



Natural Resources Conservation Service
National Soil Survey Center
Federal Building, Room 152
100 Centennial Mall North
Lincoln, NE 68508-3866

Phone: (402) 437-5499
FAX: (402) 437-5336

SUBJECT: MGT – Trip Report – Geophysical Field Assistance

April 19, 2011

TO: J. B. Martin, Jr.
State Conservationist, NRCS
Raleigh, North Carolina

File Code: 330-20-7

Jeff White
Dept. of Soil Science
North Carolina State University
101 Derieux Street
2232 Williams Hall
Raleigh, North Carolina 27695

Purpose:

To use geophysical methods (ground-penetrating radar (GPR) and electromagnetic induction (EMI)) to help assess soils and soil properties at the Upper Piedmont Experiment Station, Reidsville, North Carolina. Soil investigations were part of a collaborative effort between USDA/NRCS and North Carolina State University to determine whether and how GPR and EMI can help elucidate the spatial variability of soil profile characteristics that affect soil-plant-water relationships in these Piedmont soils.

Participants:

Alan Meijer, Extension Associate/Graduate Student, North Carolina State University, Plymouth, NC
James W. Tuttle, Soil Scientist, Soil Survey Research & Laboratory, NSSC, MS 41, NRCS, Lincoln, NE
Robert Walters, Agricultural Research Specialist, North Carolina State University, Raleigh, NC

Activities:

All field activities were completed on March 16-18, 2011.

Summary:

1. Changes in apparent conductivity were thought to be associated with changes in soil characteristics across the survey areas. Areas of higher apparent conductivity were associated with thicker subsoils containing more clay and moisture. Anomalous spikes in apparent conductivity were associated with the presence of subsurface metal objects and appeared as point features and linear features in the radar records. Features were verified with soil borings.
2. The EMI surveys completed in 2010 were conducted in a more north to south orientation and the surveys completed in 2011 were conducted in a more east to west orientation across the sites. This did not change resulting spatial patterns or resulting interpretations at the sites, which is encouraging.
3. Surveys were completed with the 200 MHz and the 400 MHz antenna at the sites. Initial surveys completed with the 400 MHz antenna resulted in higher signal attenuation rates and were of poor interpretative quality. The 200 MHz antenna proved to be a better choice and was selected to complete the surveys at both sites. Radar records obtained with the 200 MHz antenna were



generally of good to excellent interpretative quality. Observation depths were in excess of 2.5 m. Higher rates of signal attenuation observed in the radar records were thought to be attributed to increased amounts of clay and moisture within the soil profile. Soil borings confirmed an increase in clay and moisture in areas containing higher signal attenuation rates. Small localized areas containing shallower soils (soil inclusions) were observed in radar records and were verified with soil borings.

4. After observing 3-D GPR surveys and EMI surveys at both sites, findings in 2011 were similar to findings in 2010. There appears to be more variability at site 2 (behind main office) as compared to site 1 (Chinqua Penn Farm) with respects to changes in soils and soil characteristics (especially soil depth). GPR and EMI interpretations were verified with soil borings.
5. When comparing the GPR surveys with the EMI surveys completed across the same grid areas, results were similar and yielded similar interpretations. Shallower soils/thinner soil profiles consistently resulted in lower apparent conductivity.
6. Three-dimensional GPR surveys provided high intensity surveys of the sites and a good visual assessment of underlying subsurface features. The underlying soil characteristics are going to be compared to productivity and yields at the two sites. The 3-D diagrams contained in this report provide only a small understanding of subsurface features. A follow-up meeting with all collaborative partners is planned in the near future to more fully review the data from the 3-D surveys using the RADAN software. Additional insight and beneficial information will be gained by all participants involved at the follow-up meeting.
7. Geophysical interpretations are considered preliminary estimates of site conditions. The results of geophysical site investigations are interpretive and do not substitute for direct ground-truth observations (soil borings and pits). The use of geophysical methods can reduce the number of coring observations, direct their placement, and supplement their interpretations. Interpretations contained in this report should be verified by ground-truth observations whenever possible.

It was a pleasure for Wes Tuttle to work again in North Carolina with members of your fine staff.

Sincerely,

/s/ Jonathan W. Hempel

JONATHAN W. HEMPEL
Director
National Soil Survey Center

cc:

James A. Doolittle, Research Soil Scientist, Soil Survey Research & Laboratory, NSSC, MS 41, NRCS, Lincoln, NE

Micheal L. Golden, Director, Soil Survey Division, NRCS, Washington, DC

Joshua Heitman, Dept. of Soil Science, North Carolina State University, Raleigh, NC

Alan Meijer, Dept. of Soil Science, North Carolina State University, Plymouth, NC

Roy L. Vick, Jr., State Soil Scientist/MO Leader, NRCS, Raleigh, NC

Robert Walters, Department of Soil Science, North Carolina State University, Raleigh, NC

John W. Tuttle, Soil Scientist, Soil Survey Research & Laboratory, NSSC, MS 41, NRCS, Lincoln, NE

Larry T. West, National Leader, Soil Survey Research & Laboratory, NSSC, MS 41, NRCS, Lincoln, NE

**This technical report was prepared by Wes Tuttle, Geophysical Soil Scientist,
USDA-NRCS-NSSC, Wilkesboro, NC.**

Equipment:

Geonics Limited manufactures the EM38 meter.¹ This meter is portable and requires only one person to operate. No ground contact is required with this meter. McNeill (1980) and Geonics Limited (1998) have described principles of operation for the EM38 meter. Lateral resolution is approximately equal to its intercoil spacing. The EM38 meter has a 1 m intercoil spacing and operates at a frequency of 14,600 Hz. When placed on the soil surface, this instrument has a theoretical penetration depth of about 0.75 and 1.5 m in the horizontal and vertical dipole orientations, respectively (Geonics Limited, 1998). Values of apparent conductivity are expressed in millisiemens per meter (mS/m).

