National Cooperative Soil Survey Newsletter

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Issue 5

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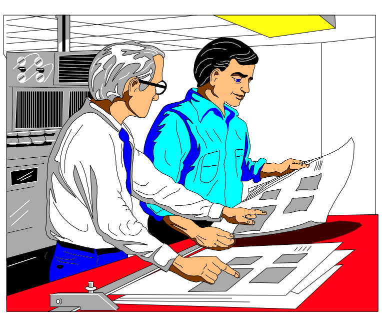
Editor's Note

Issues of this newsletter are available on the World Wide Web (www.statlab.iastate.edu/soils/soildiv). Click on NCSS and then on the desired issue number of the NCSS Newsletter.

You are invited to submit stories for future issues of this newsletter to Stanley Anderson, National Soil Survey Center, Lincoln, Nebraska. Phone—402-437-5357; FAX—402-437-5336; email—sanderson@nssc.nrcs.usda.gov.



Soil Survey Field Methods in the Late 1890's and Early 1900's

By David W. Smith, Soil Scientist, USDA, Natural Resources Conservation Service, West Regional Office, Sacramento, California.

Macy H. Lapham, a soil surveyor who worked in the soil survey program in the United States from 1899 to 1945, mapping soils in many of the Western States and then serving as Inspector for the Western Division of the Bureau of Soils, published a book entitled *Crisscross Trails: Narrative of a Soil Surveyor* in 1949. In his words: "[I offer this book] as an unpretentious historical record of the organization and development of the soil survey in which the recital of associated personal observations and incidents has been included."

I recommend the book to anyone who is interested in the story of the early soil survey and who can get hold of a copy. The book is out of print and hard to obtain.

Early Field Methods

Lapham's first season of fieldwork began in the spring of 1900, in the Sevier Valley of southern Utah. After a cross-country train ride to Richfield, Utah, he met up with Frank D. Gardner (who had mapped in the Utah Valley the first season of 1899) and was "ushered into the technique of soil survey." About his first field day, he wrote:

> After a hearty breakfast, attired in old clothes, stout shoes, and canvas leggings, I was ready for the field. With two frisky western horses and a light ambulance-like canvas covered wagon, we stopped in a vividly green alfalfa field on a red alluvial soil. Here I was shown how to handle a six-foot auger and to note the character of the fine sandy loam soil, the boundaries of which were sketched on the pages of a notebook.

Lapham summarizes the field methods used in 1900 as follows:

> The usual western field equipment consisted mainly of a cumbersome electrolytic bridge and field kit for determining the character and amount of soluble salts, popularly but inaccurately known as "alkali." Included were a six-foot soil auger with extensions; a compass; protractor and scale; a shovel or spade; and a copy of the usually inadequate county or other available base map. Technique of determining and mapping soil boundaries was acquired by experience. At that time there were no soil surveyors with previous training and no place in this country or elsewhere at which training in soil classification and mapping might be learned. Soil boundaries, determined by noting differences in texture, color, structure, and in mineral character—by means of frequent borings—were, in the absence of a suitable base map, sketched into the pages of a blank township plat book ruled off into sections. These were also

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Soil Survey Interpretations: A New Perspective via "NASIS"

By Bob Nielsen and Russ Kelsea, Soil Scientists, USDA, NRCS, National Soil Survey Center, Lincoln, Nebraska.

The objectives of the NASIS (National Soil Information System) soil survey interpretations system are as follows:

Interpretations are consistent, and large shifts in soil survey interpretive results do not occur among similar soils that have insignificant differences in physical, chemical, or climatic properties.

- Thus, soils with relatively similar physical, chemical, or climatic properties will have relatively similar NASIS interpretive results for any given practice, program application such as CRP, or other use or management involving soils. NASIS interpretive results provide the user with either numeric ratings that can be arrayed or descriptive ratings that can be used in reports.

Interpretations are natural, and the interpretive results represent the natural gradation of a soil's physical, chemical, and climatic characteristics across landscapes and broad geographical areas.

- The interpretive result is a natural fit, and slight shifts in soil interpretive properties create similar shifts in interpretive response.

Interpretations are defensible and require few or no subjective exceptions to the basic interpretive rules to correctly array soil interpretive numeric rating values across large geographical areas.

