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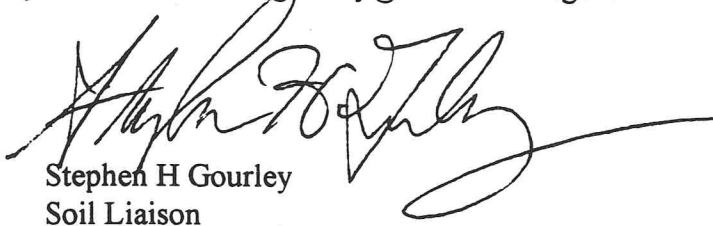
NCSS NE Conference Soil Taxonomy Committee Members

November 26, 1997

Attached is a proposal for amending the definitions of fragipans and densic materials. The proposal is based on the information that I presented at the Soil Taxonomy Conference in Portsmouth, NH and the discussion at the committee meeting that followed. A copy of my information is attached.

The purpose of the proposal is to clarify the difference between densic materials and fragipans. Please return any comments to me by December 20, 1997. I'll summarize them and passed them on to Bob Ahrens.

My email address is [sgourley@vt.nrcs.usda.gov](mailto:sgourley@vt.nrcs.usda.gov).



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Natural Resources Conservation Service  
formerly the Soil Conservation Service, works  
hand-in-hand with the American people to  
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# Soil Taxonomy Proposal

## Densic Materials

and

## Fragipans

Listed below are proposed revisions to the definitions of densic materials and fragipans. These proposals are based on the information that I presented at the Soil Taxonomy Conference in Portsmouth, NH. A copy of "The Great Fragipan Debate or The Never Ending Story" is included. As agreed at the Committee meeting held at the conference I am distributing it for comment before forwarding it to Bob Ahrens.

Please return any comments to me by **December 20, 1997**.

### Revised Definitions

These revised definitions are proposed to clarify the differences between densic materials mapped in New England and fragipans mapped in Region R.

#### Densic materials

Add after the 1st paragraph:

Densic materials share similar properties with fragipans but lack evidence of pedogenesis and are commonly much thicker than 200cm.

Densic materials commonly have platy or prismatic structure or are massive. Structure development is inherent in the parent material and was not formed by pedogenesis. Densic materials have firm of very firm consistence.

#### Fragipan

Revise the evidence of pedogenesis as follows:

A fragipan has evidence of pedogenesis, in addition to density and brittleness. The evidence, in the matrix, on faces of peds, in pores, or in seams, is in the form of bodies of oriented clay, clay films, clay linings, albic materials, iron or manganese oxides, or soil structure that differs from the structure of the substratum below the fragipan.

#### Densic Subgroup

I proposed that a densic subgroup be established to recognize those soils that are shallow to a densic contact.

Densic Subgroup - Other "insert great group names" that have a densic contact within 50 cm of the mineral soil surface.

## Discussion

There was a lively discussion at the conference in Portsmouth, on what defines evidence of pedogenesis. On one side is "pedogenesis begins as soon as the parent material is laid down." On the other side is "pedogenesis requires distinct evidence of alteration of the parent material." There were also views that fell in between the extremes. I don't think we need to resolve the evidence of pedogenesis question to refine the differences between fragipans and densic materials.

Inclusion of redoximorphic features and structure as evidence of pedogenesis for fragipans picks up all of those densic materials that have redoximorphic features and platy or prismatic structure. The Northeast Fragipan Study of 1977-1980 demonstrated that the structure of the densic materials in New England was not a result of pedogenesis.

An examination of the fragipans mapped in Region R showed that there is a change in structure from the fragipan to the underlying substratum. The fragipans are usually prismatic and the substratums are usually platy or massive. This change in structure and not just the presence of structure in the fragipan is evidence that the fragipan developed from pedogenesis.

Fragipans have a maximum thickness of 200cm. Densic materials in New England are observed in deep cuts extending to 30 feet or more. When fragipans overly friable parent materials the thickness of the fragipan is important to the user as was stated at the conference in Portsmouth. When fragipans overly densic materials there may not be a significant difference in interpretations and the thickness of the densic materials is more important than the presence of a fragipan from a users standpoint.

There were a number of suggestions at the conference in Portsmouth that densic materials or a densic contact should be recognized at the great group level as are fragipans and fragic soil properties. It was also suggested that they be recognized at the subgroup level as are lithic or paralithic contacts. Establishing a densic subgroup for soils that are shallow to a densic contact would recognize the significance of depth to a densic contact. As with lithic and paralithic contacts, if depth to a densic contact is moderately deep or deeper it would not be recognized taxonomically.

