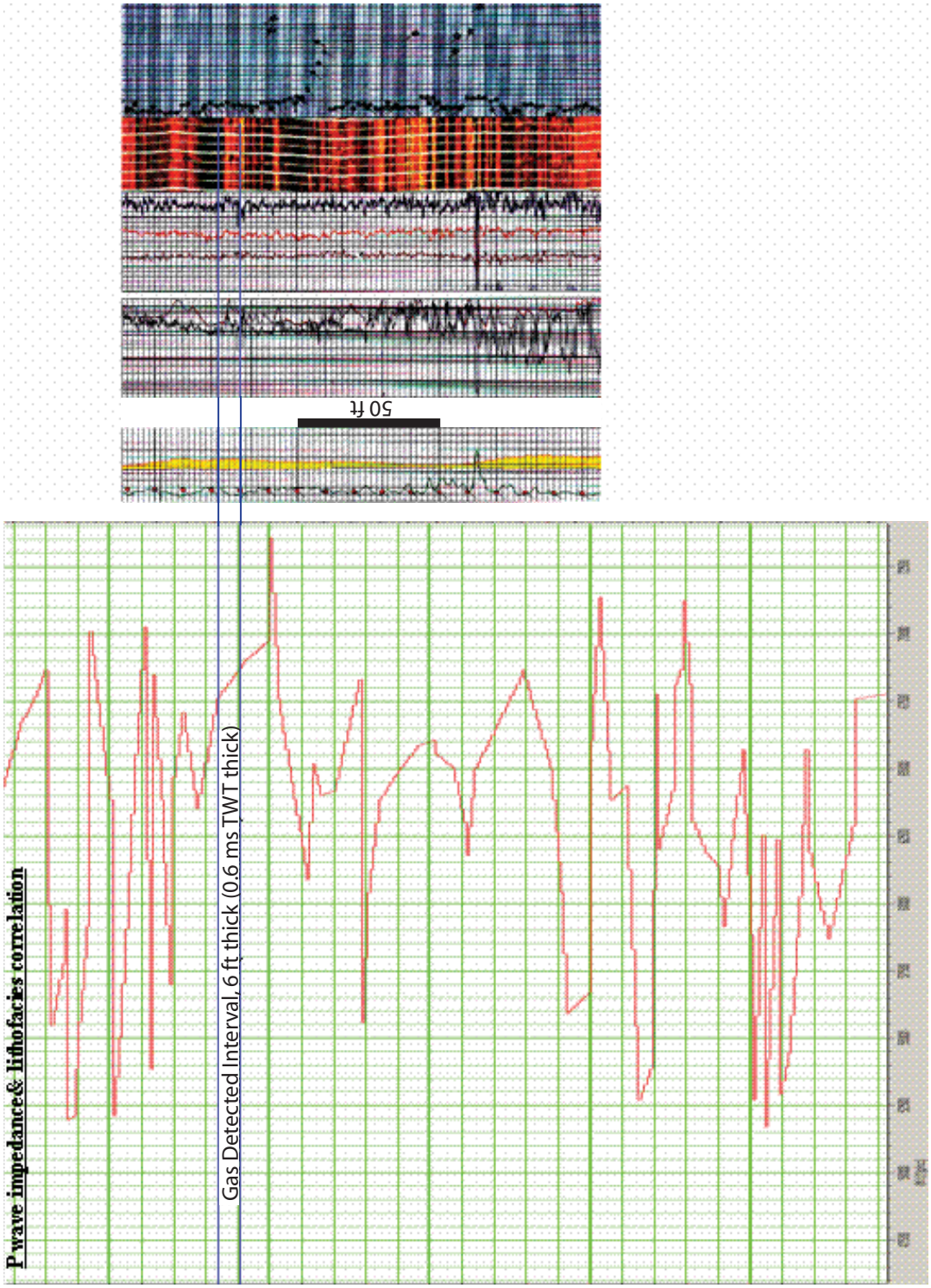

P wave impedance& lithofacies correlation
Gas Detected Interval, 6 ft thick (0.6 ms TWT thick)
50 ft