The Allegro CX field computer was used in combination with the Geonics EM38 meter to record and store EMI data. The field computer is keypad operated and measurements can either be automatically or manually triggered. EMI data was geo-referenced with a Trimble ProXT GPS receiver.¹

To help summarize the results of this study, the SURFER for Windows (version 8.0) developed by Golden Software, Inc. was used to construct two-dimensional simulations. Grids were created using kriging methods with an octant search.

The radar unit is the TerraSIRch Subsurface Interface Radar (SIR) System-3000 (here after referred to as the SIR System-3000), manufactured by Geophysical Survey Systems, Inc.¹ Morey (1974), Doolittle (1987), and Daniels (1996) have discussed the use and operation of GPR. The SIR System-3000 consists of a digital control unit (DC-3000) with keypad, SVGA video screen, and connector panel. A 10.8-volt lithium-ion rechargeable battery powers the system. The SIR System-3000 weighs about 9 lbs (4.1 kg) and is backpack portable. With an antenna, this system requires two people to operate. The 200 MHz and the 400 MHz antennas were used in this study. A GSSI model 620 survey wheel (measuring distance) was used with the 200MHz antenna and a GSSI model 623 survey cart was used with the 400 MHz antenna to conduct 3-D survey grids at the sites. The wheel and the cart provided a distance measurement/scale during the GPR surveys.

The RADAN for Windows (version 6.6) software program was used to process the radar records (Geophysical Survey Systems, Inc, 2008).¹

Electromagnetic Induction:

Electromagnetic induction is a noninvasive geophysical tool that is used for high intensity surveys and detailed site assessments. Advantages of EMI are its portability, speed of operation, flexible observation depths, and moderate resolution of subsurface features. Results of EMI surveys are interpretable in the field. This geophysical method can provide in a relatively short time the large number of observations that are needed to comprehensively cover sites. Maps prepared from correctly interpreted EMI data provide the basis for characterizing site conditions, planning further investigations, and locating sampling or monitoring sites.

Electromagnetic induction uses electromagnetic energy to measure the apparent conductivity (ECa) of earthen materials. Current flow is induced into the soil. This induced current flow is proportional to the electrical conductivity of the conducting body (ECa) for a given strength of EM field. The current flow creates a secondary electromagnetic field, the strength of which is proportional of the current flow, and hence, to ECa. ECa may be inferred from the magnitude of the induced secondary EM field generated upon imposition of a primary EM field on the conductor (soil) (Corwin and Rhoades, 1990).

Apparent conductivity is a weighted, average conductivity measurement for a column of earthen materials to a specific depth (Greenhouse and Slaine, 1983). Variations in apparent conductivity are caused by changes in the electrical conductivity of earthen materials. Electrical conductivity is influenced by the volumetric water content, phase of the soil water, temperature, type and concentration of ions in solution,

¹ Manufacturer's names are provided for specific information; use does not constitute endorsement.

and amount and type of clays in the soil matrix (McNeill, 1980). Apparent conductivity is principally a measure of the combined interaction of the soil's soluble salt content, clay content and mineralogy, and water content. The apparent conductivity of soils increases with increased soluble salts, clay, and water contents (Kachanoski et al., 1988; Rhoades et al., 1976). In any soil-landscape, variations in one or more of these factors may dominate the EMI response.

Though seldom diagnostic in itself, lateral and vertical variations in apparent conductivity have been used to infer changes in soils and soil properties. As EMI measurements integrate the bulk physical and chemical properties for a defined observation depth into a single value, responses can be associated with changes in soils and soil map units (Doolittle et al., 1996; Jaynes et al., 1993). For each soil, the inherent variability in physical and chemical properties, as well as temporal variations in soil water and temperature, will establish a unique and characteristic range of observable apparent conductivity values. Recently, EMI has been used as a soil-mapping tool to assist precision farming (Jaynes et al., 1993; Sudduth et al., 1995).

Electromagnetic induction is not suitable for use in all soil investigations. Generally, the use of EMI has been most successful in areas where subsurface properties are reasonably homogeneous. The effects of one property (e.g. clay, water, or salt content) dominate over the other properties, and variations in EMI response can be related to changes in the dominant property (Cook et al., 1992). Within a given geographic area, most similar soils should have comparable EMI responses. Dissimilar soils should have disparate EMI responses. However, the conductivities of some similar and dissimilar soils will overlap. This occurs where contrasts in EMI responses caused by differences in one property are offset by differences in another property. Some soil properties and soils can be inferred or predicted with EMI, provided one is cognizant of changes in parent materials, topography, drainage, and vegetation.

Ground-Penetrating Radar (GPR):

Ground-penetrating radar is a time scaled system. The system measures the time it takes electromagnetic energy to travel from an antenna to an interface (i.e., soil horizon, stratigraphic layer) and back. To convert travel time into a depth scale requires knowledge of the velocity of pulse propagation. Several methods are available to determine the velocity of propagation. These methods include use of table values, common midpoint calibration, and calibration over a target of known depth. The last method is considered the most direct and accurate method to estimate propagation velocity (Conyers and Goodman, 1997). The procedure involves measuring the two-way travel time to a known reflector that appears on a radar record and calculating the propagation velocity by using the following equation (after Morey, 1974):

$$V = 2D/T \quad [1]$$

Equation [1] describes the relationship between the propagation velocity (V), depth (D), and two-way pulse travel time (T) to a subsurface reflector. During this study, the two-way radar pulse travel time was compared with measured depths to known subsurface interfaces within each study site. Computed propagation velocities were used to scale the radar records.

Upper Piedmont Experiment Station, Reidsville, NC

GPR and EMI surveys were conducted of ~2 acres supporting two long-term tillage/no-tillage trials at the Upper Piedmont Experiment Station, Reidsville, NC. Substantial agronomic and soils data has been collected in these fields over the past 20+ years. Currently, Dr. Jeff White, NCSU Soil Science Dept. and Dr. Josh Heitman, NCSU Soil Science Dept. (soil physicist) are monitoring tillage treatment effects on profile soil moisture dynamics under soybean via multiple access tubes and a capacitance probe and plan to continue monitoring for three additional seasons of the corn-soybean rotation. The primary geophysical objectives are to determine whether and how GPR and EMI can help elucidate the spatial variability of soil profile characteristics that affect soil-plant-water relationships in these Piedmont soils. Ground truthing will be achieved via existing data and additional coring. Available soil moisture is frequently the single most important factor affecting crop production in the southeast US. Information gained from this study will be useful for agronomic soil management and also help determine the role that

these geophysical methods may play in future high-intensity soil surveys of Piedmont soils.



