Cornell University
Soil Survey Update

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NECSSC
22-25 May 2006

Outline

- **Pedology Position Update**
- **Diffuse Reflectance Spectroscopy(DRS) Sensing of Soil Properties**
- **Web-based Soil Science Curriculum (*JMR*)**

Faculty
(17fte)

- Soil Biology (2)
- Soil Chemistry (2)
- Soil Fertility (2)
- Soil Physics (2)
- Pedology (0)
- EIS (1)
- Agronomy (1)
- Crop Physiology (3)
- Forage Crops (2)
- Weed Science (2)

Undergraduate Programs

Majors

- Agricultural Science
- Plant Sciences
- Science of Earth Systems (SES)
- Science of Natural & Environmental Systems (SNES)

Minors

- Crop Management
- Soil Science

Landscape Pedology

"…shall focus on advancing our understanding of soil processes and behavior that affect environmental quality at variable scales of space, time, and complexity; developing advanced quantitative methods of soil survey, land evaluation, and management; and characterizing soil environments using spatial information technologies, simulation modeling, spatial statistics, and remote sensing…"

"…undergraduate courses in introductory soil science and soil genesis and morphology, including leadership of regional and national soil judging competitions; and graduate courses and seminars in soil taxonomy, soil information systems, and pedology..."

"…serving as soil survey program leader and Cornell University Agricultural Experiment Station representative to the National Cooperative Soil Survey…"

Soil Resource Inventory and Information Systems

1) Develop and evaluate methods for updating and converting soil resource inventories for environmental modeling and spatial decision support programs.

2) Develop and test methods for hyperspectral sensing of soil chemical and physical properties in support of soil classification and survey.

3) Develop scientific visualization tools for conveying relevant soil data, information, and knowledge to stakeholders.

Funding: USDA-CSREES Federal Formula Funds (FFF-Hatch)
Three years @ $25,000 10/03 – 9/06 (10/06 - 9/09, pending)

Hyperspectral Sensing of Soil Chemical and Physical Properties in Support of Classification and Survey

(1) Characterize the hyperspectral response of selected soil properties that are important to soil survey

(2) Assess quality of hyperspectral data collected *in situ* as an aid to field-based soil survey operations.

(3) Compare the quality and usefulness of hyperspectral data collected using laboratory- and field-based methods for soil classification and survey

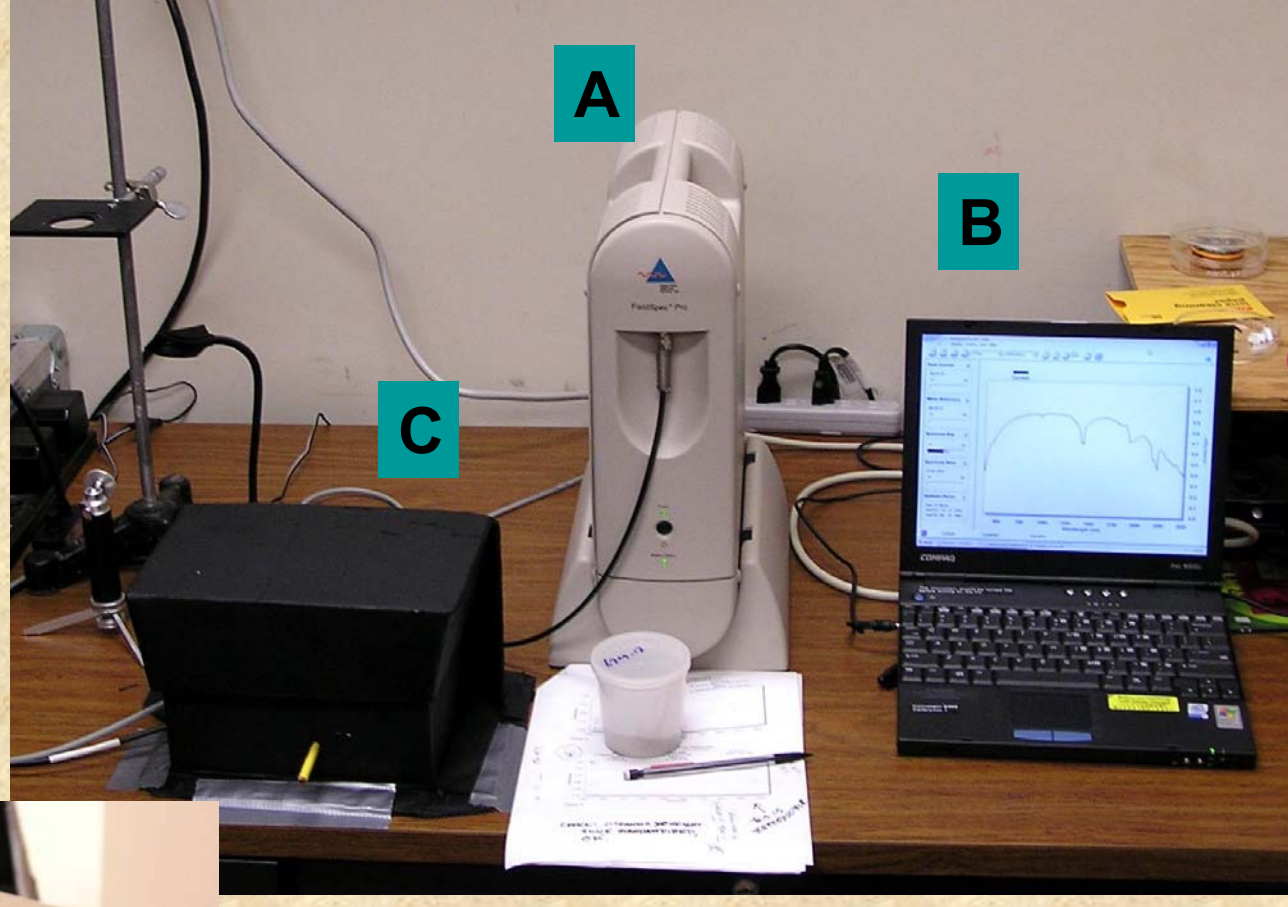
(4) Compare analytical laboratory data processed by Cornell and NSSC as possible alternatives, or complementary facilities, for soil characterization and inventory.

Spectrometer set-up used for reflectance measurements:

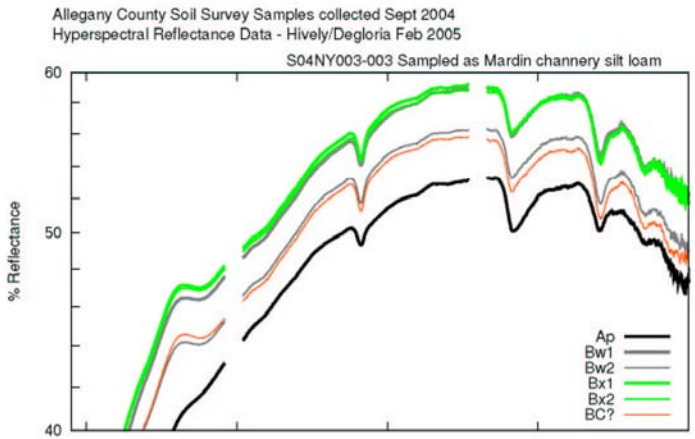
A) ASD Field Spec Pro

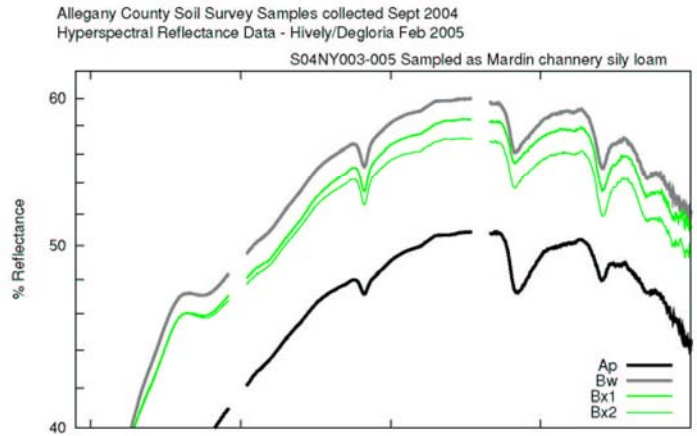
B) Laptop computer

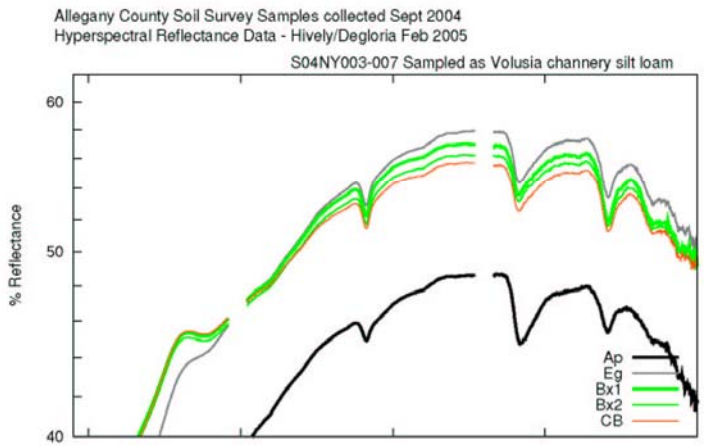
C) Box to shield light source and sample from ambient light,

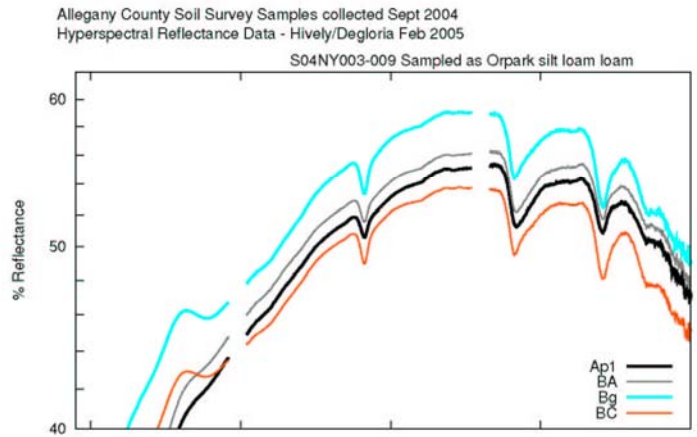


D) Mount to hold 50-mm diameter Petri dishes a fixed distance from optic fiber sensor; optic fiber containing light source is shown at lower left port of barrel.

