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Enhancing Accuracy and Applicability of U.S. Soil Taxonomy

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SSSA 2020 — Future of Pedology Symposium

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Who am I?

Andrew G. Brown

- Soil Scientist in Sonora, CA, Southwest Soil Survey Region
- Area of responsibility: Sierra Nevada Foothills & Mountains (MLRAs 18 & 22A)
- Western Region National Cooperative Soil Survey (NCSS) Standards Committee (2018, 2020)
- Contributor to *Algorithms for Quantitative Pedology* Project (http://ncss-tech.github.io/AQP/)

The *Keys to Soil Taxonomy* are like a set of sieves

KST Lookup App: https://brownag.shinyapps.io/KSTLookup
KST Preceding Taxa App: https://brownag.shinyapps.io/KSTPreceding

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Keys to Soil Taxonomy (12th) - Preceding Taxa Lookup Tool [alpha]

Enter a taxon name:

Entisols

Showing taxa that key out before:

Entisols

Show 25 **entries**

Search:

	Content	Ch.	Pg.	Key	Taxa	Code	Logic
A	*Gelisols*, p. 157	4	38	Soil Orders	*	A	NEW
B	*Histosols*, p. 167	4	38	Soil Orders	*	B	NEW
C	*Spodosols*, p. 273	4	39	Soil Orders	*	C	NEW
D	*Andisols*, p. 87	4	39	Soil Orders	*	D	NEW

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Keys to Soil Taxonomy (12th) - Taxon Criteria Lookup Tool [alpha]

Enter a taxon name:

Glacistels

Results for *Glacistels*

English

Show 25 **entries**

Search:

	Content	Ch.	Pg.	Key	Taxa	Code	Logic
1	A. Soils that have:	4	38	Soil Orders	*	A	FIRST
2	**1.** Permafrost within 100 cm of the soil surface; *or*	4	38	Soil Orders	*	A	OR
3	**2.** Gelic materials within 100 cm of the soil surface and permafrost within 200 cm of the soil surface.	4	38	Soil Orders	*	A	END
4	Gelisols, p. 157	4	38	Soil Orders	*	A	NEW
5	AA. Gelisols that have organic soil materials that meet one or more of the following:	9	157	Suborders	Gelisols	AA	OR
6	**1.** Overlie cindery, fragmental, or pumiceous materials and/or fill their interstices and directly below these materials have either a densic, lithic, or paralithic contact; *or*	9	157	Suborders	Gelisols	AA	OR
7	**2.** When added with the underlying cindery, fragmental, or pumiceous materials, total 40 cm or more between the soil surface and a depth of 50 cm; *or*	9	157	Suborders	Gelisols	AA	OR
8	**3.** Comprise 80 percent or more, by volume, from the soil surface to a depth of 50 cm or to a glacic layer or a densic, lithic, or paralithic contact, whichever is shallower.	9	157	Suborders	Gelisols	AA	END
9	Histels, p. 157	9	157	Suborders	Gelisols	AA	NEW

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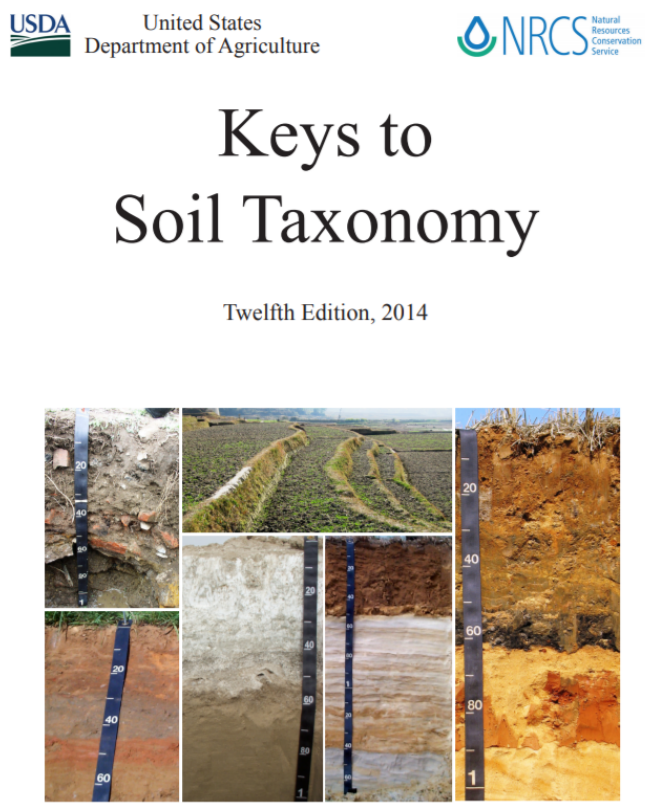
Diagnostic Features & Properties