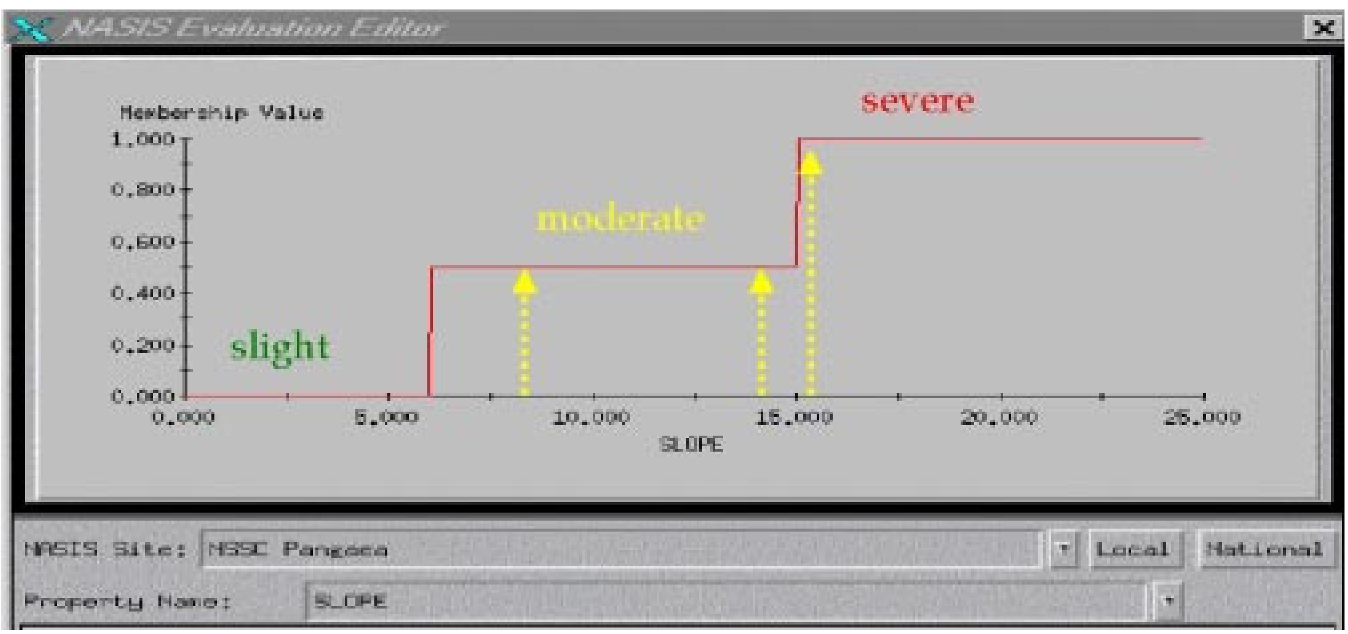
- This feature brings NASIS interpretations into alignment with NRCS national, state, and local programmatic and assessment requirements.

Threshold Response Evaluations vs. Continual Response Surface Evaluations

The following examples can be applied to the installation of agricultural waste holding facilities where slope is a limitation if it is too steep.

Threshold response evaluations are subjective or arbitrary classes, such as "slight," "moderate," or "severe," that are defined by soil properties limits. In the example of threshold response evaluations below, the slope interpretive rating is "slight" if the slope is less than 6 percent, "moderate" if 6 to 15 percent, and "severe" if more than 15 percent.

- For some sites, this statement is true (more than 15 percent slope).



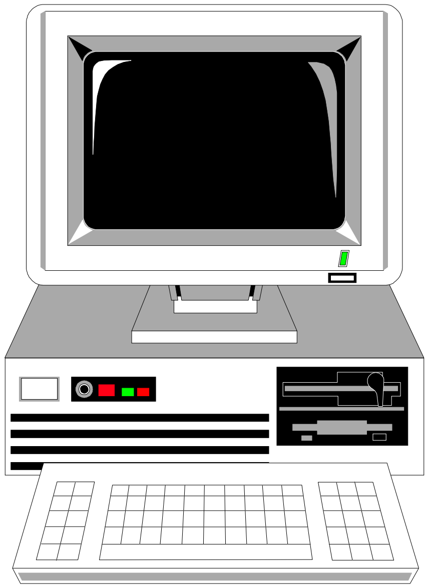
With the arbitrary linear approach, an 8 percent slope receives the same rating as a 14 percent slope, while a 15 percent slope receives a rating of "severe."

