

Andic Soil Properties: Regional concerns

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National
Cooperative
Soil
Survey

National Conference

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Asheville, North Carolina



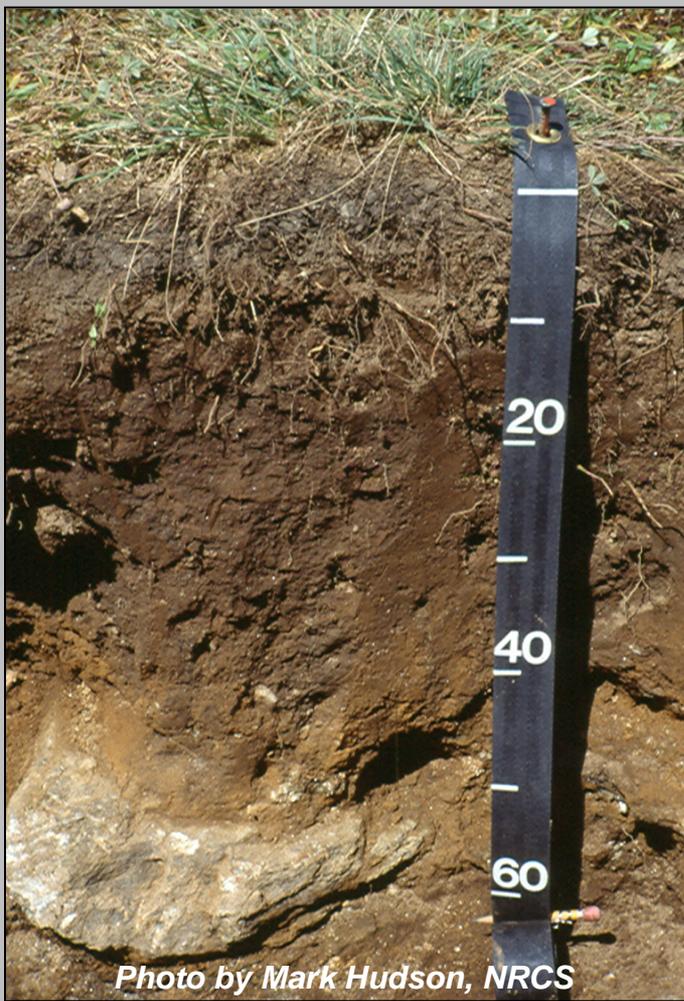


Photo by Mark Hudson, NRCS

Burton series



Photo by Mark Hudson, NRCS

Wayah series

fine-loamy, isotic, frigid Typic Humudepts



fine-loamy, isotic, frigid Andic Humudepts

Keys to Soil Taxonomy

Eleventh Edition, 2010



*Keys to Soil Taxonomy, 11th ed.,
2010*

KGDE. Other Humudepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus ½ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Humudepts

Burton (91NC021007)

