Geochemical Properties of Weathered Soils and the Underlying Overburden of the Pottsville Group in Central Appalachia

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VirginiaTech Crop & Soil Environmental Sciences

Parameter†	Treatment†		
	BROWN	GRAY	MIXED
pH			
2005	6.0 ± 0.1	8.1 ± 0.1	8.3 ± 0.1
2006	6.2 ± 0.2	8.6 ± 0.1	8.4 ± 0.1
2007	6.6 ± 0.2	8.6 ± 0.1	8.5 ± 0.1
Mean ± SE	6.3 ± 0.1b‡	8.4 ± 0.1a	8.4 ± 0.0a

Agouridis et al., 2012

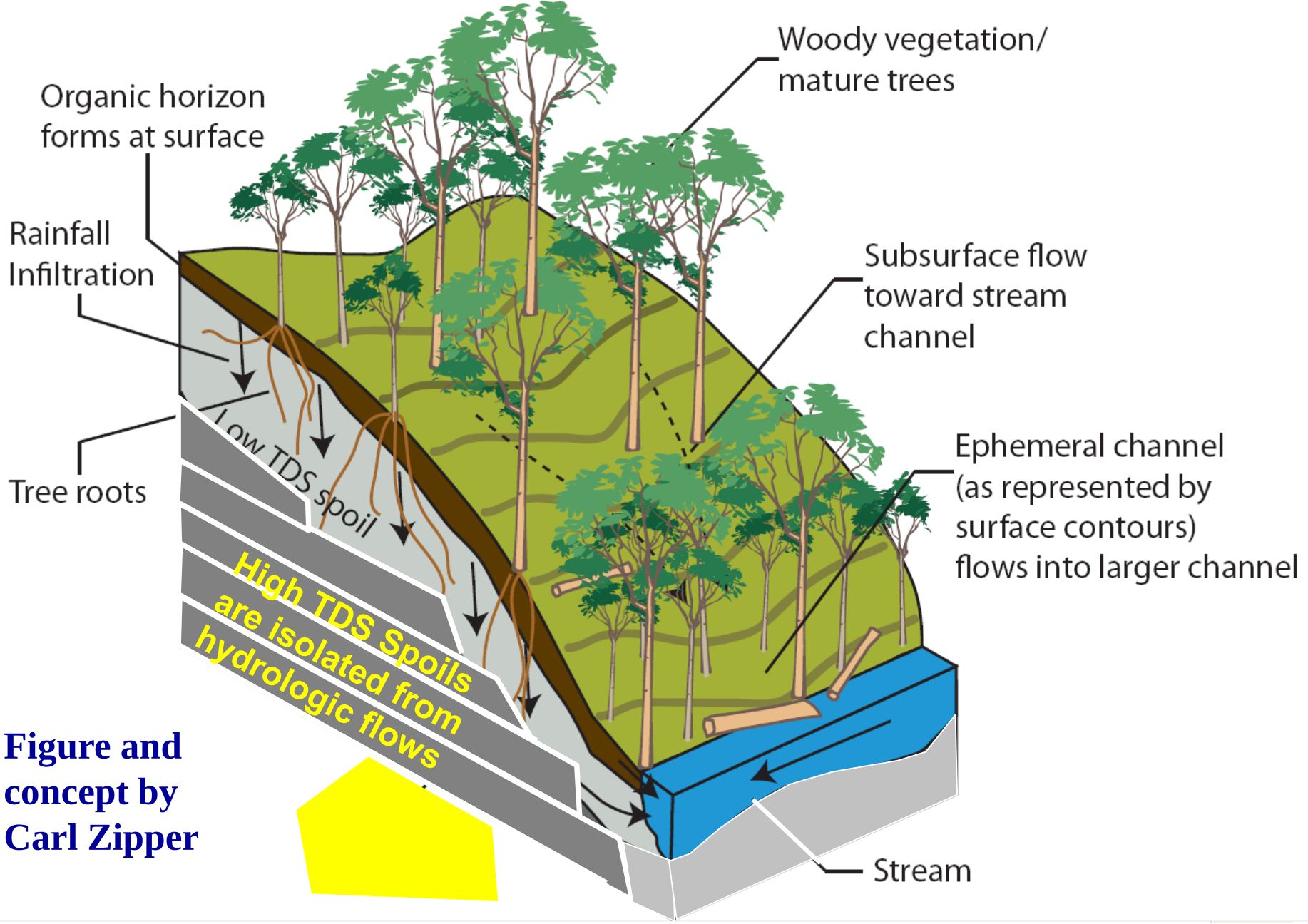


Figure and concept by Carl Zipper

Mined Land, as envisioned: Forest and Hydrologic Restoration, Water Quality Protection. With agency encouragement, we would seek operational prototypes by industry.

Objectives:

1. Characterize the weathering sequences of a range of materials originating from Pottsville Group and the overlying soils throughout the Central Appalachian coalfields.

2. Determine the relationship of pH and soluble salts with depth, color, rock type, and layer type.

3. Investigate the nature of the boundary between weathered and unweathered materials.

Study Area

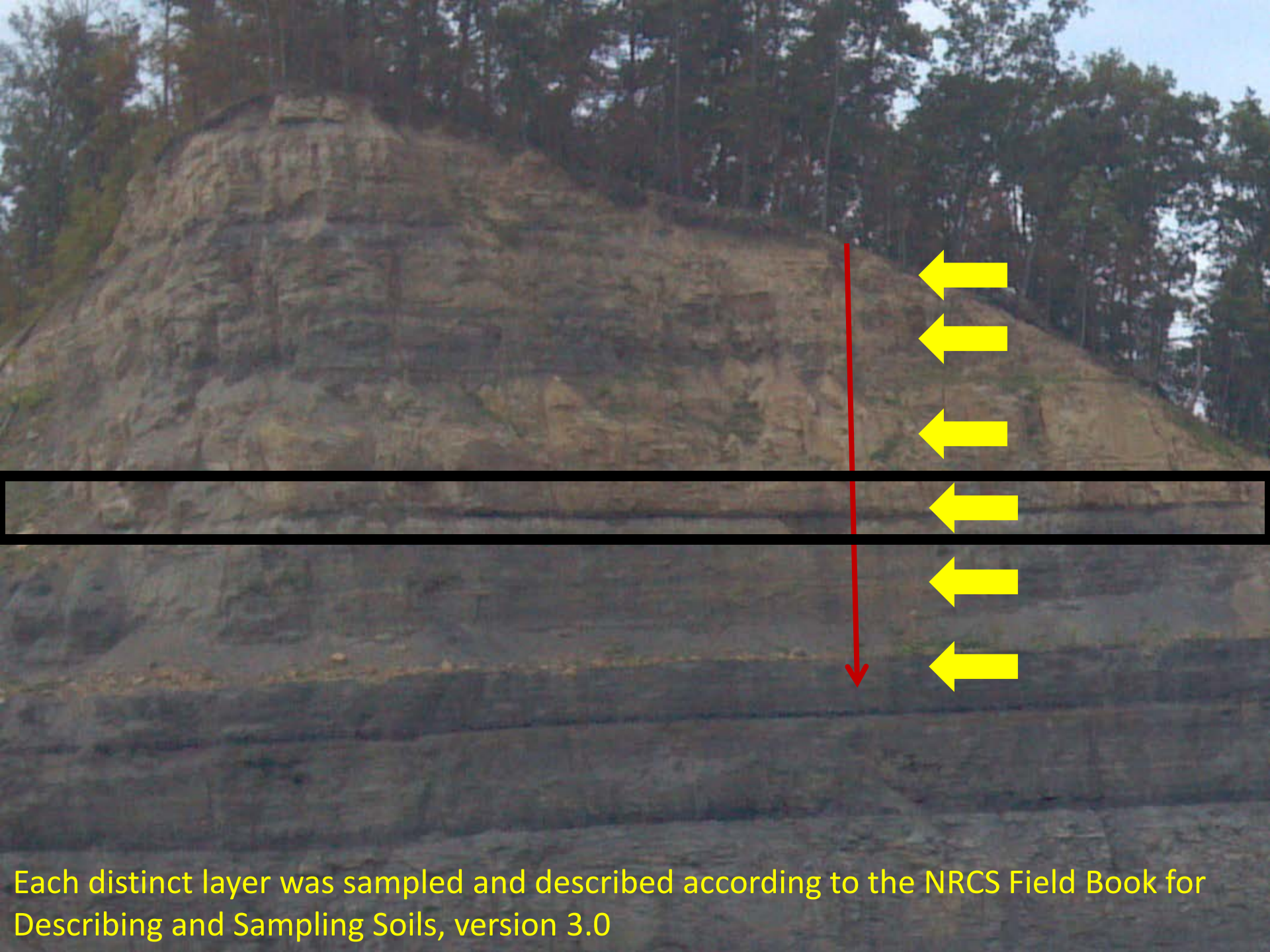
The Pottsville group is an important coal producing geologic formation found throughout Central Appalachia.

Study Area

17 weathering sequences sampled so far for a total of 110 samples

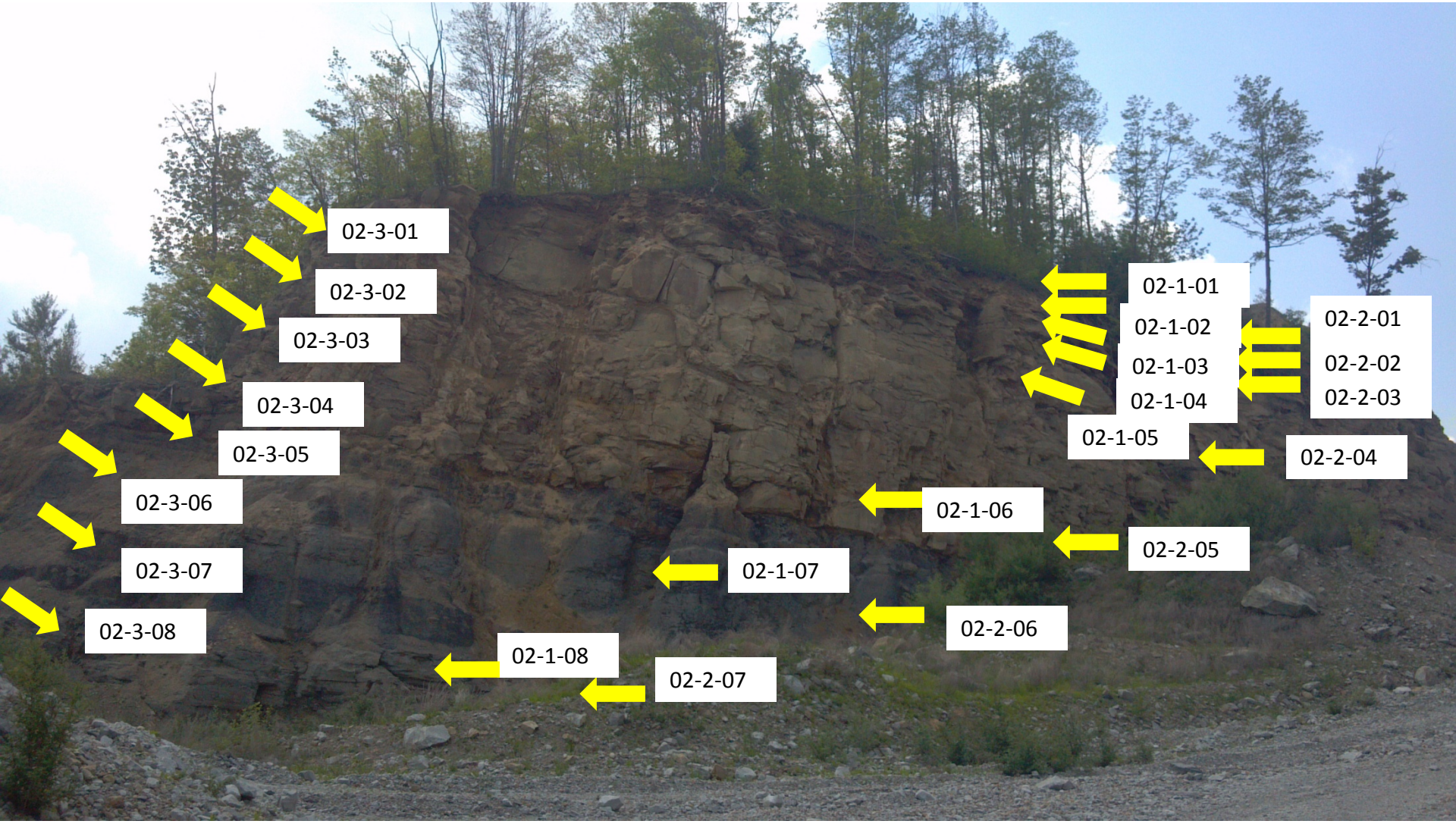
12 Unique sample locations

Replications at 3 sites



Each distinct layer was sampled and described according to the NRCS Field Book for Describing and Sampling Soils, version 3.0

