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

June 1, 2000-March 31, 2007

TOPICAL REPORT #3

First Draft: June 30, 2007

Dr. Robert Jacobi, Principal Author

DE-AC26-00NT40698

CONTRACTOR:

Research Foundation of State University of New York
P. O. Box 9
Albany, New York 12201
on behalf of:
University at Buffalo
The State University of New York
Suite 211, The UB Commons
520 Lee Entrance
Amherst, New York 14228

Dr. Robert Jacobi, Project Director
Dr. John Fountain, Co-Principal Investigator

Mr. Stuart Loewenstein, Subcontractor
Nornew, Inc
1412 Sweet Home Road, Suite 12
Amherst, NY 14228

Dr. Edward deRidder, Subcontractor
Pearson, deRidder and Johnson, Inc.
12640 West Cedar Drive, Suite 100
Lakewood, CO 80228

Dr. Bruce Hart, Subcontractor
Earth and Planetary Sciences
McGill University
3450 University Street
Montreal, Quebec
Canada H3A 2A7

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any other agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

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.

TABLE OF CONTENTS

DISCLAIMER	1
ABSTRACT	2
LIST OF GRAPHICAL MATERIALS	4
FIGURE CAPTIONS	9

LIST OF GRAPHICAL MATERIALS

FIGURE 3.2-6a. Fused ASTER and Landsat Image.

FIGURE 3.2-6b. Fused ASTER and Landsat Image With Lineaments.

FIGURE 3.2-7. Seneca Lake Contrast Values for all Fracture Frequency Groups and All Lineament Groups.

FIGURE 3.2-8. Cayuga Lake Contrast Values for all Fracture Frequency Groups and All Lineament Groups.

FIGURE 3.2-9a. Cartoon Indicating which Satellite Image and Processing Technique Resulted in the Peak Contrast Value for each Orientation and Fracture Frequency in the Seneca Lake Swath.

FIGURE 3.2-9b. Cartoon Indicating which Satellite Image and Processing Technique Resulted in the Peak Contrast Value for each Orientation and Fracture Frequency in the Cayuga Lake Swath.

FIGURE 3.3-1. Location Map for the Soil Gas Analyses in Figure 3.3-2.

FIGURE 3.3-2. Soil Gas Analyses Along the N-S Seneca Lake Traverse.

FIGURE 3.3-3. Seneca Lake N-S Transect.

FIGURE 3.3-4. General Location Map for Soil Gas Box Surveys.

FIGURE 3.3-5. Location Map for Soil Gas Box Surveys in the Vicinity of Trenton/Black River Wells.

FIGURE 3.3-6. Detailed Inset Displaying the 2002 Soil Gas Surveys in the Vicinity of Trenton/Black River Wells.

FIGURE 3.3-7. Soil Gas Traverse 2002-1 (Lodi Center Road).

FIGURE 3.3-8. Soil Gas Traverse 2002-2 (Arden Road).

FIGURE 3.3-9. Soil Gas Traverse 2002-3 (County Rte. 142).

FIGURE 3.3-10. Soil Gas Traverse 2002-4 (West Covert Road).

FIGURE 3.3-11. Soil Gas Traverse 2002-5 (West Bates Road).

FIGURE 3.3-12. Soil Gas Traverse 2002-6 (Arden Road).

FIGURE 3.3-13. Soil Gas Traverse 2002-7 (Lodi Covert Townline Road).

FIGURE 3.3-14. Soil Gas Traverse 2002-8 (Stout Road).

FIGURE 3.3-15. Soil Gas Traverse 2002-9 (West Covert Road).

FIGURE 3.3-16. Soil Gas Traverse 2002-10 (ATV Trail).

FIGURE 3.3-17. Soil Gas Traverse 2002-11 (Case and Townsend Roads).

FIGURE 3.3-18. Soil Gas Traverse 2002-12 (Burdick Road).

FIGURE 3.3-19. Soil Gas Traverse 2002-13 (Burdick Road Ext.).

FIGURE 3.3-20. Detailed Inset of Lodi Center Area Displaying Soil Gas Surveys and Modified Rose Diagrams of Fractures in the Vicinity of the Campion Trenton/Black River Test Well.

FIGURE 3.3-21. Soil Gas Traverse 2001-B1 (Wilkins Road).

FIGURE 3.3-22. Soil Gas Traverse 2001-B2 (ATV trail).

FIGURE 3.3-23. Soil Gas Traverse 2001-B3 (Seneca Road).

FIGURE 3.3-24a. Soil Gas Traverse FOU-1 (Lodi Center Road).