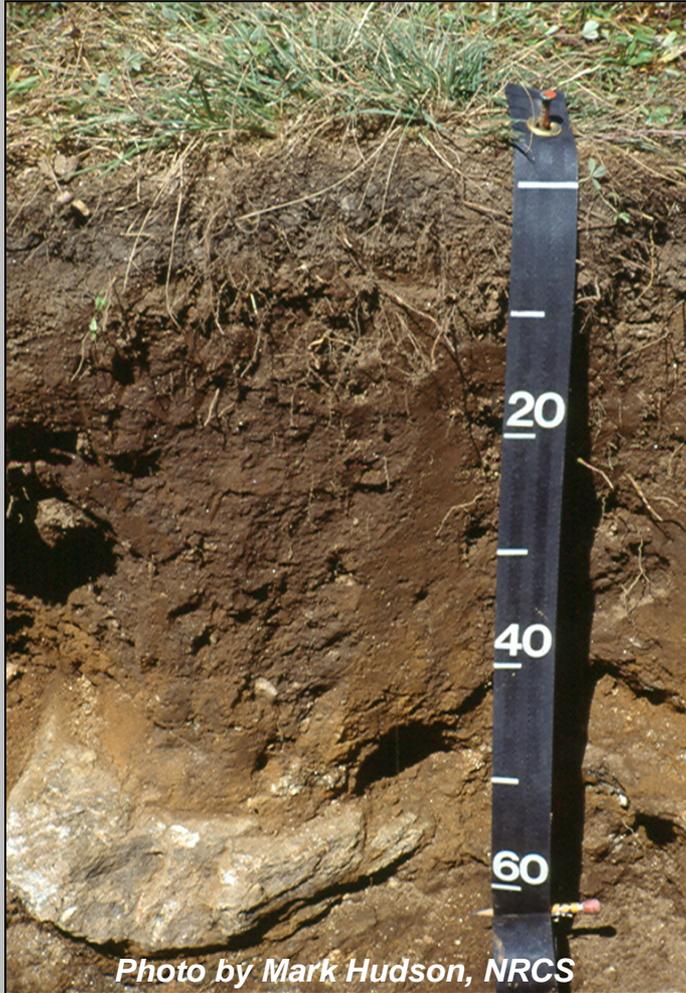
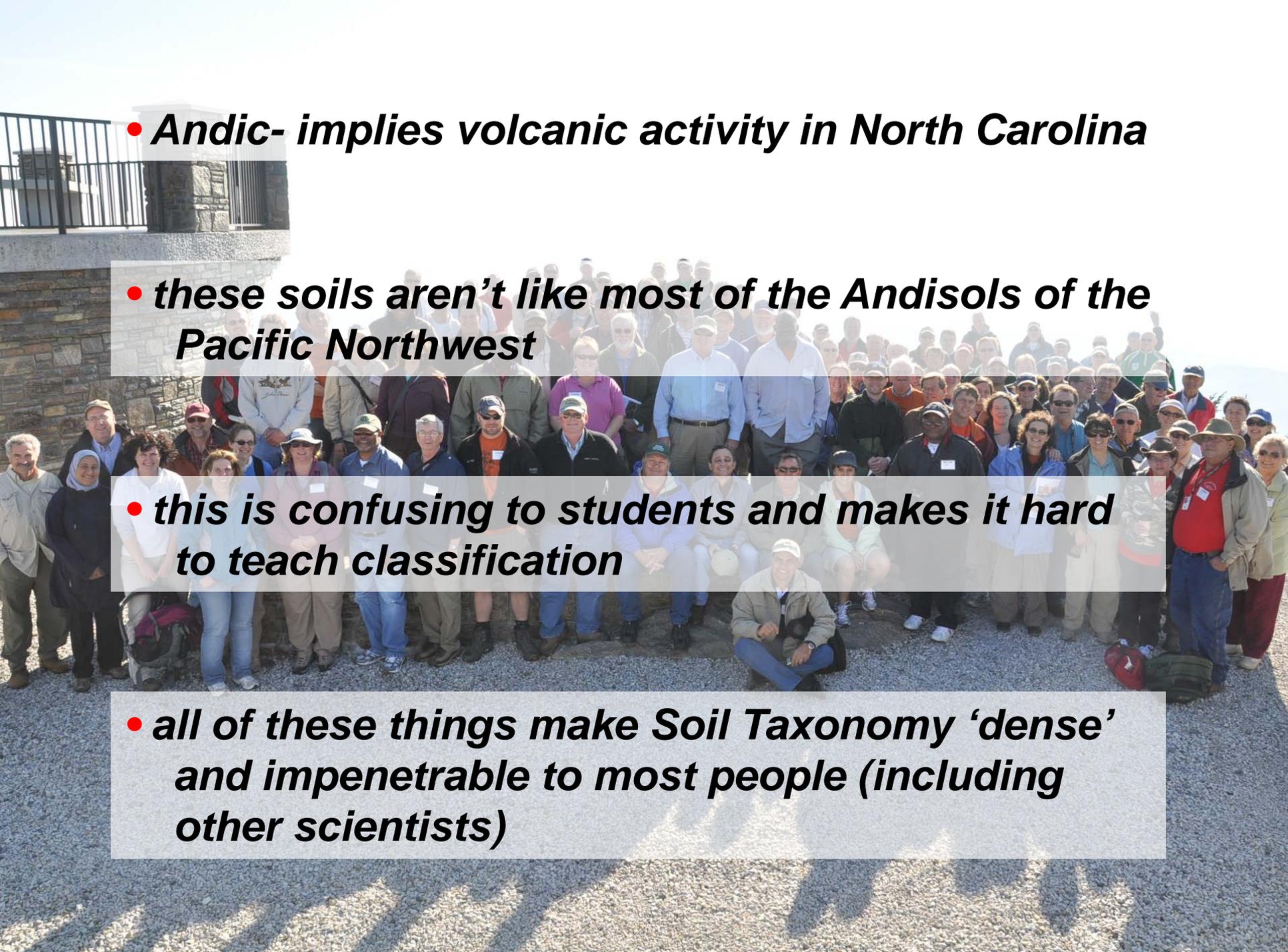


