United States Department of Agriculture

Soil Conservation Service

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

Subject: SOI - Investigations - Fragipan/Dense Till Study - New York, Connecticut and Massachusetts

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To:

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PURPOSE

The primary objective of the Fragipan/Denrse Till Soils Study in New York, Connecticut and Massachusetts was to review the techniques and procedures to consistently identify their properties in the field, and test the proposed fragipan and dense till classification criteria. We also evaluated the soil moisture and temperature regimes and organic matter component of these soils as impacting the Global environment.

The results of this study will enable the states in Region R and adjacent states to consistently apply the revised definitions for the classification of fragipan and dense till soils with the update of soil surveys.

This study was co-sponsored by the State Soil Scientists and their staffs in New York, Connecticut and Massachusetts, and the Soil Survey Quality Assurance Staff, and was held during the week of October 4 - 8, 1993.

PARTICIPANTS

See enclosed list

ACTIVITIES

The study started at the Voorheesville County Field Office in New York at noon on October 4, 1993. Cal Perkins, Area Conservationist, (also National President of Soil and Water Conservation Society) welcomed the participants to New York and Southern New England for this investigation study of fragipan and dense till soils.

A field study guidebook that was prepared by Ed Stein, Resource Soil Scientist and Will Hanna, State Soil Scientist in the state of New York. Each participant received a copy at the start of the study. This guidebook contained the pedon descriptions, geology and landscape information and laboratory data for all the soils reviewed during this study. The Soil Survey Quality Assurance Staff provided all participants with the latest criteria for identifying and classifying fragipan and dense till soils in the field, which was also included in the guidebook. The soils staff of these three states selected 14 sites for this investigative study (7 in New York, 4 in Connecticut, 3 in Massachusetts).

Each soil site was excavated by a backhoe, which enabled all participants to make a thorough review of the morphological and diagnostic properties for the classification of these soils. The available laboratory data enabled all participants to relate actual data to the observed soil properties in the field. The group discussed the observed and measured fragic and densic properties, redoximorphic features and other diagnostic characteristics, and tested the new criteria for the taxonomic classification of the soils at each site.

RECOMMENDATIONS
We want to commend Ed Stein, Will Hanna, Dick Scanu, Kip Kolesinskas and the soil survey staff members in their states for a well organized and constructive field study of fragipan and dense till soils in the states of New York, Massachusetts and Connecticut. All the diagnostic criteria proposed for the identification of fragipan and dense till soils, as listed in the guidebook, were used in the classification of these soils. Ed also provided a statistical evaluation of available data.

All participants were given the opportunity to use the techniques and procedures identified, at the start of the study, to make the fragipan and dense till determinations. After each site was reviewed in the field, the classification of soils was determined, and then the notes from the discussions were summarized and included as an enclosure to this report. The recommendations from this study will be sent to the Taxonomy Committee.

TECHNOLOGY TRANSFER
We are very pleased with the close cooperation of the soil survey staffs who were involved with this study: New York, Massachusetts, Connecticut, Pennsylvania, Ohio, Vermont, New Jersey and New Hampshire. We are also pleased with the excellent cooperation of the SCS soils staffs, the soil science staffs, and members of universities in these respective states. All the participants at this study have been shown the technological skills and procedures to identify the fragipan and dense till properties in the field and consistently apply these techniques and train field soil scientists and university students in their respective states.

All the participants were very professional in sharing their knowledge and experience with fragipan and dense till soils and very cooperative in all decisions for classifying these soils. Again, we want to compliment the Soil Survey Staffs in New York, Connecticut and Massachusetts for a job well done and we are looking forward to working with your staffs in the future.

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Enclosure:

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FRAGIPAN AND DENSE TILL SOILS STUDY
New York - Connecticut - Massachusetts
October 4 - 8, 1993

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COMMENTS ON OBSERVATION AND PROPOSED CLASSIFICATION

FRAGIPAN AND DENSE TILL SOILS STUDY

October 4 - 8, 1993
New York, Connecticut, Massachusetts
By
Loyal A. Quandt and Carl L. Glocker

Site 1. Monarda - Columbia County, New York
Classification:coarse-loamy, mixed, mesic Aeric Fragiaquepts
Land Form: Shoulder of Glaciated Hill
Morphology: very coarse prismatic structure (columns)
roots in seams 20-50 cm apart
top of fragipan at 50 cm
Fe & Mn (at 35 cm) masses along prism faces
maximum bulk density - 1.8
dense basal till (5/2 lithic chronic) >100 cm