FIGURE 3.3-24b. Soil Gas Traverse FLO1-1 (E-W Segment-Seneca Road).

FIGURE 3.3-24c. Soil Gas Traverse FLO1-1 (N-S Segment-Bishop Corners Road).

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

FIGURE 3.4-2. Interpretation of Part of Seismic Line #1 Across the Muck Farm Field.

FIGURE 3.4-3. Interpretation of Seismic Line #2.

FIGURE 3.4-4. Interpretation of Seismic Line #3.

FIGURE 3.4-5. Interpretation of Seismic Line #4.

FIGURE 3.5-1. Sample of Part of Seismic Line 2, Interpreted.

FIGURE 3.5-2. Sample of Part of Seismic Line 2, Interpreted.

FIGURE 3.5-3. Sample of Reflection Strength (Instantaneous Amplitude) Version of Seismic Line 2.

FIGURE 3.5-4. Sample of Line 2 Flattened at Basement Horizon.

FIGURE 3.5-5. Sample of Seismic Line 2 Flattened on the Knox Unconformity.

FIGURE 3.5-6. Sample of Seismic Line 2 Flattened on the Black River.

FIGURE 3.5-7. Sample of Fault Interpretations Along Seismic Line 2 Superimposed on Reflection Strength Display of Line 2.

FIGURE 3.5-8. Close-up of a Small Graben Feature, Line 2.

FIGURE 3.5-9. Close-up of a Small Graben Feature, Line 2.

FIGURE 3.5-10. Sample of Reflection Strength Display, Line 2.

FIGURE 3.5-11. Close-up, Reflection Strength Display, Line 2.

FIGURE 3.5-12. Close-up Showing Dimming and Thickness Reduction of Black River Horizon, Line 2.

FIGURE 3.5-13. Instantaneous Phase Display, Part of Line 2.

FIGURE 3.5-14. Instantaneous Phase Display, Part of Line 2.

FIGURE 3.5-15. Instantaneous Frequency Display, Line 2.

FIGURE 3.5-16. Close-up, Instantaneous Frequency Display, Line 2.

FIGURE 3.5-17. Close-up, Instantaneous Frequency Display, Line 2.

FIGURE 3.5-18. Coherency Processing, Line 2.

FIGURE 3.5-19. Well Log Display of the Trenton.

FIGURE 3.5-20. Annotated Log of the Lower, Middle and Upper Black River in a Black River Test Well in the Study Region.

FIGURE 3.5-21. Comparison of Logs with Borehole Imagery for the Upper Black River.

FIGURE 3.5-22. Comparison of Well Logs Including Borehole Imagery (FMI Log, Right) with Driller's Log (Left) in a Black River Test Well in the Study Region.

FIGURE 3.5-23. Comparison of Conventional Well Logs and Image Log in the Middle Black River.

FIGURE 3.5-24. Crossplot of Neutron Porosity Versus Sonic Porosity.

FIGURE 3.5-25. Density Porosity Versus Neutron Porosity

FIGURE 3.5-26. Log Response for the Middle and Upper Black River.

FIGURE 3.5-27. Two Gas Signatures for the Lower Black River.

FIGURE 3.5-28. Gas Signatures Crossplot (Figure 3.5-29) and Image Log of Primarily the Upper Black River.

FIGURE 3.5-29. Gas Signatures in Shaly Section, Lower Black River.

FIGURE 3.5-30. Neutron Porosity Versus True Resistivity for the Trenton and Black River.

FIGURE 3.5-31. Flushed Zone Resistivity (RXO) Versus True Resistivity (HART).

FIGURE 3.5-32. Flushed Zone Resistivity Versus True Resistivity.

FIGURE 3.5-33. Gamma Ray Versus True Resistivity.

FIGURE 3.5-34. Caliper Versus Gamma Ray Plot.

FIGURE 3.5-35. Sample of Line 2, Imported into Hampson-Russell Software.

FIGURE 3.5-36. Synthetic Seismogram Display for a Black River Test Well in the Study Region.

FIGURE 3.5-37. Initial Acoustic Impedance Model.

FIGURE 3.5-38. Close-up of a Black River Test Well Location in the Study Region with Integrated Absolute Amplitude Processing for Part of Seismic Line 2.

FIGURE 3.5-39. Close-up of Integrated Absolute Amplitude Processing for Part of Seismic Line 2.

FIGURE 3.5-40. Close-up of Integrated Absolute Amplitude Processing, Calibrated with Computed Impedance, for Part of Seismic Line 2.

FIGURE 3.5-41. Close-up of Inversion Results on Part of Seismic Line 2.