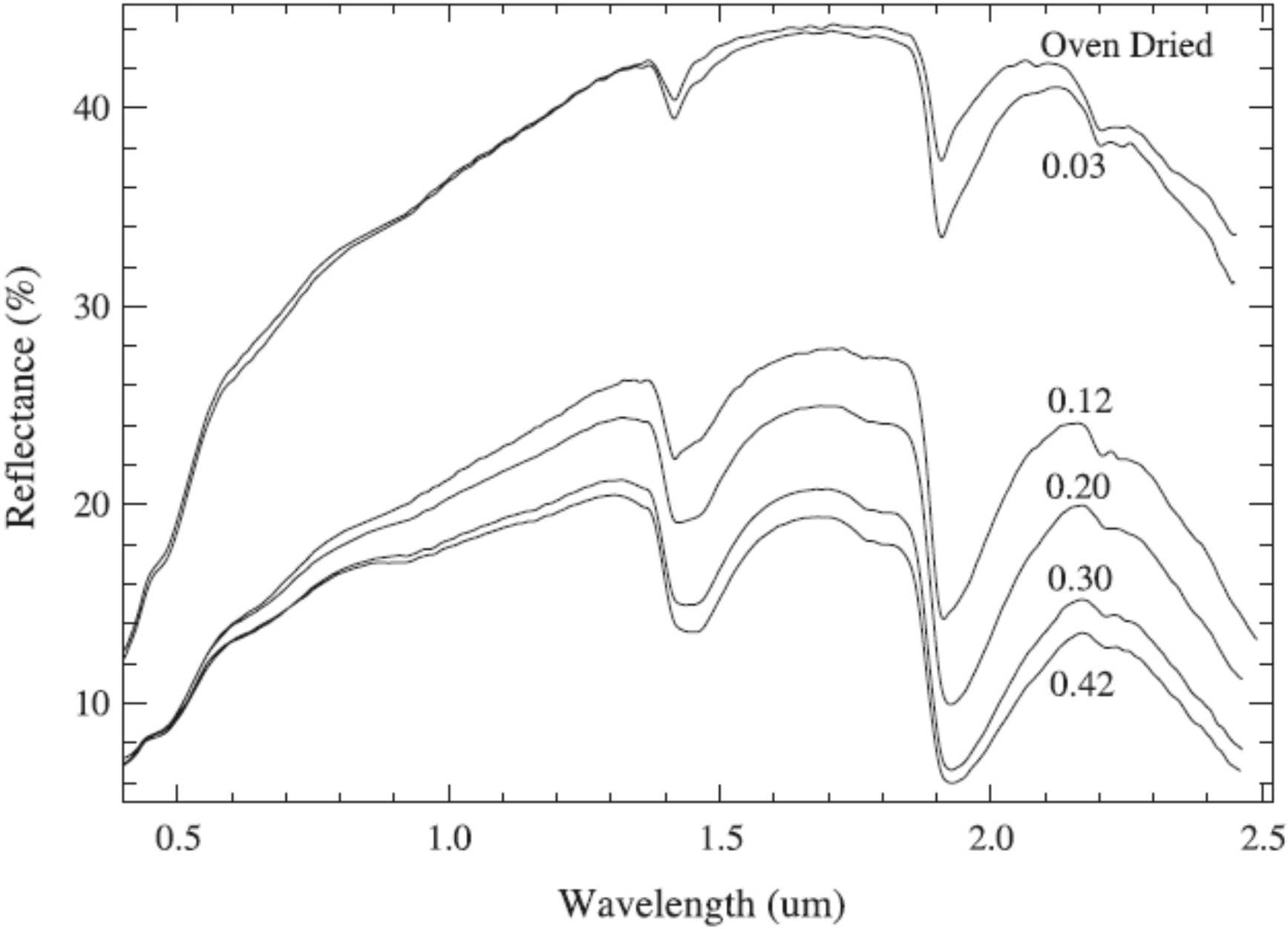

Allegany County Soil Survey Samples collected Sept 2004
Hyperspectral Reflectance Data - Hively/Degloria Feb 2005
S04NY003-003 Sampled as Mardin channery silt loam
% Reflectance
60
50
40
Ap
Bw1
Bw2
Bx1
Bx2
BC?

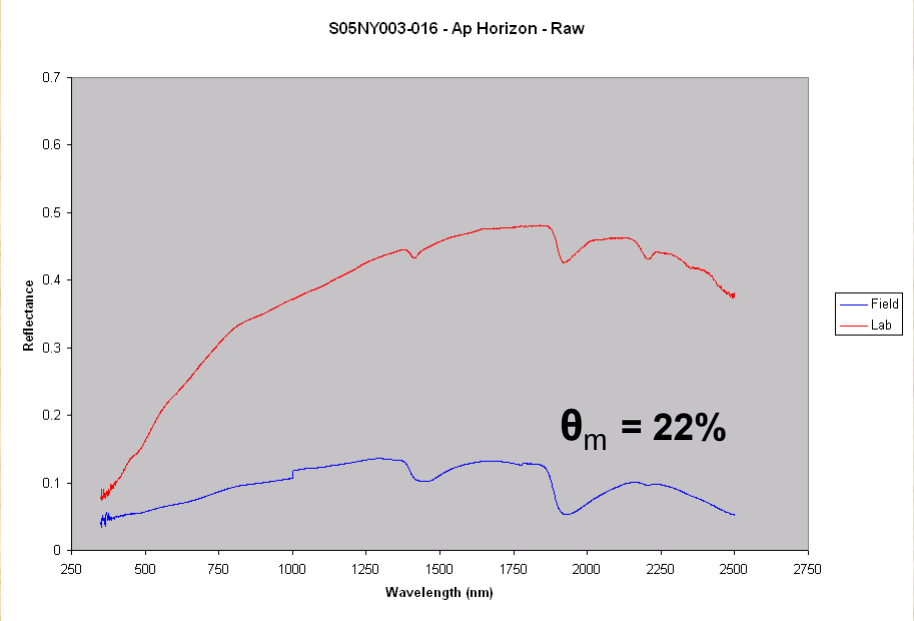

Allegany County Soil Survey Samples collected Sept 2004
Hyperspectral Reflectance Data - Hively/Degloria Feb 2005
S04NY003-005 Sampled as Mardin channery sily loam
% Reflectance
60
50
40
Ap
Bw
Bx1
Bx2

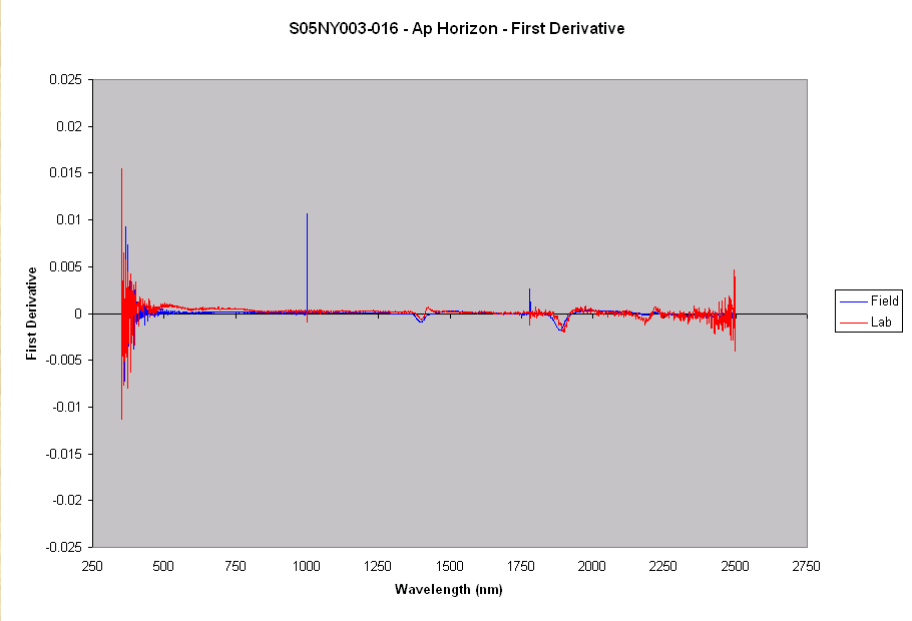

Allegany County Soil Survey Samples collected Sept 2004
Hyperspectral Reflectance Data - Hively/Degloria Feb 2005
S04NY003-007 Sampled as Volusia channery silt loam
% Reflectance
60
50
40
Ap
Eg
Bx1
Bx2
CB