Replication Scheme: samples taken at locations within 100 meters of each other



Some important factors of interest

Site	Rep	Horizon	Site-Rep	Depth (m)	Layer Type (1=A, 2=B, 3=C, 4=R)	Rock Type (0=none, 1=SS, 2=Sh, 3=LS, 4=Coal)	Below Shale Seam (Y/N)	Munsell Value	Munsell Chroma	pH	EC
1	1	1	1-1	0.25	1	0	0	2.5	1	**4.10**	**0.28**
1	1	2	1-1	1	2	0	0	5	6	**4.70**	**0.06**
1	1	3	1-1	1.45	2	0	0	5	6	**4.88**	**0.05**
1	1	4	1-1	2.36	2	0	0	5	8	**4.91**	**0.04**
1	1	5	1-1	2.92	2	0	0	7	1	**4.97**	**0.05**
1	1	6	1-1	3.1	3	0	0	2	1	**4.73**	**0.06**
1	1	7	1-1	3.35	3	0	0	2	1	**4.63**	**0.07**
1	1	8	1-1	3.66	3	0	0	5	4	**4.93**	**0.05**
1	1	9	1-1	4.87	3	0	0	5	6	**4.82**	**0.10**
1	1	10	1-1	6.09	4	1	0	4	2	**8.45**	**0.19**
1	1	11	1-1	10.06	4	1	0	5	1	**8.26**	**0.14**
1	1	12	1-1	11.89	4	1	0	5	1	**8.21**	**0.18**
1	1	13	1-1	13.72	4	1	0	5	6	**8.31**	**0.12**
1	1	14	1-1	15.85	4	1	0	4	2	**7.56**	**0.20**
1	1	15	1-1	16.76	4	2	1	3	1	**8.08**	**0.80**
1	1	16	1-1	21.64	4	1	1	4	1	**8.07**	**0.45**
1	1	17	1-1	30.78	4	1	1	3	1	**8.94**	**0.64**
1	1	18	1-1	39.93	4	2	1	2	1	**8.40**	**0.48**
1	1	19	1-1	69.19	4	2	1	2	1	**8.28**	**0.64**

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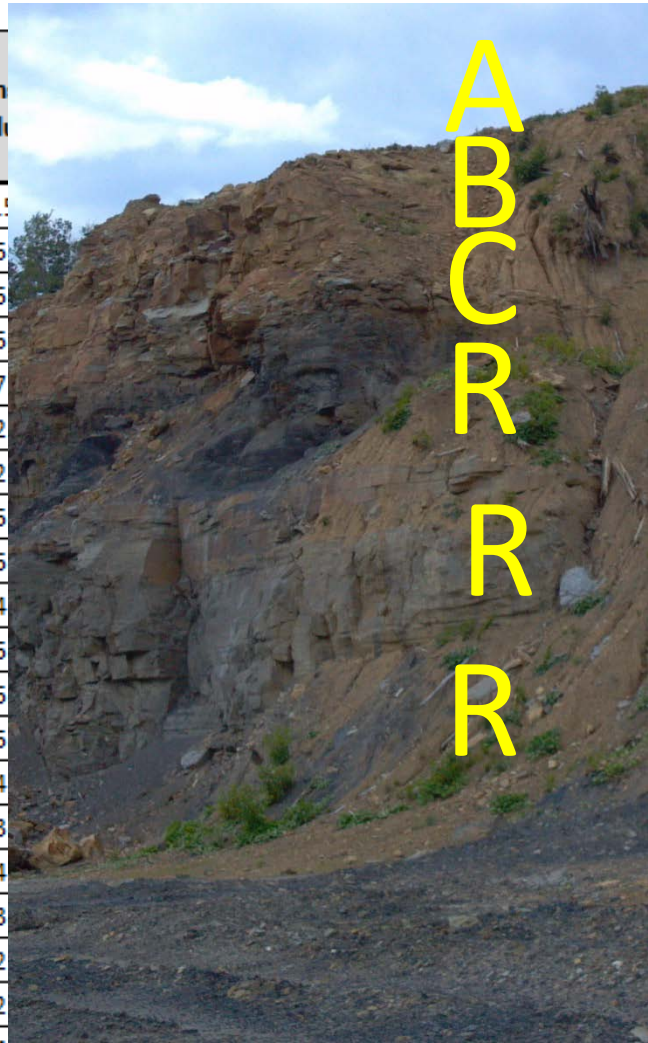

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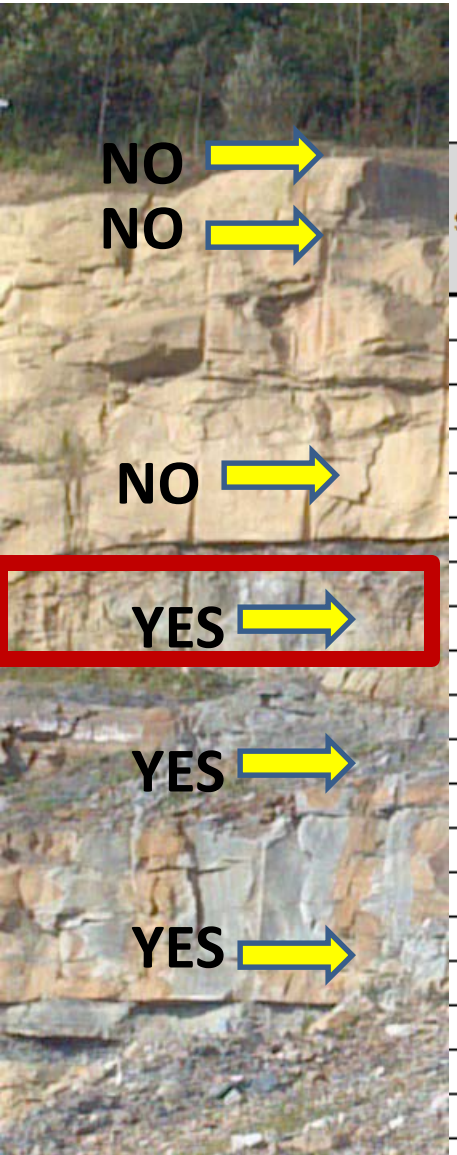

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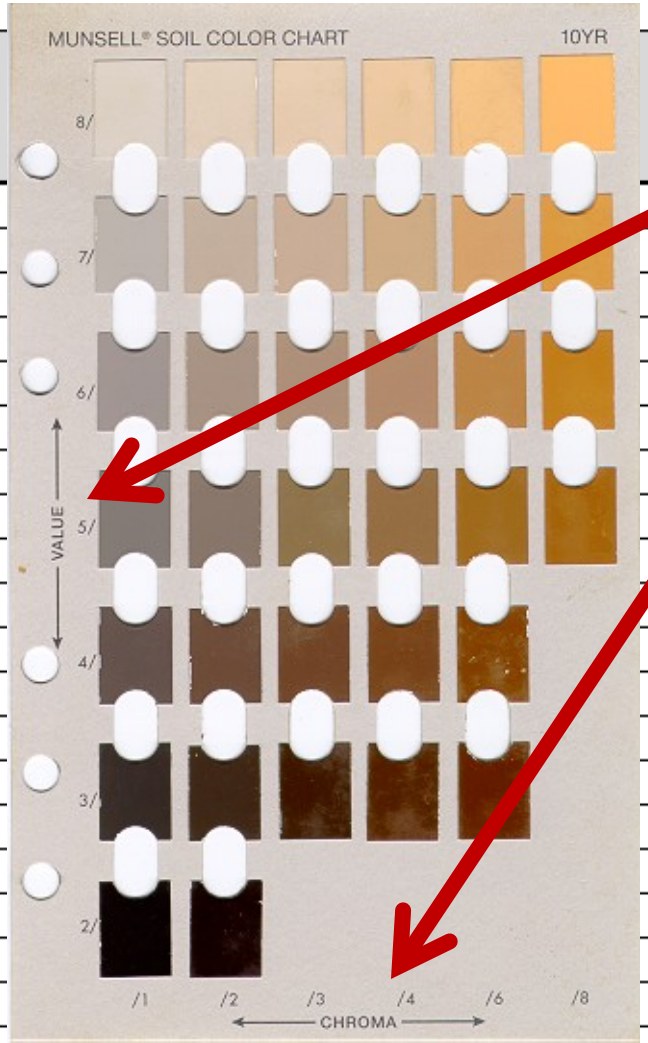