FIGURE 3.5-46

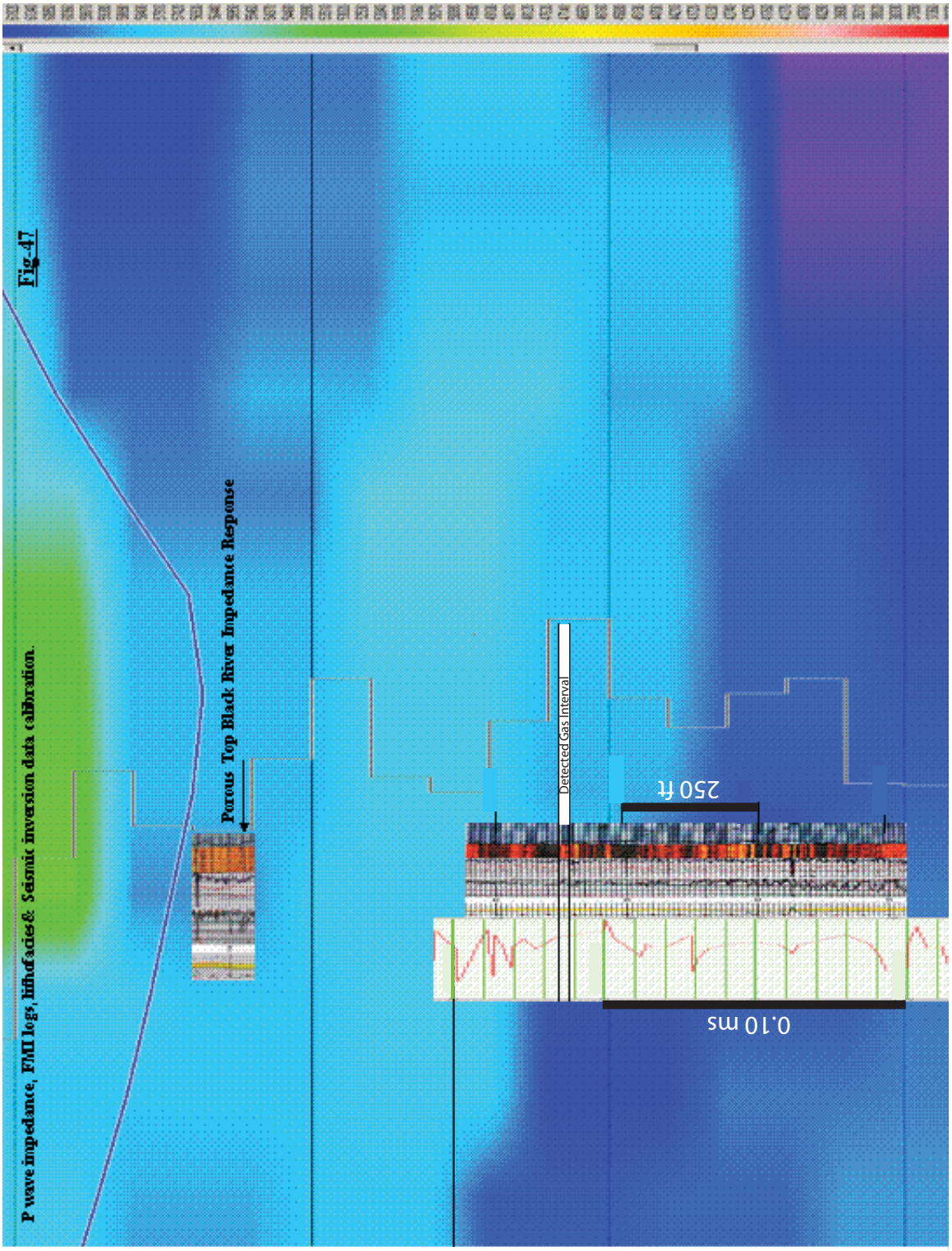


Fig-47
P wave impedance, FMI logs, lithofacies& Seismic inversion data calibration.
Porous Top Black River Impedance Response
Detected Gas Interval
250 ft
0.10 ms