Allegany County Soil Survey Samples collected Sept 2004
Hyperspectral Reflectance Data - Hively/Degloria Feb 2005
S04NY003-009 Sampled as Orpark silt loam loam
% Reflectance
60
50
40
Ap1
BA
Bg
BC

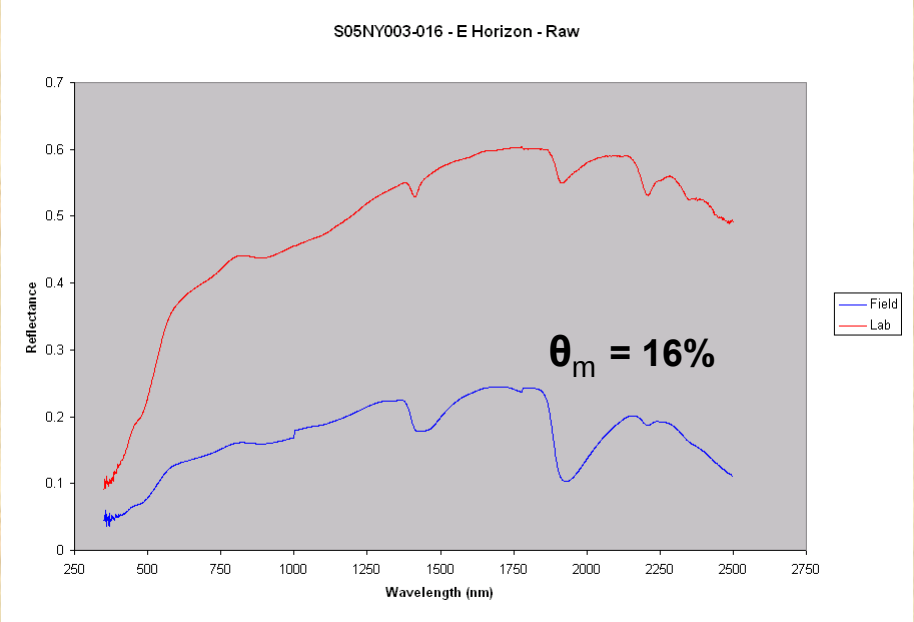
M.L. Whiting et al. / Remote Sensing of Environment 89 (2004) 535–552

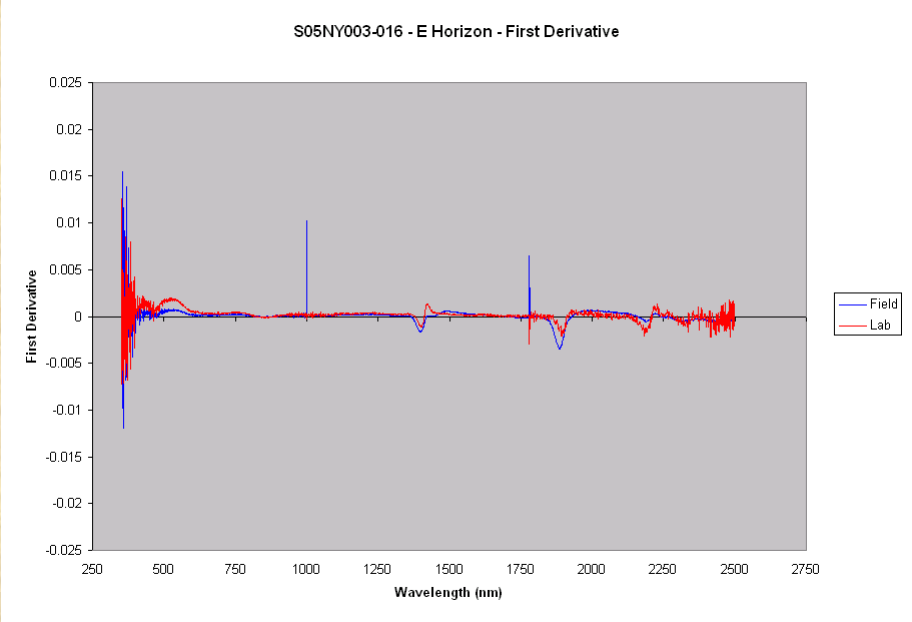






Raw (left) and first derivative (right) spectra for the Napoli Ap horizon.





Raw (left) and first derivative (right) spectra for the Napoli E horizon.

Data Modeling

- Partial Least Squares 1 (PLS1) regression for correlation with soil properties
- Principal Components Analysis for spectral discrimination of soil samples

Allegany Co. - **Lab**

Property	**Correlation** (Cal, Val)
% N	0.98, 0.96
% C	0.99, 0.98
% Clay	0.88, 0.72

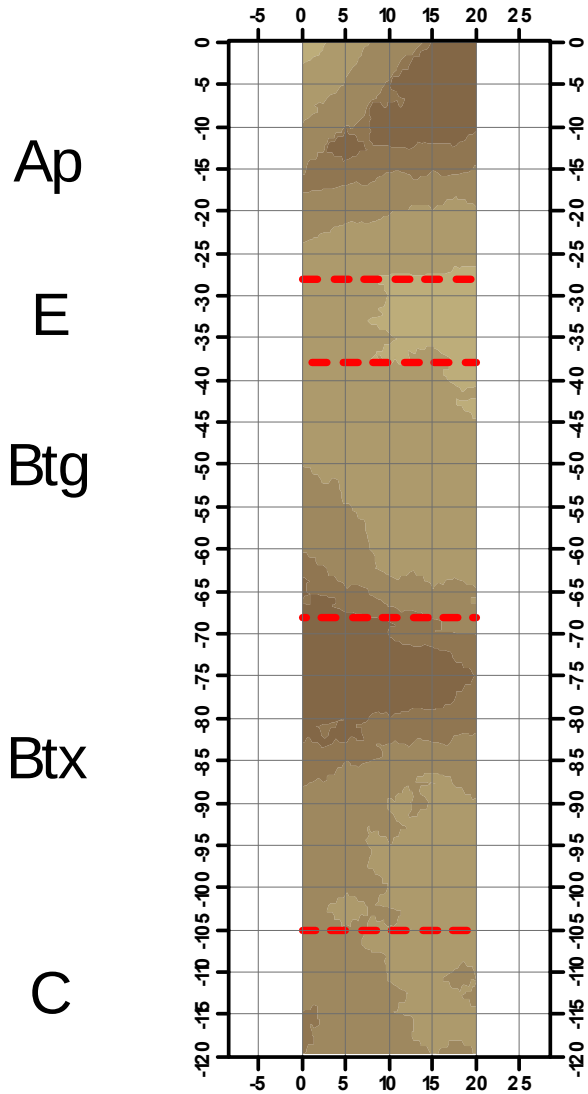
Allegany Co. - **Field**

Property	**Correlation** (Cal, Val)
% N	0.95, 0.86
% C	1.00, 0.95
% OM LOI	1.00, 0.93
pH	0.99, 0.41
% Clay	0.99, 0.72

Ontario Co. - **Field**

Property	**Correlation** (Cal, Val)
% N	0.95, 0.68
% C	0.59, 0.38
% Clay	0.58, 0.35