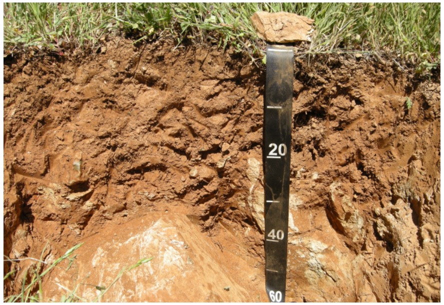


Times Used in Subgroup to Order Keys

Feature	Count
Paralithic Contact	390
Aquic Conditions	317
Argillic Horizon	259
Volcanic Glass	241
Lithic Contact	231
Andic Soil Properties	201
Slickensides	160
Mollic Epipedon	159
Linear Extensibility	159
Kandic Horizon	158
Duripan	115
Plinthite	80

Soil v.s. Non-soil & Soil Depth

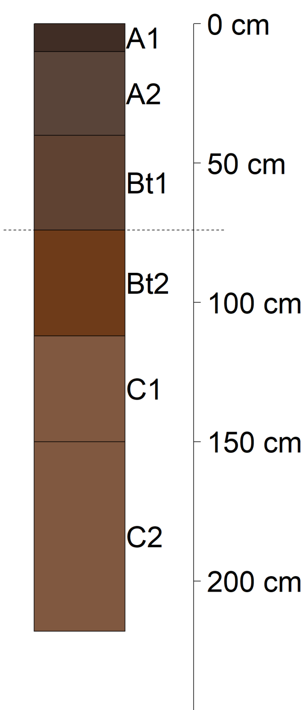
> *"The lower boundary that separates soil from the nonsoil underneath is most difficult to define* ... In some instances the more weakly cemented bedrocks ... have been described below the lower boundary of soil and used to differentiate soil series (series control section, defined in chapter 17). This is permissible even though the paralithic materials below a paralithic contact are not considered soil in the true sense." (Keys to Soil Taxonomy, 12th ed., p. 1)



The Argillic Horizon

Cohasset - ***Fine-loamy, mixed, active, mesic Ultic Haploxeralfs***

Official Series Description: https://soilseries.sc.egov.usda.gov/OSD_Docs/C/COHASSET.html



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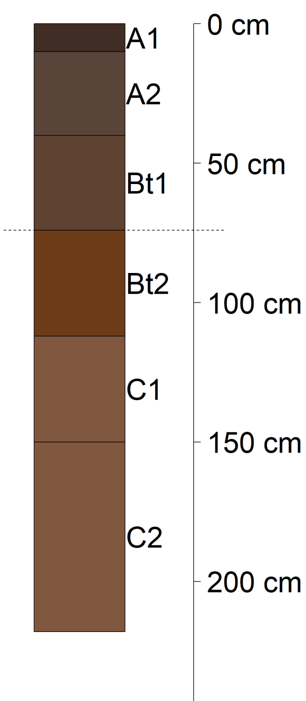

Laboratory measured clay content (%), "increase matrix"

```
##        20.6  20.9  24.6  29.9  32.4  30.8
## 20.6 FALSE FALSE FALSE FALSE FALSE FALSE
## 20.9 FALSE FALSE FALSE FALSE FALSE FALSE
## 24.6 FALSE FALSE FALSE  TRUE FALSE FALSE
## 29.9 FALSE FALSE FALSE FALSE FALSE FALSE
## 32.4 FALSE FALSE FALSE FALSE FALSE FALSE
## 30.8 FALSE FALSE FALSE FALSE FALSE FALSE
```

