A Century of Soil Survey

Soil Survey Generations

Presentation for the Oregon Society of Soil Scientist Winter Annual Meeting

March 1, 2013   By Allen Makinson, Soil Scientist

Soil Survey Information from USDA NRCS and WEB Soil Survey

Accessed November 2012 and February 2013
Soil Survey pioneer A. T. Sweet sampling soil in a Piedmont gully, Carroll County, Georgia
Curtis Fletcher Marbut (1863-1935)

Curtis Marbut, a geologist from Missouri, graduated from the University of Missouri in 1889 and Harvard University in 1894. He was an instructor of geology and mineralogy at MU in 1895 and the Professor and Curator of the Geology Museum until 1913.

Dr. Marbut was appointed to direct the Missouri Soil Survey in 1905. In 1910, he was appointed Soil Survey Scientist for the United States Department of Agriculture (USDA) and became Chief of the Soil Survey Division in 1913.

During his twenty year tenure with the USDA, the study of soils became a recognized science. For a generation, Dr. Marbut’s wisdom dominated mapping and soil classification.

In 1935, the Chinese government invited Marbut to help lead soil classification in Asia, but he died of pneumonia en route to the assignment, at the age of 72, in Harbin, Manchuria.

1922 soil survey reconnaissance work in west central Texas

Marbut published several drafts of his concepts of soil classification between 1921 and 1935

The 1935 system that was modified to become the system published in the 1938 Yearbook of Agriculture: Soils and Men: the 1938 USDA soil taxonomy

- Pedocals were used in the drier climates and referred to the carbonate rich soils.

- Pedalfers began about at the Udic border and referred to soils rich in Aluminum (Alumen) and Iron (Ferrous). Alfer became the root term for Alfisols.

- Pedalfers and Pedocals were listed as subdivisions of Zonal soils

- Lateritic soils were listed as one of three subdivisions of Pedalfers.

- Laterites were one of five subdivisions of Lateritic soils.


http://www.nagt.org/files/nagt/jge/abstracts/Brevik_v50n5p539.pdf
The 1927 First Congress of Soil Science meeting in Washington DC, opened by a speech from President Calvin Coolidge, was followed by a 30 day train excursion around the United States and Canada. This special train of Soil Scientists had 11 Pullman cars and two dining cars.

http://www.pssac.org/soilmappinghistory.htm
Soil Erosion Service (SES) created in 1933 under the U.S. Department of the Interior, labor provided by the Civilian Conservation Corps and the Works Progress Administration.

http://www.ny.nrcs.usda.gov/technical/photo_gallery/pg_historical_1.html
The Soil Erosion Service, later known as the Soil Conservation Service (SCS) emphasized the control of soil erosion as it used soil surveys for conservation planning of farms.

The concept of soil was gradually broadened. The major emphasis had been on the soil profile. After 1930, morphological studies were extended from single pits to long trenches or a series of pits in an area of a soil. (polypedon)

The morphology of a soil came to be described by ranges of properties deviating from a central concept instead of a single “typical” profile.

WWII techniques of aerial photograph interpretation

Photograph published in 'The Royal Air Force in Pictures including aircraft of the Fleet Air Arm', prepared by Major Oliver Stewart, 1941. Page 91.
Aerial photographs with “Stereo Overlap” was used as a base to determine photo tonal patterns, slope and aspect for soil mapping.
Scaled Orthophoto basemaps of aerial photographs increased the precision with which soil boundaries could be delineated.

Drainage is inked first, individual streams are properly joined, matched. Then, culture features such as roads and political boundaries.

Over the years many models of augers were developed to for optimum design for various soil types

- Edelman augers
- Riverside auger
- Stony soil auger
- Spiral auger
- Stone catcher
- Soft soil auger
- Gouge auger
- Piston sampler
With advances in soil chemistry, soil physics, soil mineralogy, and soil biology, the formation of soil was treated as the aggregate of many interrelated physical, chemical, and biological processes.

Modification of the 1938 system in 1949 corrected some of its deficiencies but also illustrated the need for a reappraisal of concepts and principles. This resulted in the 7th Approximation, for sale in 1960 for $2.25.

This report is designed to describe and outline the extensive geomorphic surfaces of the Willamette Valley and to discuss the general relation of the soils to the surfaces.

Demonstrating the time sequence of landscape development and establishing the relation of the soils of the valley to the geomorphic units is the primary purpose of this publication.