Site 2. Ashfield - Franklin County, Massachusetts
Proposed Classification: coarse-loamy, mixed, frigid Densiaquic Dystrochrepts
Landform: Dissected alluvial fan
Morphology: platy structure (upper 12 cm of Cd)
structural dessication cracks with depth
roots restricted to cracks (>75 cm apart)
consider cracks as stress or dessication
>90 % dense brittle basal till at 63 cm
faint redox features in upper part
maximum bulk density - 1.88
consider BCd horizon for Cd1 horizon

Site 3. Bernardston - Franklin County, Massachusetts
Proposed Classification: coarse-loamy, mixed mesic Typic Densiochrepts
Landform: Crest of drumloidal hill
Morphology: platy structure (upper 12 cm of densic material)
structural dessication cracks with depth
root restrictive at 60 cm depth
stress & dessication cracks >60 cm apart
> 90 % dense brittle basal till
iron coats in upper part of cracks
maximum bulk density - 1.77 (1.8)
consider BCd horizon for Cd1

Site 4. Montauk (Becket) - Franklin County, Massachusetts
Proposed Classification: coarse-loamy, mixed, mesic Typic
Densiochrepts
Landform: Convex side slope of glaciated hill
Morphology: platy structure (upper 9 cm of densic material)
structural dessication cracks with depth
root restrictive at 60 cm depth
> 95% dense brittle basal till (lithic chromic)
no redox features
lithologic discontinuity at densic contact point
maximum bulk density - 1.8

Site 5. Wethersfield - Middlesex County, Connecticut
Proposed Classification: coarse-loamy, mixed, mesic
Densic Dystrochrepts
Landform: Dissected hillside
Morphology: platy structure (upper 20 cm of densic material)
structural dessication cracks with depth
argillan in vesicular pores at 60 to 70 cm
root restrictive at 70 cm depth
> 95% dense Illinoin till? - Triassic material
redox features below 100 cm - red mattrix mask
Fe oxides and masses?
maximum bulk density - 1.7
consider BCd horizon for Cd1

Site 6A. Wethersfield - Middlesex County, Connecticut
Proposed Classification: coarse-loamy, mixed, mesic
Densic Dystrochrepts
Landform: Crest of drumloidal hill
Morphology: platy structure (upper 40 cm of densic material)
structural dessication cracks with depth
evidence of argillans or coatings at 55 - 100 cm
root restrictive at 56 cm depth
desssication cracks >75 cm apart below 100 cm
and > 90% densified mattrix
redox features are masked by red mattrix color?
bulk density range 1.6 - 1.8 in lower part
some observed lithologic discontinuity at 56 cm

Site 6b. Cheshire - Middlesex County, Connecticut
Classification: coarse-loamy, mixed, mesic Typic
Dystrochrepts
Landform: Lower footslope of same drumlin as 6a
Morphology: Ablation till from Triassic materials
Solum to 65 cm and Bulk density of
substratum is 1.3 - 1.4

Site 7. Paxton - Litchfield County, Connecticut
Sunny Valley Conservancy District Farm

Proposed Classification: coarse-loamy, mixed, mesic Densic Dystrochrepts

Landform: Summit of Drumloidal Hill

Morphology: platy structure (upper 20 cm of Cd) then cracks
faint redox features in this layer, consider BCd
> 85% brittle basal unoxidized till - geogenic
root restrictive at 42 cm with Bd of 1.7
maximum Bd of 1.8 at 150 cm
dessication cracks at 90 cm spacing

Site 8. Paxton (Woodbridge) - Westchester County, New York

Proposed Classification: coarse-loamy, mixed, mesic Aquic Densiochrepts

Landform: Footslope of glaciated hill

Morphology: extremely coarse prims or cracks in substratum
platy in upper 25 cm in substratum
root restrictive at 64 cm
dessication cracks at > 65 cm spacing
> 90% dense brittle basal till
bulk density 1.8 in Cd1 & 1.9 in Cd2
some evidence of pedogenic development in Cd1 horizon

Site 9. Morris - Delaware County, New York

Classification: coarse-loamy, mixed, mesic Aeric Fragiaquepts

Landform: Foot slope of glaciated hill

Morphology: Fragipan (40 cm thick) over dense basal till
root restrictive at 40 cm
very coarse primatic (columnar) structure over dense brittle basal till
redox features and clay films in fragipan
bulk density: fragipan - 1.7, dense till - 2.0
diagnostic abic seams in fragipan 10-60 cm apart
dessication cracks in dense till > 75 cm apart

Site 10. Willdin (Mardin) - Delaware County, New York
Steve Seifried farm

Classification: pedon observed considered an inclusion in Mardin soils and classify as coarse-loamy, mixed, mesic Typic Fragiochrepts - if top of Fragipan below 100 cm then Fragalbic Dystrochrepts