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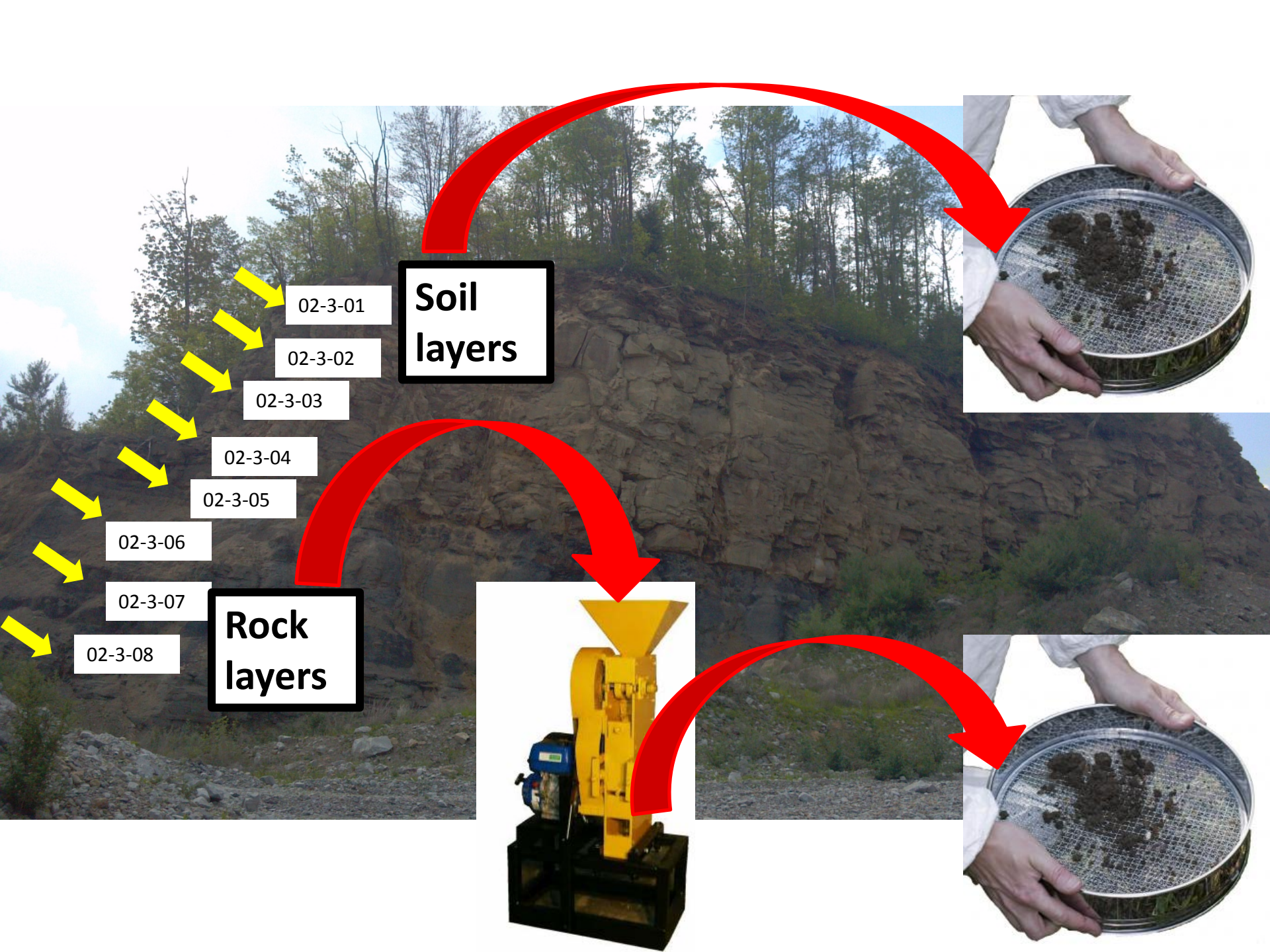
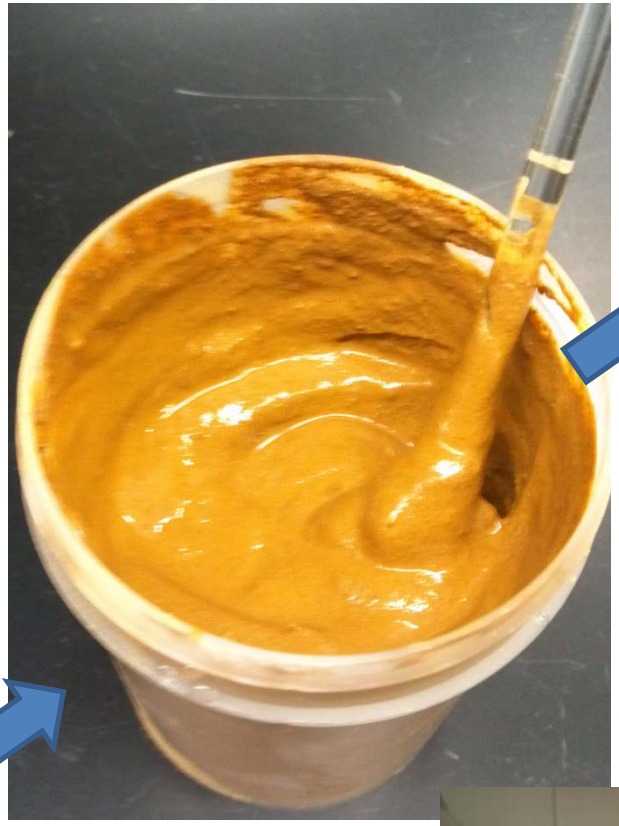
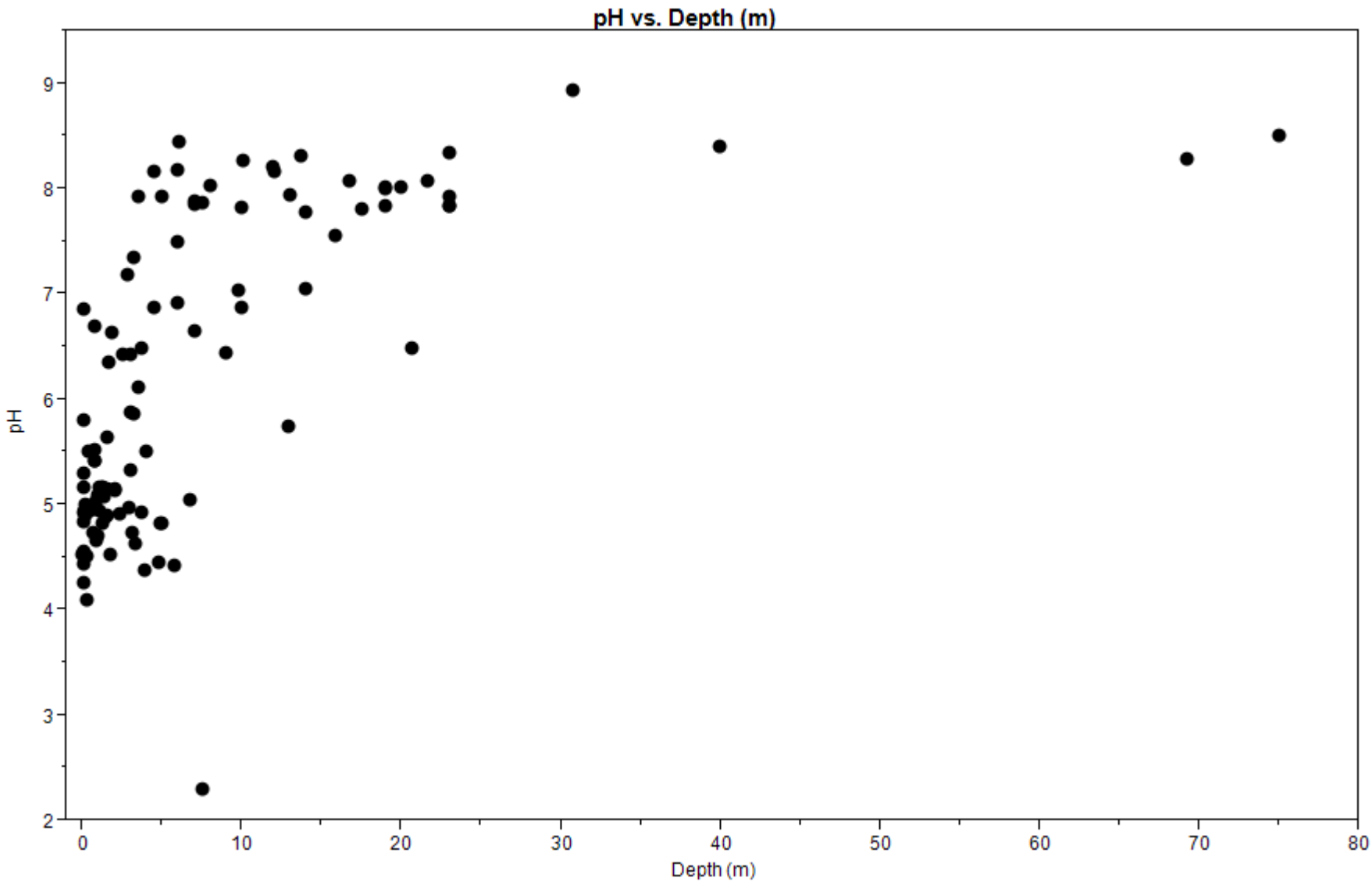
Unweathered Sandstone

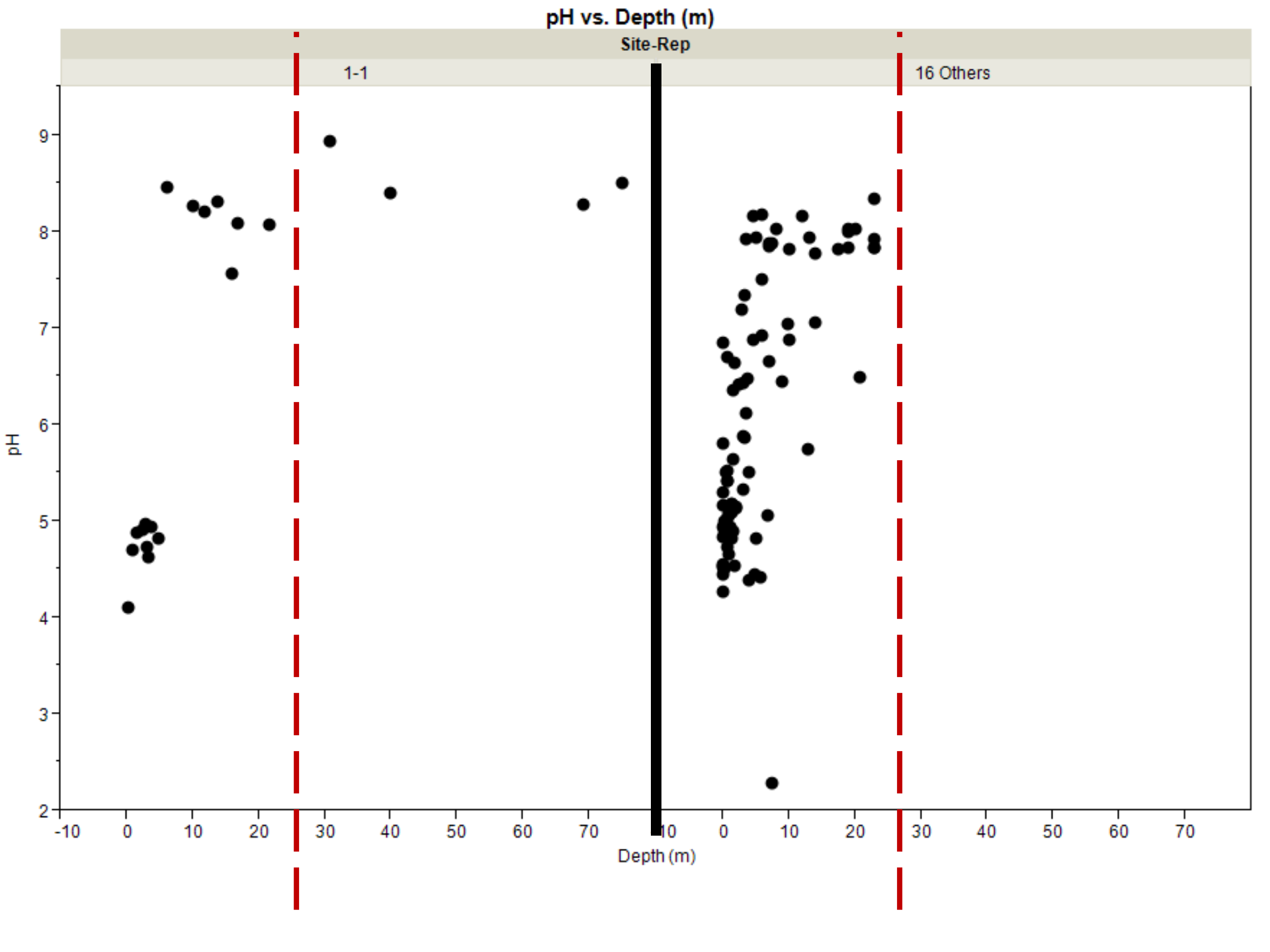
Weathered Sandstone

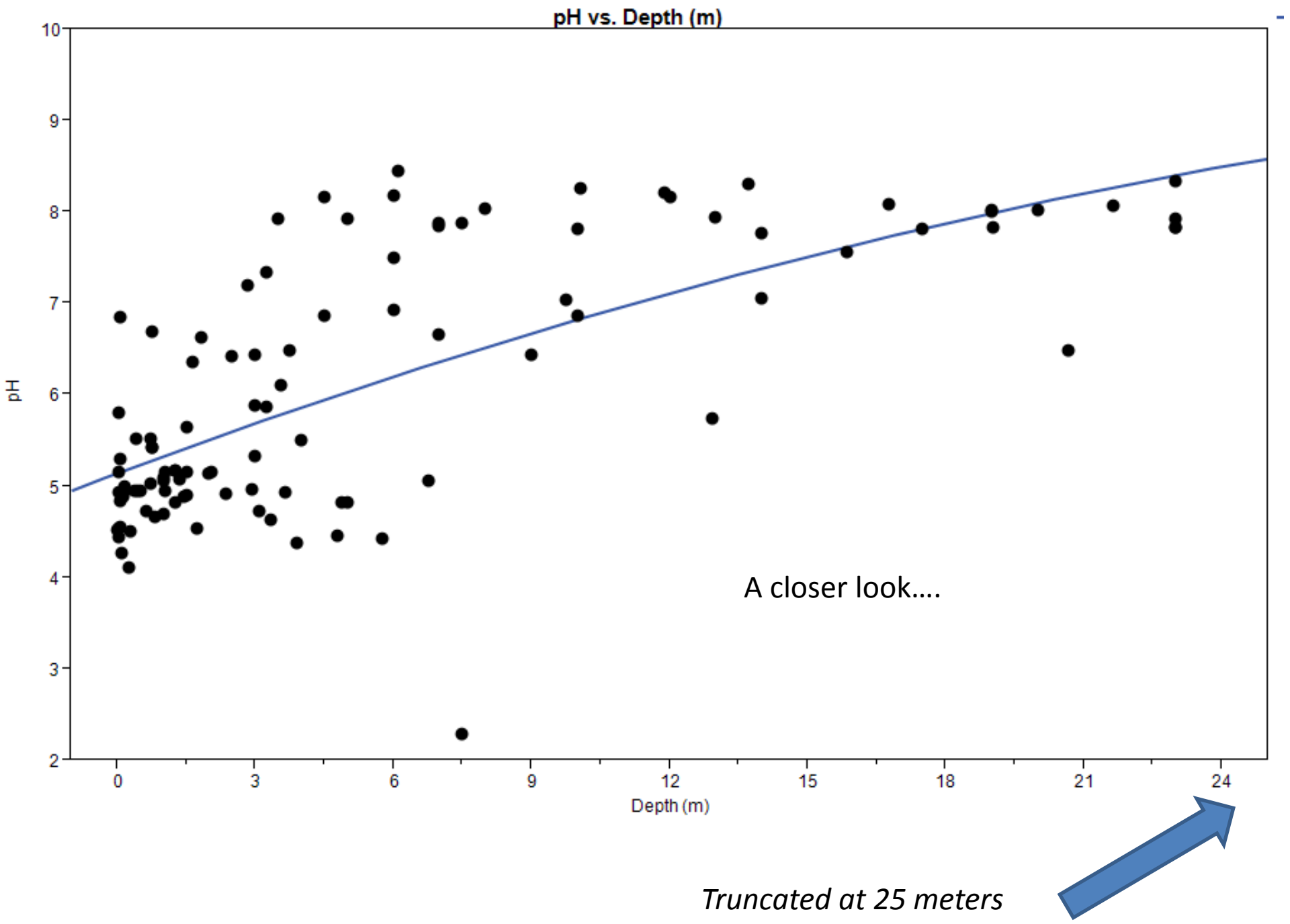

02-3-01
02-3-02
02-3-03
02-3-04
02-3-05
02-3-06
02-3-07
02-3-08
Soil layers
Rock layers