As a result, it is hoped that soil genesis will be better understood and soil mapping facilitated.
Consistent Slopes, Aspects, and Elevations were achieved with USGS 1:24,000, Quadrangle Sheets in the 70’s
OSU SOILS CLUB 1970
Working with the agricultural department, this club is directed toward students who have specific interests in learning more about soils. The members learn to work with special soil-testing equipment.
The creation of the Environmental Protection Agency and Clean Water Act of the late 60’s fueled the environmental movement of the 70’s.

In 1973 Oregon’s statewide land use planning program was created with Senate Bill 100. Cities and counties were required to have comprehensive plans Conserving farm land, forest land, and other important natural resources
More than 15 years of work under the leadership of Guy Smith culminated in a new soil classification system. This became the official classification system of the U.S. National Cooperative Soil Survey in 1965.

Published in 1975 as *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys*. For sale in 1976, for $15.00.

It was a period of Turmol before the 7th Approximation. Soil Scientist won the first battle, striking against the Geologic Empire, still using the 1938 soil classification system.

After this period, soil scientists prefected the USDA soil classification system and Soil Taxonomy with the 8th Approximation. During this Period Oregon soil scientist also created the OR1. A single sheet wonder with Soil Series Properties, Interpretations and Land Use Classifications for both Agriculture and Urban uses.

Unfortunately the Geologic and Geographic Empires continued to use the 1938 soil terminology and the AASHTO soil classification system. This created unrest and confusion among Soil and Agriculture students taking classes in Geology and Geography.

Custodians of the 8th Approximation spent over a decade spreading the Word of Pedology. Finally the PolyPedon Force was restored to Soil Science and the Geologic Empire accepted the 8th Approximation.

Amazingly the terms “Pedalfer” and “Pedocal”, are still used in many introductory geology texts.
The dream of 90’s may still be alive somewhere in Portland

Commercial Internet service providers (ISPs) began to emerge in the late 1980s

- In 1986, the National Science Foundation funded NSFNet as a 56 Kbps Internet

- Since the mid-1990s, the Internet has had a revolutionary impact, including the rise of near-instant communication by **electronic mail**, and the **World Wide Web**
Global Positioning System (GPS) System of Satellites and Orbits for 27 Satellites in 1998

Global Positioning System Satellites and Orbits
for 27 Operational Satellites on September 29, 1998
Satellite Positions at 00:00:00 9/29/98 with 24 hours (2 orbits) of Ground Tracks to 00:00:00 9/30/98
Satellites Composing the A-Train fly in formation to make near-simultaneous observations of Earth.
Aerial LiDAR creates digital elevation models (DEMs) with a laser scanner. The LiDAR DEM elevation topography is overlayed on digital orthophotos which corrects perspective distortions in aerial or satellite images.

http://www.blm.gov/or/gis/lidar.php
The SSURGO database contains information about soil as collected by the National Cooperative Soil Survey over the course of a century.

The information can be displayed in tables or as maps and is available for most areas in the United States and the Territories, Commonwealths, and Island Nations served by the USDA NRCS.

The information was gathered by walking over the land and observing the soil. Many soil samples were analyzed in laboratories. The maps outline areas called map units. The map units describe soils and other components that have unique properties, interpretations, and productivity.
The SSURGO format has had two major versions and four minor versions.

- **Version 1.0, circa 1990?** The format of the tabular component is based on the State Soil Survey database (SSSD), the precursor to NASIS (National Soil Information System).

- **Version 2.0, January 2001,** The format of the tabular component is based on the NASIS database.

- **Version 2.1, December 2003,** The format of the tabular and spatial component is modified in order to support more explicit versioning of soil survey data. This format became available with the advent of the Soil Data Mart.

- **Version 2.2 October 2005,** The format of the tabular component is modified to include the data necessary to drive the Soil Data Viewer application.

THE TWELVE ORDERS OF SOIL TAXONOMY
The Web Soil Survey site, originally launched in August 2005, continues to be improved and enhanced to meet the demands of its growing customer base of several million hits a year. The web-based program provides anyone with computer access a wealth of soils information including soil maps, properties, and interpretations.

http://websoilsurvey.nrcs.usda.gov
But Wait there's More!
SoilWeb for Smartphones

- SoilWeb for the **iPhone** is a portable version of our online interface to **USDA-NRCS digital soil survey** data.

- The application uses the GPS built into the iPhone to acquire your current location, and then submits an HTTP request to our server via the SoilWeb API.

- A graphical summary of the soils mapped at your current location is presented on-screen, with links to details through our online soil survey, or via the USDA-NRCS official series description (OSD) archive.