Photo 1. Soil moisture measurements are being recorded in the foreground as an electromagnetic induction (EMI) survey is being conducted in the background at the Upper Piedmont Experiment Station located near Reidsville, NC.

Soils: Taxonomic Classification and Description

Casville - Fine, mixed, semiactive, mesic Typic Hapludults family. The very deep, well drained Casville soils formed in residuum from felsic or intermediate igneous or metamorphic rock on ridges and interfluves on Piedmont uplands. These soils were formerly classified as Wedowee (thermic).

Fairview - Fine, kaolinitic, mesic Typic Kanhapludults. The very deep, well drained Fairview soils formed in residuum from felsic metamorphic or igneous rock on ridges and interfluves on Piedmont uplands. These soils were formerly classified as Pacolet (thermic).

Rhodhiss - Fine-loamy, mixed, semiactive, mesic Typic Hapludults family. The very deep, well drained Rhodhiss soils formed in residuum from felsic metamorphic or igneous rock on ridges and interfluves on Piedmont uplands. These soils were formerly classified as Rion (thermic).

Stott Knob – Fine-loamy, parasesquic, mesic Typic Hapludults family. The moderately deep to soft bedrock and deep or very deep to hard bedrock, well drained Stott Knob soils formed in residuum from felsic to intermediate metamorphic or igneous rock on hills and ridges of Piedmont uplands. (The Stott Knob series is a mesic Piedmont counterpart of the Cowee series).

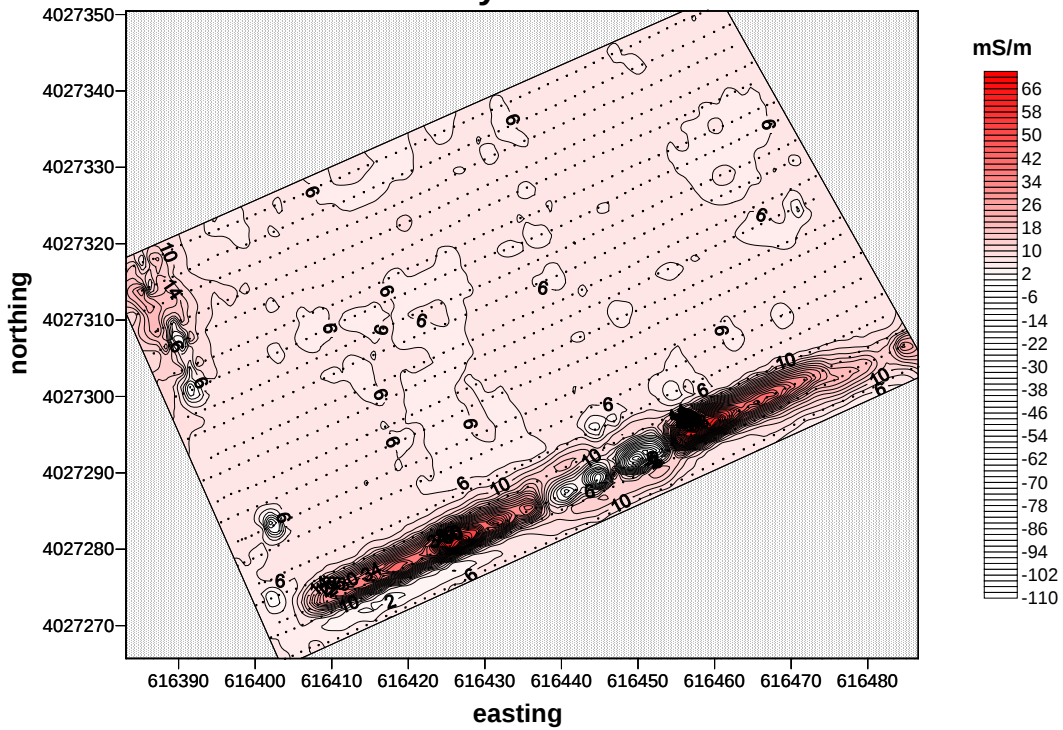
Electromagnetic Induction

Survey Design: 03/2011 Survey

Site 1 (Chinqua Penn Farm site - Casville soils)

A 90m x 50m grid was established across the site (*Figure 1*). Survey procedures were simplified to expedite fieldwork. Two parallel lines (50 m in length) defined the upper and lower boundaries of the survey site. The