SO5NY003-016 - % Clay

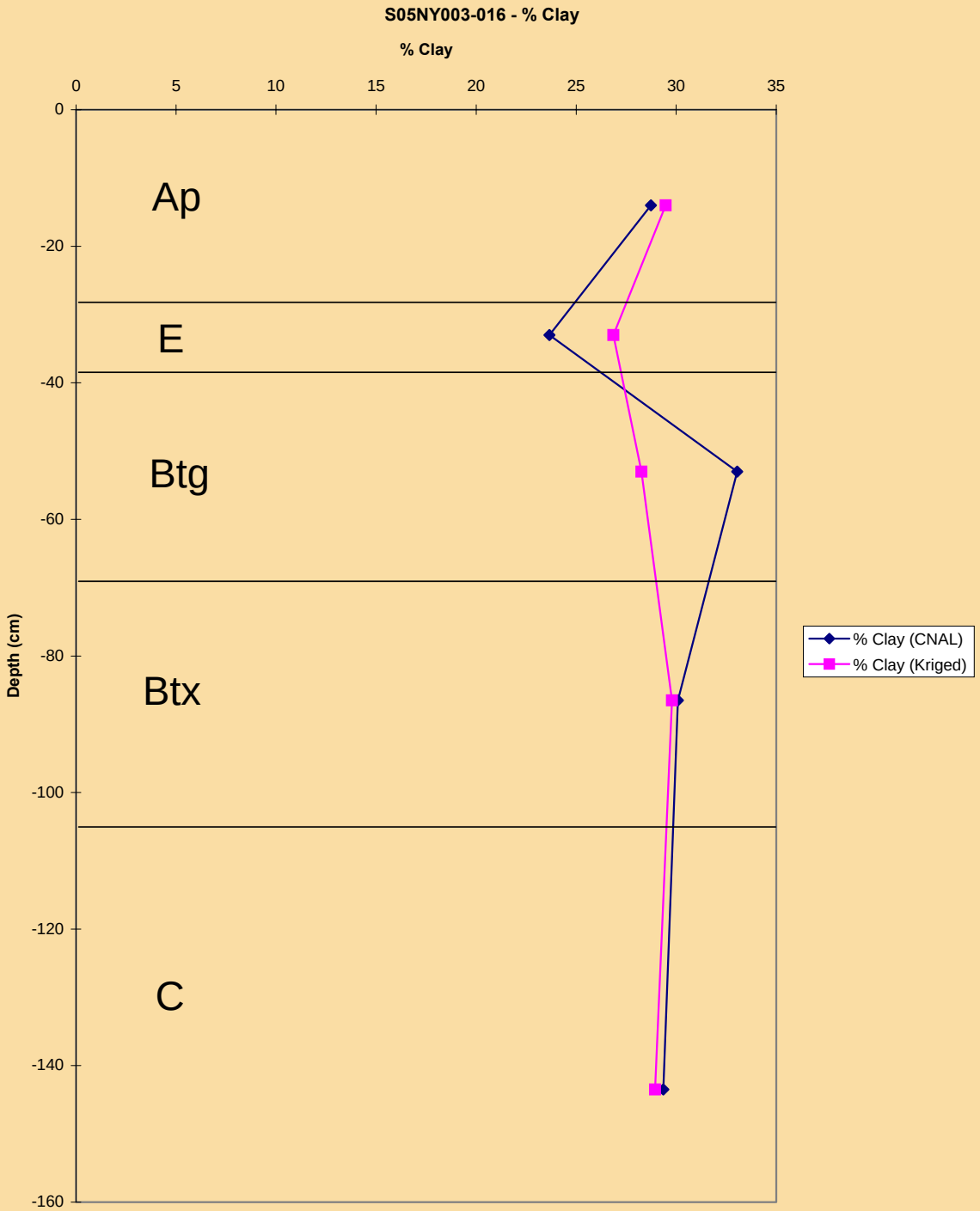


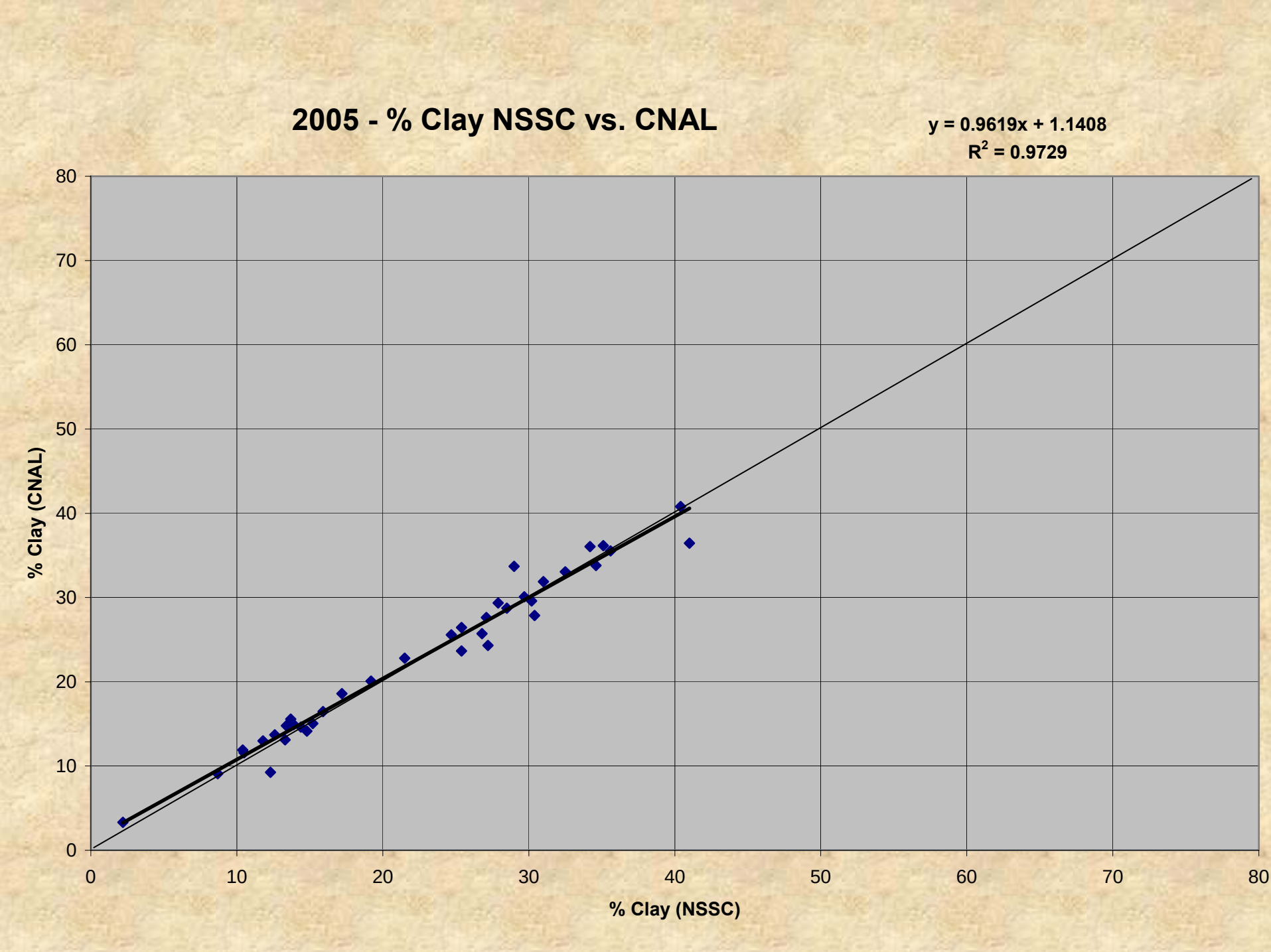
Legend

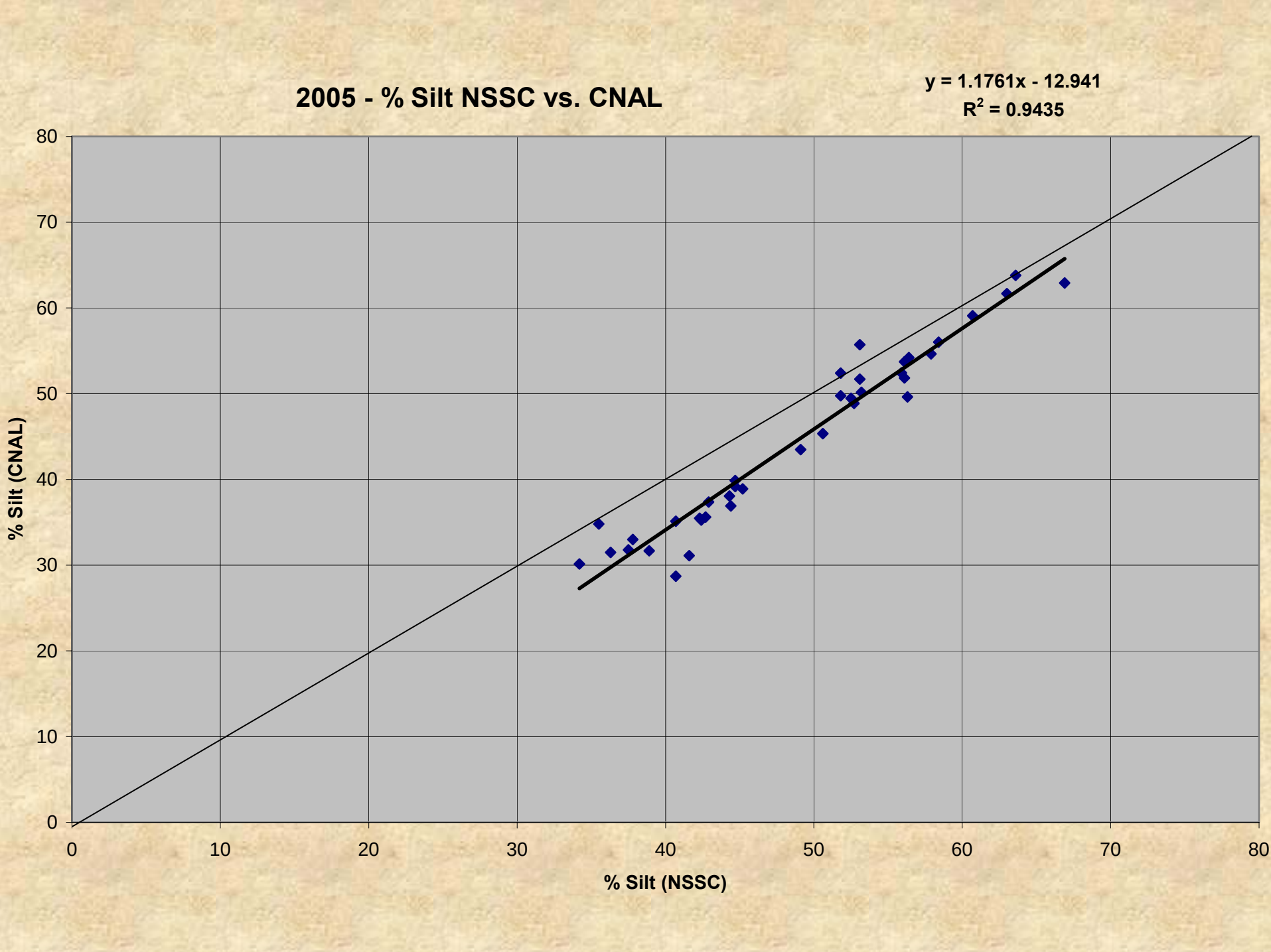
Ordinary Kriging - % Clay

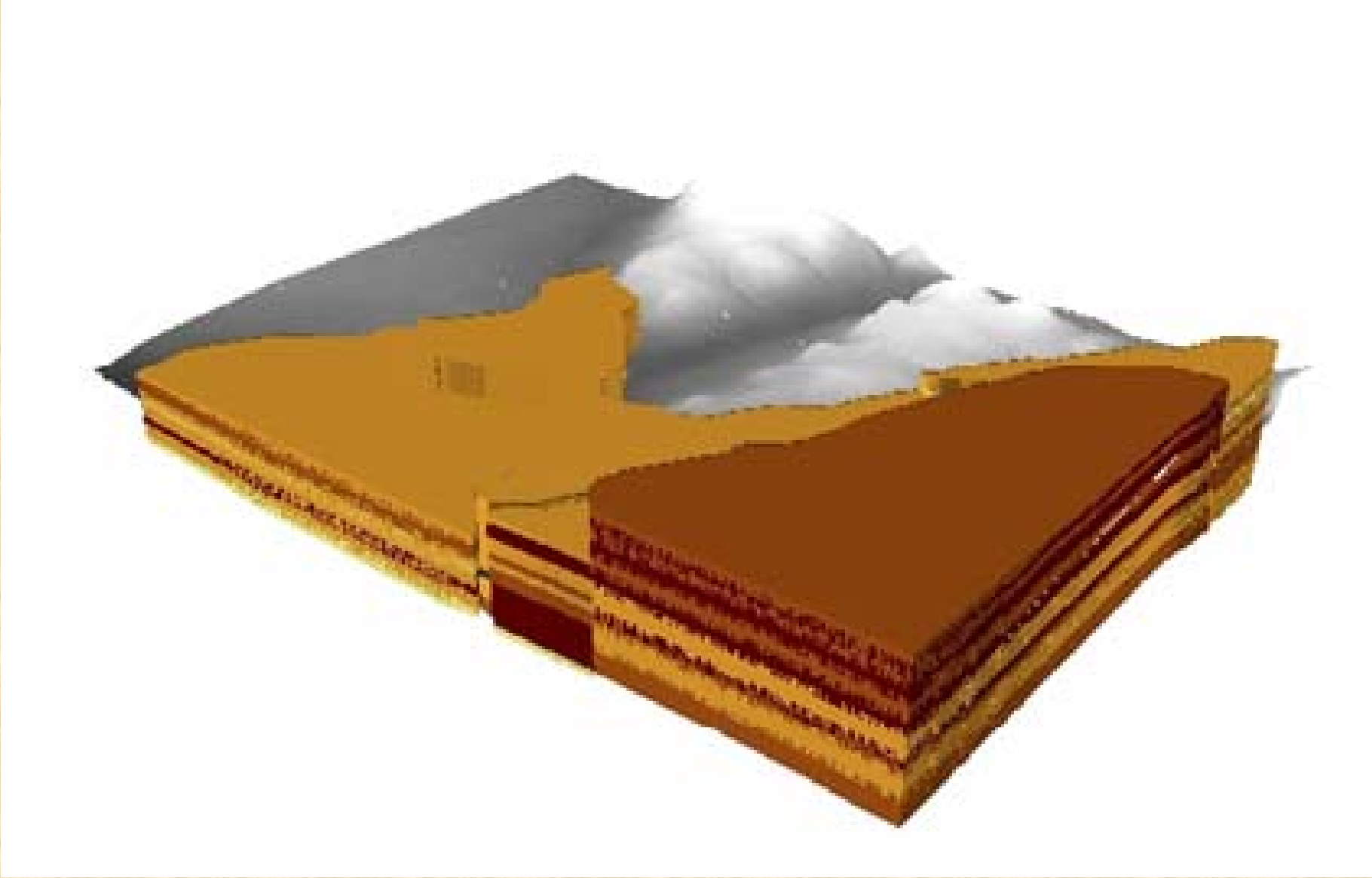
- 0.00 - 11.59
- 11.59 - 19.01
- 19.01 - 23.76
- 23.76 - 26.81
- 26.81 - 28.75
- 28.75 - 30.00
- 30.00 - 30.80
- 30.80 - 32.05
- 32.05 - 34.00
- 34.00 - 37.04
- Horizon Boundaries

Grid values are in cm.


S05NY003-016 - % Clay
% Clay
0
5
10
15
20
25
30
35
0
-20
-40
-60
-80
-100
-120
-140
-160
Depth (cm)
Ap
E
Btg
Btx
C
% Clay (CNAL)
% Clay (Kriged)


2005 - % Clay NSSC vs. CNAL
y = 0.9619x + 1.1408
R2 = 0.9729
% Clay (CNAL)
% Clay (NSSC)
0
10
20
30
40
50
60
70
80


2005 - % Silt NSSC vs. CNAL
y = 1.1761x - 12.941
R2 = 0.9435
% Silt (CNAL)
% Silt (NSSC)
0
10
20
30
40
50
60
70
80



Soil landscape block diagram illustrating integration and visualization of soil geographic and attribute data superimposed on a digital elevation model (Courtesy of A. Lembo, Cornell University).

Questions?/Discussion

Objectives

- Characterize the hyperspectral response of selected soil chemical and physical properties that are important to soil survey
- Assess quality of hyperspectral data collected *in situ* as an aid to field-based soil survey operations
- Compare the quality and usefulness of hyperspectral data collected using laboratory- and field-based methods for soil classification and survey

Listing of pedons and horizons sampled September 2004 and September 2005 for Allegany County and October 2005 for Ontario County, including horizon designation and depth intervals.

Alleghany County Soil Samples (27)
Collected September 2004 by Soil Survey (Matt Havens)
Processed by DeGloria, Hively/Shindelbeck, Neafsey, CNAL
CNAL Field # 18937

CNAL Sample #	Pedon code	Horizons	Top	Bottom
			cm	cm
	S04NY003-003	Sampled as Mardin channery silt loam		
1	S04NY003-003	Ap	0	32
2	S04NY003-003	Bw1	32	40