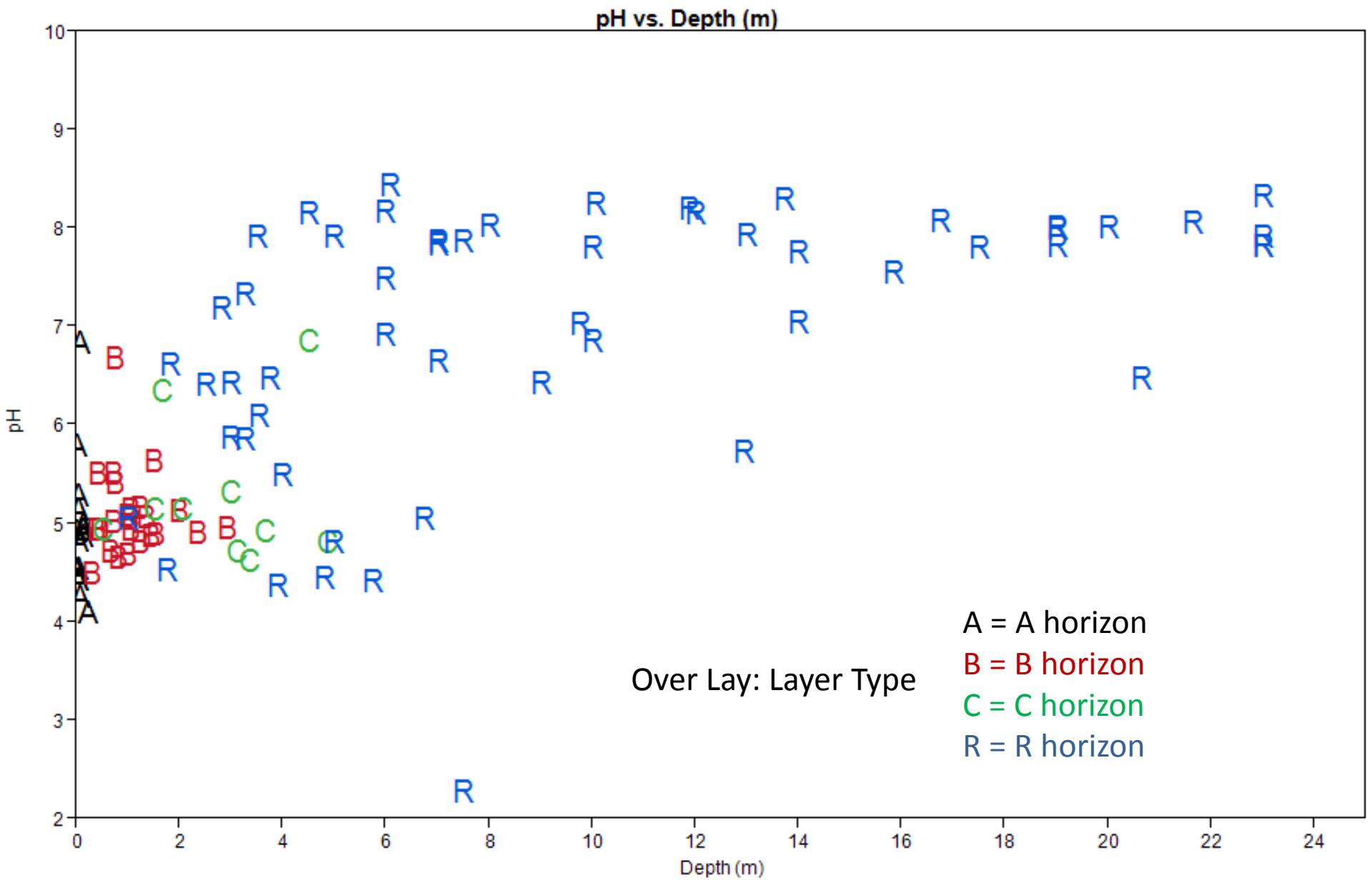


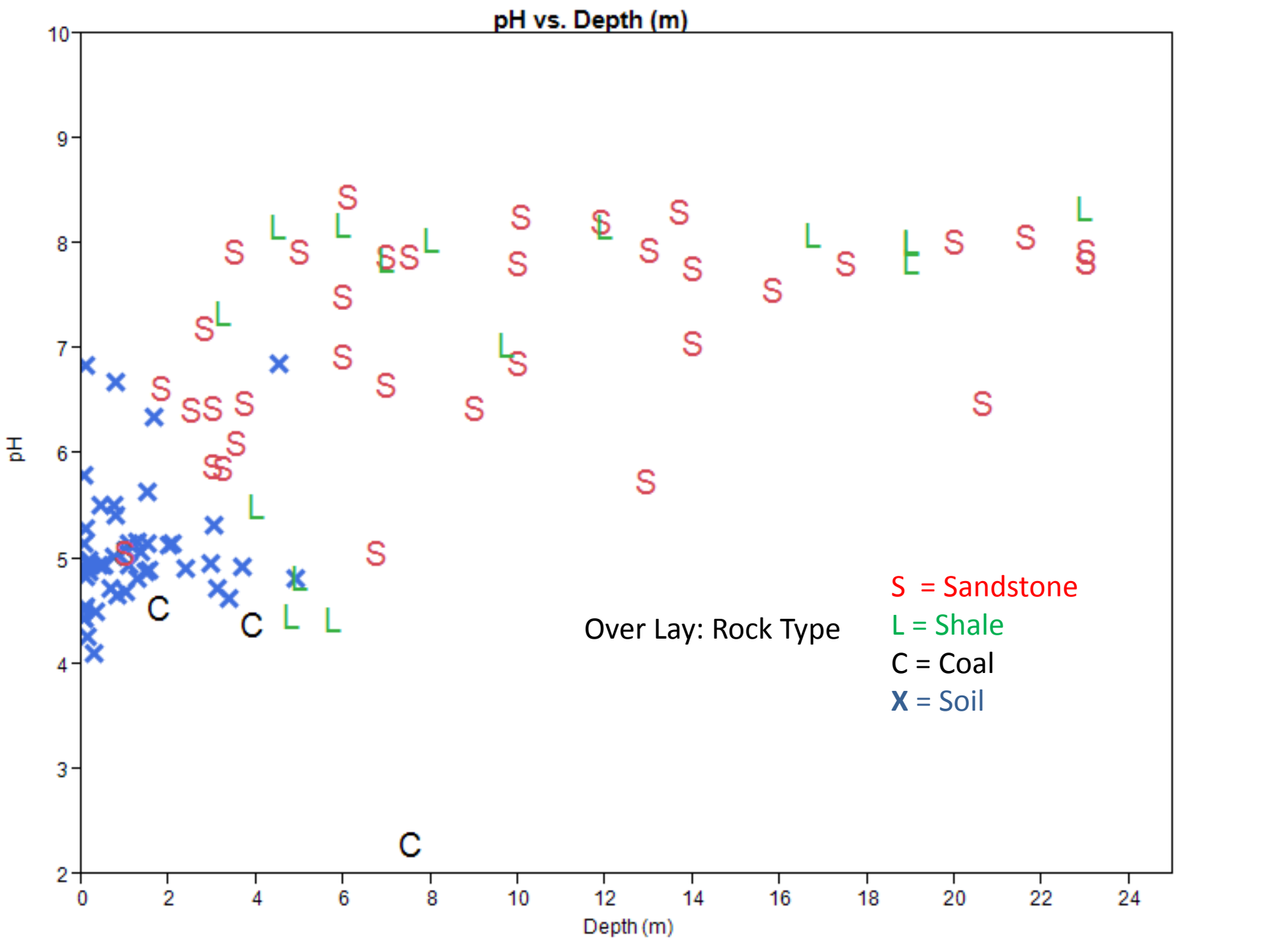
Each Sample is Analyzed for Saturated Paste Electrical Conductance (EC) and pH

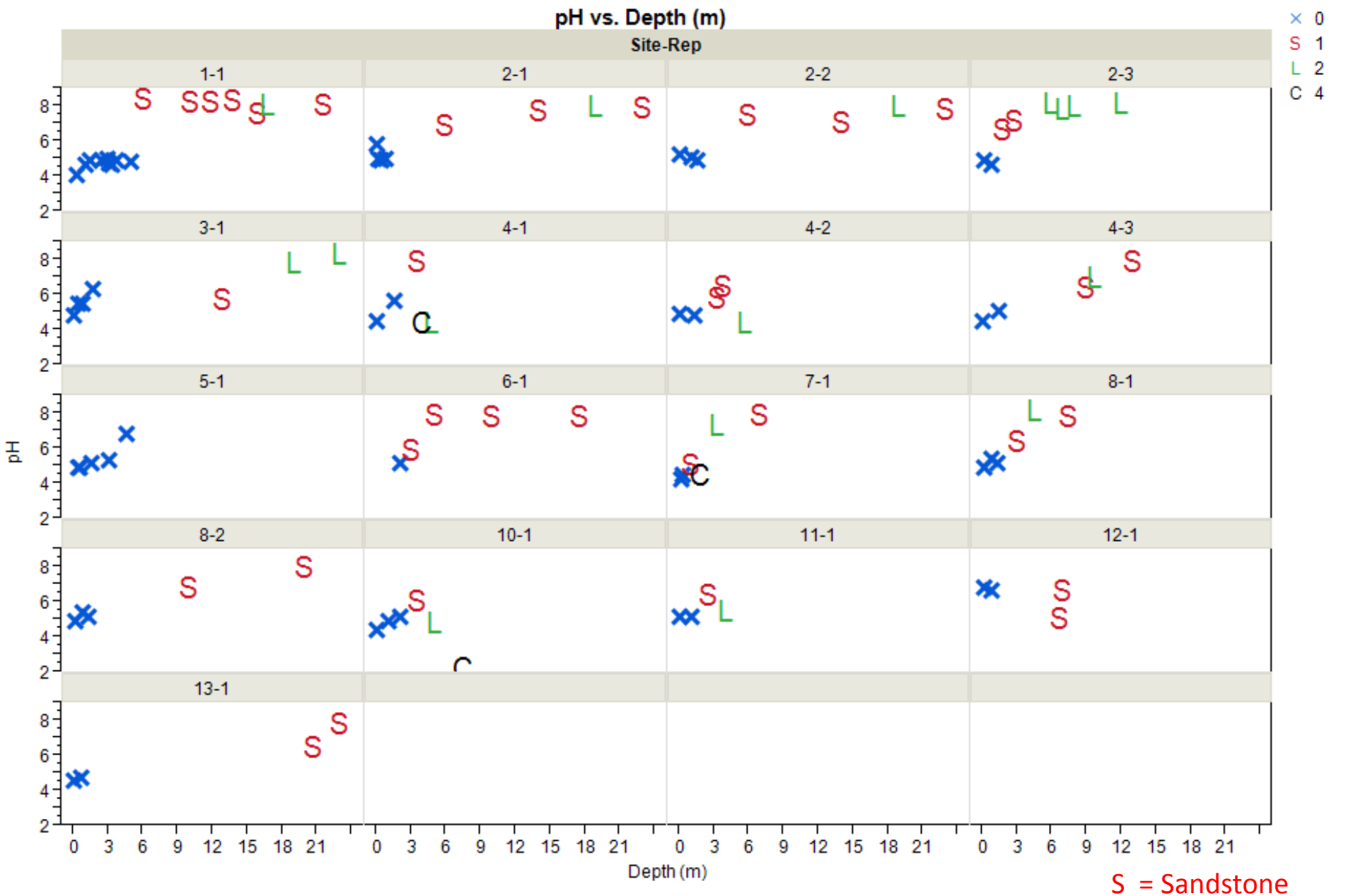

pH vs. Depth (m)
pH
Depth (m)
9
8
7
6
5
4
3
2
0
10
20
30
40
50
60
70
80


pH vs. Depth (m)
Site-Rep
1-1
16 Others
pH
9
8
7
6
5
4
3
2
-10
0
10
20
30
40
50
60
70
10
0
10
20
30
40
50
60
70
Depth (m)


pH vs. Depth (m)
pH
Depth (m)
10
9
8
7
6
5
4
3
2
0
3
6
9
12
15
18
21
24
A closer look….
Truncated at 25 meters


pH vs. Depth (m)
pH
Depth (m)
Over Lay: Layer Type
A = A horizon
B = B horizon
C = C horizon
R = R horizon


pH vs. Depth (m)
pH
Depth (m)
Over Lay: Rock Type
S = Sandstone
L = Shale
C = Coal
X = Soil