Chinqua Penn Farm Site Surveyed 03/2011



Chinqua Penn Farm Site Surveyed 03/2010

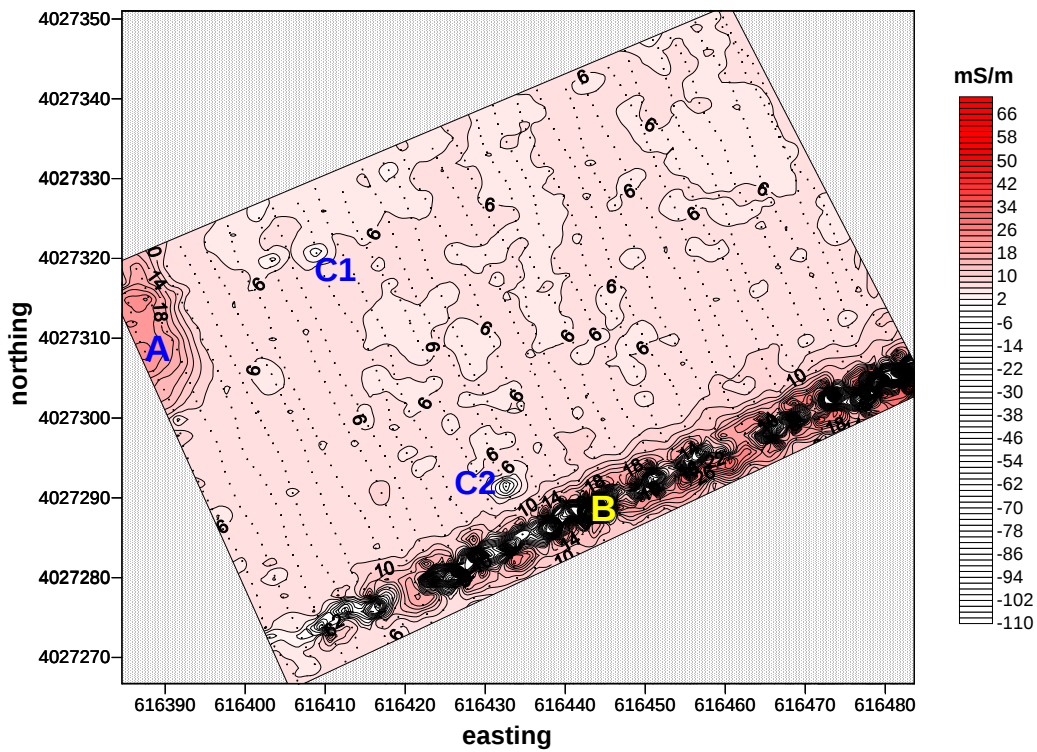


Figure 1 – Apparent conductivity measured with the EM38 meter in an area of Casville (Wedowee) soils. The two comparative EMI surveys were completed approximately 1 year apart and at the same approximate time of the year. The soils are located on 2 to 8 percent slopes. Apparent conductivity values were measured in mS/m (millisiemens/meter).

lines were spaced approximately 90 m apart. An EMI survey was completed by walking at a fairly uniform pace between similarly numbered lines in a back and forth pattern. An interval of approximately 3 m was maintained between each survey line to ensure accuracy. The EM38 meter was carried at a height of approximately 8 cm (3 inches) above the surface and was operated in the continuous mode with measurements recorded at a 1-sec interval. The meter was carried in the vertical dipole orientation. Measurements of apparent conductivity were geo-referenced.

Results: (03/2010)

A total of 1235 measurements were recorded with the EM38 meter. In the vertical dipole orientation apparent conductivity averaged 7.1 mS/m and ranged from -175.4 to 79.4 mS/m. One-half of the observations had an apparent conductivity between 5.9 and 7.6 mS/m.

Results: (03/2011)

A total of 1324 measurements were recorded with the EM38 meter. In the vertical dipole orientation apparent conductivity averaged 8.4 mS/m and ranged from -22.4 to 72.6 mS/m. One-half of the observations had an apparent conductivity between 6.1 and 7.6 mS/m.

Results: (03/2010)

Higher apparent conductivity at “A” was thought to result from contributions and the close proximity to a metal boundary fence. There was also an overlying power transmission line, above this location of the survey area that may have contributed to higher conductivity measurements observed at “A”. The contrasting linear feature observed across the southern portions of the survey area at “B” was attributed to an underlying metal pipe line. The linear feature was verified with soil borings at multiple locations at depths ranging from 35 cm to 50 cm. Anomalous spikes in conductivity at “C1” and “C2” were thought to be attributed to buried metal objects and metal debris.

Changes in spatial patterns of apparent conductivity were thought to be associated with changes in soil characteristics across the survey area. Soils and soil characteristics were thought to be fairly homogenous across the site. Changes in apparent conductivity were relatively small and soil borings taken across the site confirmed relatively small variations in soils and soil characteristics.

Comparison of the two EMI surveys (2010 and 2011):

A comparison of the two EMI surveys resulted in very similar interpretations. Spatial patterns were very similar and apparent conductivity values were very similar. The difference in overall range in apparent conductivity between two surveys was attributed not to differences in soil properties but to the presence and detection of metallic objects across the survey area. The presence of metal characteristically results in extremes in apparent conductivity (both negative and positive) in the EMI surveys. Anomalous features (at “A” - nearby fence and overlying power transmission lines and at “B” - underground metallic pipe) observed in 2010 were observed in the 2011 survey.

Additional Note: Orientation of survey lines

The survey completed in 2010 was conducted in a more north to south orientation and the survey completed in 2011 was conducted in a more east to west orientation across the site. The change in survey line orientation did not change resulting spatial patterns or resulting interpretations at the site, which is encouraging. Resulting spatial patterns were still very similar while comparing surveys from the same site for two different years.

Site 2 (Site located behind the main office - Fairview and Rhodhiss soils)

Survey Design: 03/2011 Survey

An EMI survey was conducted across the site (*Figure 2*). Survey procedures were simplified to expedite fieldwork. The survey area was semi-rectangular in shape. A 40 m x 70 m grid was established across most of the site. Survey procedures were simplified to expedite fieldwork. A smaller portion of the survey area (northern) was also surveyed and included in the overall survey of the area. An EMI survey was completed by walking at a fairly uniform pace between similarly numbered lines in a back and forth

pattern. An interval of approximately 3 m was maintained between each survey line to ensure accuracy. The EM38 meter was carried at a height of approximately 8 cm (3 inches) above the surface and was operated in the continuous mode with measurements recorded at a 1-sec interval. The meter was carried in the vertical dipole orientation. Measurements of apparent conductivity were geo-referenced.

