

Characterizing Soil Variability of a Research Farm Using Order 1 Soil Survey on Loess Covered Till Plain

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Abstract:

Knowledge of spatial extent of soils on a research farm is imperative in designing and arranging test plots. Soil variability should be minimized within experimental designs for most agronomic research. Some of the variability in the research farm include: (1) loess thickness over till; (2) thickness of mollic epipedon; (3) depth and concentration of carbonates; (4) presence of sand or gravel layer at the contact between the loess and till; (5) wetness characteristics of the soil; and (6) sand wedges within the till. One hundred thirty-five pedons were sampled to describe the soil properties, about one for each acre of land. Sampling locations were found using GPS. A total of eleven concos were made for each soil. High resolution Digital Elevation Model and EM 38 data were useful in separating the soil series. Research plots are being established using the order 1 soil survey data collected.

The new Agronomy Farm is located 3 miles north of Brookings, South Dakota in MLRA 102A

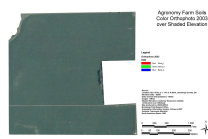


The parent materials are glacial till and outwash with a thin cover of loess

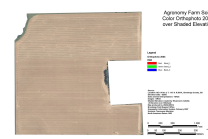
How was mapping done

Used a 1 acre grid with 135 GPS sampling locations
 Imagery used included: Color Orthophotos 2003, 2004, 2005
 A detailed elevation survey and slope map were completed before the soil mapping began
 An EM 38 survey and map were completed prior to mapping
 Flags were placed at GPS points prior to mapping
 Collected a tray sample at 135 locations using a 2 or 2.5 inch soil sampling tube
 Soil features noted included: soil horizons, mollic thickness, depth to carbonates, depth to redox features, texture, parent materials, etc.
 Checked soils with push probe in at least another 135 locations between the GPS points
 The field work took about 8 days

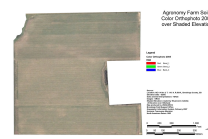
The 2003 Orthophoto was not very useful due to uniform crop on the field



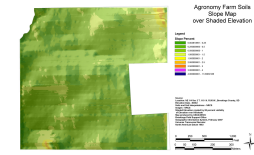
The 2004 Orthophoto was not very useful due to uniform crop on the field



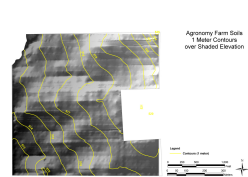
The 2008 Orthophoto was not very useful due to uniform crop on the field



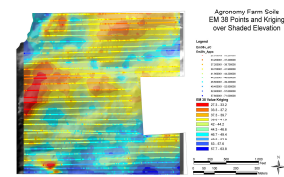
Slopes were generally less than 2 percent except a small 2-6 percent area in the southwest part of the farm. The map is made from the elevations collected by a survey grade GPS.



Relief on the farm was about 12 meters



The EM 38 data was useful in mapping the soils; however, the same color did not always relate to the same soil. Kriging is a method of making a raster layer from point data by evaluating the neighboring data points.

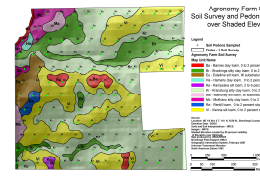


Example Tray Sample - SDSU Agronomy Farm

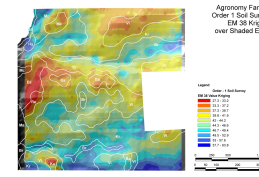
November 16, 2006
 Row 10 Column 3
 Brookings (border to McKranz)
 135 Tray samples were taken.
 All pedons were assigned the best series.
 Sand wedges were noted.
 Many pedons had more worm working than is typical of the series.
 Carbonates were brought by worms several inches above the main Bk horizon and also black non-calcareous can be found several inches into the Bk horizon.
 A detailed description could be written of each location.



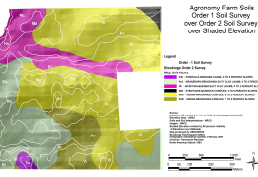
Ten concos (single name map units) were used to describe the soils on the farm. Tray samples were collected at each GPS point.



Droughty soils on more convex locations had lower EM 38 values and had a relationship to the soils. More moist soils had a lower value. However, the same soil may have a different value in another part of the farm.



The colored polygons are for the Order 2 soil survey. Many more polygons were mapped on the Order 1 survey. Generally, many of the same soils were found, but at different detail.

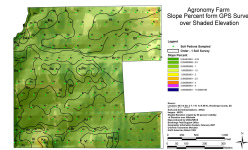


Order 1 vs. Order 2

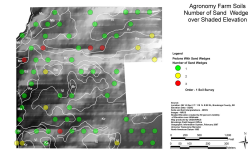
Conco-sos
 Scale 1:3000
 Sampled or checked about 2 places per acre or total about 270 acres or total about 14 places
 Field work took about 8 days
 Profile descriptions taken: 135

Complexes
 Scale 1:20,000
 Sampled or checked about 1 places per 10 acres or total about 14 places
 Field work took about 2 hours
 Profile descriptions taken: none

Slopes were generally less than 2 percent except a small 2-6 percent area in the southwest part of the farm (Ka - Kampska). The detailed slope map was a time saver and useful. Slope checking during mapping was not necessary.