# **The Great Fragipan Debate or The Never Ending Story**

## **Background**

In 1976 fragipans soils were mapped throughout Northern New England. In New Hampshire they were described with Cx horizons that were typically firm and brittle with weak to moderate thin to thick platy structure. They extended from about 15 inches to more than 65 inches below the surface. A lower boundary was rarely described. There was a cambic or spodic horizon described in the solum.

It was thought that these fragipans were not genetic in nature and as a result were not described with Bx horizons. The fragipans remained unchanged when seen in deep cuts of 20 feet or more. They appeared to be parent material that was compressed by the weight of the glacier.

## **Northeast Fragipan Study**

A Northeast Fragipan Study was initiated in 1977 to study those soils being mapped as fragipan soils. The study concluded that these soils could be divided into three groups as follows:

1. Soils that have true genetic fragipans.
2. Soils forming in essentially unaltered dense basal till.
3. Soils forming in dense basal till that has been affected by soil forming process.

Soils in group one were the least extensive and were seen only on the Tug Hill Plateau in New York and in Vermont. They had the following characteristics:

1. Coarse prismatic structure with well defined prism faces.
2. Continuous clay films on ped faces.
3. Firm and brittle peds.
4. Definite lower boundaries.
5. Predicable landscape positions.

Soils in group 2 were the most extensive. They had the following properties:

1. Platy structure with plates that tapered laterally to form lens shaped overlapping peds.
2. Peds were commonly found at angles of 30 to 45 degrees to the soil surface.
3. Prisms were common, but were thought to be stress or desiccation fractures because the fracture extended to 20 feet or more and they were widest at the top.
4. The dense till was observed to depths of 30 feet or more.
5. Stratification with friable to loose material could occur randomly through out the dense till.
6. Unpredictable landscape positions.
7. Silt or sometimes clay coatings on dense till fragments were observed at depths ranging from the top of the till to 30 feet or more. This was not considered pedogenic evidence because of depths at which it was observed and the perceived age of the soils.

Soils in group 3 were similar to group 2 except that some pedogenesis was observed in the upper part of the till.

The Northeast fragipan study concluded that most of the "fragipans" in New England were not genetic in origin and should be considered dense basal till. Many of the fragipan soils in New England were reclassified to non fragi great groups. The study proposed using the subscript r instead of x for a horizon designation.

criteria for evidence of pedogenesis, which would eliminate some well drained soils currently described with fragipans.

The change to structure and redoximorphic features as evidence of pedogenesis means that any dense till soil that has structure and redoximorphic features shows evidence of pedogenesis. Many dense till soils have platy structure. Well drained dense tills don't have redoximorphic features and would not show evidence of pedogenesis. The moderately well drained to very poorly drained members of the catena would show evidence of pedogenesis if the Cd horizon has platy structure.

There are 5 properties proposed for fragipan identification in the revised chapter 3 of Soil Taxonomy. They are as follows:

1. The layer is 15 cm or more thick; and

Almost all Cd horizons would meet this criteria.

2. It has evidence of pedogenesis, within the horizon or, at a minimum, on the faces of structural units; and

Many Cd horizons meet this criteria. Many have structure and redoximorphic features.

3. It has very coarse prismatic, columnar, or blocky structure of any grade, has weak structure of any size, or is massive. Separations between structural units that allow roots to enter have an average spacing of 10 cm or more on the horizontal dimensions; and

Many Cd horizons have weak structure or are massive. The 10 cm root separation rule is also a defined characteristic of a densic contact and densic materials. The 1976 to 1980 Northeast Fragipan study sighted evidence as to why very coarse prismatic structure is not always formed as a result of pedogenesis.

4. Air-dry fragments of the natural soil fabric, 5 to 10 cm in diameter, from more than 50 percent of the horizon slake when they are submerged in water; and

All Cd horizons should slake when submerged in water. Materials forming a densic contact are defined as slaking when submerged in water.

5. It has, in 60 percent or more of the volume, a firm or firmer consistence, a brittle manner of failure at or near field capacity, and roots virtually absent.

Roots can enter fragipans in cracks that are more than 10 cm apart, criteria 3. Cd horizons are firm and root restrictive by definition. They are often described as brittle in nature.

Clarification is needed on how to describe brittleness in the field. The Cd horizons in the dense till soils are often described as brittle. These may be older descriptions that were described as Cx horizons before 1980 but some of them are in fact brittle even by today's concepts. While brittleness doesn't appear to be excluded from densic materials it appears that exclusion was the intent of the definitions. However, because brittleness is an interpreted result that is the end product of other soil properties, it is reasonable to assume that some densic materials may appear to be brittle to some observers. Actually the definition of densic materials as late as February 1994 stated that densic materials were "brittle in 40 to 90 percent of the matrix." The proposal for the fragipan study that concluded in 1980 also referred to "dense brittle till" being different from fragipans.