- Argillic & Particle Size Control Section start at 74 cm
- A 0.5% clay content difference in the **Bt1** shifts the Particle Size Control Section downward by 34 cm

The Argillic Horizon

Problems

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- *Bottom of the Argillic* — depends on (lack of) clay films or other accumulation
- *Truncated Argillics* — depends on a lithologic discontinuity or exposure
- *"Wimpy" Argillics* — low total clay content, marginal clay increase, limited development of morphology (e.g. clay films)

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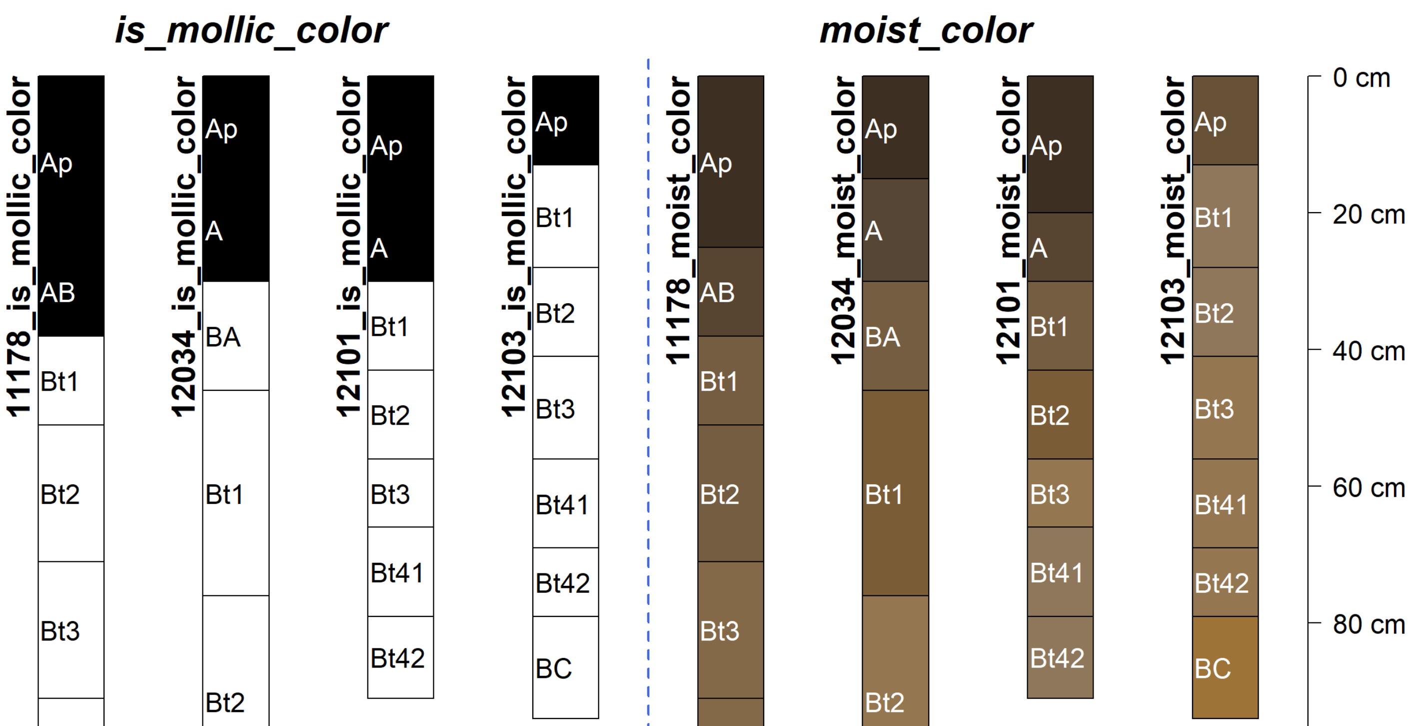
The Mollic Epipedon

Tama - ***Fine-silty, mixed, superactive, mesic Typic Argiudolls***

Official Series Description: https://soilseries.sc.egov.usda.gov/OSD_Docs/T/TAMA.html