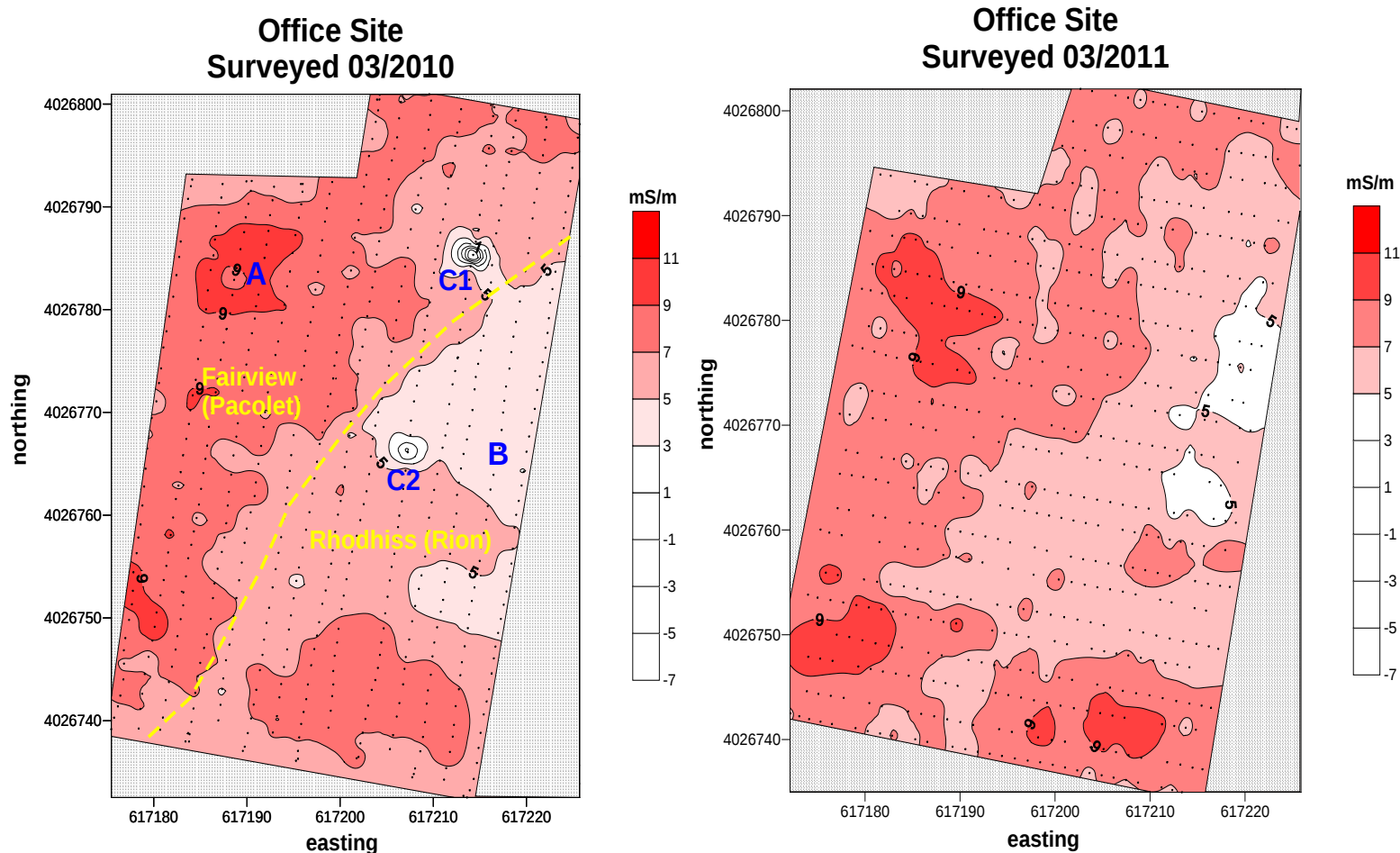


Figure 2 – Apparent conductivity measured with the EM38 meter in an area of Fairview (Pacolet) and Rhodhiss (Rion) soils. The two comparative EMI surveys were completed approximately 1 year apart and at the same approximate time of the year. The soils are located on 2 to 8 percent slopes. Apparent conductivity values were measured in mS/m (millisiemens/meter).

Results: (03/2010)

A total of 587 measurements were recorded with the EM38 meter. In the vertical dipole orientation apparent conductivity averaged 6.5 mS/m and ranged from -12.4 to 10.4 mS/m. One-half of the observations had an apparent conductivity between 5.6 and 7.6 mS/m.

Results: (03/2011)

A total of 582 measurements were recorded with the EM38 meter. In the vertical dipole orientation apparent conductivity averaged 7.2 mS/m and ranged from 2.4 to 10.9 mS/m. One-half of the observations had an apparent conductivity between 6.3 and 8.1 mS/m.

Results: (03/2010)

Changes in apparent conductivity were thought to be associated with changes in soil characteristics across the survey area. Areas of higher apparent conductivity were associated with thicker subsoils containing more clay and moisture. Soil borings at “A” revealed a thicker subsoil containing clay, clay loam and sandy clay loam textures (Fairview soils) with subsoil depths in excess of 100 cm, as compared to soil borings observed at “B”. Soil borings at “B” revealed a thinner sandy clay loam subsoil (Rhodhiss soils)

with saprolite (sandy loam) occurring at 75 cm. A dashed yellow line approximates the soil boundary between Fairview soils (formerly Pacolet soils) and Rhodhiss soils (formerly Rion soils) and is consistent with interpretations from resulting apparent conductivity spatial patterns across the site. Anomalous spikes in conductivity at “C1” and “C2” were thought to be attributed to buried metal objects and metal debris.

Comparison of the two EMI surveys (2010 and 2011):

A comparison of the two EMI surveys resulted in very similar interpretations. Spatial patterns were very similar and apparent conductivity values were very similar. The difference in overall range in apparent conductivity between two surveys (lower extreme values in 2010) was attributed not to differences in soil properties but to the presence and detection of metallic objects across the survey area in the 2010 EMI survey (wire from marker flags and miscellaneous metal debris being detected in the EMI surveys).

Associated changes in spatial patterns across this site (behind office) suggest slightly more diversity in soils and soil characteristics (especially with soil depth) as compared to the Chinqua Penn site (more homogeneous). Soil borings verified this assumption.

Additional Note: Orientation of survey lines

The survey completed in 2010 was conducted in a more north to south orientation and the survey completed in 2011 was conducted in a more east to west orientation across the site. The change in survey line orientation did not change resulting spatial patterns or resulting interpretations at the site, which is encouraging. Resulting spatial patterns were still very similar while comparing surveys from the same site for two different years.