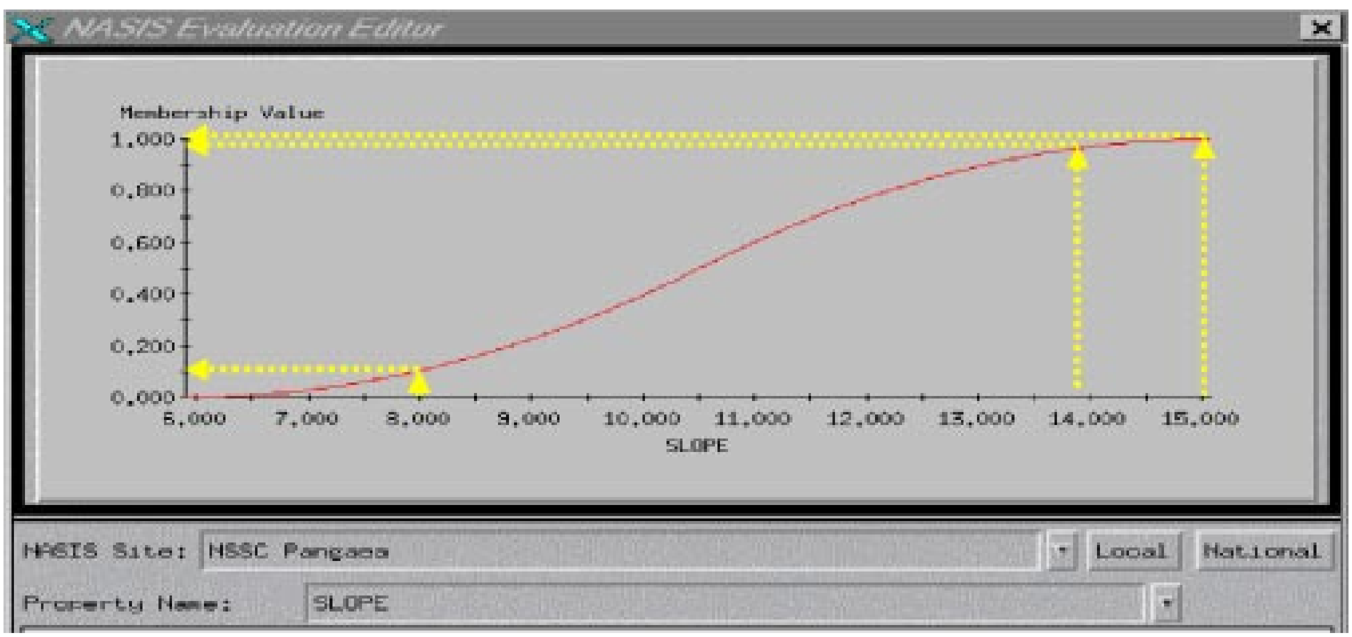
- For others, the statement is false (less than 6 percent slope).
- For others, the statement is not quite true or false. The point breaks are arbitrary (6 to 15 percent), and all sites that fit within the break points are assigned the same rating.

Continual response surface evaluations differ from threshold response evaluations in that slopes of less than 6 percent receive a rating of 0, slopes of 6 to 15 percent receive a rating between 0 and 1, and slopes of more than 15 receive a rating of 1. The difference, as illustrated in the example, is that a slope of 8 percent receives a numerical rating of about 0.15 and a slope of 14 percent receives a rating of about 0.95. This approach shows that even though a soil with 10 percent slope and a soil with 14 percent slope may be rated as moderate for a particular interpretation, the 14 percent slope has a greater degree of limitation than does the 10 percent slope.

- For some sites, this statement is true. If the slope is more than 15 percent, the rating is 1.00
- For others, the statement is false. If slope is less than 6 percent, the rating is 0.00
- For others, the statement is not quite true or false. The numeric rating is a function of the response surface, and sites are assigned a number between 1 and 0.

The following soil interpretation for conservation buffers is an example of the continual response surface concept applied to conservation practices. The results from the NASIS conservation buffers soil interpretation can be used to evaluate the suitability of soils for this conservation practice. The numeric rating for each soil characteristic considered in the conservation buffers interpretation is relative to the scale where 0 is no limitation and 1.0 is a severe limitation. ■





With the continual response approach, an 8 percent slope receives a numerical rating of 0.14, which is significantly different from the 0.95 rating for the 14 percent slope, which is similar to the 1.00 rating for the 15 percent slope. Thus, similar slopes have similar ratings.

Oxyaquic Soils—A Short Course: Continuing Activities of the New Hampshire Soils Team

By Stephen J. Hundley, State Soil Scientist, USDA, Natural Resources Conservation Service, Durham, New Hampshire.

Long before the first soil survey was conducted in New England, the pioneers recognized that much of the landscape is underlain by very firm and dense soil material. Locally called a "hard pan," this material behaves a lot like concrete when it is dry, is nearly impermeable to water and plant roots, and perches surface water from snowmelt in the spring, resulting in the onset of the "mud season." Modern-day soil scientists recognize this phenomenon as an interruption in saturation, a situation where the upper portion of the soil is saturated because of perching of water on top of the "hard pan," the middle portion of the soil (the "hard pan" itself) remains relatively dry, and the lower portion is saturated once again because of the ground-water system. This interruption in saturation is very significant in the assessment of soil behavioral characteristics and in the development of soil interpretations for different kinds of land use.