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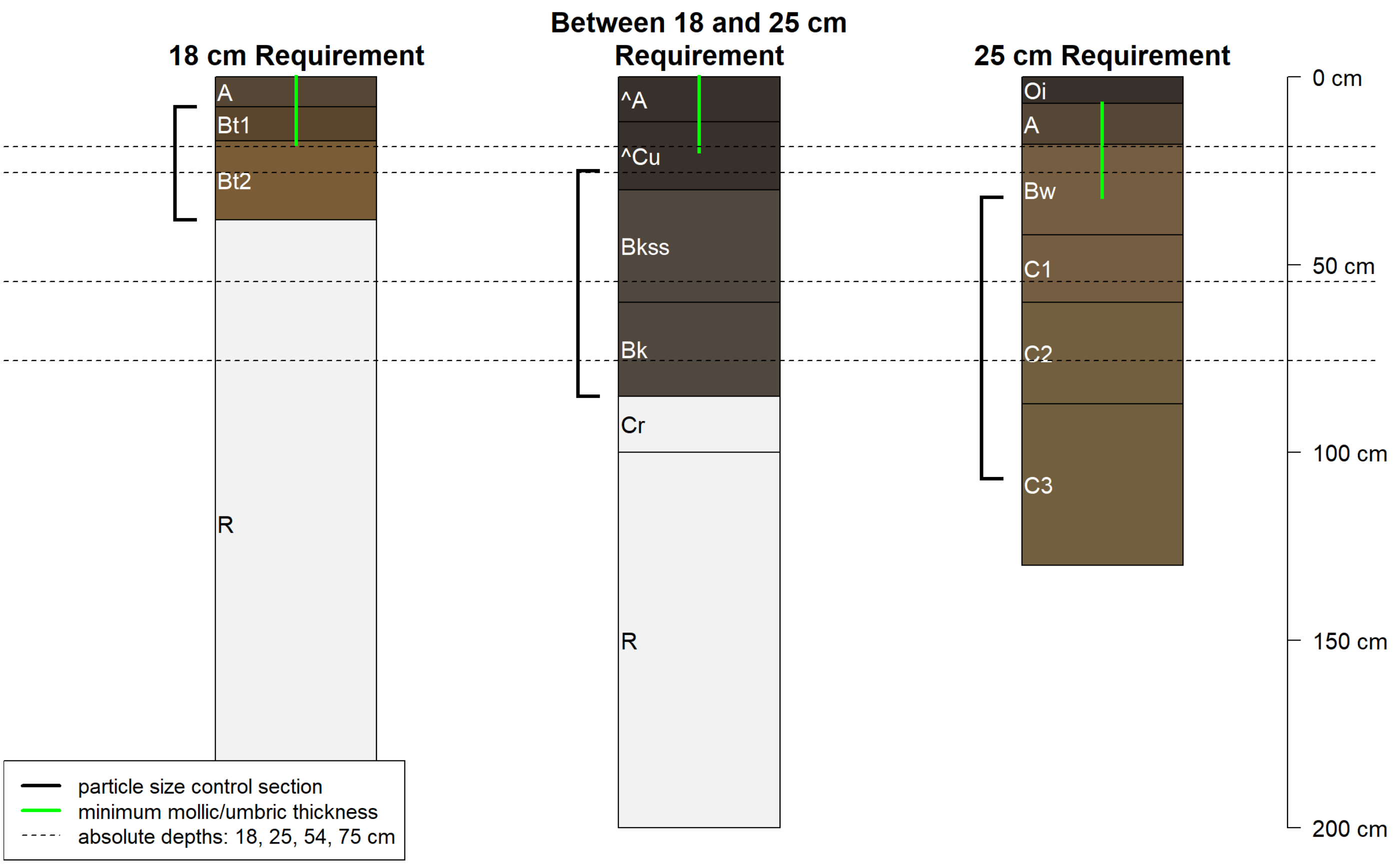


Soil Series

- The soil series is the lowest, most detailed taxonomic level in U.S. Soil Taxonomy
- Nominally, a soil series has a *single* family-level classification. This is in the *Official Series Description* (OSD).
- The *Range in Characteristics* (RIC) should **not** range outside the series family.