Photo by Mark Hudson, NRCS

	Depth	D_b	Al+½Fe
	<i>cm</i>	<i>g cm⁻³</i>	<i>%</i>
Oa	0-7	0.51	0.98
A1	7-23	0.90	1.42
A2	23-38	0.88	1.83
Bw	38-63	1.06	1.42





- ***Andic- implies volcanic activity in North Carolina***

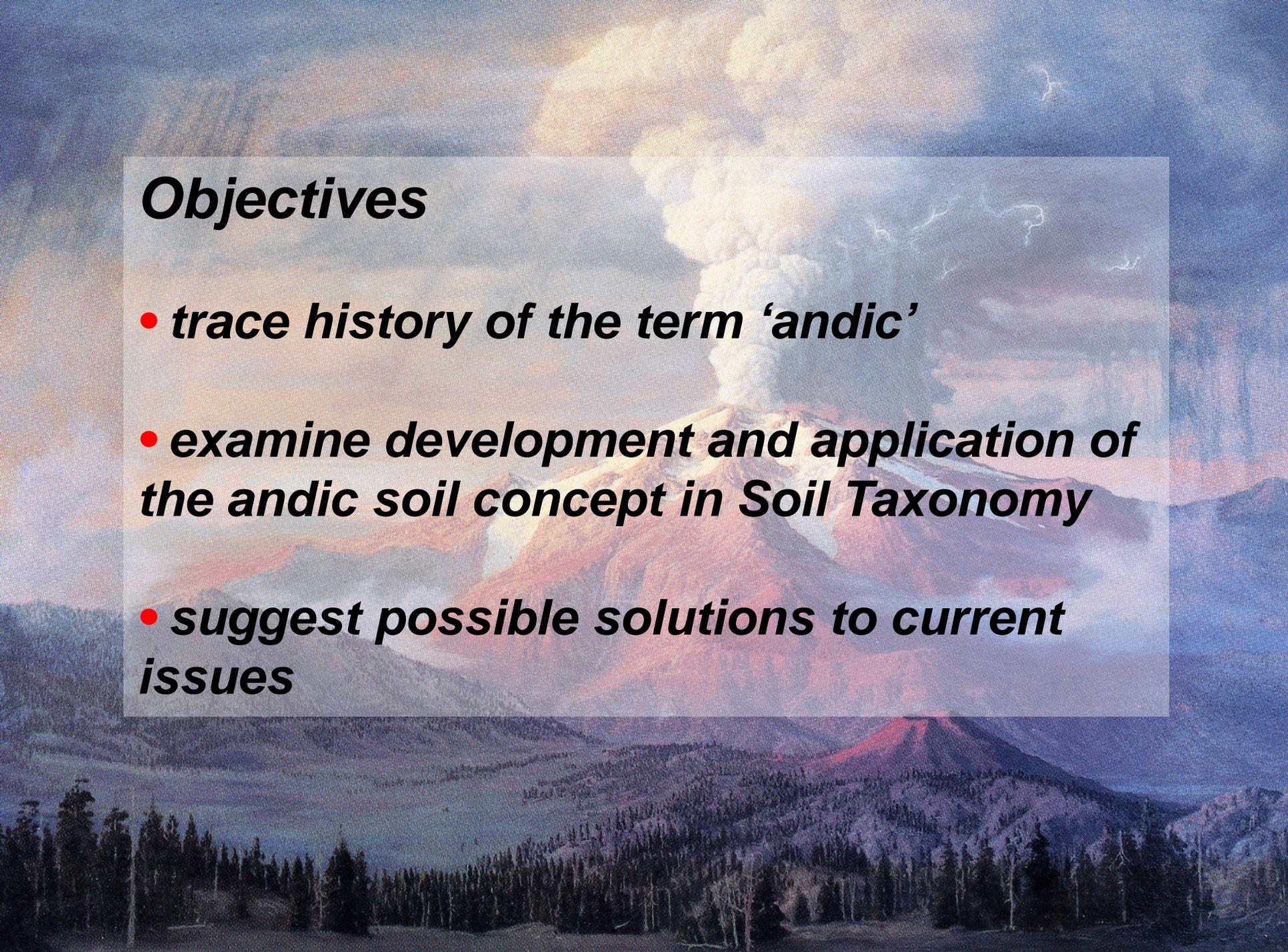
- ***these soils aren't like most of the Andisols of the Pacific Northwest***