Initial SoilWeb Concept on Paper

WEB Soil Surveys can be used for general farm, local, and wider area planning. Onsite investigation is needed in some cases, such as conservation and engineering applications.

**Warning: Soil Map may not be valid at this scale.**
You have zoomed in beyond the scale at which the soil map for this area is intended to be used. Mapping of soils is done at a particular scale. The soil surveys that comprise your AOI were mapped at 1:20,000. The design of map units and the level of detail shown in the resulting soil map are dependent on that map scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.
Hazelair-Willakenzie Soils near Yamhill, from WEB Soil Survey. Note inclusions in drainages are not identified. The Soil Web Google images can be enlarged to show greater detail of drainage patterns and possible wetland inclusions.
1. **Plot Placement** - ......The delineator must strive to have each plot be representative of a single plant community with uniform topographic position, soil and hydrology characteristics. A plot should never overlap different elevations. For example, if you are sampling in a 4 foot wide swale, the recommended 5-foot radius herbaceous plot will not work. ......

2. **Paired Plots** - ........Also, the paired plots must be located close enough together to support the placement of the wetland boundary (for example, 4-5 feet apart).....

3. **Determining desired map accuracy** -..........The most accurate mapping method is to flag or stake the boundaries and plots in the field (with a sufficient number of numbered flags) and have them (and the parcel boundaries) professionally land surveyed. ....
Determining Soil Mapping Accuracy

- How was the soil survey made? Is the survey area Order 2 or are there areas of Order 3 or Order 4 mapping detail. Oregon fieldwork prior to 1985 was mapped at an Order 2 level. It was thought to be more accurate to map consociations, ignoring “inclusions” of 1 to 2 acres due to aerial photo scale.

- Field work for Soil Surveys may have been completed over a period of many years and by many different soil scientists. Field work may have been done without developing the relationships to Geomorphic Surfaces. Geographic Setting or Associated Soils may not be consistent. The result is mapping “hole to hole” (connecting the dots) with ‘random” transects.

- Hazelair soils are mapped at elevations of 200 to 2,500 feet (Yamhill). Is it Hazelair on a terrace, below 300 feet?
When was the field survey work done? Field work may have been completed before the publishing of the 8th approximation. Much of the soil mapping in the Willamette Valley was completed prior to 1968.

Has there been extensive alterations such as Laser Land Leveling and Deep Ripping to the soil and/or landscape that would affect soil classification?

Mapping soil characteristics affecting agricultural crops may have been emphasized more than soil taxonomy and pedolgy. Also the depth of Auger holes or test pits may have only been to the subsoil or the control section.

The Soil Scientist may have not graduated from Oregon State University. “There is no such thing as a residual soil.” - Roger Parsons, 1981
Touchet Formation Burlingame Canyon west of Walla Walla, Washington, where 41 distinct flood deposit layers occurring 16,450 to 13,750 BCE.
1957 February Flood with Ice slabs over a foot thick on Powder River south of Baker

Gallery #1--BAKER CITY. -Flood of February 1957, Baker County Library, Baker City OR.
http://173.201.75.33/webphoto/exhibit1/e11237a.htm
Piles of Ice Age dropstones and erratics are often found on field margins in the Mission Valley, Columbia Basin, Yakima Valley, Umatilla Basin and Willamette Valley. On the Waterville Plateau, many fields contain multiple piles of boulders and stones left by the ice lobe.
Soil Catena and Associated soils on the Senecal (Bethal), Calapoyia to Winkle Geomorphic Surfaces. Inclusions of the Luckiamute surface is common.
This Catena includes the Senecal (Bethel), Calapooyia, Winkle and Ingram Geomorphic Surfaces. The Calapooyia Geomorphic surface is dominated by **heavy clay subsoils**.

With decades of intensive grass seed cultivation, this geomorphic surface (and adjoining surfaces) have been extensively modified, leveled and sloped for surface drainage.

Most of the original mound-swale complexes of Woodburn, Amity, Dayton and Awbrig soils have been heavily modified, destroyed or no longer exist.
Description  Map Unit 33  Dayton silt loam

- **Slope:** 0 to 2 percent

- **Depth to restrictive feature:** 12 to 24 inches to abrupt textural change

- **Drainage class:** Poorly drained

- **Capacity of the most limiting layer to transmit water (Ksat):** Very low to moderately low (0.00 to 0.06 in/hr)

- **Depth to water table:** About 0 to 18 inches

- **Frequency of flooding:** None

- **Frequency of ponding:** Frequent

- **Available water capacity:** Low (about 3.2 inches)

Typical profile of Dayton silt loam, 0 to 2 percent slopes.