FIGURE 3.5-42. Close-up of Inversion Results on Part of Seismic Line 2.

FIGURE 3.5-43. Flattened Inversion Results for Part of Seismic Line 2.

FIGURE 3.5-44. Inversion Results for Part of Seismic Line 2.

FIGURE 3.5-45. Comparison of Borehole Image Log and Acoustic Impedance Log.

FIGURE 3.5-46. Comparison of Borehole Image Log and Acoustic Impedance Log.

FIGURE 3.5-47. Close-up of Inversion Results for Part of Seismic Line 2.

FIGURE 3.5-48. Inversion Results for Part of Seismic Line 2.

FIGURE 3.5-49. Time-Depth Calibration, Acoustic Impedance and Borehole Image Logs, Upper Black River Section.

FIGURE 3.5-50. Time-Depth Calibration, Acoustic Impedance and Borehole Image Logs, Middle Shaly Black River Section.

FIGURE 3.5-51. Close-up of Inversion Results for Part of Seismic Line 2 with FMI Log and AI overlay.

FIGURE 3.5-52. Close-up of Inversion Results for Part of Seismic Line 2.

FIGURE CAPTIONS FOR TOPICAL REPORT #3

FIGURE 3.2-6a. Fused ASTER and Landsat Image.

After Drechsel et al. (2004) and Cruz et al. (2005).

FIGURE 3.2-6b. Fused ASTER and Landsat Image with Lineaments.

After Drechsel et al. (2004) and Cruz et al. (2005).

FIGURE 3.2-7. Seneca Lake Contrast Values for all Fracture Frequency Groups and all Lineament Groups.

After Drechsel et al. (2004) and Cruz et al. (2005).

FIGURE 3.2-8. Cayuga Lake Contrast Values for all Fracture Frequency Groups and all Lineament Groups.

After Drechsel et al. (2004) and Cruz et al. (2005).

FIGURE 3.2-9a. Cartoon Indicating which Satellite Image and Processing Technique Resulted in the Peak Contrast Value for each Orientation and Fracture Frequency in the Seneca Lake Swath.

After Drechsel et al. (2004) and Cruz et al. (2005).

FIGURE 3.2-9b. Cartoon Indicating which Satellite Image and Processing Technique Resulted in the Peak Contrast Value for each Orientation and Fracture Frequency in the Cayuga Lake Swath.

After Drechsel et al. (2004) and Cruz et al. (2005).

FIGURE 3.3-1. Location Map for the Soil Gas Analyses in Figure 3.3-2.

Note Ovid in the upper part of Figure.

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.

FIGURE 3.3-3. Seneca Lake N-S Transect.

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.

FIGURE 3.3-4. General Location Map for Soil Gas Box Surveys.

FIGURE 3.3-5. Location Map for Soil Gas Box Surveys in the Vicinity of Trenton/Black River Wells.

Location of map shown by the large rectangle in Figure 3.3-4.

FIGURE 3.3-6. Detailed Inset Displaying the 2002 Soil Gas Surveys in the Vicinity of Trenton/Black River Wells.

Inset location shown by large rectangle in 3.3-4.

FIGURE 3.3-7. Soil Gas Traverse 2002-1 (Lodi Center Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-8. Soil Gas Traverse 2002-2 (Arden Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-9. Soil Gas Traverse 2002-3 (County Rte. 142).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-10. Soil Gas Traverse 2002-4 (West Covert Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-11. Soil Gas Traverse 2002-5 (West Bates Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-12. Soil Gas Traverse 2002-6 (Arden Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-13. Soil Gas Traverse 2002-7 (Lodi Covert Townline Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-14. Soil Gas Traverse 2002-8 (Stout Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-15. Soil Gas Traverse 2002-9 (West Covert Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-16. Soil Gas Traverse 2002-10 (ATV Trail).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-17. Soil Gas Traverse 2002-11 (Case and Townsend Roads).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-18. Soil Gas Traverse 2002-12 (Burdick Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-19. Soil Gas Traverse 2002-13 (Burdick Road Ext.).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-6.

FIGURE 3.3-20. Detailed Inset of Lodi Center Area Displaying Soil Gas Surveys and Modified Rose Diagrams of Fractures in the Vicinity of the Champion Trenton/Black River Test Well.

Inset location shown by square in Figure 3.3-5.

FIGURE 3.3-21. Soil Gas Traverse 2001-B1 (Wilkins Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-20.

FIGURE 3.3-22. Soil Gas Traverse 2001-B2 (ATV trail).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-20.

FIGURE 3.3-23. Soil Gas Traverse 2001-B3 (Seneca Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-20.