Soil Series (Fayette RIC)

Fayette - ***Fine-silty, mixed, superactive, mesic Typic Hapludalfs***

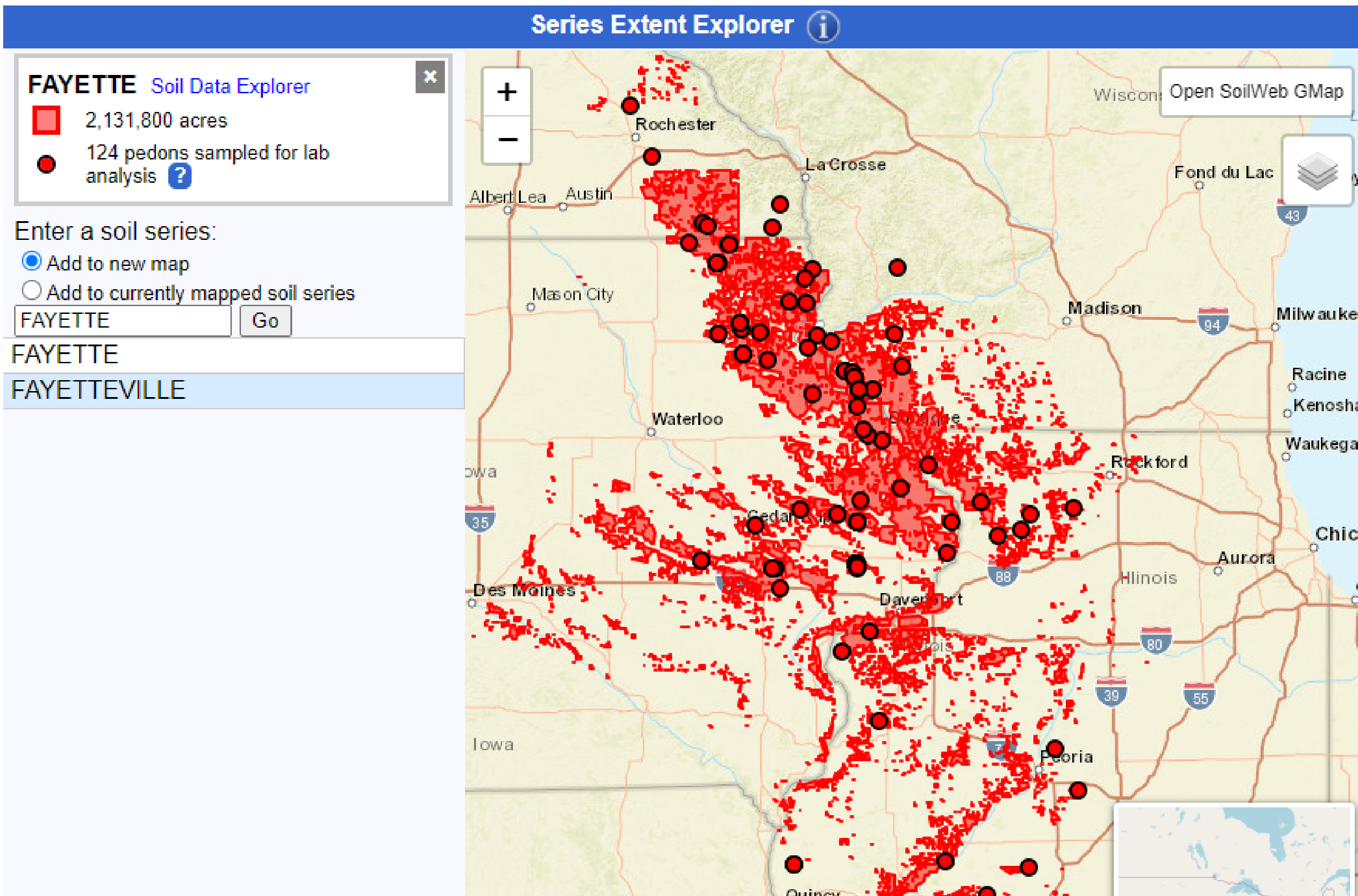
Official Series Description: https://soilseries.sc.egov.usda.gov/OSD_Docs/F/FAYETTE.html