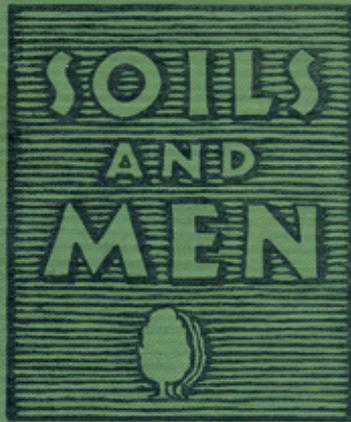
- ***this is confusing to students and makes it hard to teach classification***

- ***all of these things make Soil Taxonomy 'dense' and impenetrable to most people (including other scientists)***

Objectives

- ***trace history of the term 'andic'***
- ***examine development and application of the andic soil concept in Soil Taxonomy***
- ***suggest possible solutions to current issues***





- ***No taxa in 1938 Classification System specifically identify soils formed in volcanic ash***
- ***Many forested soils of the Pacific Northwest (classified today as Andisols or vitrandic intergrades) classified as Gray-Brown Podzolic Soils – e.g. Helmer-Santa-Benewah***

1938 Yearbook of Agriculture

Mark Baldwin, Charles E. Kellogg, and James Thorp. 1938. Soil Classification. pp. 979-1001. Yearbook of Agriculture, US Dept. Ag., US Govt. Print. Office.

1945-1949 – Reconnaissance soil surveys in Japan by US soil scientists; unique properties of soils formed in volcanic ash are recognized

1947 – W.S. Ligon suggests possible names for new great soil groups:

Ando* [dark (an) + soil (do)] *Podzolic soils

***Anshoku* [dark (an) + colored (shoku)]
*Podzolic soils***

1947 – New great soil group is approved:

“Ando soils”



Melanudand – Japan



“The Ando soils are given a tentative name, coined from the Japanese language, which means dark soils.”

“The Division of Soil Survey has not reached a decision as to whether the Ando soils should be grouped with the Brown Forest soils or be recognized as a new soil group.”

“The soils range from strongly to slightly acid in reaction and generally have low exchangeable divalent bases and high exchangeable alumina.”