Landform: Colluvium on toe slope of glaciated hill

Morphology: root restrictive at 90 cm
albic seams, redox features, argillans start at 90 cm - very coarse prismatic structure
at east edge of pit a albic horizon at 102 cm
65% of the fragipan is brittle prims
bulk densities of Bx horizons are 1.7

Site 11. Ontusia - Delaware County, New York
Classification: fine-loamy, mixed, mesic Aeric Fragiaquepts
Landform: Sideslope - glaciated hill
Morphology: very coarse prismatic with albic seams 10 to
50 cm apart - 70% of mattrix is brittle
maximum bulk density - 1.8
prominent redox features - argillans in pores

Site 12. Road Cut - Otsego County, New York
Observed fragipan properties in a shallow road cut - perched watertable and root restrictions and influence of available water holding capacity on crops in adjacent fields

Site 13. Lansing - Schoharie County, New York
Proposed Classification: fine-loamy, mixed, mesic Fragic (Densic) Glossudalfs
Landform: Shoulder of Drumloidal Hill
Morphology: albic and a transitional albic over argillc
horizons - many medium pores in subsoil
root restrictive at 95 cm - wavy boundary
bulk density in C is 1.7 - in Cd 1.8
redox features is prominent in lower subsoil
and substratum - also dessication cracks
calcareous at 140 cm

CLASSIFICATION OF DENSIC SOILS

The proposed criteria for the classification of Densic soils were reviewed by all the participants at the Fragipan/Dense Till soil study in New York, Connecticut and Massachusetts. During the exit conference on Friday, October 8, 1994 the group recommended the following:

1. That Dense Basal Till soils be recognized at the Great Group and Subgroup level in the Taxonomic Classification of Soils. Examples as follows:

   Great Group: Densiorthods, Densiochrepts,

   Subgroup: Densic Dystrochrepts, Densic Haplorthods
Densiaquic Dystrochrepts

2. That Taxonomic definitions be developed for these categories and sent to the Northeast Taxonomy Committee. Enclosed are these revised definitions for your review and comments. We request that your staff review these definitions and the other options and send your comments to Loyal or Carl by March 30, 1994.

3. We included another option of adjusting the proposed definition for Fragipan (Fragalbic) to accomodate some of the Densic soils especially those with pedogenic development in the upper part of the pan.

At the present time, we will continue to classify these Densic soils as Series differentiae. Any recommended changes for Soil Taxonomy is a time consuming process, however, these changes should be recognized in the future update of soil surveys by the MLRA process.

DENSIPAN

A densipan is a very dense, very slowly permeable, acid, mostly loamy subsurface soil material that can underlie an albic, argillic, cambic, or spodic horizon. This horizon restricts the entry of very fine and fine feeder roots. It has very high bulk density. There are a few, faint coats of any kind on faces of peds. Most soils with densipans formed in cool, humid climates under forest vegetation.

Most of the soil matrix is brittle. Interparticle binding is at least partially the result of earthy fragment structure (SSM-Oct. 1991 p. 163) and its resistance to wetting and drying. It is dominantly loamy particle size class, very low shrink swell, low base saturation, and low reaction contribute to this brittleness.

Densipans have all of the following properties:

1. The faces of peds have minimal evidence of pedogenesis. There are a few faint organo-clay coats, or few coats of albic material on faces of peds in the upper part.

2. The soil material of the densipan has structural dessication cracks (SSM 10/91 p.168) and platy structure in the upper part. The smallest diameter of the extremely coarse prisms (closed loop), if present, is 75 cm.

3. The moist (33kPa) bulk density is 1.7g cm-3 or more where the clay content is 25 percent of more, or 1.8g cm-3 or more where the clay content is less than 25 percent.

4. The thickness is 15 cm or more.

5. The clay content is 5 to 35 percent. The content of sand coarser than very fine is less than 75 percent.

6. The top of the Densipan is within 100 cm of the mineral soil surface.

7. The matrix is brittle is 90 percent or more of the volume. a/

8. The rupture resistance class is uncemented. It slakes when air-dried and submerged in water.

9. The COLE is < 0.03; the WRD is $< .07$ cm/cm; reaction class is strongly acid or more acid. (consider as criteria).

a/ A specimen is defined as brittle if the matrix, when at or near field capacity, undergoes sudden nonplastic deformation when compressed between thumb and forefinger.

Example - Great Group Classification

ABCD. - Other Ochrepts that have a densipan that has it top within one meter of the mineral soil surface.

Typic Densiochrepts

DENSIC PROPERTIES

Densic properties of subsurface horizons are physical soil properties that restrict the entry of very fine and fine feeder roots. They have all of the properties listed for densic horizons except for any or all of the criteria, as modified below:

1. Some vertical dessication cracks or seams are present, a few form closed loops 10 to 75 cm in diameter.

2. The particle size distribution is as follows; less than 5 percent clay, more than 35 percent clay or, more than 75 percent fine sand and coarser.