RANGE IN CHARACTERISTICS:
Depth to carbonates--greater than 100 centimeters
Content of clay in the particle-size control section (weighted average)--24 to 32 percent
Content of sand in the particle-size control section (weighted average)--less than 5 percent
Coarse silt to fine silt ratio in the particle-size control section--0.9 to 1.5

A horizon:
Hue--10YR
Value--2 or 3
Chroma--1 or 2
Texture--silt loam
Clay content--15 to 27 percent
Reaction--very strongly acid to neutral

Ap horizon (if present):
Hue--10YR
Value--4
Chroma--2 or 3
Texture--silt loam
Clay content--15 to 27 percent
Reaction--very strongly acid to neutral

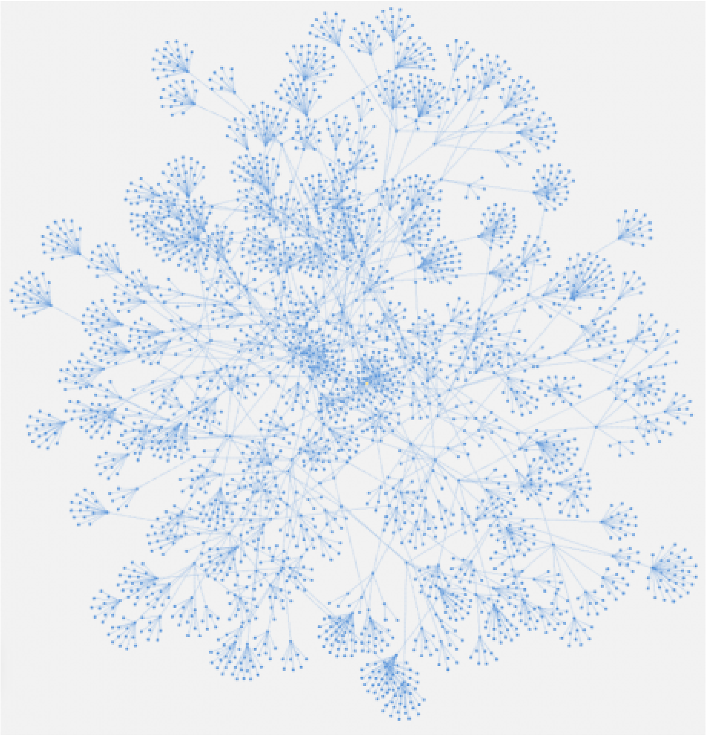
Soil Series (Fayette Extent)



Soil Series in Soil Mapping

- Soil mapunit component ranges need not exactly match those of the series RIC, often they are wider.
- In practice, especially in less-detailed (Order 3+) mapping, Series-level components in the U.S. include:
    - Soils *within* the RIC of the series
    - Soils *outside* the RIC that *have same family* as the named series (generally: "similar soils", formerly: "variant")
    - Soils *not* in the series family (taxadjuncts or less-prevalent series) that *interpret* the "same" based on local model
- *Dissimilar* soils are separated based on interpretive difference(s) from the dominant condition in a mapunit.
    - Dissimilar, *non-limiting*, soils may not be reflected consistently in more general mapping if they are not extensive.

Future of Soil Taxonomy



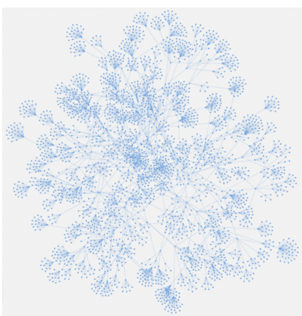
All 3082 subgroup to order level taxa in U.S. Soil Taxonomy, "rooted" to a common node.