“They consist, primarily, of a dark-brown to black A1 horizon, averaging about 1 foot thick, of fine-crumb or granular structure with an organic content ranging up to 30 per cent in the darkest members of the group.”

Thorp, J. and G.D. Smith. 1949. Higher categories of soil classification: Order, suborder, and great soil groups. Soil Sci. 67: 117-126.

Genetic pathways in Andisols

Volcanic parent materials



**pH = 5-7
moderate-high Si activity
low OM accumulation**



allophanic mineralogy

**pH < 5
abundant organic acids
high OM accumulation**



non-allophanic mineralogy

ALLOPHANIC

vs.

NON-ALLOPHANIC



- *allophane dominant*
- *low humus content*
- *slightly acid*
- *low exchangeable Al^{3+}*

- *Al-organic complexes dominant*
- *high humus content*
- *strongly acid*
- *high exchangeable Al^{3+}*

SOIL CLASSIFICATION

A COMPREHENSIVE SYSTEM

7th Approximation

SOIL SURVEY STAFF
SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE
AUGUST 1960

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price \$2.25

7th Approximation, 1960

- *Andepts are born...*

“Other Inceptisols in which more than 60 percent of the clay fraction of any ochric, umbric, or mollic epipedon or any cambic horizon consists of allophane, or in which the silt and sand fraction have more than 60 percent of volcanic ash or pumice”.

The Guy Smith Interviews:

Rationale for Concepts in Soil Taxonomy

Guy D. Smith



“The original concept of the Andepts came from the concept developed in Japan of the [Kuroboku] soils which have very dark colors, are fairly strongly weathered, and are very high in their percentage of organic matter”.

Smith, G.D. 1986. *The Guy Smith Interviews: Rationale for concepts in Soil Taxonomy. SMSS Tech. Monograph no. 11.*

SOIL TAXONOMY

A Basic System of
Soil Classification for
Making and Interpreting
Soil Surveys

Soil Taxonomy, 1975

- ***Andepts formalized***

“Andepts are the more or less freely drained Inceptisols that formed in ash, pumice, or other pyroclastic materials, either fresh or reworked. They are rich either in glass or in allophane, which is an amorphous clay.”

SOIL TAXONOMY

A Basic System of
Soil Classification for
Making and Interpreting
Soil Surveys

Soil Taxonomy, 1975

- ***Andic- subgroups introduced***

Andic Haplumbrepts –

“These soils have a surface mantle that has low bulk density; they have evidences of amorphous clays but are otherwise like Typic Haplumbrepts”.

KEYS
to
SOIL TAXONOMY
by
SOIL SURVEY STAFF

Agency for International Development
United States Department of Agriculture
Soil Management Support Services



SMSS Technical Monograph No. 19
Fourth Edition, 1990

Virginia Polytechnic Institute
and State University

- ***Andisol order established***

Ando + soils = “Andisols”

- ***defined on the basis of andic soil properties***

***Keys to Soil Taxonomy, 4th ed.,
1990***

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**Keys to Soil Taxonomy, 4th ed.,
1990**

Andic soil properties –

<25% organic carbon, and

1. a. Acid-oxalate-extractable Al + $\frac{1}{2}$ Fe \geq 2.0%, and
 - b. Bulk density at 33 kPa water retention \leq 0.9 g/cm³
 - c. Phosphate retention \geq 85%; **or**
2. Phosphate retention \geq 25%; and
 - a. Al + $\frac{1}{2}$ Fe \geq 0.40 % and at least 30% glass, or
 - b. Al + $\frac{1}{2}$ Fe \geq 2.0 % and at least 5% glass, or
 - c. [% glass + 15.625 (Al + $\frac{1}{2}$ Fe)] \geq 36.25

- **these requirements are more restrictive than those for andic soil properties**

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- ***Alic- subgroups appear***

Alic- subgroups of Andisols –

“... have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm.”