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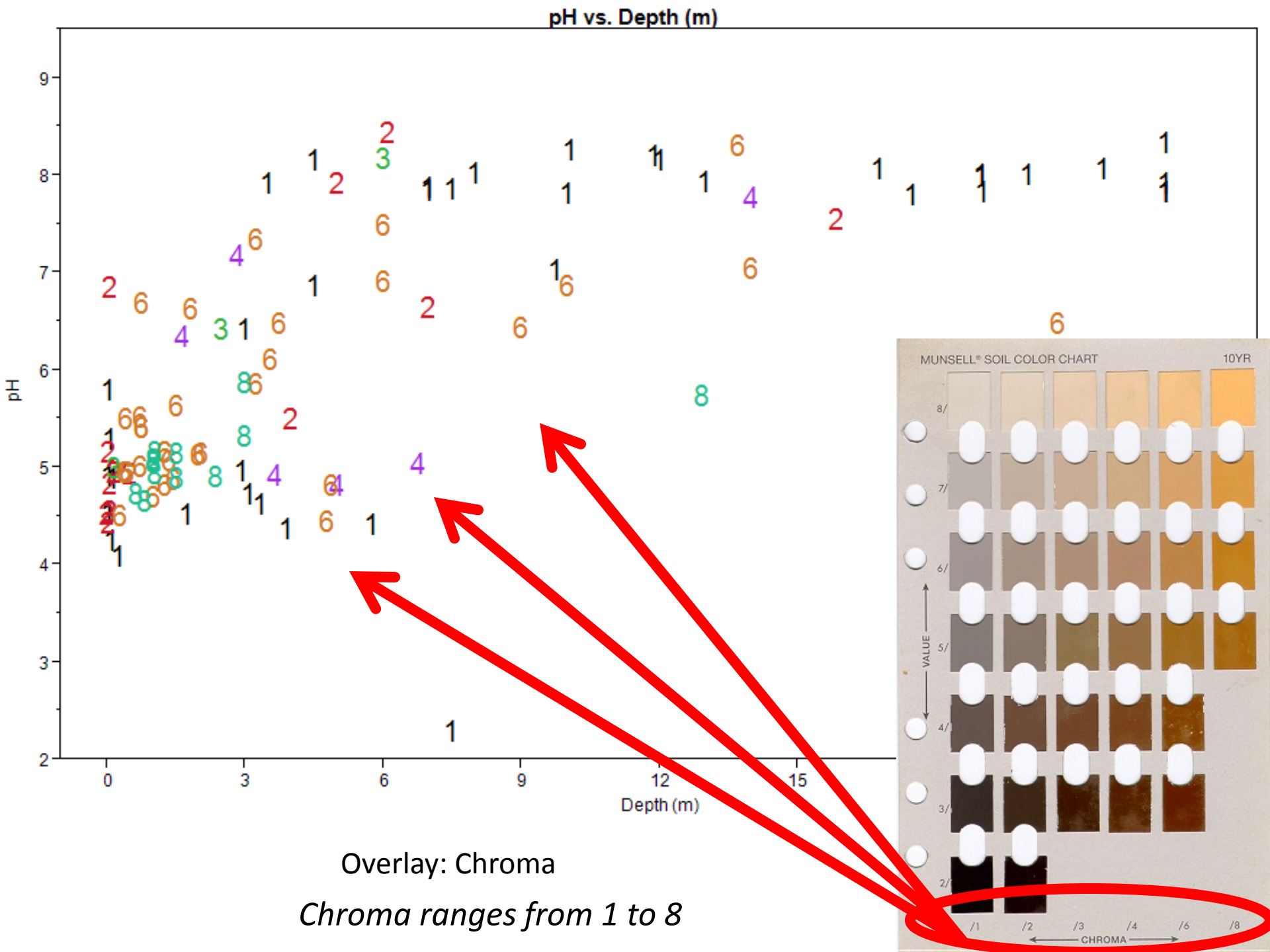
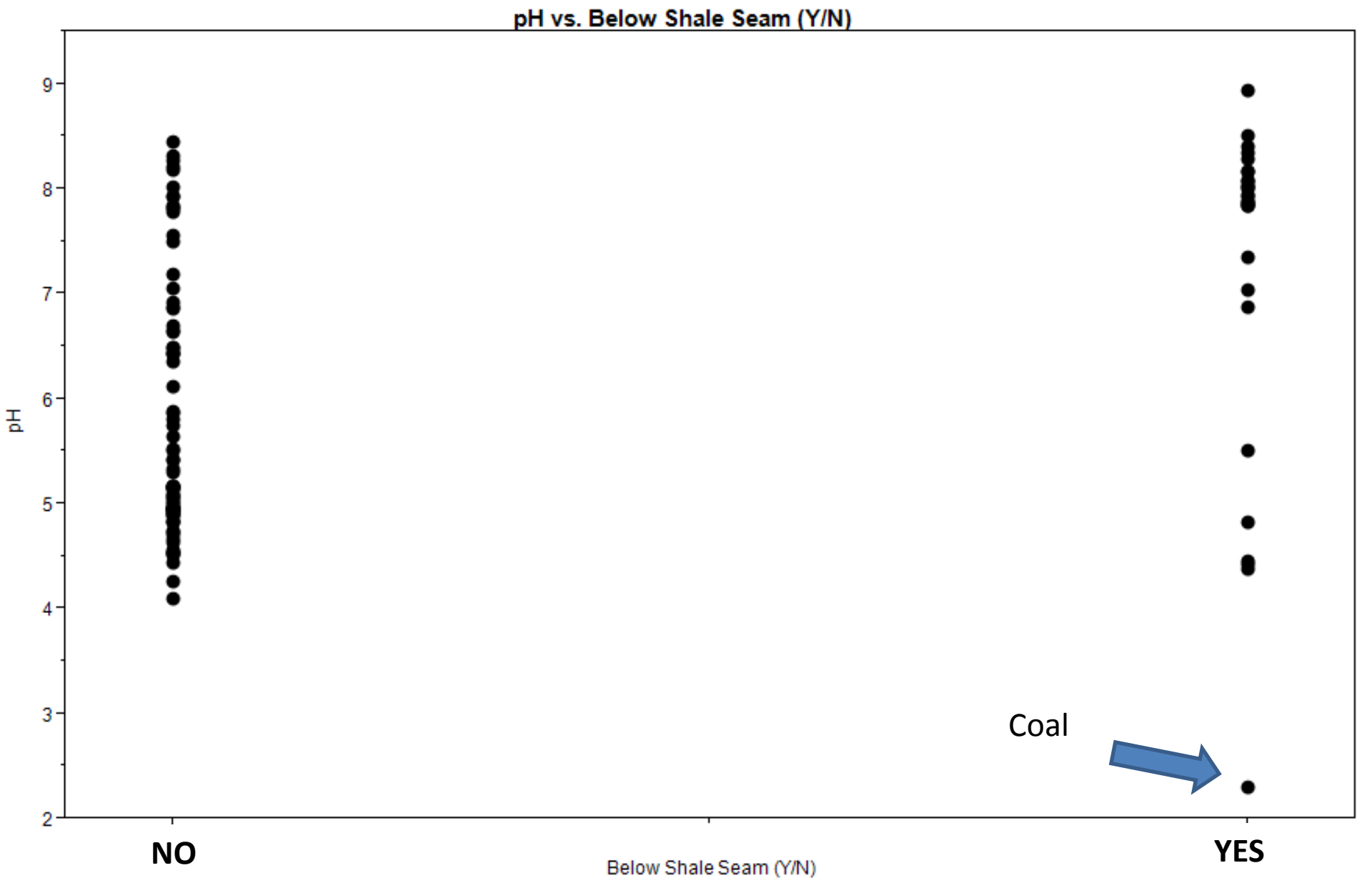