Ground-Penetrating Radar (3-Dimensional)

Survey Setup and Design

Site 1 (Chinqua Penn Farm)

A 82 m x 54 m grid was established. Two parallel lines defined the upper and lower boundaries at each survey site. Each line was 54 m long. The lines were spaced 82 m apart. GPR records were completed by towing the 200 MHz antenna and survey wheel along parallel lines in a back and forth pattern while maintaining a 1 m interval across the entire grid area.

Site 2 (Behind Office)

A 42 m x 54 m grid was established. Two parallel lines defined the upper and lower boundaries at each survey site. Each line was 54 m long. The lines were spaced 42 m apart. GPR records were completed by towing the 200 MHz antenna and survey wheel along parallel lines in a back and forth pattern while maintaining a 1 m interval across the entire grid area. A smaller area adjoining the 42 m x 54 m grid was also surveyed in similar fashion and combined to make one grid area.

Results

Surveys were completed with the 200 MHz and the 400 MHz antenna at the sites. Initial surveys completed with the 400 MHz antenna resulted in higher signal attenuation rates and were of poor interpretative quality. The 200 MHz antenna proved to be a better choice and was selected to complete the surveys at both sites. Radar records obtained with the 200 MHz antenna were generally of good to excellent interpretative quality. Observation depths with the 200 MHz antenna were in excess of 2.5 m. Higher rates of signal attenuation (isolated areas) were thought to be attributed to increased amounts of clay and moisture within the soil profile. Soil borings confirmed an increase in clay and moisture in areas containing higher attenuation rates.

Surveys were completed with the 200 MHz antenna (scanning time of 65 ns). Based on a measured depth (55 cm) to a subsurface reflector, the velocity of propagation through relatively moist sandy loam/sandy clay loam was estimated to be about 0.078 m/ns at site 1 (Chinqua Penn Farm) and 0.081 m/ns at site 2 (behind office) with the 200 MHz antenna. The dielectric permittivity was 14.8 at site 1 (Chinqua Penn Farm) and 13.7 at site 2 (behind office).

Site 1 (Chinqua Penn Farm)

Figure 3 is a 3-D GPR survey completed with the 200 MHz antenna. Areas with higher amplitude signals (areas in red - **A**) were associated with shallower soil profiles underlain with saprolite and/or bedrock (small isolated areas). Shallow depths to quartz bedrock were verified in soil borings at **A**. The higher amplitude signal observed at **B** was attributed to a buried utility line (metal pipe). This anomaly was also apparent in the EMI survey (Figure 1). The EMI survey grid area was slightly larger and extended approximately 3 to 4 meters further in a southwardly direction (lower portions of the grid area). The location and orientation of the underground pipe can be observed to a greater extent in Figure 1. The 3-D survey resulted in a very comprehensive and detailed survey of the site.

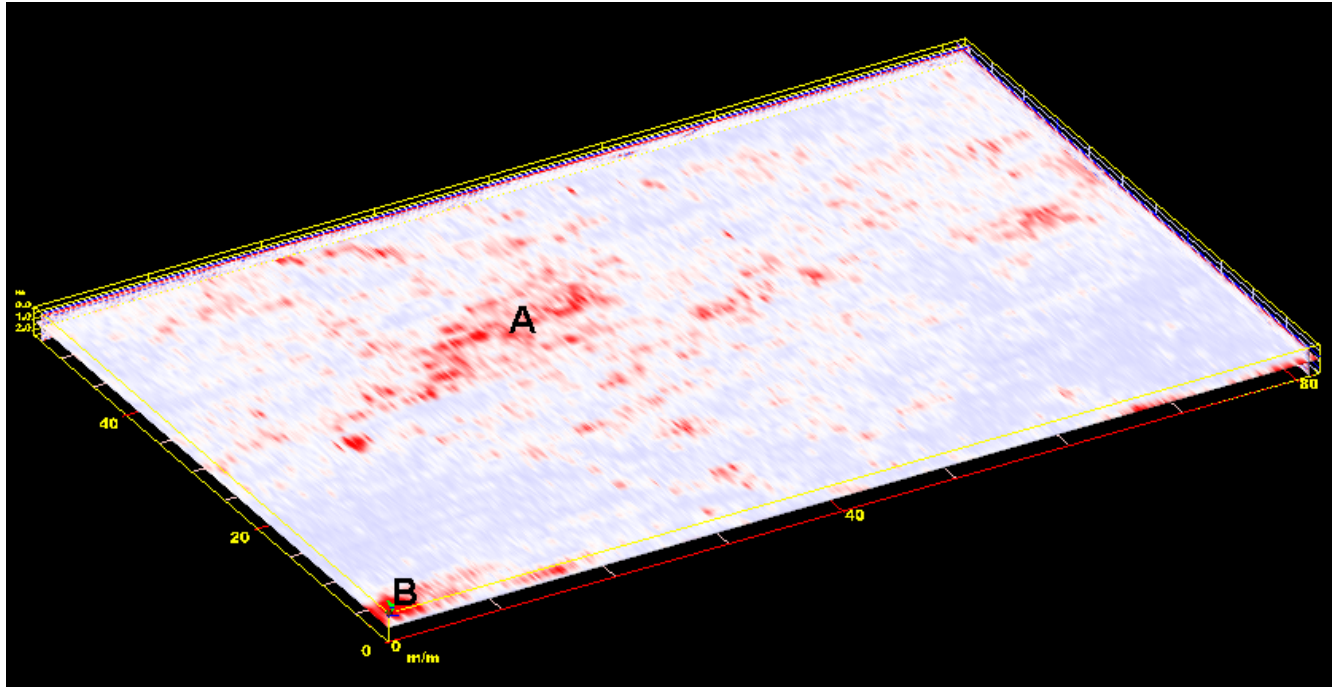


Figure 3. Representative 3-D GPR survey (1.2 m slice) from an area of Casville soils (Chinqua Penn Farm site), measured with the 200 MHz antenna. Scale is in meters.