***Keys to Soil Taxonomy, 4th ed.,
1990***

Soil Taxonomy

A Basic System of Soil Classification for
Making and Interpreting Soil Surveys

Second Edition, 1999

Soil Taxonomy, 2nd ed., 1999

“The central concept of an Andisol is that of a soil developing in volcanic ejecta (such as volcanic ash, pumice, cinders, and lava) and/or in volcani-clastic materials, the colloidal fraction of which is dominated by short-range-order minerals or Al-humus compounds. Andisols can form in almost any environment, however, as long as suitable temperature and adequate moisture are available to permit weathering and the formation of short-range-order minerals”.

Keys to Soil Taxonomy

Eleventh Edition, 2010



*Keys to Soil Taxonomy, 11th ed.,
2010*

“Andic soil properties commonly form during weathering of tephra or other parent materials containing a significant content of volcanic glass. Soils that are in cool, humid climates and have abundant organic carbon, however, may develop andic soil properties without the influence of volcanic glass.”

Volcanic parent materials



pH = 5-7
moderate-high Si activity
low humus content



Allophanic mineralogy

pH < 5
abundant organic acids
high OM accumulation

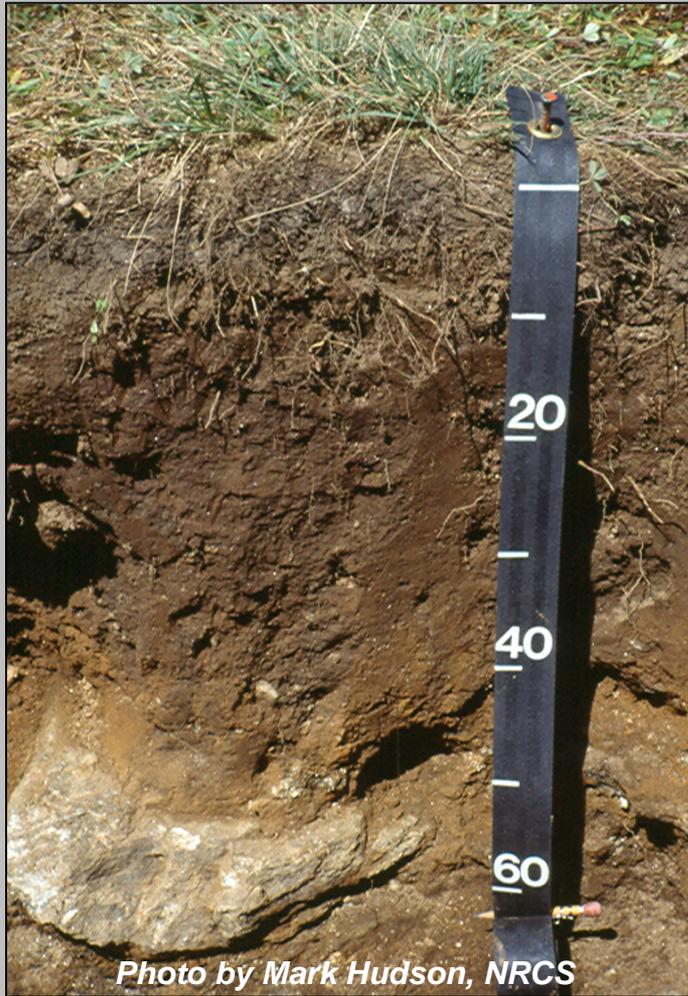


Non-allophanic mineralogy

cool, humid

Other parent materials

Burton (91NC021007)



	Depth	pH	OC	Extr Al	Al sat.
	<i>cm</i>		<i>%</i>	<i>cmol+/kg</i>	<i>%</i>
Oa	0-7	4.0	16.34	6.1	72
A1	7-23	4.4	6.55	4.2	91
A2	23-38	4.5	4.76	3.2	97
Bw	38-63	4.9	1.32	1.1	92

- ***meets requirements for Alic- great group***

Andic Humudept – NC
(Burton – 91NC021007)