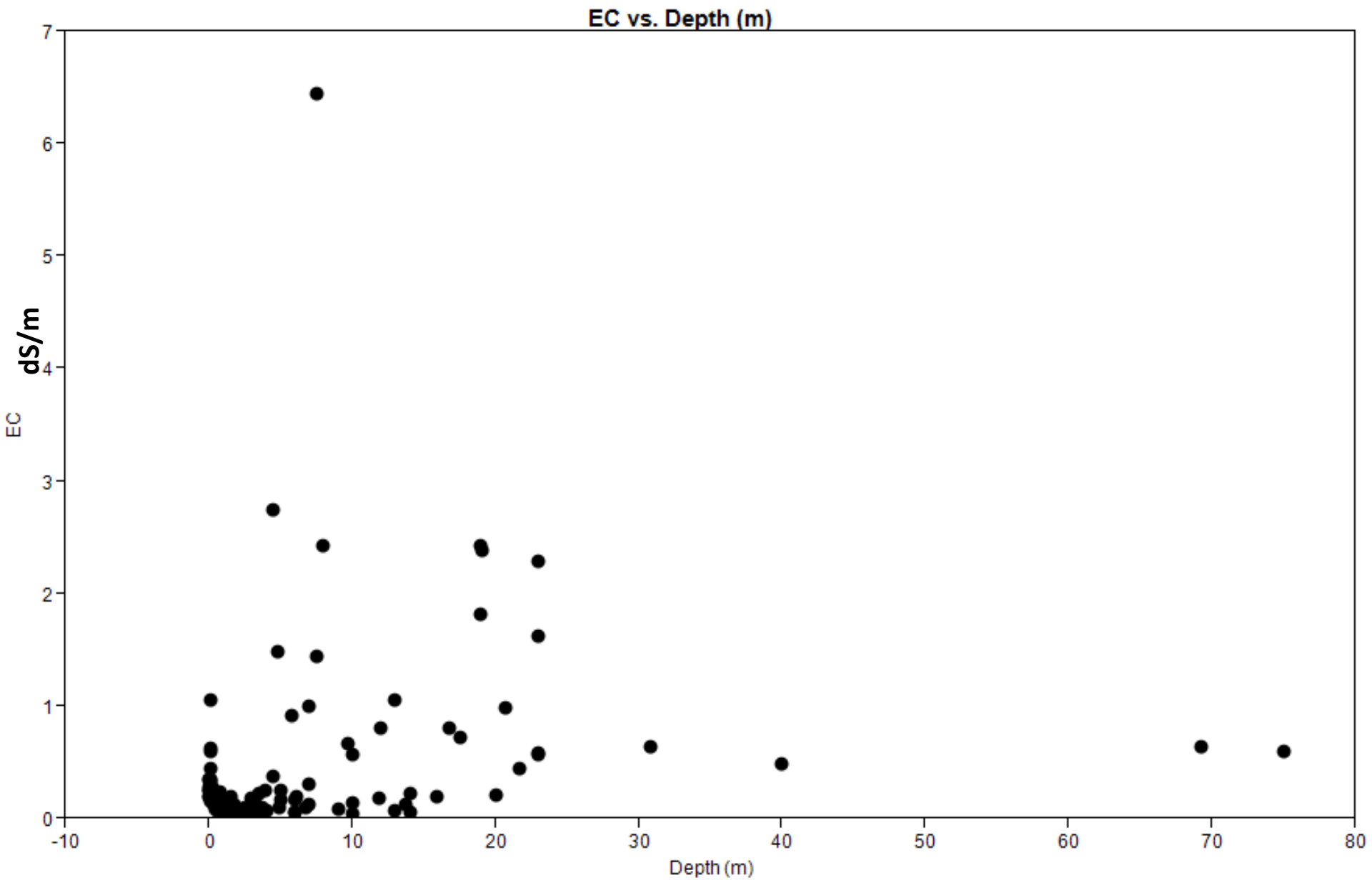
Overlay: Chroma

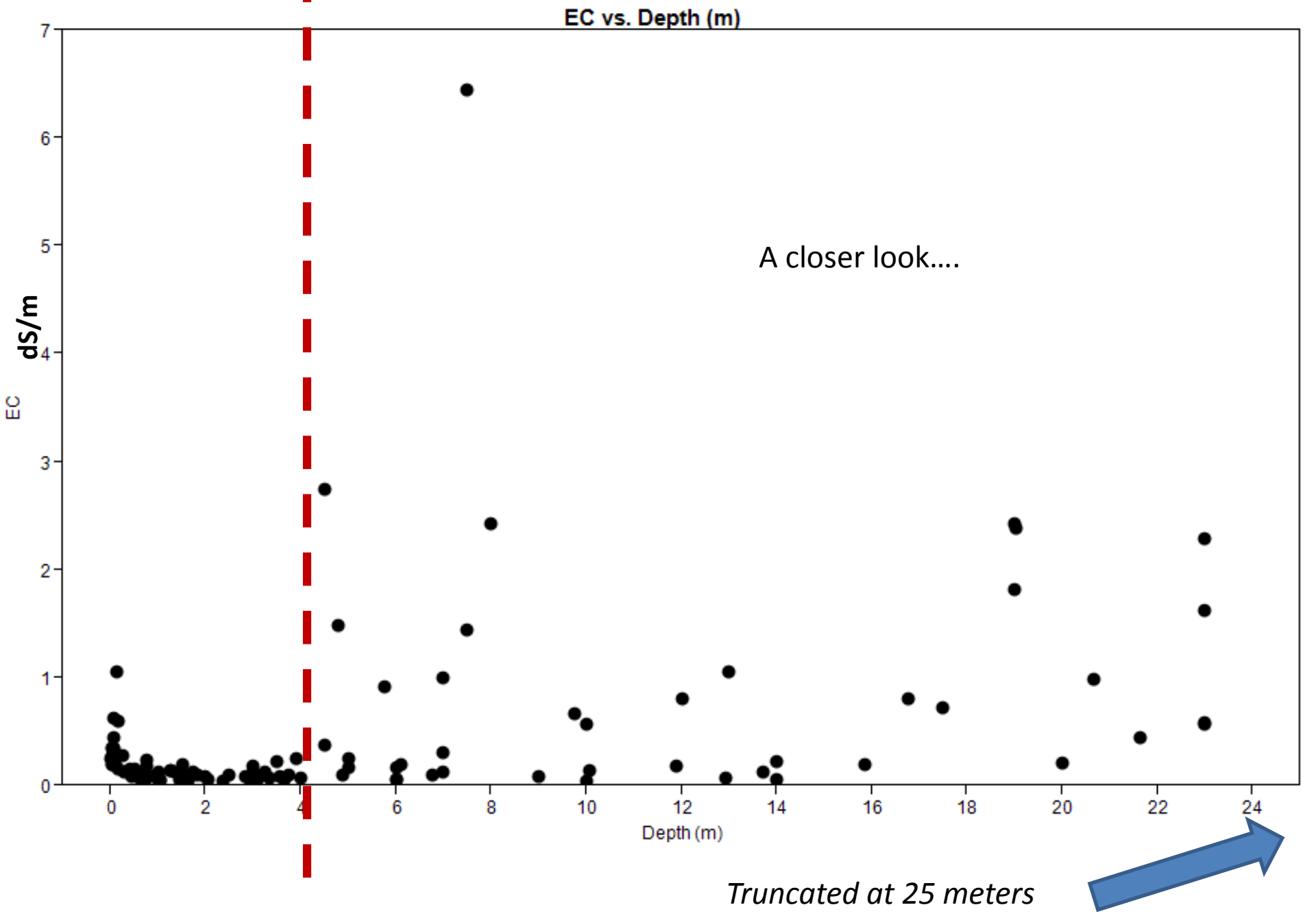
Chroma ranges from 1 to 8

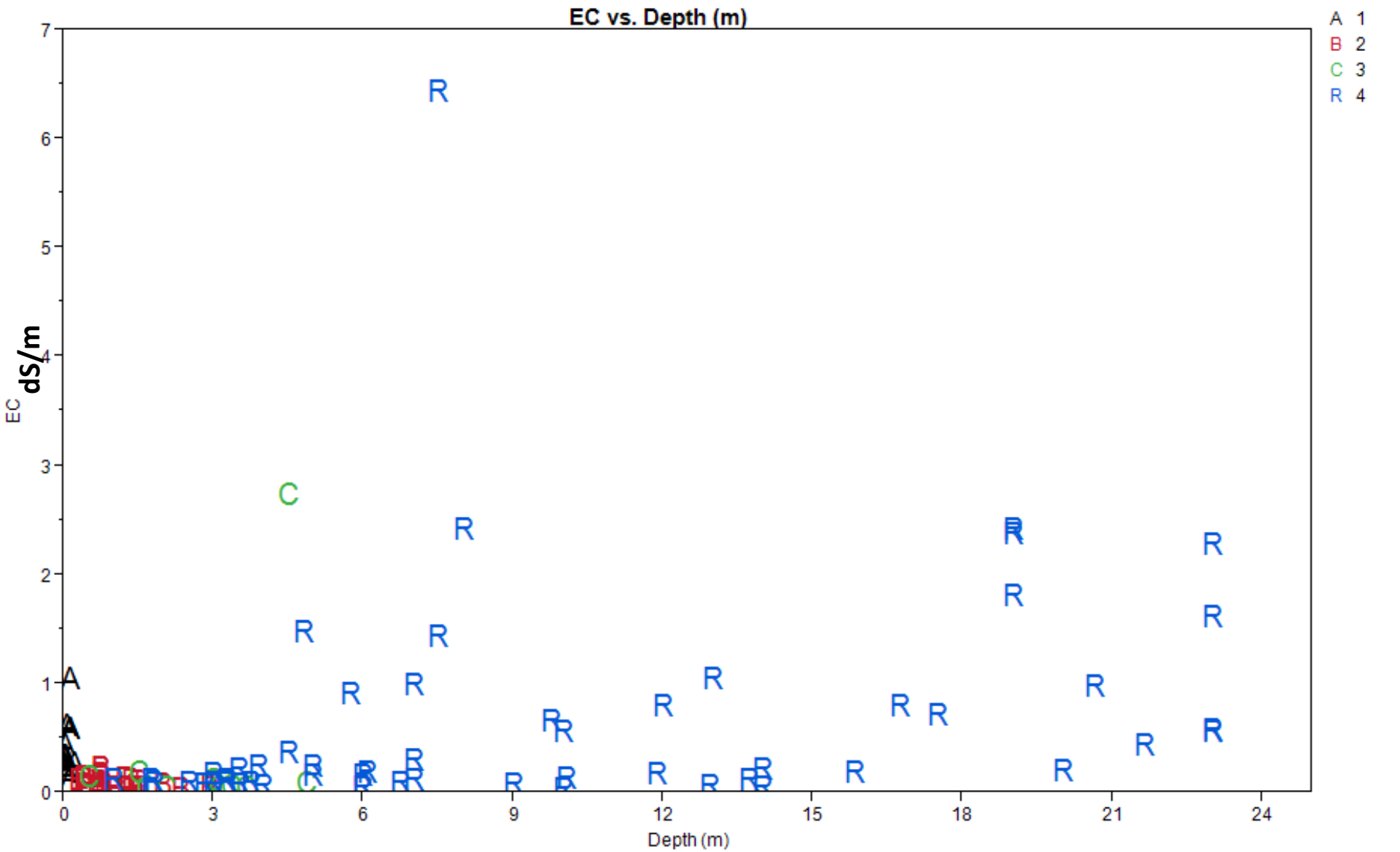


Above **shale seam**

Below **shale seam**


EC vs. Depth (m)
EC
dS/m
7
6
5
4
3
2
1
0
-10
0
10
20
30
40
50
60
70
80
Depth (m)


EC vs. Depth (m)
EC
dS/m
Depth (m)
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
14
16
18
20
22
24
A closer look….
Truncated at 25 meters