FIGURE 3.5-47

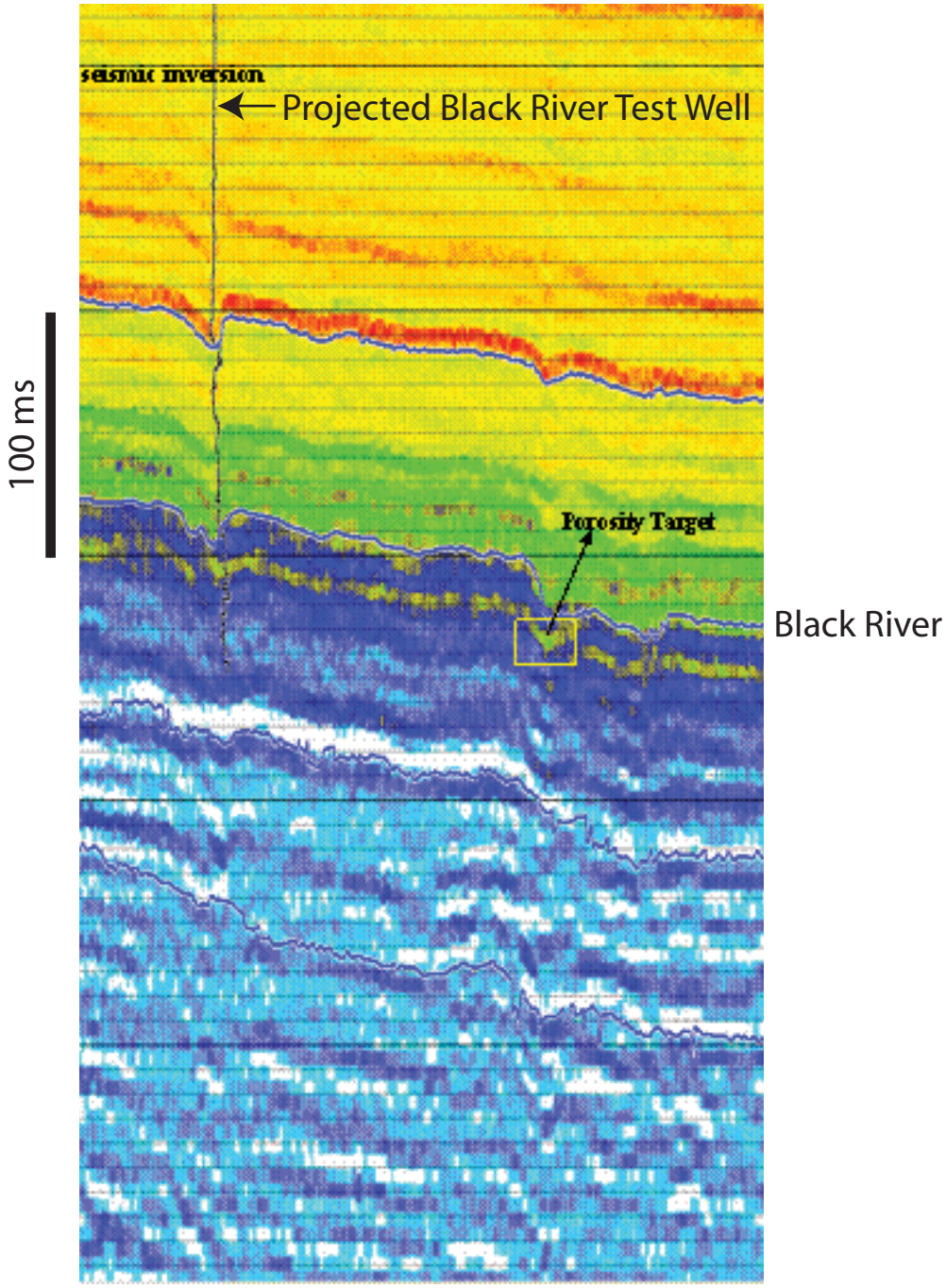

seismic inversion
Projected Black River Test Well
100 ms
Porosity Target
Black River

