This proposal is submitted in order to better describe, classify, and interpret soil material or soil horizons containing “high” or significant amounts of limnic material in soils that DO NOT classify as Histosols. This proposal specifically addresses diatomaceous earth material but should also be considered for marl and coprogenous earth materials.

PROPOSAL--This proposal is to change the use of limnic materials by allowing limnic material (nomenclature, textural modifier, limnic subgroup, substitute particle-size class and mineralogy class) to be used in soils that do not classify as Histosols.

This proposal has 5 parts, all of which are inter-connected, but parts 1, 2 and 3 could be acted upon separately from parts 4 and 5, however, parts 4 and 5 need to be addressed together. The 5 parts are as follows and are addressed separately below in this document;

1. Allow the use of the L master horizon to be used as horizon nomenclature when describing soils that do not classify as Histosols.
2. Allow the use of the diatomaceous, marly, and coprogenous earth textural modifiers to be used in describing soil texture for soil horizons in which the soil being described does not classify as Histosols.
3. Allow for the use of the Limnic subgroup to be used in other great groups outside of Histosol great groups.
4. Establish a substitute particle-size class (diatomaceous and perhaps marly and coprogenous) to be used in mineral soils containing limnic material.
5. Establish a mineralogy class (opaline) for mineral soils in which the substitute particle-size class of diatomaceous and perhaps marly, and coprogenous (item 4 above) are used.

BACKGROUND— In 2006 a field study tour was held in Klamath Falls, Oregon. The purpose was to observe, describe, classify, and interpret soil material containing various amounts of diatomaceous earth and to recommend changes to Soil Surveys Standards (Taxonomy, NSSH, Field Book for Describing Soils) in order to better capture the properties associated with diatomaceous earth. The following attachments are materials distributed to the field study tour participants along with the final comments and recommendations from the participants at each stop.

Attachment 1a-Objectives, issues, tasks and discussion at the field tour stops.
Attachment 1b-List of participants on the field tour.
Attachment 1c-Excerpt from “Guy Smith Interviews: Rationale for Concepts in Soil Taxonomy” indicating that Soil Taxonomy does not adequately address limnic materials in soils that are low in organic matter (soils not classifying as Histosols).
Attachment 1d-Diatomaceous earth references in Soil Taxonomy, NSSH and Field Book for Describing Soils per 2006.
Attachment 2a--Location of field tour stops.
PROPOSAL 1—Allow the use of the L master horizon to be used as horizon nomenclature in pedons that do not classify as Histosols.

Currently; per the 12th Edition 2014 Keys to Soil Taxonomy, page 335, second column, second sentence “They are used only in Histosols”. We recommend this sentence be deleted and allow for the use of the L master horizon to be based on the properties and observation of limnic materials in the soil horizon regardless of the pedon classification Soil Order.

L horizons or layers: Limnic horizons or layers include both organic and mineral limnic materials that were either (1) deposited in water by precipitation or through the actions of aquatic organisms, such as algae and diatoms, or (2) derived from underwater and floating aquatic plants and subsequently modified by aquatic animals.

L horizons or layers include coprogenous earth (sedimentary peat), diatomaceous earth, and marl. They have only the following subordinate distinctions: co, di, or ma. They do not have the subordinate distinctions of the other master horizons and layers.

As per attachment 1c (Guy Smith Interviews) and pedons observed during the field tour (stops 1, 3 and 4), significant amounts of diatomaceous earth do occur in pedons in which the soil does not classify as a Histosol. Due to the “unique” properties of the limnic material (see attachment 4a), the pedon
description/horizon(s) should be allowed to identify the layer/horizon with the L master horizon and the appropriate suffix’s co (coprogenous), di (diatomaceous), or ma (marl).

Pedon at tour stop 1 has limnic material from 33 to 61 centimeters (Eg horizon). Pedon classifies as Cryaquepts. The properties of the Eg horizon are—field texture silt loam with estimated clay of 10%, particle-size analysis texture silty clay loam with measured clay of 30%, calculated clay (15 bar water to clay ratio is >1.0) of 75%, liquid limit of 140, plasticity index is NP, bulk density is <0.6, total carbon is 3%. Recommend the Eg horizon be recognized as Ldi.