The clay layer is between 12 and 24 inches.

http://soildatamart.nrcs.usda.gov/Manuscripts/OR003/0/BentonOR.pdf
Irish Bend (West of Halsey) Willamette River bank Dayton silt loam, 0 to 2 percent slopes.

http://soildatamart.nrcs.usda.gov/Manuscripts/OR003/0/BentonOR.pdf
Map Unit 3, Amity Silt loam with what looks like an inclusion of Map Unit 33, Dayton Silt loam. Terrace escarpment of Map Unit 106A Woodburn and Amity in the background.
# Map Unit Legend

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
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<tbody>
<tr>
<td>3</td>
<td>Amity silt loam</td>
</tr>
<tr>
<td>7</td>
<td>Awbrig silty clay loam</td>
</tr>
<tr>
<td>8</td>
<td>Bashaw silty clay</td>
</tr>
<tr>
<td>27</td>
<td>Concord silt loam</td>
</tr>
<tr>
<td>33</td>
<td>Dayton silt loam</td>
</tr>
<tr>
<td>99</td>
<td>Wapato silty clay loam</td>
</tr>
<tr>
<td>102</td>
<td>Willamette silt loam</td>
</tr>
<tr>
<td>106A</td>
<td>Woodburn silt loam, 0 to 3 percent slopes</td>
</tr>
</tbody>
</table>

This is Dayton in a Map Unit 3 Amity silt loam. But wait there’s more, could it be an, Amiton Daytamity Complex, due to Land Leveling.
ARMY CORPS Aerial
Photo from floods of 1996

You Tube Flooding at Corvallis Feb. 9, 1996
Flooding Frequency Class Definition

None  No reasonable possibility of flooding; one chance out of 500 of flooding in any year or less than 1 time in 500 years.

Very rare Flooding  is very unlikely but is possible under extremely unusual weather conditions; less than 1 percent chance of flooding in any year or less than 1 time in 100 years but more than 1 time in 500 years.

Rare Flooding  is unlikely but is possible under unusual weather conditions; 1 to 5 percent chance of flooding in any year or nearly 1 to 5 times in 100 years

Occasional Flooding  is expected infrequently under usual weather conditions; 5 to 50 percent chance of flooding in any year or 5 to 50 times in 100 years

Frequent Flooding  is likely to occur often under usual weather conditions; more than a 50 percent chance of flooding in any year (i.e., 50 times in 100 years), but less than a 50 percent chance of flooding in all months in any year.

Very frequent Flooding  is likely to occur very often under usual weather conditions; more than a 50 percent chance of flooding in all months of any year.
### Winkles Units of Coburg Soils

<table>
<thead>
<tr>
<th>Map Unit</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>8</td>
<td>Amity silty loam</td>
</tr>
<tr>
<td>12</td>
<td>Awbrig silty clay loam</td>
</tr>
<tr>
<td>48</td>
<td>Coburg silty clay loam</td>
</tr>
<tr>
<td>50</td>
<td>Rarely &amp; occasionally flooded</td>
</tr>
<tr>
<td>49</td>
<td>Coburg silty clay loam</td>
</tr>
<tr>
<td>52</td>
<td>Conser silty clay loam</td>
</tr>
<tr>
<td>56</td>
<td>Holcomb silty clay loam</td>
</tr>
<tr>
<td>61</td>
<td>Dupee silt loam</td>
</tr>
<tr>
<td>111</td>
<td>Malabon silty clay loam</td>
</tr>
<tr>
<td>177</td>
<td>Woodburn silt loam</td>
</tr>
<tr>
<td>Map Unit</td>
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<td>-----------</td>
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</tr>
<tr>
<td>8</td>
<td>Bashaw clay</td>
</tr>
<tr>
<td>31</td>
<td>Coburg silty clay loam</td>
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<td>33</td>
<td>Conser silty clay loam</td>
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<td>56</td>
<td>Holcomb silty clay loam</td>
</tr>
<tr>
<td>75</td>
<td>Malabon silty clay loam</td>
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<tr>
<td>78</td>
<td>McAlpin silty clay loam</td>
</tr>
<tr>
<td>130</td>
<td>Waldo silty clay loam</td>
</tr>
</tbody>
</table>

Is Map Unit 8 Bashaw, Dayton on the Calapooyaia Surface? Map Unit 130 Waldo includes overflow channels and permanent ponded areas. Map Unit 78 McAlpin includes hydric and non-hydric soils on the Ingram surface.