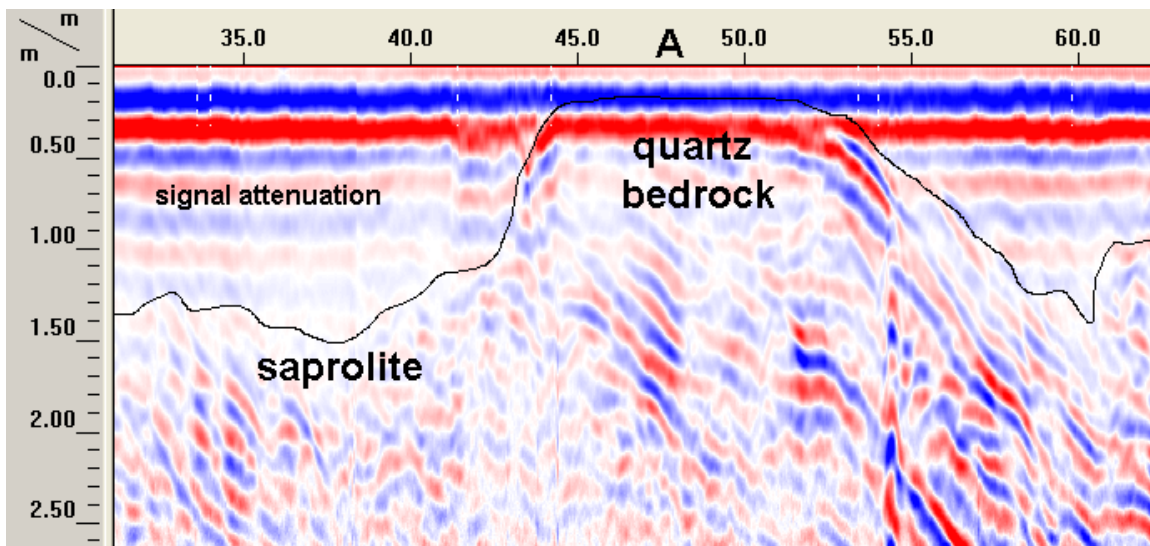


Figure 4. Representative radar record from an area of Casville soils, measured with the 200 MHz antenna. Scale is in meters. Depth scale is exaggerated. This radar record was collected in March, 2010 at site 1 (Chinqua Penn Farm). Point A corresponds with the location of point A in Figure 3.

In *Figure 4*, soil borings at **A** revealed hard quartz bedrock encroaching towards the surface which is consistent with the higher amplitude signal in this portion of the radar record. Bedrock occurred at a depth of 25 cm. A black line highlights the soil/bedrock or saprolite contact.

Site 2 (Behind Office)

Figures 5a and 5b obtained with the 200 MHz antenna are different displays of the same area. Multiple displays often improve interpretations and provide additional information to help with interpretations. Areas in red (as observed in the right-hand portion of the survey area) are associated with shallower soil profiles underlain with soft bedrock and saprolite. Soil borings revealed saprolite and soft bedrock occurring at depths of approximately 50 cm to 90 cm which is consistent with GPR interpreted depth. The 3-D survey resulted in a very comprehensive and detailed survey and suggests the location of the shallower soils across the site.

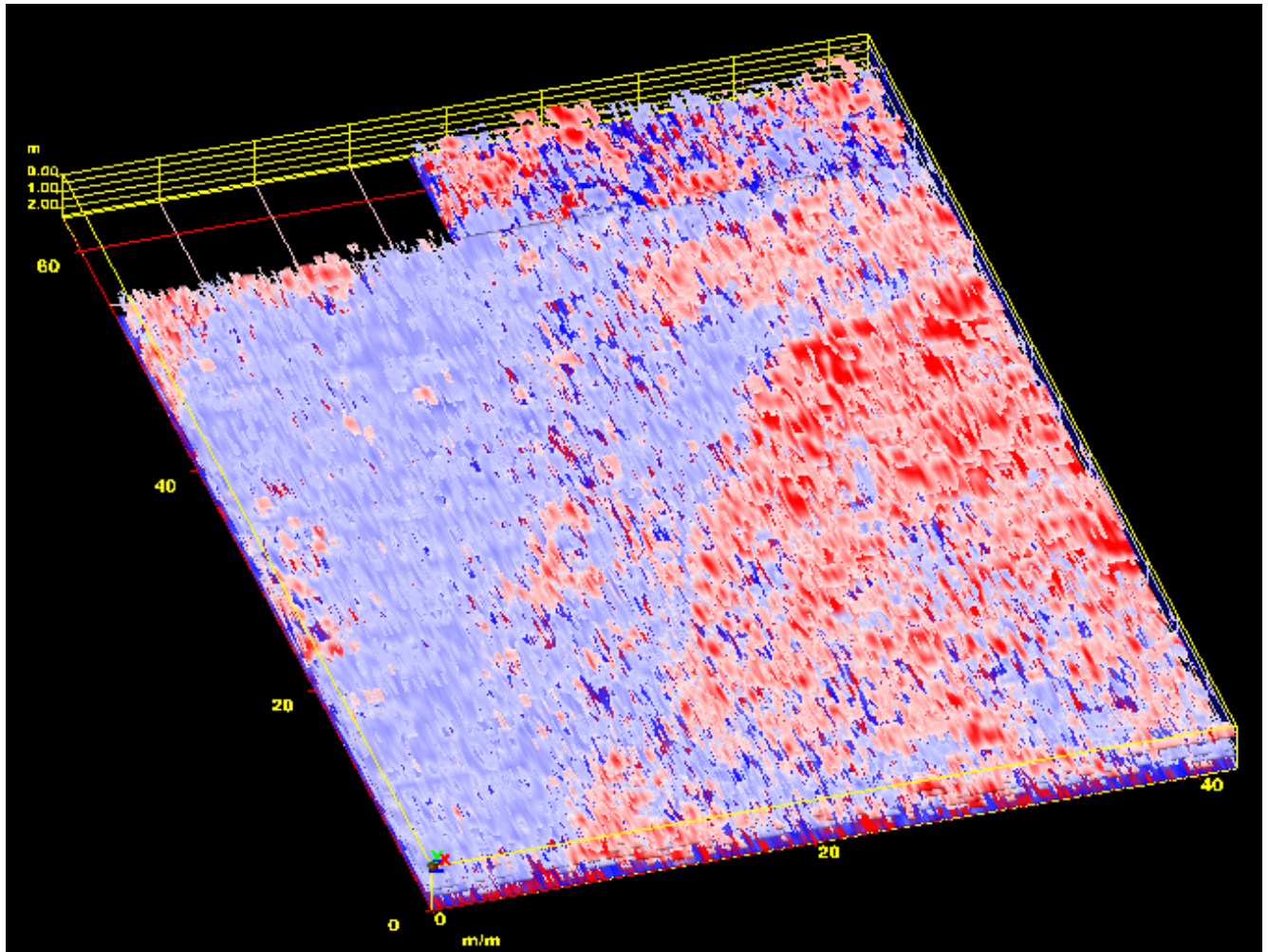


Figure 5a. Representative 3-D GPR survey completed at site 2 (behind office). Areas in red are associated with shallower soils.