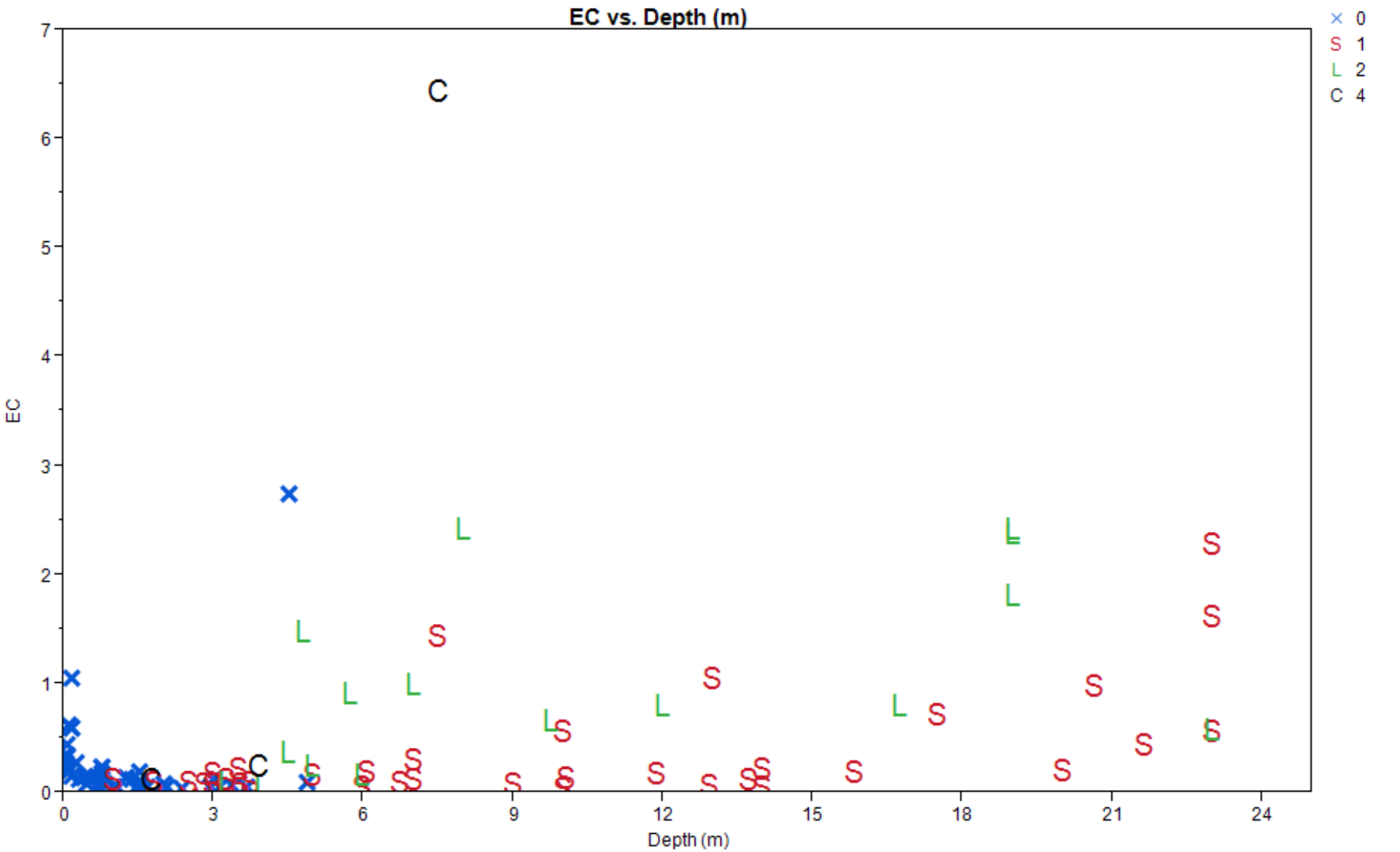


A = A horizon

B = B horizon

C = C horizon

R = R horizon



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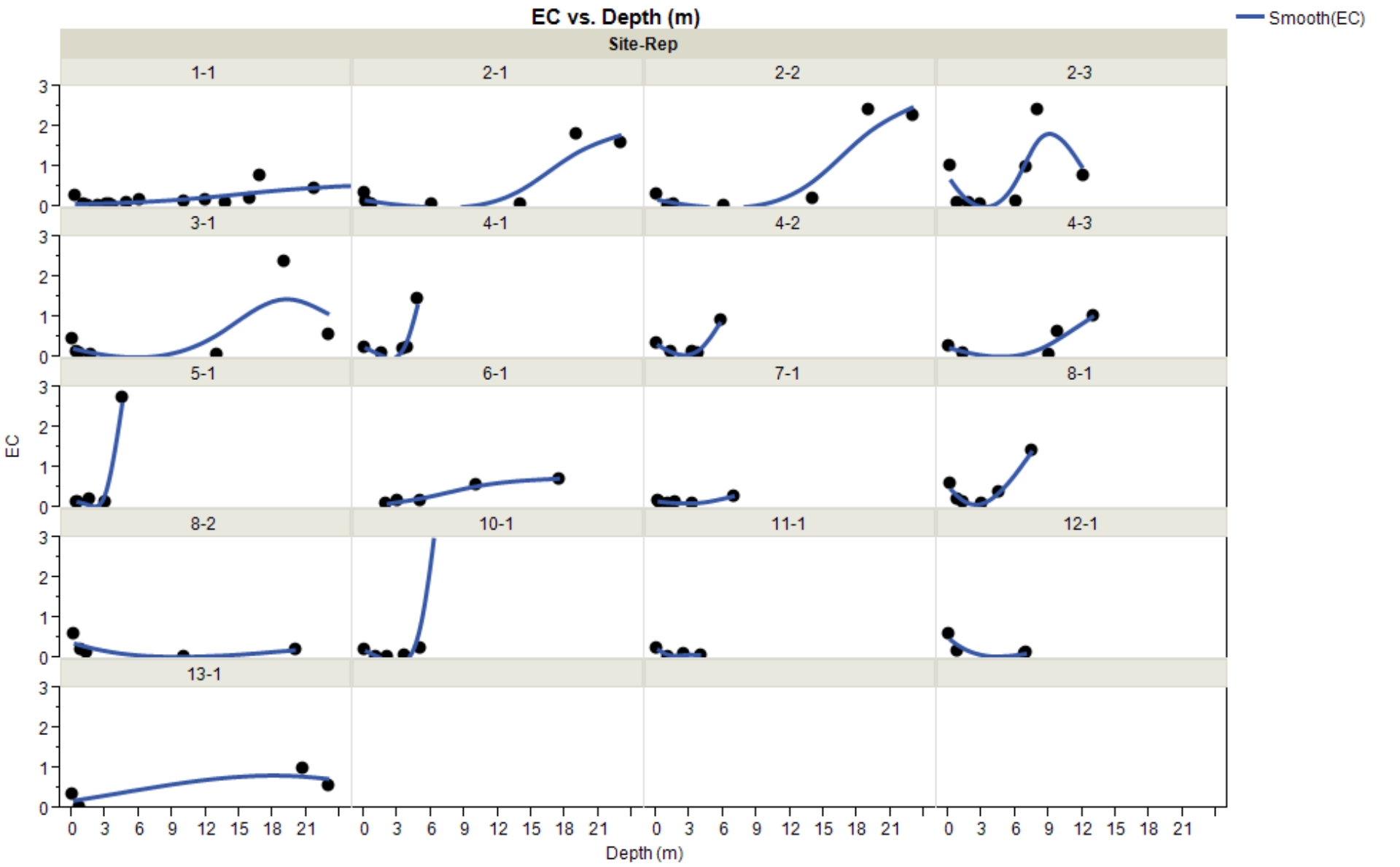
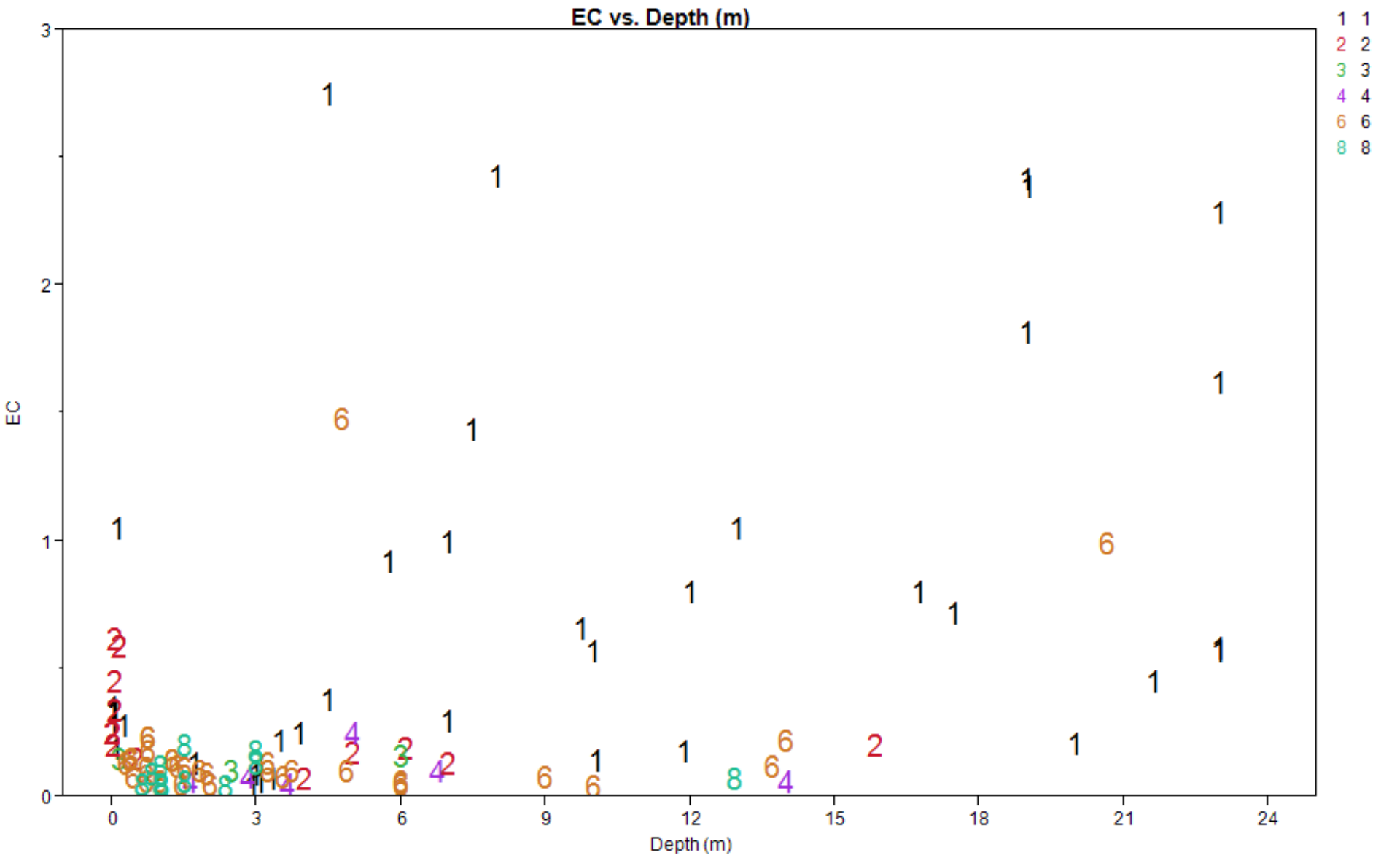
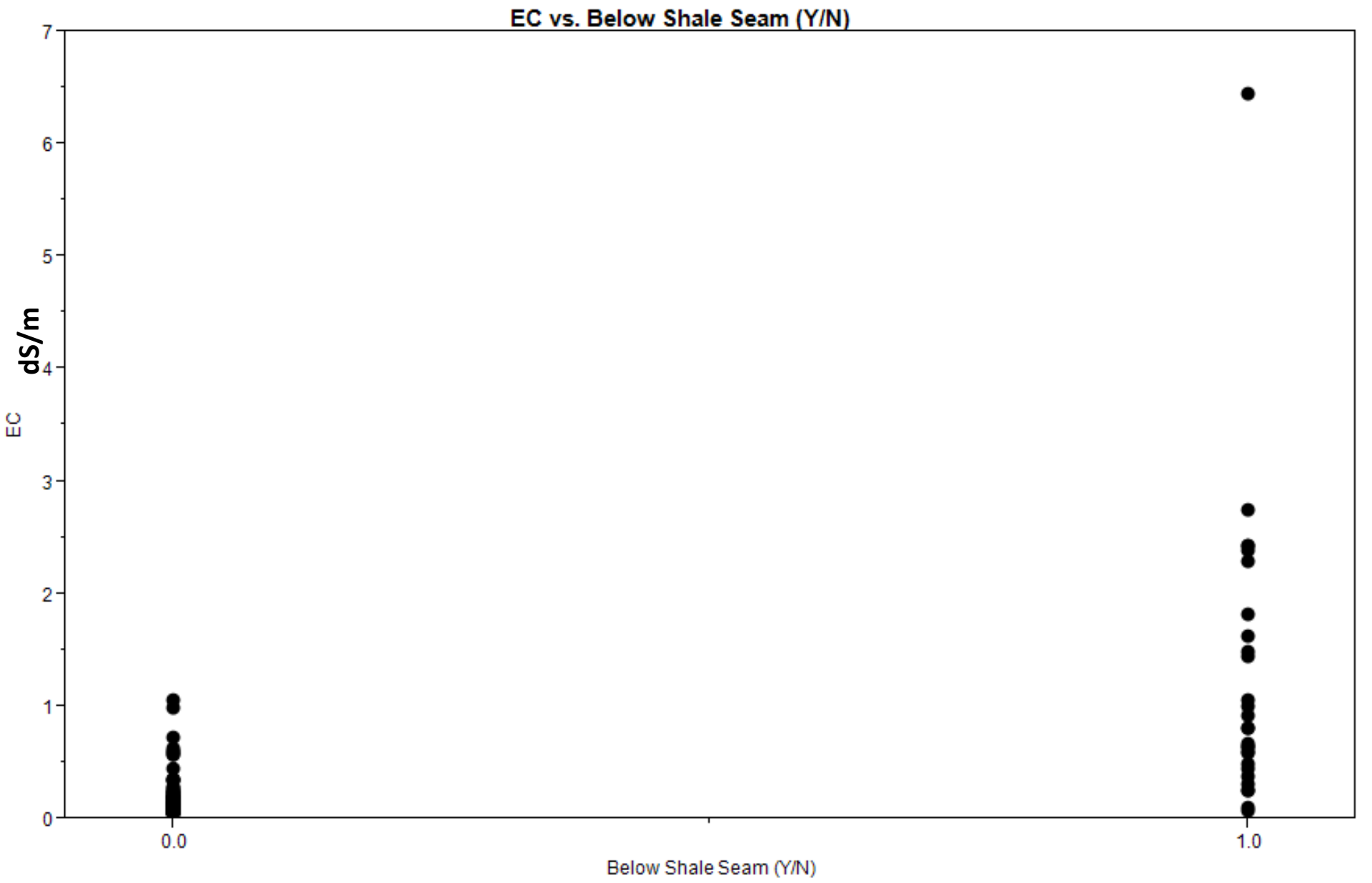

EC vs. Depth (m)
Smooth(EC)
Site-Rep
1-1
2-1
2-2
2-3
3-1
4-1
4-2
4-3
5-1
6-1
7-1
8-1
8-2
10-1
11-1
12-1
13-1
EC
Depth (m)
0
3
6
9
12
15
18
21
1
2