Black and White Aerial Photos from 1952 shows overflow channels.
Bashaw soil

Typical profile of a Bashaw clay

0 to 41 inches: Clay

41 to 63 inches: Silty clay

Vertisol with Prismatic structure

Bashaw soils occur on the Ingram, Luckiamute, Winkle, Calapooyia, and Dolph units. Bashaw* soils are poorly drained, fine-textured soils developed on nearly level or slightly concave flood plains, fans, and terraces. Balster and Parsons 1968. page 15

http://soildatamart.nrcs.usda.gov/Manuscripts/OR003/0/BentonOR.pdf
Geologic Interpretation of Floodplain Deposits of the Southwestern Willamette Valley Study (2003)

…….This initial study, with the cooperation of many scientists and the University of Oregon, resulted in a surprising find which redefined the origin of the surficial gray clay in the Willamette Valley as being from the Mt. Mazama volcanic eruption, over 7700 years ago. Research and refinement of the characterization of this stratigraphic unit continues and supports the significance of this discovery.
Figure 1.1 These 1936 air photos of the west Eugene area show Willow Creek and the historic drainage patterns of Amazon Creek. The darker vegetation pattern evident in the center of the photos is a relict Willamette River channel. Agriculture had altered the landscape and urbanization was well underway with the building of streets and railroads.
...measurable deposits of Irish Bend Member aren’t found above 325-350’ a.s.l. (the West Eugene study area elevation is 380-450’ a.s.l.).
MAP Unit 38, Dayton site T-1 in West Eugene Area. Unit IV is younger (6280 BP) than Unit III (16000 BP).

Photo 3.1.1 This photo shows the stratigraphy of site T-1. Note that the sediment at deeper depth was younger than the stratigraphic unit above it.
Map Unit 38 Dayton, does not have a substratum of Irish Bend silts. This unit is similar to the adjoining map unit of 85 Natroy. But wait, this unit could be a **Daytroy**. Dayton with a deep clay layer and substratum similar to Natroy.
It appears that deposits of the Irish Bend Member may not be found in the South Willamette Valley above 320 feet. This was described in Balster and Parsons 1968

- Typical pedon of Dayton silt loam, clay substratum, is 312 feet in elevation junction of Territorial and Cox Butte Roads, Lane County. Located just to the west of the Long Tom Ranch

- In 1999, on the Long Tom Ranch, we found nearly 8 feet of Irish Bend silts when excavating a pond to about 16 ft. The clay substratum may be the same as the Dayton, Awbrig and Natroy soils mapped further south in Lane County.
Pond Excavation at Long Tom Ranch in 1999
Linn gravels occurred at about 12 feet in depth.
A situation that may prove especially troublesome to soil surveyors is the distribution of soils along the margins of the Winkle-Senecal surfaces.

Many different soils may occur where Winkle scour was not deep enough to remove Senecal sediments, (e.g., Willamette Silts) and thickness of the Winkle alluvium varies in a short horizontal distance. In these areas, prudent selection of profiles to be examined in deciding the most logical placement of the map delineation is suggested.

Perhaps further study is necessary to evaluate the extent and characteristics of soils that occur along the margins of the geomorphic surfaces.
Woodburn* and Amity soils occur on three geomorphic units: Quad, Senecal, and Champoeg. These surfaces are separated by enough relief to belong in separate geomorphic units and, therefore, represent some differences in age or elapsed time during the geomorphic evolution of the Willamette Valley.

It is also possible that the deposits associated with the surfaces may be different, and the soil parent materials, therefore, would have been different. If the surface, age, and parent material are variables, it follows that the soils on the surfaces can be expected to be different. Various combinations of the soil-forming factors—climate, vegetation, parent material, topography, and time—produce different soils.

Further research may be warranted on the soils of these surfaces to determine whether or not additional series should be recognized.
"I hope the answer to your question is clearly indicated in what I have written. It is that the soil survey will never be completed because I cannot conceive of the time when knowledge of soils will be complete. Our expectation is that our successors will build on what has been done, as we are building on the work of our predecessors."

R. S. Smith, Director, Illinois Soil Survey in September 27, 1928.
Who were these captains of Soil Survey, and how can you tell these Soil Generations apart?

One generation will prefer the original 60’s TV series of Star Trek.

The next generation will prefer watching The Star Trek Movies.

Finally the new generation will refer to the 1st Star Wars Movie as Episode IV.
"Soil Mapping is only possible because one can examine a profile at point and successfully predict its occurrence at another point where surface indications are similar." Unknown Author

The Dream of 90's is Alive in Portland