FIGURE 3.5-48

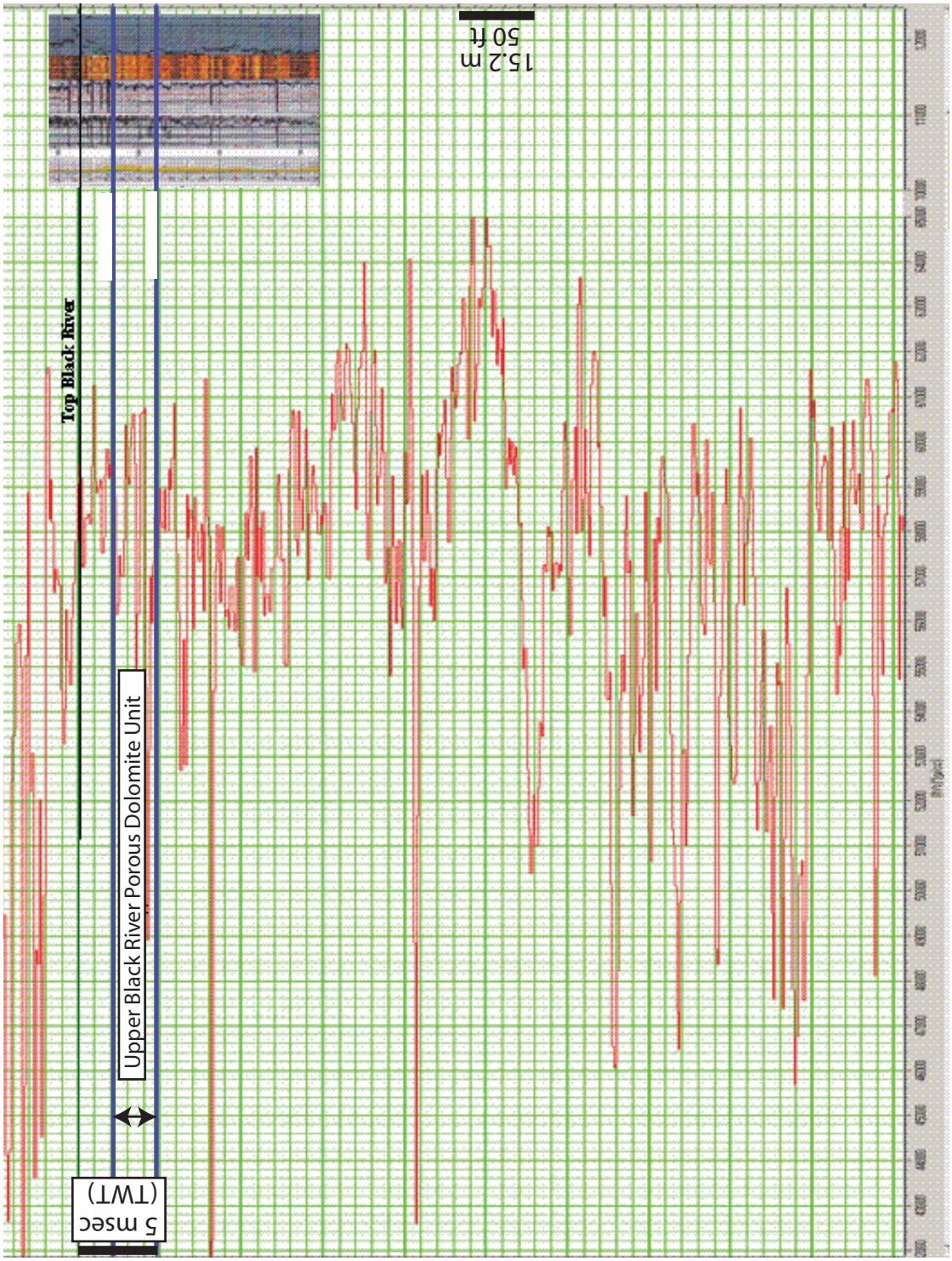

Top Black River
Upper Black River Porous Dolomite Unit
5 msec
(TWT)
15.2 m
50 ft

FIGURE 3.5-49