Pedon at tour stop 3 has limnic material from 11 to 65 centimeters (AE and Eg horizons). Pedon classifies as Cryaquepts. The properties of the AE and Eg horizons are—field texture silt with estimated clay of 10%, particle-size analysis texture silty clay with measured clay of 42%, calculated clay (15 bar water to clay ratio is 0.75) of 68%, liquid limit of 118, plasticity index is NP, bulk density is 0.7, total carbon is 3.5%. Recommend the AE and Eg horizons be recognized as Ldi1 and Ldi2.

Pedon at tour stop 4 has limnic material from 10 to 50 centimeters (A1 and A2 horizons). Pedon classifies as Cryaquepts. The properties of the A1 and A2 horizons are—field texture silty clay loam with estimated clay of 30%, particle-size analysis texture is clay with measured clay of 60%, calculated clay (15 bar water to clay ratio is 0.70) of 105%, liquid limit of 127, plasticity index is NP, bulk density is 0.65, total carbon is 15%. Recommend the A1 and A2 horizons be recognized as ALdi1 and ALdi2 based on properties of the diatoms (L) and accumulation of organic matter (A).

Pedon at tour stop 2 has limnic material from 97 to 145 centimeters (2Ldi1 and 2Ldi2 horizons). Pedon classifies as Cryopsaprists. The properties of the 2Ldi horizon are—field texture very fine sandy loam with estimated clay of 10%, particle-size analysis texture is silty clay loam with measured clay of 33%, calculated clay (15 bar water to clay ratio is >1.0) of 85 to 125%, liquid limit of 360, plasticity index is NP, bulk density is <0.3, total carbon is 3%. This pedon classifies as a Histosol and the L nomenclature is allowed. The soil properties in the L horizon material in pedon 2 (Histosol) are similar in trend to the properties in the Eg horizon in pedon 1 (Cryaquepts), the AE and Eg horizons in pedon 3 (Cryaquepts), and the A1 and A2 horizons in pedon 4 (Cryaquepts).

Based on similar properties, mode of soil formation, and parent material (diatoms) the horizon nomenclature should be similar. Thus the recommendation to allow the L master horizon to be used in horizon nomenclature outside of the Histosol order.

PROPOSAL 2—Allow the use of the diatomaceous, marly, and coprogenous earth textural modifiers to be used in describing soil texture for soil horizons in which the soil being described does not classify as Histosols.

Currently; The Field Book for Describing and Sampling Soils, Version 3.0, page 2-41; it states “Limnic Materials (used only in Histosols)”

Coprogenous COP

Diatomaceous DIA

Marly MAR
Currently; the National Soil Survey Handbook, part 618.71, item H2xi, provides guidance on the use of the coprogenous, diatomaceous, and marly textural modifiers, BUT there is NO mention that the modifiers are to only be used with Histosols (see NSSH guidance below).

Limnic materials have modifiers to texture to connote the origin of the material. The three kinds of limnic materials are coprogenous earth, diatomaceous earth, and marl. These materials were deposited in water by precipitation or through the action of aquatic organisms or derived from plants and organisms. Refer to the Keys to Soil Taxonomy for the complete definitions and taxonomic criteria of limnic materials. The following three compositional texture modifiers are used with limnic materials to indicate presence and origin without respect to any set quantity of pellets, grains, or particles:

- **Coprogenous.**—Soil material that is a limnic layer containing many very small (0.1 to 0.001 mm) fecal pellets.
- **Diatomaceous.**—Soil material that is a limnic layer composed of diatoms.
- **Marly.**—Soil material that is a limnic layer that is light colored and reacts with HCl to evolve CO₂.

Examples are "coprogenous silty clay loam," "diatomaceous very fine sandy loam," and "marly silt loam."