When comparing the GPR survey (*Figures 5a and 5b*) with the EMI survey (*Figure 2*) completed across the same grid area, similar interpretations can be gathered. Shallower soils observed in radar records were associated with lower apparent conductivity.

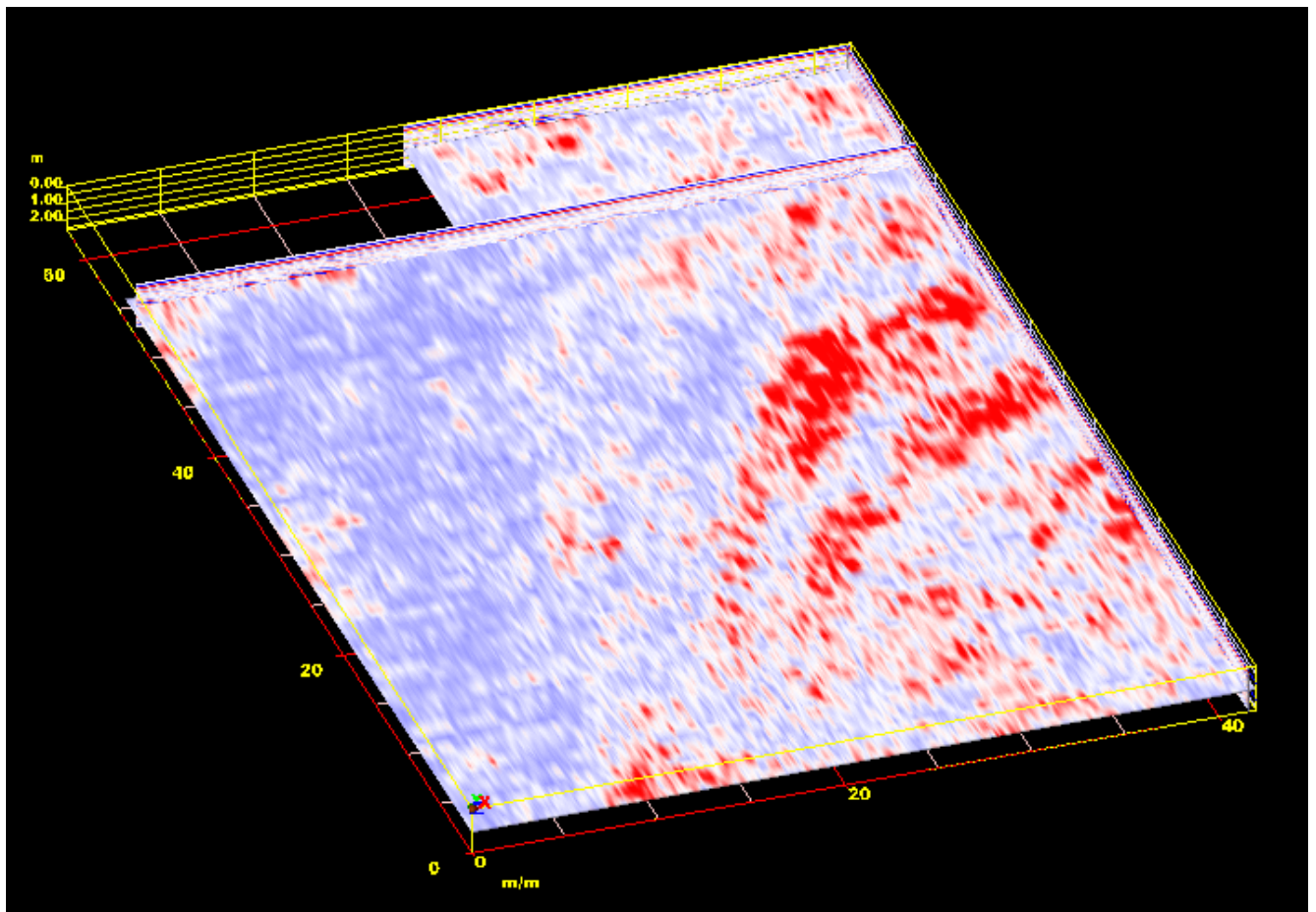


Figure 5b. Representative 3-D GPR survey (1.4 m slice) completed at site 2 (behind office). Areas in red are associated with shallower soils.



Photo 2. GPR surveys were conducted with the 200 MHz antenna across the sites. GPR was used to determine depths to contrasting subsurface features including bedrock, saprolite and buried utility lines.

Summary

After observing 3-D GPR surveys and EMI surveys at both sites, findings in 2011 were similar to findings observed in 2010. There appears to be more variability at site 2 (behind main office) as compared to site 1 (Chinqua Penn Farm) with respects to changes in soils and soil characteristics (especially soil depth). GPR and EMI interpretations were verified with soil borings.

Three-dimensional GPR surveys provided high intensity surveys of the sites and a good visual assessment of underlying subsurface features. The underlying features are going to be compared to productivity and yields at the two sites. The 3-D diagrams contained in this report provide only a small understanding of subsurface features. A follow-up meeting with all collaborative partners is planned in the near future to further review the data from the 3-D surveys using the RADAN software. Additional insight and beneficial information will be gained by all participants involved at the follow-up meeting.

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<http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>