To reconcile the "divisive" nature of the Keys and questions of "similarity" — *what do we need?*

- Graph databases capable of querying complex relationships between taxa, criteria, and metadata.
- A U.S. Soil Taxonomy ontology to define our terms and serve as a scaffold for other National Cooperative Soil Survey Standards

Future of Soil Taxonomy

Goals and dreams



1. "Fuzzy taxon membership" developed using *defined* weights, assumptions and heuristics

2. Sensitivity analysis using properties *and* geometry for "most likely" profile taxonomic placement

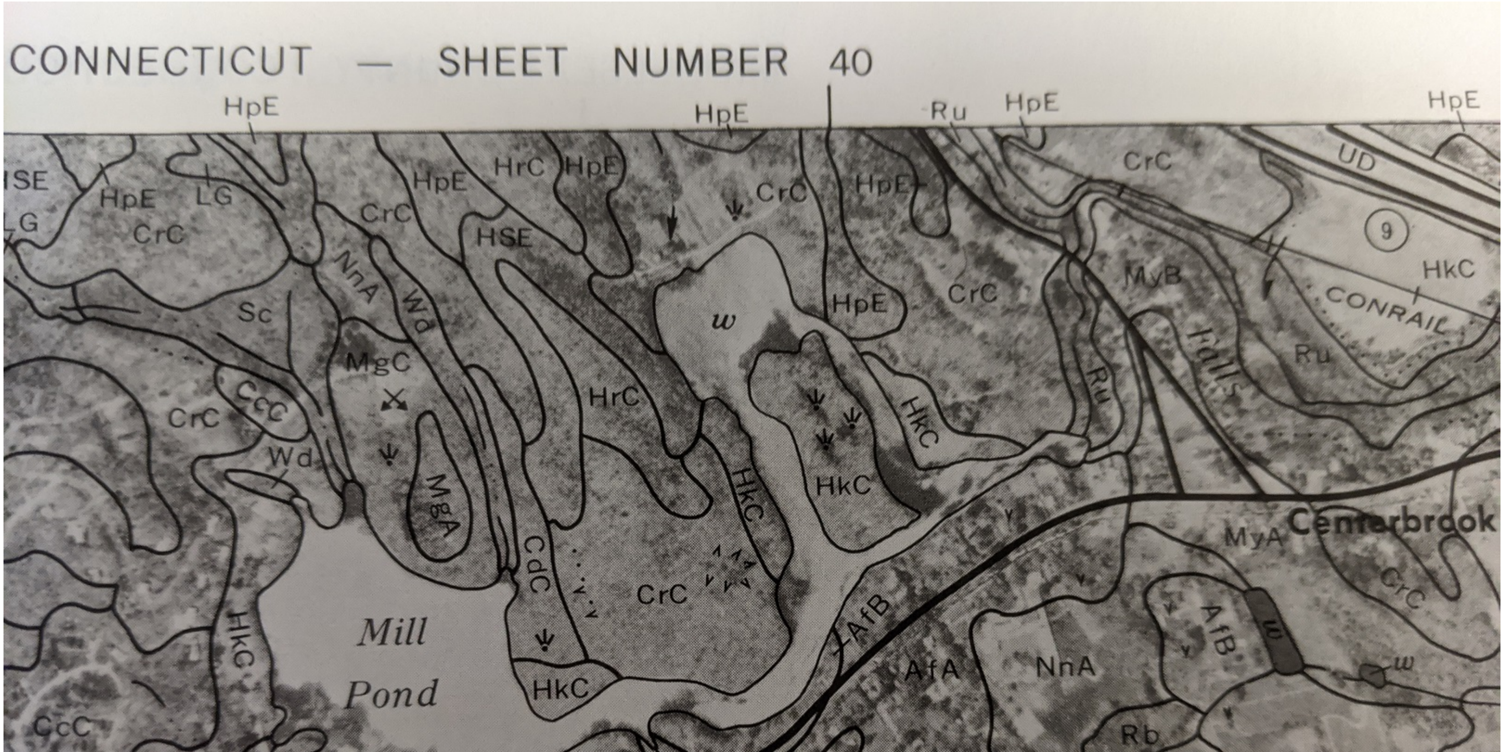
3. Regional/purposive subsets or "views" of the complete taxonomy: to aid in education, reduce fatigue and increase accessibility for non-specialists

4. Justification (and possible simplification) of concepts

5. Quantification of impacts and a unit-testing suite for proposed revisions

Impacts on Soil Mapping

- All soils are "different" — defined rules and systems allow us to "consistently" reason over them
- *Taxadjunct is **not** a dirty word.* Embrace the variations nature has to offer.



Thank you for your attention!

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