Sand wedges are common in this till sheet. They are generally diagonal or vertical and fill to 1 inch thick. It is believed that the sand wedges formed as this Early Wisconsin Age till dried. Clacks formed and sand blew in the cracks. I estimate that there is a sand wedge at about every 2 to 3 feet in the glacial till. Most of the wedges would reach the top of the till at some point.



Note the sand wedge in the lower center of the photo

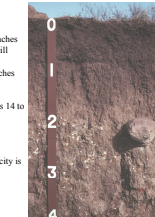


Kranzburg/Brookings Association is on part of the farm. The higher positions are Kranzburg and the lower positions are Brookings. The whitish areas are Kranzburg and the drainage ways are Badger. (not photo of farm but similar landscape)



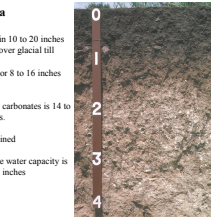
Kranzburg

Formed in 20 to 40 inches of loess over glacial till
 Dark color 7 to 16 inches deep.
 Depth to carbonates is 14 to 36 inches.
 Well drained
 Available water capacity is about 11 inches



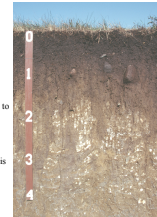
Vienna

Formed in 10 to 20 inches of loess over glacial till
 Dark color 8 to 16 inches deep.
 Depth to carbonates is 14 to 26 inches.
 Well drained
 Available water capacity is about 11 inches



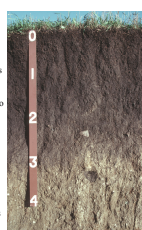
Barnes

Formed completely in glacial till
 Dark color 8 to 16 inches deep.
 Depth to carbonates is 10 to 24 inches.
 Well drained
 Available water capacity is about 10 inches



Brookings

Formed in 20 to 40 inches of loess over glacial till
 Dark colors 16 to 25 inches deep.
 Depth to carbonates is 20 to 38 inches.
 Moderately well drained
 In lower landscape positions that accumulate sediments and water during heavy rainfall events.
 Available water capacity is about 11 inches

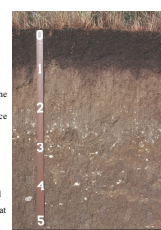


Kranzburg and Brookings soil in brownish areas. McKranz soil has a whitish crust. Badger soil is the area where the water concentrates and flows. (not photo of farm but similar landscape)



McKranz

(Formerly McLatoh)
 Formed in loess over glacial till
 Upward water movement brings the carbonates to the surface. There may be a grayish crust on the surface in the spring or other wet periods when the water is moving up.
 Dark color 7 to 16 inches deep.
 Somewhat poorly drained
 Carbonates are generally at the surface or within 7 inches.



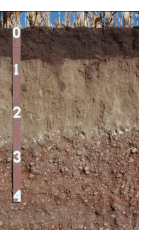
Estelline

Formed in 20 to 40 inches of loess over glacial outwash
 Estelline on Agronomy Farm has till at 40 to 60 inches
 Dark colored usually 7 to 16 inches.
 Depth to carbonates is 15 to 40 inches.
 Well drained - Available water capacity is about 7 inches

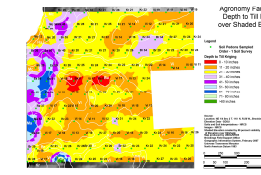


Kampska

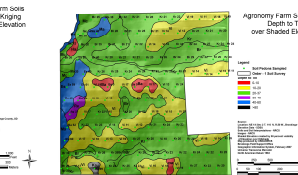
Formed in 20 to 40 inches of loess over glacial outwash
 Kampska on Agronomy Farm is on this ridge
 Dark colored usually 7 to 10 inches.
 Depth to carbonates is 0 to 7 inches.
 Well drained - Available water capacity is about 5 inches



The Kriging values generally follow the depth to till of the map units mapped.



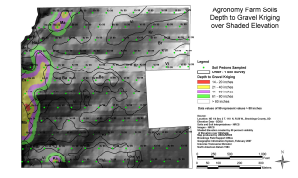
Depth to till using the detailed soil mapping. Note that the series are distinct categories based on till depth and landscape changes.