The definitions of fragipans, fragic soil properties, and densic materials need to be revised. Unique characteristics of densic materials need to be identified. These characteristics should be recognizable in the field.

redoximorphic features or evidence of clay movement. The primary structure was typically massive or platy.

#### **Densic Materials Data**

There are 34 series mapped in New Hampshire and Vermont that have dense substratums. The following data was compiled:

Horizon designation.

Roots in the horizon above the dense layer.

Roots in the dense layer.

Location of a lower boundary of the dense layer.

Redoximorphic features in the dense layer.

Primary and secondary structure of the dense layer.

Consistence of the dense layer.

Evidence of pedogenesis in the dense layer.

#### **Discussion**

Soil drainage ranged from well drained to very poorly drained.

The horizons were predominantly described as Cd horizons. A few Cr and Cx horizons remain, which will be changed to Cd horizons by the next official series description updates.

Most of the well drained soils do not have redoximorphic features in the Cd horizon. All of the moderately well drained to very poorly drained soils had redoximorphic features in the Cd horizon.

All of the Cd horizons were described to a depth of 65 inches below the soil surface.

Primary structure of the Cd horizon was typically platy or massive. A few had prismatic structure.

Most of the Cd horizons were described with firm or very firm consistence. One third of the Cd horizons were described as brittle.

Almost half of the Cd horizons met the definition of evidence of pedogenesis with structure and redoximorphic features. Only one was described with clay films.

#### **Summary**

There are significant differences between the fragipan soils mapped in region R and those soils that are being described with densic materials in New Hampshire and Vermont.

Fragipans are identified as a form of a Bx horizon with either clay films or clay pore linings. They are brittle. They typically have very coarse prismatic structure. The structure changes to massive or platy in the horizons below the fragipan. The lower boundary of the fragipan is usually observed in a 65 inch profile.

Densic materials are identified with a Cd horizon. There are no clay films or clay pore linings present. They are sometimes described as brittle. They typically have massive or platy structure. They always extend to deeper than 65 inches below the surface.

The following is suggested as a modification densic materials:

The first 2 paragraphs are OK as is. Add the following paragraphs for clarification.

Densic materials commonly have platy structure or are massive. Structure development is inherent in the parent material and was not formed by pedogenesis. Densic materials have firm or very firm consistence and may occasionally appear to be brittle in nature.

Densic materials are share similar properties with fragipans. However, densic materials lack evidence pedogenesis and are commonly much thicker then 200 cm.

### **Summary**

Fragipan soils in region R have characteristics that differ from the soils that are mapped as densic basal till soils in New Hampshire and Vermont. Fragipans and densic materials share common properties. But, there are distinct properties, that can be identified in the field, that separate fragipans from densic materials. Soil Taxonomy should be revised to highlight the differences between fragipans and densic materials.

## Fragipan Data

Roots in the fragipan		
None		34
Along prism faces		18
Between prisms		6
Few		3
Very few		1
Common		1
Redox features in the fragipan		
Yes		46
No		17
Other evidence of pedogenesis in the fragipan		
Clay films		39
Clay pore linings		18
Albic material		3
None		3
Primary structure of the fragipan		
Very coarse prismatic only		42
Platy only		5
Subangular blocky only		2
Combinations with prismatic		14
Consistence of the fragipan		
Very firm		38
Few		18
Firm to very firm		7
Brittleness in the fragipan		
Brittle		56
Slightly brittle to brittle		5
Slightly brittle		2
E horizon just above the fragipan		
No		34
Yes		29
Designation of the horizon below the fragipan		
C		19
Cd		16
2C		6
BC, C		5
2Cd		3
Cdg		3
2B't		1
CB, Cd		1
None		9

## Densic Materials Data

<b>Soil Drainage</b>	
Well	9
Well/ Moderately Well	1
Moderately Well	10
Moderately Well/ Somewhat Poorly	1
Somewhat Poorly	2
Somewhat Poorly/ Poorly	2
Poorly	6
Very Poorly	3
<b>Horizon designation of the densic materials</b>	
Cd	29
2Cd	2
Cr	2
Cx	1
<b>Redoximorphic features in the densic materials</b>	
Yes	26
No	8
<b>Roots in the horizon above</b>	
Few	17
None	8
Common	6
Very few	2
Many	1
<b>Roots in the densic materials</b>	
None	27
Few	7
<b>Bottom layer below 65 inches</b>	
Yes	34
No	0
<b>Primary structure of the densic materials</b>	
Platy	10
Massive	9
Prismatic	5
Massive plus other	6
Other	4
<b>Consistence of the densic materials</b>	
Firm	21
Very firm	9
Extremely firm	1
Combination	3