3	S04NY003-003	Bw2	40	56
4	S04NY003-003	Bx1	56	89
5	S04NY003-003	Bx2	89	130
6	S04NY003-003	Bc?	130	182
	S04NY003-004	Sampled as Rushford taxajunct		
7	S04NY003-004	Ap	0	30
8	S04NY003-004	Bw1	30	46
9	S04NY003-004	Bw2	46	61
10	S04NY003-004	B/C	61	183
	S04NY003-005	Sampled as Mardin channery silt loam		
11	S04NY003-005	Ap	0	25
12	S04NY003-005	Bw	25	51
13	S04NY003-005	Bx1	51	79
14	S04NY003-005	Bx2	79	152
	S04NY003-007	Sampled as Volusia channery silt loam		
15	S04NY003-007	Ap	0	31
16	S04NY003-007	Eg	31	40
17	S04NY003-007	Bx1	40	63
18	S04NY003-007	Bx2	63	127
19	S04NY003-007	CB	127	183
	S04NY003-008	Sampled as Towerville silt loam		
20	S04NY003-008	Ap	0	31
21	S04NY003-008	Bw1	31	48
22	S04NY003-008	Bw2	48	64
23	S04NY003-008	Bw3	64	89
	S04NY003-009	Sampled as Orpark silt loam		
24	S04NY003-009	Ap1	0	13
25	S04NY003-009	BA	13	25
26	S04NY003-009	Bg	25	57
27	S04NY003-009	BC	57	89

Alleghany County Soil Samples (17)
Collected September 2005 by Soil Survey (Matt Havens)
Processed by DeGloria, Neafsey, CNAL
CNAL Field #?????

CNAL Sample #	Pedon code	Horizons	Top	Bottom
			cm	cm
	S05NY003-016	Sampled as Napoli silt loam		
1	S05NY003-016	Ap	0	28
2	S05NY003-016	E	28	38
3	S05NY003-016	Btg	38	68
4	S05NY003-016	Btx	68	105
5	S05NY003-016	C	105	
	S05NY003-018	Sampled as Hornellsville silt loam		
6	S05NY003-018	Ap	0	22
7	S05NY003-018	Eg	22	33
8	S05NY003-018	Bg	33	59
9	S05NY003-018	2Cr	59	132
ns	S05NY003-018	R	132	
	S05NY003-019	Sampled as Hornellsville taxajunct		
10	S05NY003-019	Ap	0	21
11	S05NY003-019	Btg	21	51
12	S05NY003-019	BC	51	79
ns	S05NY003-019	2Cr	79	97
ns	S05NY003-019	2R	97	
	S05NY003-020	Sampled as Napoli silt loam		
13	S05NY003-020	Ap	0	23
14	S05NY003-020	Eg1	23	31
15	S05NY003-020	Eg2	31	48
16	S05NY003-020	Btg	48	66
17	S05NY003-020	Btx	66	94
ns	S05NY003-020	C	94	183

Mount Pleasant Soil Samples (n=10)
Collected 14 October 2005 by CSS (DeGloria/Neafsey)
Processed by DeGloria, Neafsey, CNAL
CNAL Field # ?????