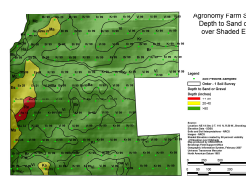
Statistics for depth to till of the map units with 5 or more data points. Depth to till is Vienna < Kranzburg < McKranz < Brookings < Estelline

Depth to Till	Brookings Depth Till	Estelline Depth Till	Kranzburg Depth Till	McKranz Depth Till	Vienna Depth Till
Count	15	5	61	7	40
Average	30.3	54.6	23.4	24.1	15.9
Max	40	61	34	34	21
Min	21	43	20	12	11
StdDev	6.20	7.83	2.88	7.58	2.65
High Normal	37	62	26	32	19
Low Normal	24	47	20	17	13

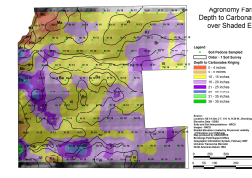
All of the soils underlain by sand or gravel are in the west part of the farm. Most of the depths were from 20 to 40 inches. With the exception of the Kampska area, these areas are underlain by till at depth of 40 to 60 inches.



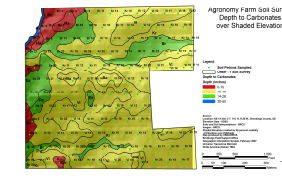
The gravel becomes thinner at the edge of the map unit rather than deeper as the Kriging would indicate.



Depth to carbonates is influenced by landscape position, parent materials, and the direction of water movement (up or down).



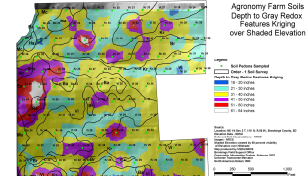
Most McKranz, Hamery, Mahoney and Kampska soils have carbonates at the surface or within 7 to 10 inches. Though the ranges overlap, the Brookings, Estelline and Restill soils are deeper to carbonates than the Vienna and Brookings soils. Badger soil generally are > 38 inches to carbonates. No sampling points fell in the Badger and Hamery soils.



Statistics for depth to carbonates of the map units with 5 or more data points. Depth to carbonates is McKranz < Vienna < Kranzburg < Estelline < Brookings

Depth to Carbonates	Brookings Depth Carb	Estelline Depth Carb	Kranzburg Depth Carb	McKranz Depth Carb	Vienna Depth Carb
Count	15	5	61	7	40
Average	20.5	19.8	15.6	5.0	14.8
Max	39	28	28	9	22
Min	12	15	10	0	10
StdDev	7.01	5.36	3.56	4.69	3.11
High Normal	28	25	19	10	18
Low Normal	14	14	12	0	12

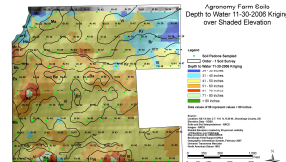
Kriging depth to gray redox features.



Statistics for depth to Gray Redox Features for soils with more than 5 data points. Depth to gray redox features is McKranz < Vienna < Kranzburg < Brookings < Estelline. Logic would have the gray features higher in the Brookings soil. This same observation has been made in other areas comparing the darker low landscape soil with soils on higher landscape positions.

Depth Gray Redox Features	Brookings Depth Gray	Estelline Depth Gray	Kranzburg Depth Gray	McKranz Depth Gray	Vienna Depth Gray
Count	15	5	61	7	40
Average	39.5	49.8	33.5	29.9	32.5
Max	64	61	67	43	61
Min	27	38	21	20	18
StdDev	9.45	9.98	7.74	8.11	8.91
High Normal	49	60	41	38	41
Low Normal	30	40	26	22	24

All sampling locations had free water within a depth of 80 inches on Nov. 30, 2006. Except the Kampska soil. The wheat field has not used much water since early July. The water was closest on the McKranz and Mahoney soils.



Statistics for depth to Water on November 30, 2006 for soils with more than 5 data points. Depth to water is McKranz < Kranzburg < Brookings < Vienna < Estelline

Water 11-30-2006	Brookings Dep Water	Estelline Dep Water	Kranzburg Dep Water	McKranz Dep Water	Vienna Dep Water
Count	15	5	61	7	40
Average	45.7	51.2	45.4	38.3	47.5
Max	69	67	56	67	73
Min	32	46	28	24	32
StdDev	8.47	4.87	7.08	7.80	7.66
High Normal	54	56	53	46	55
Low Normal	37	46	38	30	40

Results and Discussion

An effort was made to make the best soil map possible for the farm. The images available were not very useful due to the date they were taken and the vegetative cover. The EM 38 data was very useful in mapping the soils; however the break was not the same in all areas of the field. The Order 1 soil survey will be useful in laying out experimental plots. The soils are as uniform as can be expected for the parent material present. Overall a good location for an experiment farm.

Acknowledgements

Thanks to Joe Schumacher who completed the detailed elevation survey, EM 38 survey, and marked the GPS points prior to mapping. Thanks to Carrie Werkmeister who helped run the probe truck and collected water data. Thanks to Doug Malo for organizing the soil mapping effort.