Photo by Mark Hudson, NRCS

- does not have andic soil properties
- has non-allophanic mineralogy
- in upper 31 cm, has 3.2-4.2 cmol+/kg Al³⁺ and 91-97% Al saturation

'Alic' Humudept

Andic Fragiudalf – ID
(Kauder – 07ID0570017)



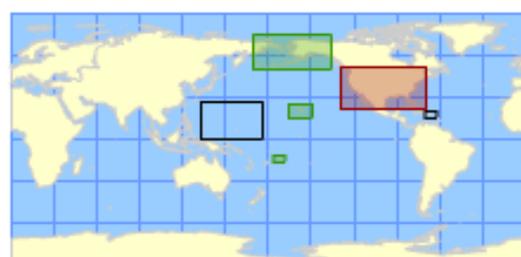
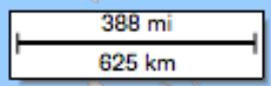
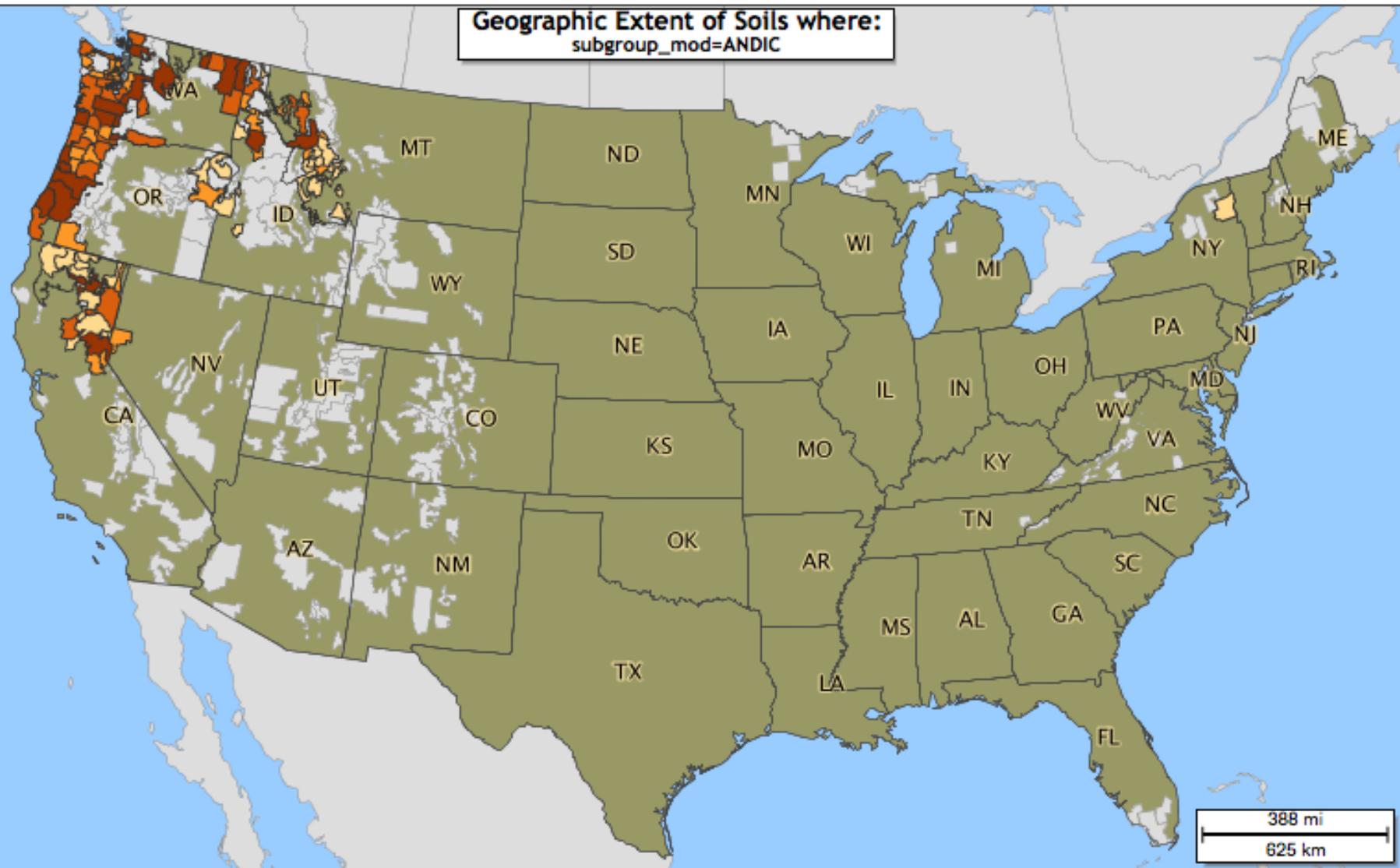
- upper 27 cm has formed in volcanic ash
- has andic soil properties in upper 27 cm
- has allophanic mineralogy