FIGURE 3.3-24a. Soil Gas Traverse FOU-1 (Lodi Center Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-20.

FIGURE 3.3-24b. Soil Gas Traverse FLO1-1 (E-W Segment-Seneca Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-20.

FIGURE 3.3-24c. Soil Gas Traverse FLO1-1 (N-S Segment-Bishop Corners Road).

Green topographic profile after Delorme. For location of profile, see Figure 3.3-20.

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).

FIGURE 3.4-5. Interpretation of Seismic Line #4.

Note the well-imaged grabens 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 3.5-1. 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.

FIGURE 3.5-3. Sample of Reflection Strength (Instantaneous Amplitude) Version of Seismic Line 2.

Complete seismic line with shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-4. Sample of Line 2 Flattened at Basement Horizon.

This flattening emphasizes Paleozoic thickness trends. Complete seismic line with shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-5. Sample of Seismic Line 2 Flattened on the Knox Unconformity.

Complete seismic line with shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-6. Sample of Seismic Line 2 Flattened on the Black River.

Complete seismic line with shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-7. Sample of Fault Interpretations Along Seismic Line 2 Superimposed on Reflection Strength Display of Line 2.

Complete seismic line with shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-8. Close-up of a Small Graben Feature, Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-9. Close-up of a Small Graben Feature, Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-10. Sample of Reflection Strength Display, Line 2.

Alternate color display. Complete seismic line with shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-11. Close-up, Reflection Strength Display, Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-12. Close-up Showing Dimming and Thickness Reduction of Black River Horizon, Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-13. Instantaneous Phase Display, Part of Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-14. Instantaneous Phase Display, Part of Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-15. Instantaneous Frequency Display, Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-16. Close-up, Instantaneous Frequency Display, Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-17. Close-up, Instantaneous Frequency Display, Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-18. Coherency Processing, Line 2.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-19. Well Log Display of the Trenton.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-20. Annotated Log of the Lower, Middle and Upper Black River in a Black River Test Well in the Study Region.

Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-21. Comparison of Logs with Borehole Imagery for the Upper Black River.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-22. Comparison of Well Logs Including Borehole Imagery (FMI Log, Right) with Driller's Log (Left) in a Black River Test Well in the Study Region.

Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-23. Comparison of Conventional Well Logs and Image Log in the Middle Black River.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-24. Crossplot of Neutron Porosity Versus Sonic Porosity.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-25. Density Porosity Versus Neutron Porosity

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-26. Log Response for the Middle and Upper Black River.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-27. Two Gas Signatures for the Lower Black River.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-28. Gas Signatures Crossplot (Figure 3.5-29) and Image Log of Primarily the Upper Black River.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-29. Gas Signatures in Shaly Section, Lower Black River.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-30. Neutron Porosity Versus True Resistivity for the Trenton and Black River.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-31. Flushed Zone Resistivity (RXO) Versus True Resistivity (HART).

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-32. Flushed Zone Resistivity Versus True Resistivity.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-33. Gamma Ray Versus True Resistivity.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-34. Caliper Versus Gamma Ray Plot.

Data from a Black River test well in the study region. Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-35. Sample of Line 2, Imported into Hampson-Russell Software.

Shot point numbers and depths not shown in order to preserve the proprietary nature of the seismic line.

FIGURE 3.5-36. Synthetic Seismogram Display for a Black River Test Well in the Study Region.

Depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-37. Initial Acoustic Impedance Model.

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.

FIGURE 3.5-38. Close-up of a Black River Test Well Location in the Study Region with Integrated Absolute Amplitude Processing for Part of Seismic Line 2.

Shot points and depths and shot points not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-39. Close-up of Integrated Absolute Amplitude Processing for Part of Seismic Line 2.

Depths and shot points not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-40. Close-up of Integrated Absolute Amplitude Processing, Calibrated with Computed Impedance, for Part of Seismic Line 2.

Depths and shot points not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-41. Close-up of Inversion Results on Part of Seismic Line 2.

Data near a Black River test well and to the south. See Figure 3.5-43 for color scale. Depths and shot points not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-42. Close-up of Inversion Results on Part of Seismic Line 2.

Data near a Black River test well and to the north. See Figure 3.5-43 for color scale. Depths and shot points not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-43. Flattened Inversion Results for Part of Seismic Line 2.

Depths and shot points not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-44. Inversion Results for Part of Seismic Line 2.

Inversion generated using sonic log derived from density log via Gardner equation. Depths and shot points not shown in order to preserve the proprietary nature of the data.

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.

FIGURE 3.5-46. Comparison of Borehole Image Log and Acoustic Impedance Log.