CNAL Sample #	Pedon code	Horizons	Top	Bottom
			cm	cm
	MP051014F	Sampled as Mardin (Forested site)		
1	MP051014F	A	0	20
2	MP051014F	Bw	20	33
3	MP051014F	E	33	48
4	MP051014F	Bx1	48	66
5	MP051014F	Bx2	66	107
ns	MP051014F	Cd	107	183
	MP051014A	Sampled as Mardin (Agricultural site)		
6	MP051014A	Ap	0	20
7	MP051014A	Bw	20	33
8	MP051014A	E	33	48
9	MP051014A	Bx1	48	66
10	MP051014A	Bx2	66	107
ns	MP051014A	Cd	107	183

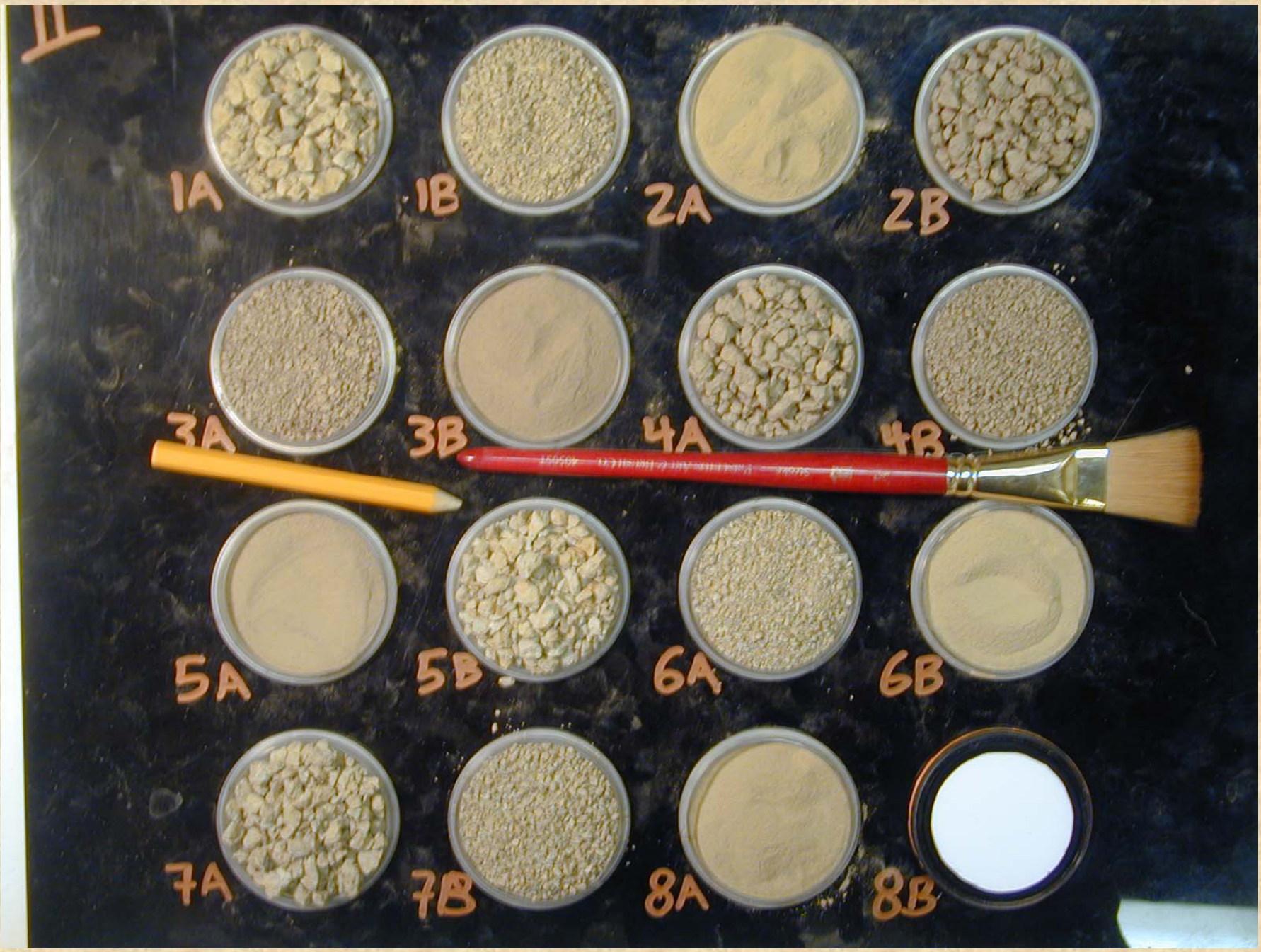
Ontario/Yates County Soil Samples (n=30)
Collected October 2005 by Soil Survey (Steve Antes)
Processed by DeGloria, Neafsey, CNAL
CNAL Field # ?????

CNAL Sample #	Pedon code	Horizons	Top	Bottom
			cm	cm
	S05NY069-005	Sampled as Honeoye fine sandy loam		
1	S05NY069-005	Ap	0	23
2	S05NY069-005	Bt/E	23	33
3	S05NY069-005	Bt	33	51
4	S05NY069-005	C1	51	165
5	S05NY069-005	C2	165	203
	S05NY069-006	Sampled as Lima silt loam		
6	S05NY069-006	Ap	0	25
7	S05NY069-006	Bt/E	25	36
8	S05NY069-006	Bt/E	36	51
9	S05NY069-006	BC	51	66
10	S05NY069-006	C	66	153
	S05NY069-007	Sampled as Kendaia silt loam		
11	S05NY069-007	Ap	0	30
12	S05NY069-007	Bw	30	40
13	S05NY069-007	Bg	40	58
14	S05NY069-007	BCg	58	86
15	S05NY069-007	C	86	183
	S05NY069-008	Sampled as Honeoye fine sandy loam		
16	S05NY069-008	Ap	0	25
17	S05NY069-008	Bt/E	25	48
18	S05NY069-008	Bt	48	66
19	S05NY069-008	C1	66	102
20	S05NY069-008	C2	102	153
	S05NY069-009	Sampled as Honeoye silt loam		
21	S05NY069-009	Ap	0	25
22	S05NY069-009	Bt/E	25	38
23	S05NY069-009	Bt	38	53
24	S05NY069-009	C1	53	84
25	S05NY069-009	C2	84	183
	S05NY069-010	Sampled as Honeoye silt loam, eroded		
26	S05NY069-010	Ap1	0	23
27	S05NY069-010	Bt	23	48
28	S05NY069-010	BC	48	74
29	S05NY069-010	C1	74	104
30	S05NY069-010	C2	104	153

2005 Field Sampling

- ***In situ* measurements:**

  (3 pedons Allegany County Survey (ASC Farm); 2 pedons Ontario C.)
  - **Three readings/horizon (10 scans/reading) for three pedons**
  - **Unaligned 5 cm x 5cm grid sample: array 125 cm x 25cm (n= 125 readings; 5 scans/reading); one pedon**
- **Laboratory measurements: 4 pedons Allegany; 6 pedons Ontario**
  - **Chemical, physical properties**
  - **Hyperspectral scans: <2mm fraction**
  - **Gravimetric moisture content (composite samples by horizon)**
- **Alternate *in situ* measurements:**
  - **Sensor placement (fn: distance from surface)**
  - **Sensor orientation (single angle v. 90° rotation)**
  - **Land use: field v. forest; Mt. Pleasant CSS 260 Mardin pits (7 Oct 05)**