3. Brittle in 40 to 90 percent of the matrix. a/

4. The moist (33kPa) bulk density is less than 1.7g cm-3.

5. The COLE is 0.03 - 0.06; the WRD is 0.07 - 0.10, reaction class is less acid than strongly acid. (consider as criteria)

a/ A specimen is defined as brittle if the matrix, when at or near field capacity, underggoes sudden nonplastic deformation when compressed between thumb and forefinger.

Example - Subgroup Classification

EFG. - Other Dystrochrepts that have densic soil properties within a depth of 100 cm, or have the top of the densipan between 100 to 200 cm.

Densic Dystrochrepts

DENSIC CONTACT

A densic contact is a boundary between a albic, cambic, argillic or spodic and the dense underlying soil material. It differs from a paralithic contact in that the underlying soil material is not continuous, coherent rock-like material. It differs from lithic contact in that it does not have the hardness associated with indurated bedrock. It differs from fragipans in that it has little pedogenic development, redoximorphic features and illuviated layer-lattice silicate clays.

When submerged in water, an air dry specimen of dense basal till completely slakes in less than 1 hour. Normally the soil material (in situ) underlying the densic contact has a bulk density greater than 1.8g cm-3, is brittle when moist, has dessication or stress cracks more than 75 cm apart, and has coarse platy structure (dominantly in upper part). The disturbed soil material of dense basal till is friable.

Densic contact can be used as subgroup classification

Example - Subgroup Classification
HIJK - Other Dystrochrepts that 100 cm or less to a densic contact.
Densic Dystrochrepts

DENSE BASAL TILL

Dense basal till vs ablation till is presently used as series differentiae in Northeastern states.

Example - Paxton Series

ADJUST PROPOSED FRAGIPAN DEFINITION

Use the present framework of the proposed two kinds of fragipans. To use this option the horizon described must be a B horizon (Bwd, BCd, Bd, Bgd or B?). The "dense till" horizons can be "soil" even though pedogensis is not well expressed. The platy nature of this material seems to favor the proposed Fragalbic pan. A revision of the fragalbic criteria is being prepared and probably be used in other areas even if it is not adopted in the Northeastern states.

Summary of Selected Data

BULK DENSITIES

Sites	Db (1/3 bar)	lower above	lower below	Al sat%	
1	1.57	yes	no-same	*	
2	1.88(63 cm)	yes	yes	60%	
3	1.77(51 cm)	yes	yes	67%	
4	1.82(102cm)	yes	yes	67%	
5	1.64(70 cm)	yes	yes	100%	
6a	1.77(190cm)	yes	yes	*	
6b	*	*	*	*	
7	1.78(60 cm)	yes	yes	*	
8	1.84(64 cm)	yes	no	* (pH 6.2)	
9	1.75(25 cm)	yes	yes	24(pH 4.7) 1/	
10	1.74(112cm)	yes	no	48 (pH 4.8)	
11	1.87(65 cm)	yes	yes	*	
12	Roadcut				
13	1.68(124cm)	yes	no	none (pH 5.9)	"friable till"
Conesus Series	1.66 (36 cm)	yes	yes	*	B/E

* Not determined

1/ 2.33 reported at 41 to 61 cm; with 1.75 above and 1.69 below. Is this Db accurate?

CLAY CONTENT

SITE	DEPTH	MOIST Db	DENSE HORIZON	ANY ABOVE	BELOW
2	63 cm	1.88	4.9	7.5	3.6
3	51 cm	1.77	16.3	14.2	15.9
4	102 cm	1.82	3.6	4.2	4.0
5	Doesn't make "densic" with data supplied.				
6a	56 cm	1.62(?)	8.5	12.1	17.0
7	60 cm	1.78	16.7	13.9	17.3
8	64 cm	1.82	6.0	8.1	8.4
10	105 cm	Ex here meets all Fragalbic criteria as presently written.			
10	66 cm	1.64	10.3	13.3	12.2
13	124 cm	1.68	9.8	25.4	none

EVALUATION-

1. Bulk density data strongly suggests that there has been at least some densification of the parent material. However it is possible that each strata has its' own bulk density and it just came out in this order. There is some problem with separating fine earth plus rock fragment bulk density from fine earth bulk density. Only Db of the fine earth fraction is considered here.

2. Clay contents are consistently lower in the first horizon having high Db than in an horizon below as required by the fragalbic pan. Site 7 is the only one that doesn't meet this criterion. Most of the sites have lithologic discontinuities above the "pan", and therefore, are not evidence of elluviation.

3. It appears that the two most critical factors for fragalbic horizons are met if these sites exhibit representative soils.