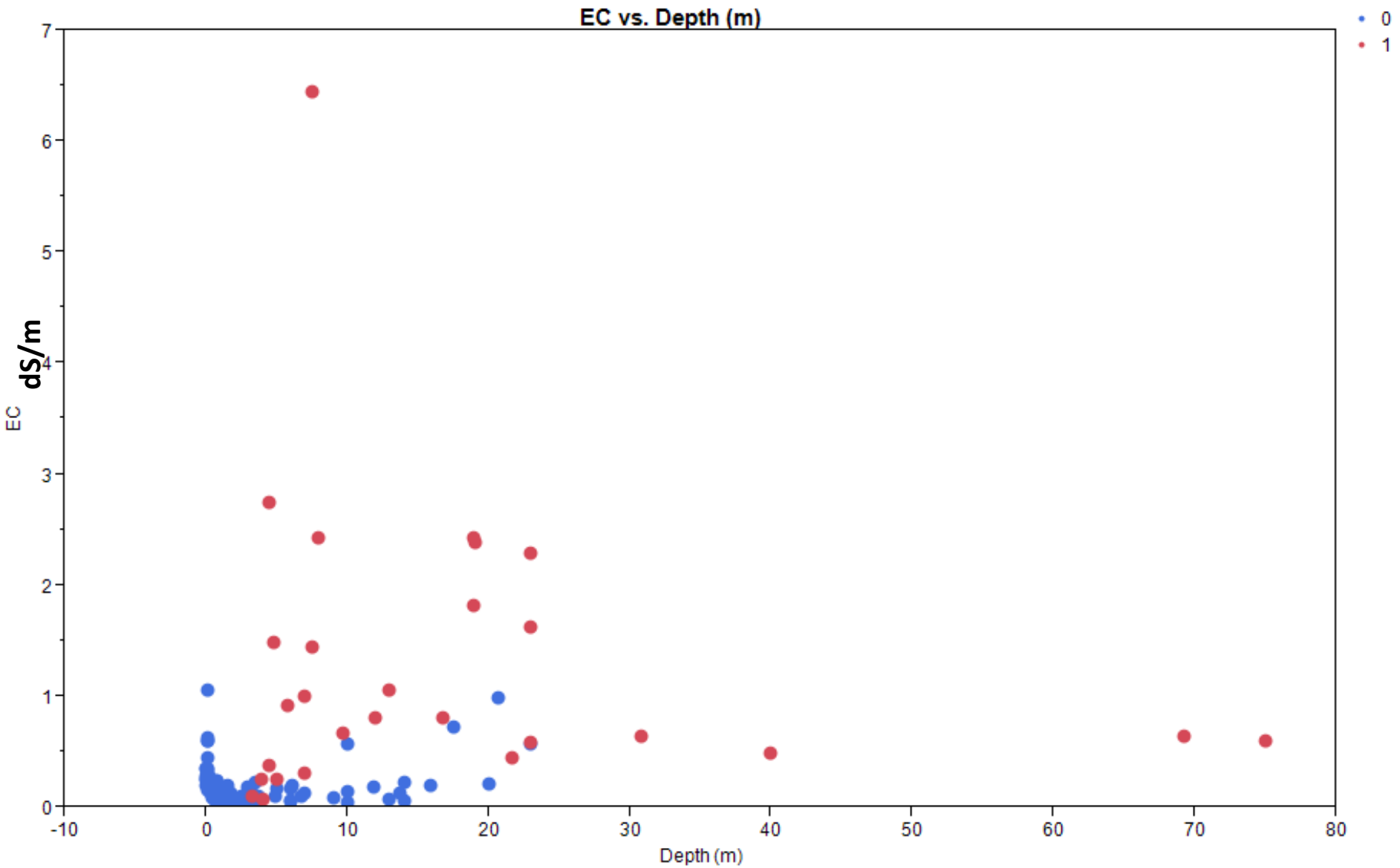
Overlay: Chroma

Chroma ranges from 1 to 8



Above **shale seam**

Below **shale seam**



Overlay: Below Shale Layer Y/N

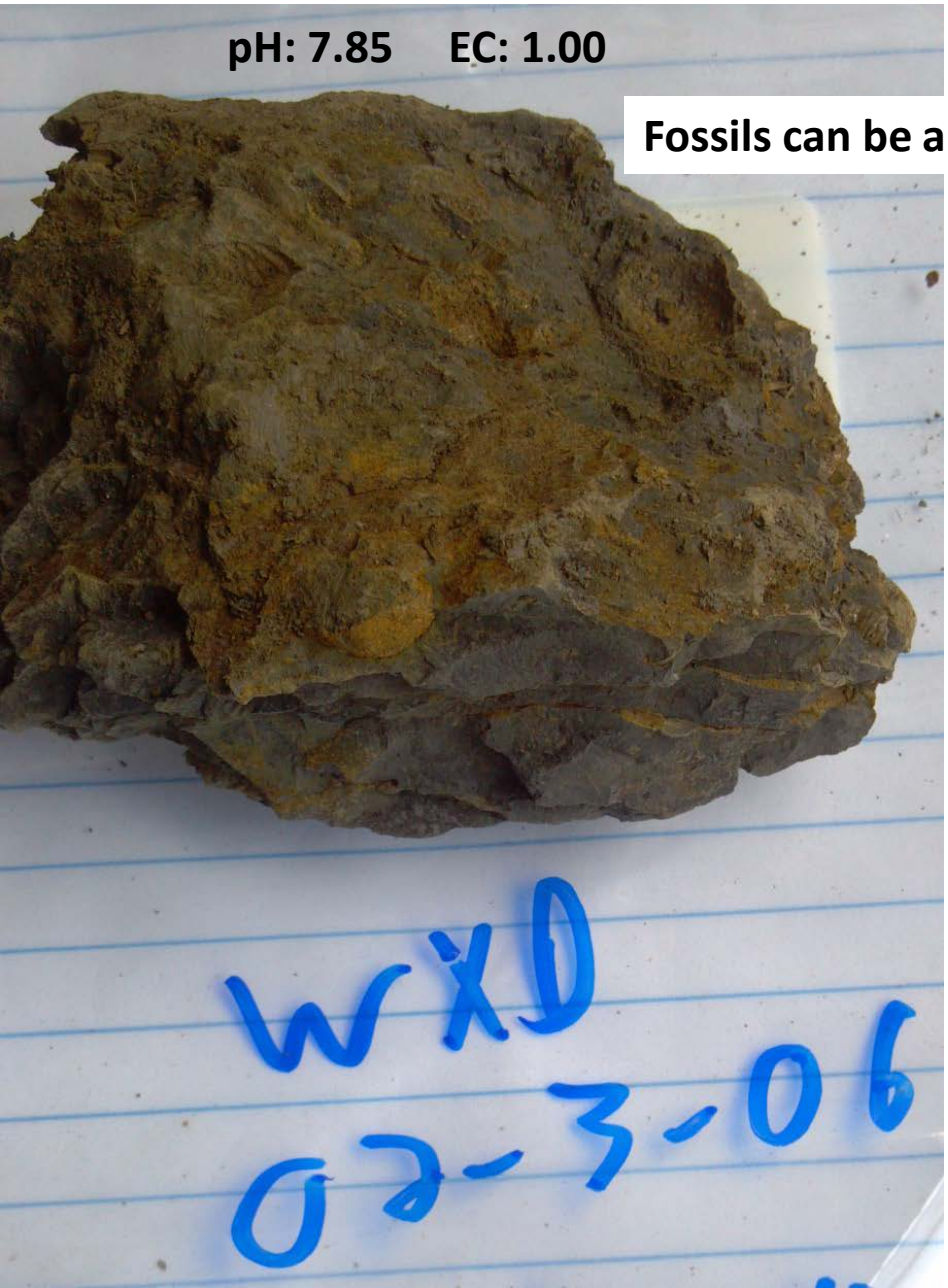
= *Above* shale layer

= *Below* shale layer

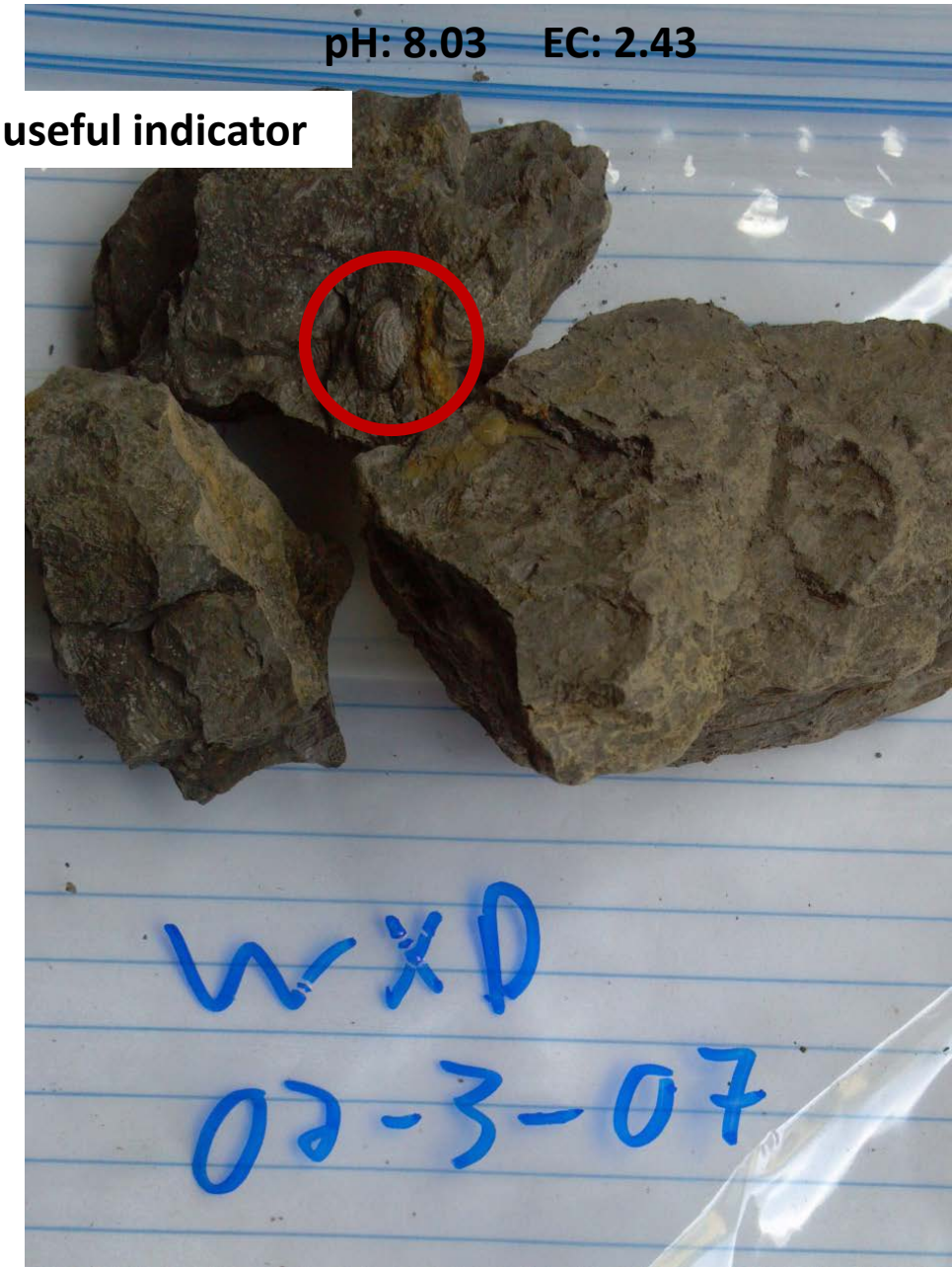
Depth (m)	*Layer type*	*Rock Type*	*Hue*	*Value*	*Chroma*	*pH*	*EC*
.25	A	None	7.5YR	2.5	1	4.10	0.279
1.00	Bt	None	7.5YR	5	6	4.70	0.062
1.45	Bt	None	5YR	5	6	4.88	0 .051
2.36	Bt	None	5YR	5	8	4.91	0 .040
2.92	Bt	None	7.5YR	7	1	4.97	0 .045
3.10	C	Soft Coal	7.5YR	2	1	4.73	0 .063
3.35	C	Soft Coal	10YR	2	1	4.63	0 .068
3.66	Cr	Soft Shale	10YR	5	4	4.93	0.053
4.87	Cr	Soft Shale	10YR	5	6	4.82	0.104
6.09	R	Sandstone	10YR	4	6	8.45	0.192
10.06	R	Sandstone	10YR	4	3	8.26	0.144
11.89	R	Sandstone	10YR	5	1	8.21	0.183
13.72	R	Sandstone	10YR	5	6	8.31	0.124
15.85	R	Sandstone	10YR	4	2	7.56	0.204
16.76	R	Shale	10YR	3	1	8.08	0.796
21.64	R	Sandstone	10YR	4	1	8.07	0.445
30.78	R	Sandstone	10YR	3	1	8.94	0.643
39.93	R	SS w/ Shale	10YR	4	1	8.40	0.483
69.19	R	Shale	10YR	3	1	8.28	0.640

Layer Type	Depth (m)	Rock Type	Below Shale Seam?	Hue	Valu	Chroma	Sat Pst pH	Sat Pst EC
A	0.02	Soil	no	7.5YR	2.5	2	**4.52**	**0.25**
Bw	1.5	Soil	no	10YR	5	6	**5.64**	**0.11**
R1	3.5	SS	no	7.5YR	5	8	**7.92**	**0.22**
R2	3.9	coal	yes	10YR	2	1	**4.38**	**0.25**
A	0.04	Soil	no	10YR	2	1	**4.93**	**0.34**
Bw	1.25	Soil	no	10YR	5	6	**4.82**	**0.14**
R1	3.25	SS	no	7.5YR	4	6	**5.86**	**0.13**
R2	3.75	SS	no	7.5YR	4	6	**6.48**	**0.10**
R3	3.75	Shale	yes	7.5YR	3	1	**4.42**	**0.92**
A	0.03	Soil	no	10YR	2	1	**4.54**	**0.28**
Bw	1.35	Soil	no	10YR	5	6	**5.08**	**0.12**
R1	9	SS	no	7.5YR	4	6	**6.44**	**0.08**
R2	9.75	Shale	yes	10YR	3	1	**7.04**	**0.66**
R3	9.75	SS	yes	10YR	6	1	**7.94**	**1.05**

Possible Sources of Error and Interesting Notes



Fossils can be a useful indicator



Possible Sources of Error and Interesting Notes

pH	EC
6.85	0.62
6.69	0.18
5.05	0.10
6.65	0.13

Physical accessibility poses challenges for sampling some layers

Sampling at some sites was not deep enough to capture the change between weathered and unweathered materials.

Conclusions:

1. Both pH and EC generally increase with depth below surface.

2. The potential for higher EC materials drastically increases below a depth of about four meters.

3. Soil layers generally have a lower pH and EC compared to hard rock layers from the same location.

4. Certain factors, such as rock type, layer type, and location in relation to shale seem have a large influence on the relationship of pH/EC with depth.

Conclusions:

5. Munsell color (i.e. brown vs. gray) can indicate the degree of weathering, but is not an accurate predictor without considering other factors.

6. The boundary between weathered and unweathered materials is often a shale layer, which presumably retards the movement of water and oxygen deeper into the profile.

7. A larger sample set is needed to help improve the data set. (Sample collection is still under way.)

8. Other factors not explored here, such as reaction to Hydrochloric Acid, reaction to Hydrogen Peroxide, degree of cementation, presence of fossils, and pH/EC following rapid oxidation with Hydrogen Peroxide may prove to be useful indicators and we are currently investigating the these factors.

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