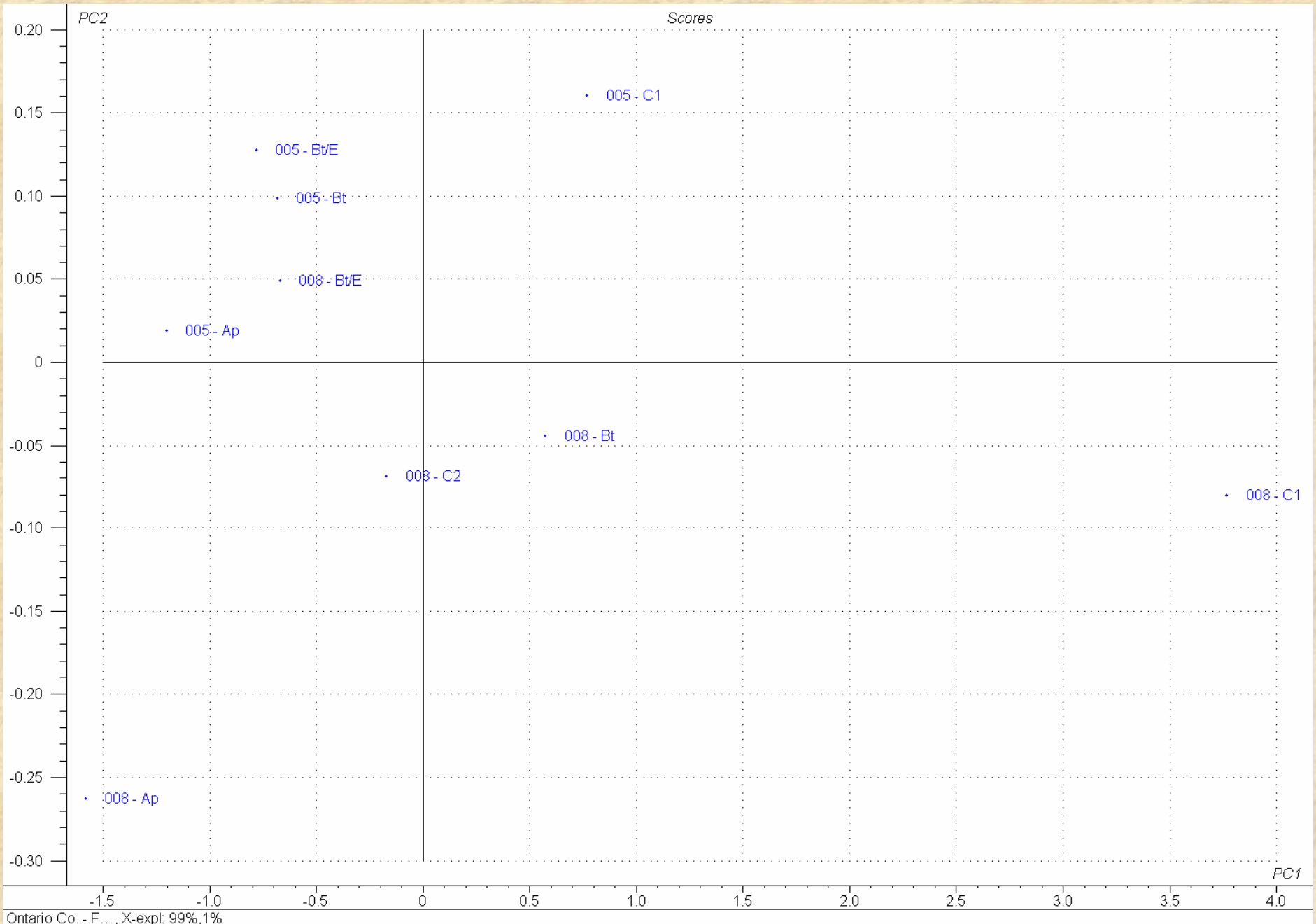


Sieved soil samples prepared for scanning (2004 samples).