**Based on observation and measurement that limnic materials are present in horizons in which the pedon does not classify as a Histosol (see attachments 2b, 2d, and 2e), it is proposed that the guidance in the Field Book for Describing and Sampling Soils “(used only in Histosols)” be deleted. This will avoid confusion between the two documents and allow for the use of the textural modifiers to be based on presence of the material regardless of Soil Order.**

<table>
<thead>
<tr>
<th>LIMNIC MATERIALS (used only with Histosols)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coprogenous</td>
</tr>
<tr>
<td>Diatomaceous</td>
</tr>
<tr>
<td>Marly</td>
</tr>
</tbody>
</table>

NOTE: ashy and medial textural modifiers are NOT restricted for use only in Andisols. Ashy and medial modifiers are based on properties, this should be the case with the limnic modifiers.

**PROPOSAL 3**—Allow for the use of the Limnic subgroup to be used with great groups outside of Histosol great groups.

Currently; per 12th edition 2014 Keys to Soil Taxonomy, page 24, second column under Kinds of Limnic Materials, it states “The presence or absence of limnic deposits is taken into account in the higher categories of Histosols but not Histels”.

The current statement as mentioned above infers or is interpreted that limnic deposits are only to be recognized for classification purpose in the higher categories of Histosols but not Histels. Thus the Limnic subgroup and its criteria is NOT to be used outside of Histosols. As mentioned in the Guy Smith Interviews and as observed and measured at field tour stop pedons 1, 3, and 4 (see attachments 2b, 2d
and 2e), limnic materials are present in soils that do not classify as Histosols. The layers of these limnic materials are significant in thickness, have “unique” soil properties (see discussion under proposal 1 above), and can be consistently identified and measured. The thickness of the limnic material in pedon stop 1 is from 33 to 61 cm, pedon stop 2 is from 11 to 65 cm, and pedon stop 4 is from 10 to 50 cm. The material has a strong impact on soil interpretations and should be recognized at a classification level above the soil series level. It was the conscience of the field tour participants that pedons 1, 3, and 4 be best classified as Limnic Cryaquepts.

It is proposed that the limnic subgroup be allowed to be used in Soil Orders outside of Histosols. This will require the re-wording of the current statement as given above in the 12th Edition of the Keys to Soil Taxonomy.

Kinds of Limnic Materials

Limnic materials include both organic and inorganic materials that were either (1) deposited in water by precipitation or through the action of aquatic organisms, such as algae or diatoms, or (2) derived from underwater and floating aquatic plants and subsequently modified by aquatic animals. They include coprogenous earth (sedimentary peat), diatomaceous earth, and marl.

It is also proposed that the Limnic subgroup to Cryaquepts be established. The Limnic Cryaquepts would follow after Histic Cryaquepts (KAFE) in the sequence to the Cryaquepts subgroups. It is proposed the Limnic subgroup when used in mineral soils be as follows; “Other Cryaquepts that have one or more limnic layers with a total thickness of 12.5 centimeters or more beginning at or within 100 centimeters of the soil surface.”

KAFE. Other Cryaquepts that have a histic epipedon.  
Histic Cryaquepts

KAFF. Other Cryaquepts that have one or more limnic layers with a total thickness of 12.5 centimeters or more beginning at or within 100 centimeters of the soil surface.

Limnic Cryaquepts

KAFG. Other Cryaquepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, one or more of the following: .......

PROPOSAL 4—Allow for the establishment of the diatomaceous, marly and coprogenous earth terms to be used as substitute particle-size classes in mineral soils.

Currently; for mineral soils there are family particle-size classes and substitute particle-size classes. In the 12th Edition, 2014, Keys to Soil Taxonomy, page 317 under the heading Definition of Particle-Size Classes and Their Substitutes for Mineral Soils it states “The substitute classes are used for soils that have andic soil properties or a high content of volcanic glass, pumice, cinders, rock fragments or gypsum.” It is proposed that a substitute particle-size class term (s) be established when limnic materials comprise a layer 12.5 centimeters or more thick within or beginning within the particle-size control section. Since limnic materials typically develop in lacustrine deposits, it is anticipated that strongly contrasting family particle-size classes will be recognized/proposed and the aniso class used in family classification due to the stratification of lacustrine deposits.
Pedon stops 1 (Hoxie), 3 (Chinchallo), and 4 (Cosbie) are currently classified as Cryaquepts. The particle-size control section for the three pedons is 25 to 100 centimeters from the mineral surface.