Andic Fragiudalf

Conclusions

- ***'Ando' was a poor choice of terms to apply to all soils formed in volcanic ejecta***
- ***Alic- subgroups could be used to identify 'non-volcanic' soils exhibiting non-allophanic character***
- ***Andic- subgroups could be restricted to those soils with andic soil properties, but not meeting thickness requirements for Andisols***

**Geographic Extent of Soils where:
subgroup_mod=ANDIC**



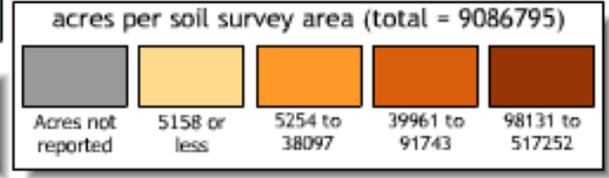
SERIES NAME EXACT MATCH **SERIES NAME SEARCH** **TAXONOMIC LEVEL** **CLASSIFICATION SEARCH**

Generate soil extent maps based on taxonomic queries. Click to open taxonomic query panel.

- Hillshade layer visible
- MLRA layer visible
- Soil Series fill visible

data available	data not available

acres per soil survey area (total = 9086795)



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**Keys to Soil Taxonomy, 4th ed.,
1990**

Andic Haplumbrepts –
“... are like Typic Haplumbrepts
except for:

a. ‘Do not have a layer in the upper
75 cm finer than loamy fine sand,
that is as much as 18 cm thick, that
has bulk density (at 1/3-bar water
tension of 0.95 g cm^{-3} or less in the
fine-earth fraction, and that has either
(1) a ratio of measured clay to 15-bar
water (percentages) of 1.25 or less or
(2) a ratio of CEC (at pH near 8) to
15-bar water of >1.5 and more
exchange acidity than the sum of
bases plus KCl-extractable
aluminum’

and/or

f. ‘Have an umbric or mollic epipedon
that is less than 50 cm thick”

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7th Approximation, 1960

- ***“Andept” concept introduced***

“The Andepts include the Inceptisols that have a high content of allophane, volcanic ash, or both. In early stages of weathering of volcanic ash or ash and pumice in humid climates, allophane seems to be the clay mineral that is formed from the Arctic to the Tropics.”



SOIL TAXONOMY

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Soil Taxonomy, 1975

Andic Haplumbrepts –

a. *'... have a layer in the upper 75 cm finer than loamy fine sand, that is as much as 18 cm thick, that has bulk density (at 1/3-bar water tension of 0.95 g cm^{-3} or less in the fine-earth fraction, and that has either (1) a ratio of measured clay to 15-bar water (percentages) of 1.25 or less or (2) a ratio of CEC (at pH near 8) to 15-bar water of >1.5 and more exchange acidity than the sum of bases plus KCl-extractable aluminum'*

and/or

f. *[Do not] 'have an umbric or mollic epipedon that is less than 50 cm thick'*