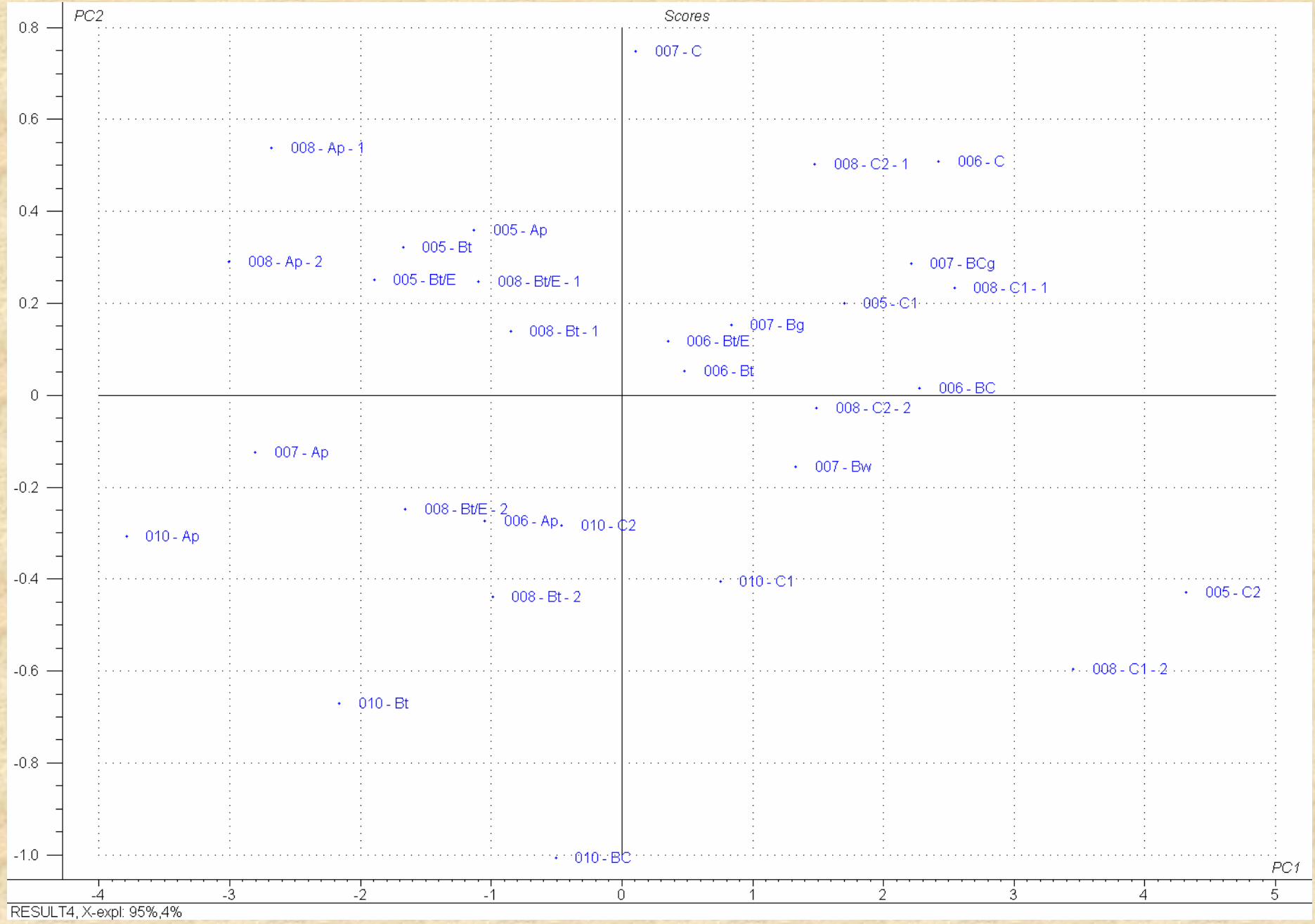
Allegany Co. - **Lab**

Allegany Co. - **Field**

Ontario Co. - **Field**



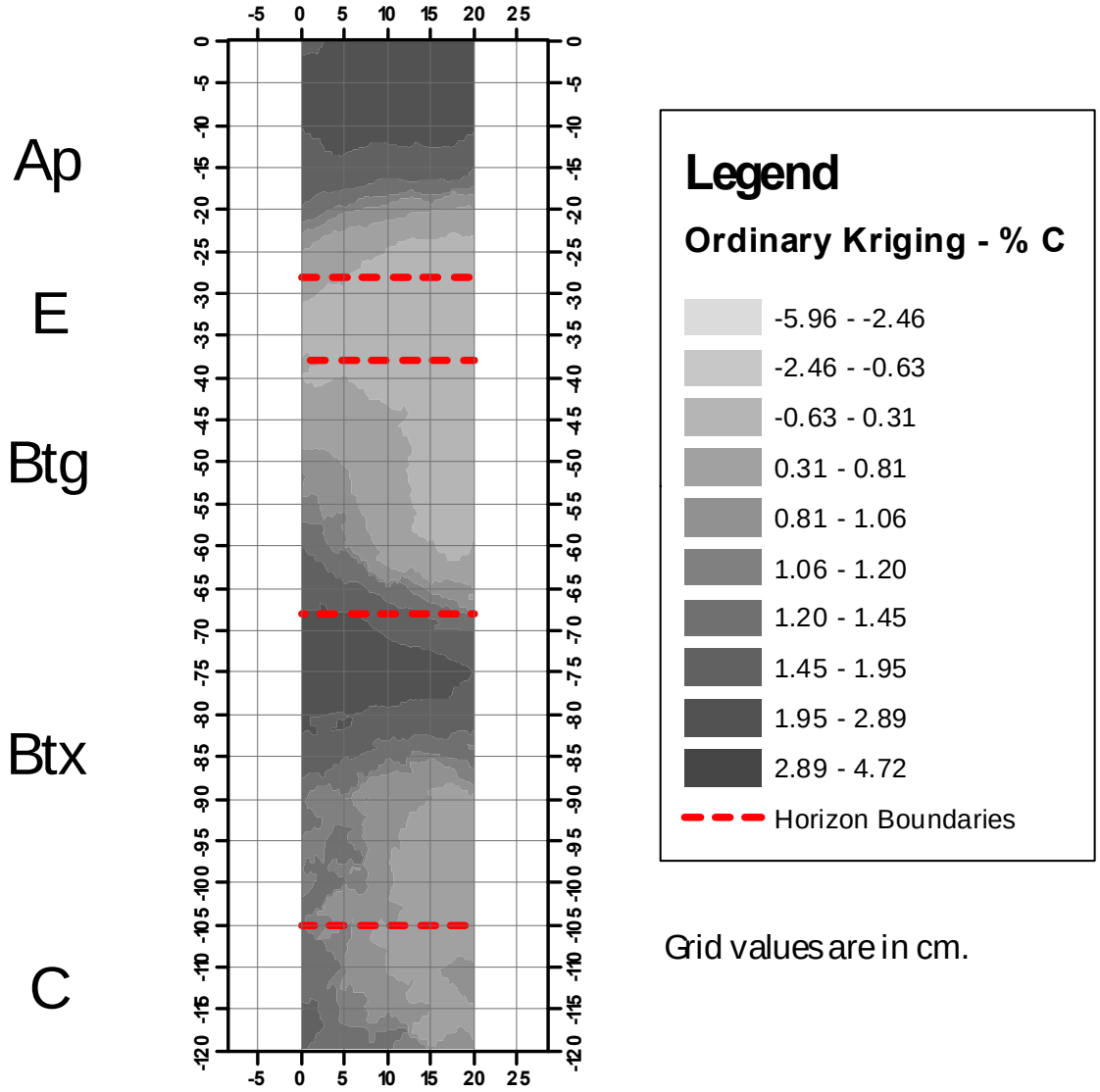
Ontario Co. - **Lab**

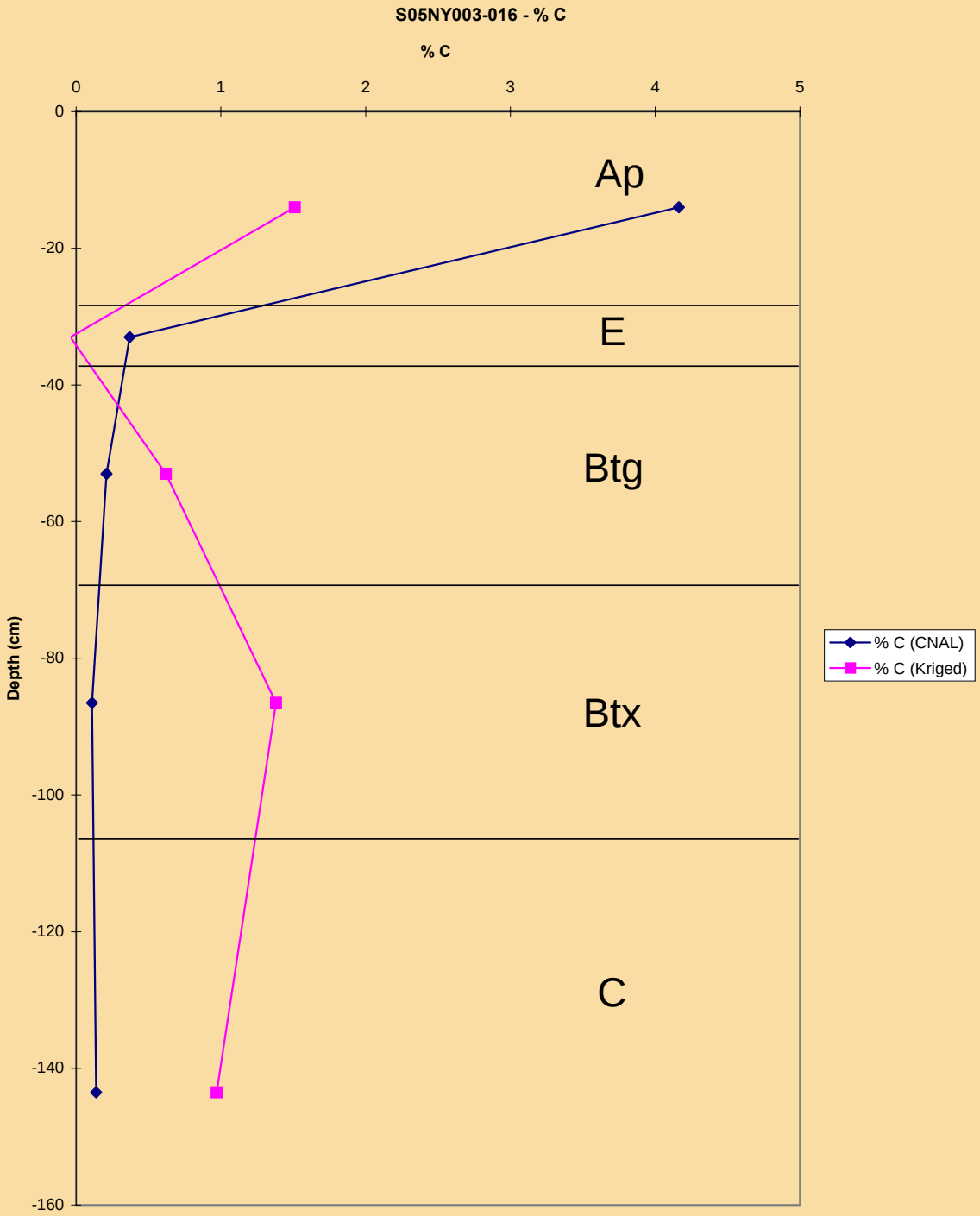


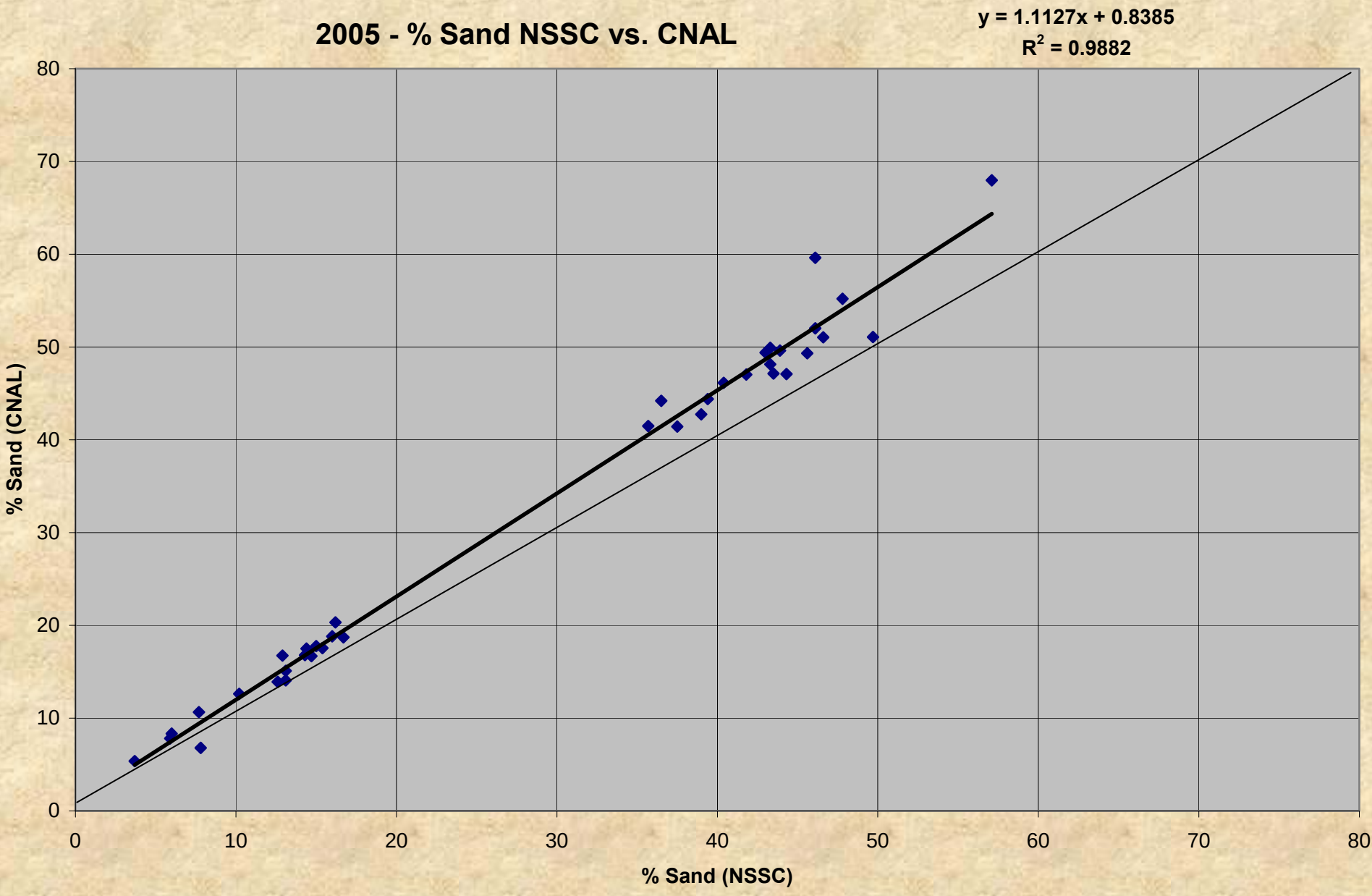
Ontario Co. - **Lab**

Property	**Correlation** (Cal, Val)
% N	0.99, 0.94
% C	0.99, 0.94
% Clay	0.94, 0.91

SO5NY003-016 - % C




S05NY003-016 - % C
% C
0
1
2
3
4
5
0
-20
-40
-60
-80
-100
-120
-140
-160
Depth (cm)
Ap
E
Btg
Btx
C
% C (CNAL)
% C (Kriged)


2005 - % Sand NSSC vs. CNAL
y = 1.1127x + 0.8385
R2 = 0.9882
% Sand (CNAL)
% Sand (NSSC)
0
10
20
30
40
50
60
70
80