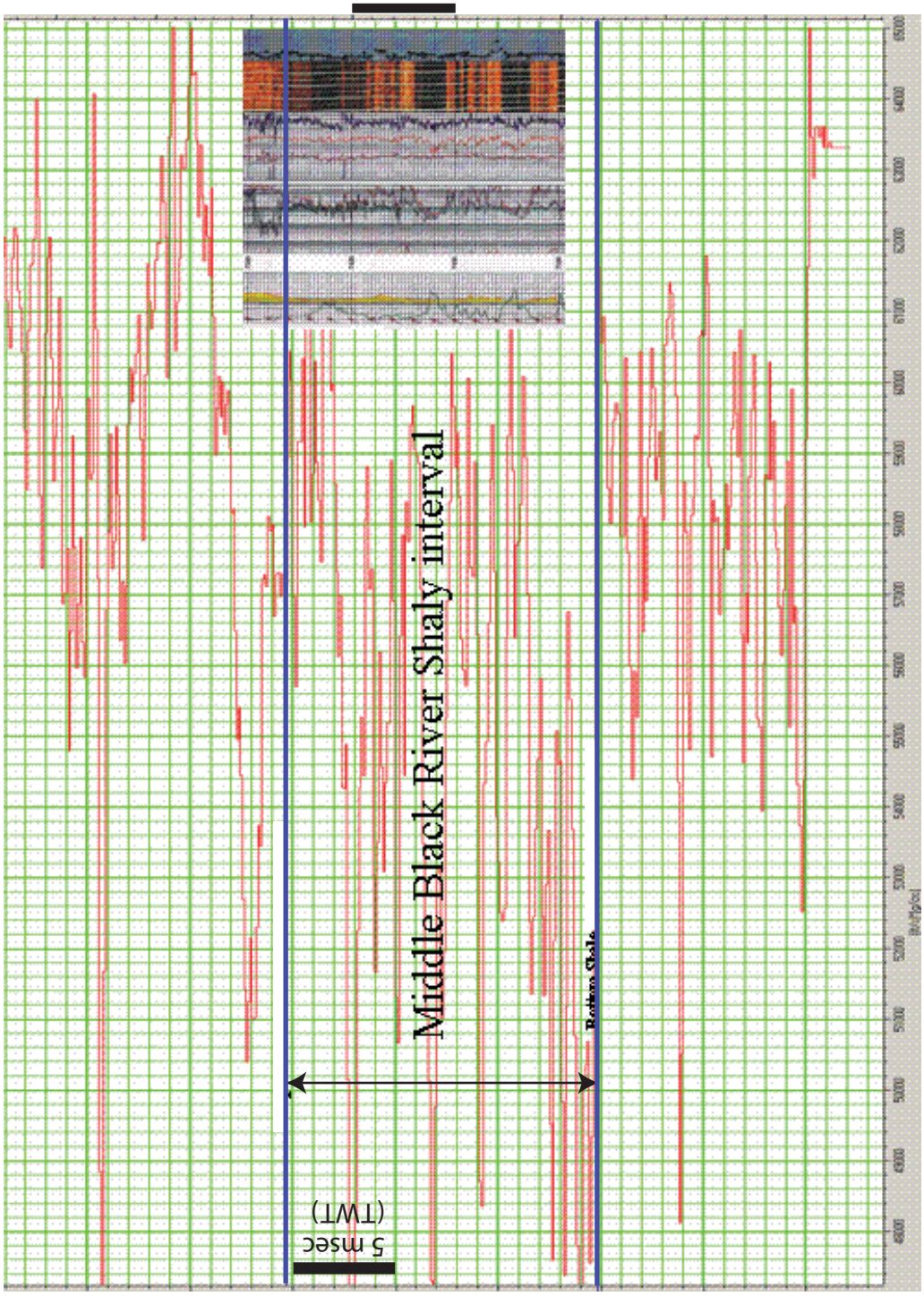

5 msec
(TWT)
Middle Black River Shaly interval
Bottom Shale
50 ft
15.2 m

FIGURE 3.5-50

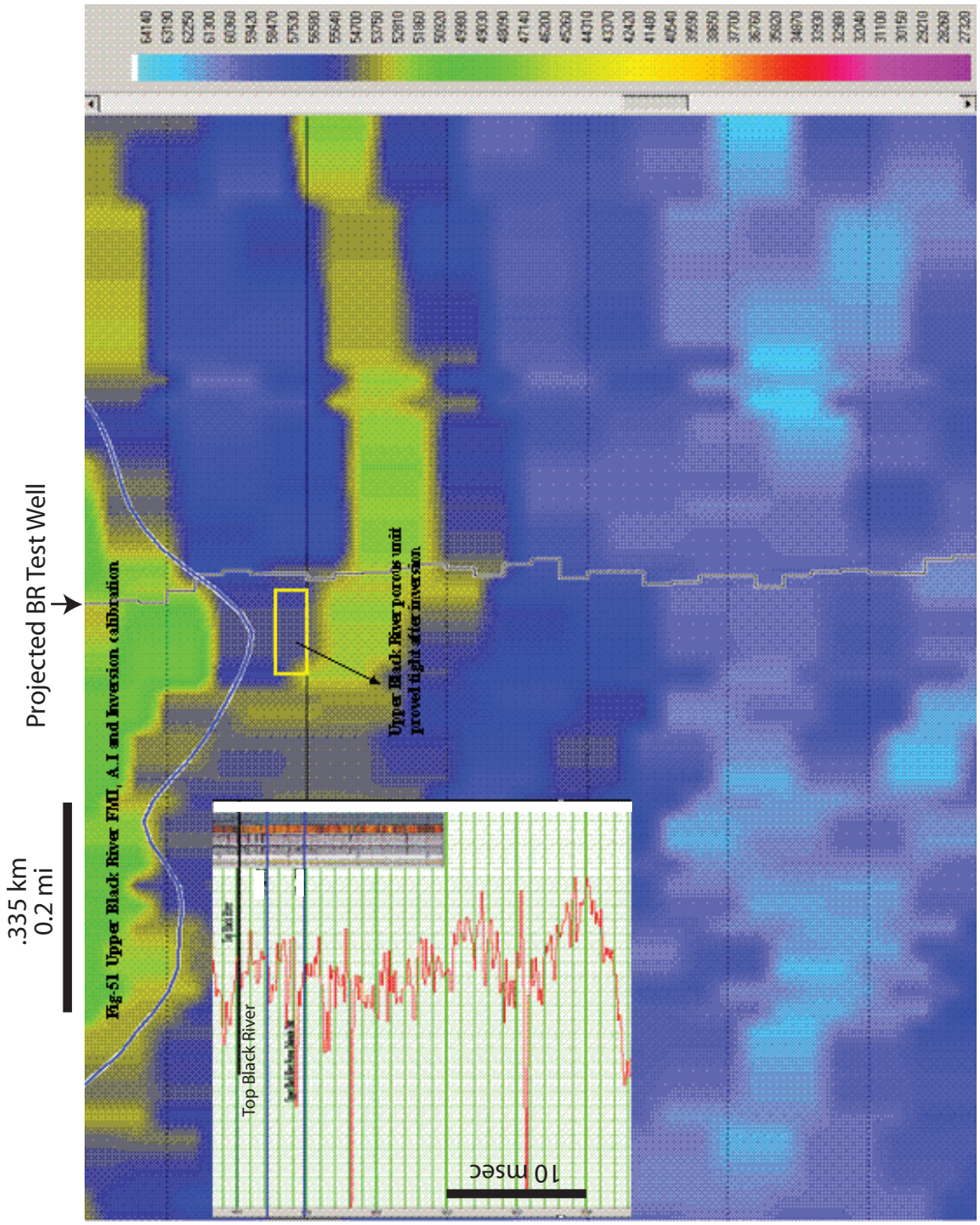

Projected BR Test Well
.335 km
0.2 mi
Fig-51 Upper Black River FMI, A.I and Inversion calibration
Upper Black River porous unit
proved tight after inversion
Top Black River
10 msec