The pedon at stop 1 is currently placed into a very-fine particle-size class based on “poor” dispersion. The ratio of water content at 15 bar tension to clay content is >0.6 (range is 0.87 to 1.88 AND <0.6 is considered dispersed) for the zone from 8 to 70 centimeters. Given the formula for calculating percent clay when exhibiting poor dispersion, the weighted average clay content for the upper part of the particle-size control section (25 to 70 centimeters) is 72 percent clay. The field estimated clay content for the same zone was 10 percent (silt loam and loam texture) and the laboratory measured clay content was 27 percent (fine-loamy). The placement into a very-fine family, “groups” this soil with other soils that are probably very high in measured clay and field estimated clay. The additional properties of low bulk density, very high liquid limit, and low plasticity index makes for the placement of this pedon into a very-fine family misleading for interpretations.

The pedon at stop 3 is currently placed into a very-fine family particle-size class. As with the pedon at stop 1, the ratio of 15 bar water tension to clay is >0.6 for the zone from 0 to 65 centimeters. Given the formula for calculating clay in soils with poor dispersion, the zone from 25 to 65 centimeters has weighted average clay content of 72 percent. The field estimated clay content was 10 percent (silt texture) and the measured clay content was 33 percent (fine-loamy). As with the pedon at stop 1 and this pedon, the very-fine family particle-size class placement is misleading for interpretations.

The pedon at stop 4 is currently placed into an ashy-pumiceous family particle-size class. The placement is based on the thickest part within the control section. The upper part of the particle–size control section (25 to 50 centimeters) has >0.6 ratio 15 bar water tension to clay and the weighted average calculated clay is 106 percent (very-fine). The field estimated clay was 10 percent (silt texture) and the measured clay was 60 percent (very-fine/fine). The lower part of the control section (50 to 100 centimeters is ashy–pumiceous. The pedon would classify as very-fine over ash or ash pumiceous if such a strongly contrasting class were approved, but since it not approved the thickest part rule applies for the family particle–size class placement. Again as with the pedons at stops 1 and 3, the upper part of this pedon is misleading for interpretations even if the strongly contrasting class of very-fine over ash or ashy-pumiceous were approved for use.

Based on the final comments from the field tour participants the conscience was to recommend placing the three pedons containing the diatomaceous/limnic material into a substitute particle-size class. The recommended substitute class term was diatomaceous. If a substitute class of diatomaceous were approved and strongly contrasting classes approved; the soil a stop 1 would be diatomaceous over loamy, stop 3 would be diatomaceous over ashy or ashy-pumiceous and stop 4 would be diatomaceous over ashy-or ashy-pumiceous.

It is proposed that a diatomaceous substitute particle-size class be established for use with mineral soils. A more comprehensive term could be considered if marly and coprogenous earth were to also be included as part of the substitute class definition. The diatomaceous substitute class would follow after the hydrous substitute class on page 321 of the 12th edition of Keys to Soil Taxonomy and be worded as: “They have a fine earth fraction consisting of limnic material and having a ratio of water content at 15 bar tension to clay of >0.6, moist bulk density of <0.80 g/cm3, and moist liquid limit is >100.”
c. Have less than 35 percent (by volume) rock fragments.

4. They have a fine earth fraction consisting of limnic material and having a ratio of water content at 15 bar tension to clay of >0.6, moist bulk density of <0.80 g/cm³, and moist liquid limit is >100.

Diatomaceous

5. They have, in the fraction less than 20 mm in diameter, 40 percent of more (by weight) gypsum and one of the following:

NOTE: The above criteria addresses diatomaceous earth and not marly or coprogenous earth limnic materials. A more generic substitute class term could be proposed if marly and coprogenous earth were to be included in the class, BUT the bulk density, liquid limit and dispersion criteria would need to be evaluated for the marl and coprogenous earth material.

PROPOSAL 5—Allow for the establishment of a new mineralogy class for use in mineral soils having a substitute class of diatomaceous (see proposal 4 above).