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

FIGURE 3.5-47. Close-up of Inversion Results for Part of Seismic Line 2.

Figure displays p-wave impedance and image logs that overlie the inversion results. Data from one of the T/BR test wells in the region. Shot points and depths not shown in order to preserve the proprietary nature of the data.

FIGURE 3.5-48. Inversion Results for Part of Seismic Line 2.

Inversion derived using edited density log. Shot points and depths not shown in order to preserve the proprietary nature of the data.

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

FIGURE 3.2-7

FIGURE 3.2-8

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)
EARTHSAF 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 3.2-9b

FIGURE 3.3-1

FIGURE 3.3-2

FIGURE 3.3-3

Seneca and Schuyler Counties, NY

Locations of soilgas study areas

- Roads
- Creeks
- Lakes
- Major Rivers
- EARTHSAT Lineaments

FIGURE 3.3-4

FIGURE 3.3-5

FIGURE 3.3-6

FIGURE 3.3-7

LEGEND

FIGURE 3.3-8

LEGEND

FIGURE 3.3-9

LEGEND

FIGURE 3.3-10

FIGURE 3.3-11

FIGURE 3.3-12

FIGURE 3.3-13

LEGEND

FIGURE 3.3-14

Traverse 2002-9 - West Covert Road

LEGEND

FIGURE 3.3-15

FIGURE 3.3-16

LEGEND

FIGURE 3.3-17

LEGEND

FIGURE 3.3-18
LEGEND

FIGURE 3.3-19

Lodi Center area, NY Soilgas and Fracture Data Map

FIGURE 3.3-20

LEGEND

FIGURE 3.3-21

LEGEND

FIGURE 3.3-22

FIGURE 3.3-23

FIGURE 3.3-24A

LEGEND

FIGURE 3.3-24B

LEGEND

FIGURE 3.3-24C

GLODES CORNERS ROAD

FIGURE 3.4-1

FIGURE 3.4-2

LINE 2

FIGURE 3.4-3

LINE 3

FIGURE 3.4-4

LINE 4

NORTH

1 mi

1 km

SOUTH

FIGURE 3.4-5

FIGURE 3.5-1

FIGURE 3.5-2

FIGURE 3.5-3

FIGURE 3.5-4

FIGURE 3.5-5

FIGURE 3.5-6

FIGURE 3.5-7

FIGURE 3.5-8

FIGURE 3.5-9

FIGURE 3.5-10

FIGURE 3.5-11

FIGURE 3.5-12

FIGURE 3.5-13

FIGURE 3.5-14

FIGURE 3.5-16

FIGURE 3.5-17

FIGURE 3.5-18

FIGURE 3.5-19

FIGURE 3.5-20

Sonic Porosity, Neutron and Density porosity response of the Porous upper. Black River

Fig. 21

Figure 21 displays a multi-panel geophysical log for the Porous upper. Black River. The log includes tracks for Sonic Porosity (SPH2), Neutron Porosity (NPH2), and Density Porosity (DPH2) in the top panel. The middle panel shows Sonic Porosity (SPH2) and Neutron Porosity (NPH2) in the upper section. The bottom panel shows Sonic Porosity (SPH2) and Neutron Porosity (NPH2) in the lower section. A 'Porous dolomite zone' is highlighted in the middle panel. A 'Possible gas bearing units' is indicated in the bottom panel. A scale bar shows 10 m and 50 ft. A 'Trenton' label is present in the middle panel.

Fig-21

FIGURE 3.5-22

FIGURE 3.5-23

FIGURE 3.5-24

FIGURE 3.5-25

FIGURE 3.5-26

FIGURE 3.5-28

FIGURE 3.5-29

FIGURE 3.5-30

FIGURE 3.5-31

FIGURE 3.5-32

FIGURE 3.5-33

FIGURE 3.5-34

Projected BR Test Well

0.1 sec

FIGURE 3.5-35

FIGURE 3.5-36

FIGURE 3.5-37

Projected BR
Test Well

FIGURE 3.5-38

Projected BR
Test Well

FIGURE 3.5-39

Projected BR
Test Well

FIGURE 3.5-40

FIGURE 3.5-41

Projected BR
Test Well

FIGURE 3.5-42

FIGURE 3.5-43

Projected BR
Test Well

Black River

FIGURE 3.5-44

FIGURE 3.5-45

FIGURE 3.5-46

FIGURE 3.5-47

FIGURE 3.5-48

FIGURE 3.5-49

FIGURE 3.5-50

FIGURE 3.5-51

FIGURE 3.5-52