FIGURE 3.5-51

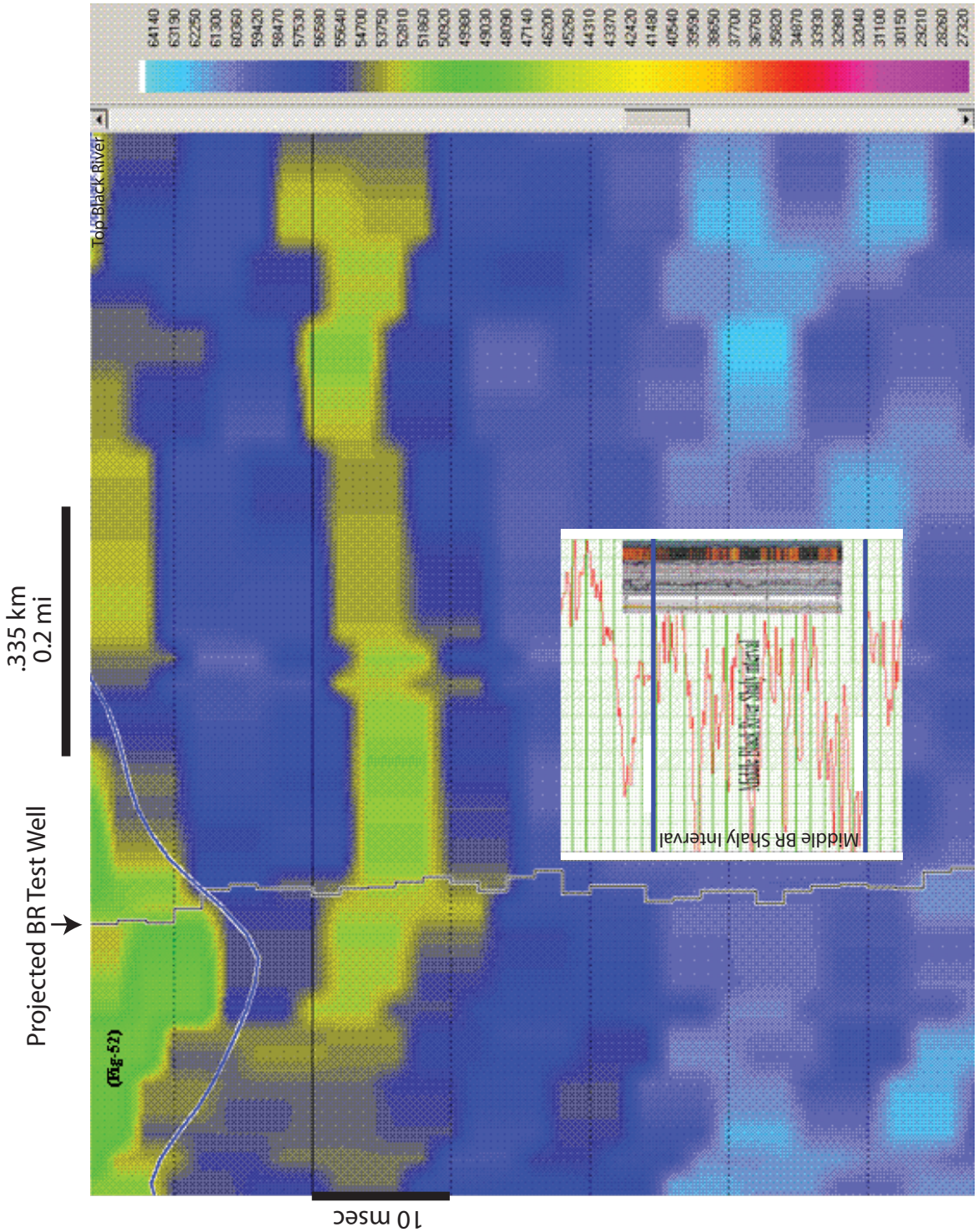

Projected BR Test Well
.335 km
0.2 mi
10 msec
Top Black River
Middle BR Shaly Interval
64140
63190
62250
61300
60360
59420
58470
57530
56580
55640
54700
53750
52810
51860
50920
49980
49030
48090
47140
46200
45250
44310
43370
42420
41480
40540
39590
38650
37700
36760
35820
34870
33930
32980
32040
31100
30150
29210
28260
27320

FIGURE 3.5-52