Currently; per 12th edition 2014 Keys to Soil Taxonomy, page 325, first column under Mineralogy Classes, it states, “A mineralogy class is assigned to all mineral soils, except for Quartzipsamments” and “The control section for the mineralogy class is the same as that defined for the particle-size classes and their substitutes.” Thus the mineral soils discussed under proposal 4 would need to be assigned to a mineralogy class. The current classes for use with substitute particle-size classes are; hypergypsic, amorphic, ferrihydritic, glassy and mixed. These classes are not well suited for limnic material and a new class is proposed.

Pedon stops 1 (Hoxie), 3 (Chinchallo), and 4 (Cosbie) are currently classified as Cryaquepts. The particle-size control section for the three pedons is 25-100 centimeters from the mineral soil surface. With the adoption of proposal 4 above for a “new” substitute particle-size class an associated “new” mineralogy class is also proposed.

The pedon at stop 1 is currently classified as very-fine, isotic

The pedon at stop 3 is currently classified as very-fine, mixed

The pedon at stop 4 is currently classified as ashy-pumiceous, glassy

With the establishment of the diatomaceous substitute particle-size class (proposal 4), the pedons would classify as;

Stop 1--diatomaceous over loamy, glassy over isotic
Stop 2—diatomaceous over ashy or ashy-pumiceous, glassy

Stop 3—diatomaceous over ashy or ashy-pumiceous, glassy

The glassy mineralogy class does not reflect the “unique” properties of the diatomaceous earth material even though glass content in the diatomaceous earth material is relatively high. Note: that diatoms are silica rich organisms and can appear as glass when broken. The following is a summary of the mineralogy information in the upper part of control section for the three pedons;

Stop 1 Hoxie; 25-70 cm ---25-61 cm has 21% diatoms and plant opal and 21% glass

61-70 cm has 2% diatoms and plant opal and 5% glass

Stop 3 Chinchallo; 25-65 cm---25-29 cm has 59% diatoms and plant opal and 35% glass

---29-65 cm has 52% diatoms and plant opal and 38% glass

Stop 4 Cosbie; 25-50 cm---25-30 cm has 30% diatoms and plant opal and 45% glass

---30-50 cm has 37% diatoms and plant opal and 22% glass

NOTE: The mineral counts were made on the coarse-silt fraction (0.02 to 0.05) of the 0.02 to 2.0 mm fine-earth particle-size range. For the three pedons, the total amount of fine-earth material between 0.02 and 2.0 mm ranges from 1 to 5%, thus 95 to 99% of the mineral fine-earth fraction is fine silt and clay size particles. The current placement into the glassy mineralogy family is based on only 1-5% of the total fine-earth fraction of sand, silt and clay. The limnic materials (diatoms) are dominantly fine silt and clay size.

It is proposed the term “opaline” be established as a mineralogy class to complement the proposed substitute particle-size class of diatomaceous (proposal 4). The mineralogy class would key out after B1 Hypergypsic on page 326 of the 12th edition of the Keys to Soil Taxonomy and be worded as “2. 30 percent or more (by weight) diatoms, plant opal and sponge spicules in the fine earth fraction.”

1. 40 percent of more (by weight) gypsum either in the fine-earth fraction or in the fraction less than 20 mm in diameter, whichever has a higher percentage of gypsum.

   Hypergypsic

Or

2. 30 percent or more (by weight) diatoms, plant opal and sponge spicules in the fine earth fraction.

   Opaline

NOTE; Proposal 4 and 5 need to be addressed together.

Given the establishment of the diatomaceous substitute particle-size class and the opaline mineralogy class, the pedons at stop 1, 3, and 4 would classify as;

Stop 1--diatomaceous over loamy, opaline over glassy

Stop 3—diatomaceous over ashy or ashy-pumiceous, opaline over glassy
Stop 4—diatomaceous over ashy or ashy-pumiceous, opaline over glassy

With the adoption of proposal 4 and 5, the family classification will more accurately reflect the properties and interpretations of the diatomaceous earth material.