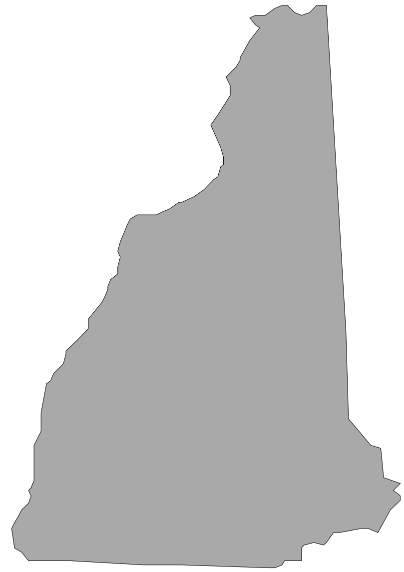
During the winter of 1993, soil correlators from around New England gathered in Orono, Maine, to agree upon how these kinds of soil would be classified under the recently revised system of soil classification. There was unanimous agreement that these soils do, in fact, perch surface water in the spring and should be assigned to an Oxyaquic subgroup in the taxonomic system. No one in the New England soil science community, however, had ever actually conducted field investigations during the spring to document the fact that these soils perch water.

In 1995, with financial support from the Global Change Initiative and with great enthusiasm from the New Hampshire soils staff, monitoring sites were established in three locations in New Hampshire. One of the sites was expanded so that soil scientists could monitor soil-water behavior at four locations representing an entire landform, from the crest of the hill to the foot slope. Kathy Swain took charge of this study site on the outskirts of Concord and has been monitoring the site for 2 years.

To date, much to the surprise of the soil science community, two of the four sites have remained dry throughout the spring, when these soils should be perching water. The soil scientists have no good explanation. These soils are very representative of the type of "hard pan" soils that occur through the region. If certain soil conditions or landscape positions preclude these soils from perching water, then there may be a need for a major paradigm shift in how soil scientists interpret the behavioral characteristics of the soils.

The New Hampshire soils staff developed an intensive data collection and interpretation program at the Concord Oxyaquic Study Site. The initial effort included installation of special instruments at each site, called tensiometers, to monitor the unsaturated soil moisture content. Assistance was requested from the National Soil Survey Laboratory and the U.S. Geological Survey. The week of August 18, 1997, commenced a flurry of activity.

Intensive soil investigations and soil sampling were conducted by Warren Lynn, Research Soil Scientist from the National Soil Survey Center. Kathy Swain and Peter Whitcomb worked continuously with Warren, typically putting in 10- to 12-hour days. Phil Schoenberger, Research Soil Scientist from the National Soil Survey Center, brought four Compact Constant Head



Permeameters with him to conduct extensive data collection on the saturated hydrologic conductivity of the "hard pan." New Hampshire has its own permeameter, so at times during the week there were up to five permeameters functioning simultaneously. Phil received a lot of much needed assistance from Laura Morton, Soil Scientist WAE in Concord; Marc Southerland and Marie Danforth, NRCS volunteers; Francesca Latawiec, Principal Planner with New Hampshire Office of State Planning; and Ann Titus, Merrimack Conservation District Administrator. Through a cooperative arrangement with USGS, we were able to utilize the expertise of Joseph Ayotte, Hydrologist, and make use of Ground Penetrating Radar (GPR) technology. With the assistance of Joe Homer, Joe Ayotte conducted GPR transects across the study site to develop imagery that provides a "picture" of the nature and properties of the underlying "hard pan." We cannot forget the tremendous effort that was needed to hand dig the soil pits to enable proper investigation and soil sampling. Four soil pits about 3 by 5 feet in size were dug to a depth of 5 feet through this "hard pan" material, which behaves like concrete. Much credit goes to Pete Whitcomb, Kathy Swain, Marie Danforth, and Laura Morton and to Marc Southerland, the human backhoe,

As the volumes of data start coming in, they will need to be compiled and interpreted. Additional studies are planned at this site to help complete the picture of what is going on in terms of soil-water behavior. All of this information will enable the soil science community to better predict the behavior of these kinds of soil under specific kinds of land use.

Preliminary observations completed during the week of data collection indicate that surface water may not necessarily perch on top of the "hard pan" in certain locations. Some preliminary evidence indicates that the "hard pan" is made up of many discontinuous bands that act as hydrologic barriers. Instead of perching on the "hard pan," however, water may cascade through discontinuous "hard pan" layers, flowing laterally through sandy layers and spilling over one barrier to the next—like a giant, elaborate underground fountain.

This kind of information and documentation is critically important in our attempt to provide knowledgeable and meaningful interpretations to developers, consultants, farmers, home buyers, and other property owners. It is very valuable information for the proper siting and installation of septic systems. Having scientifically based documentation of this nature provides credibility to the National Cooperative Soil Survey and adds to our reservoir of knowledge about soil behavior. The information that comes out of projects of this nature ensures that NRCS soils information and interpretations and the data extracted out of the NASIS data base are technically sound and legally defensible. ■

Field Methods continued from page 1

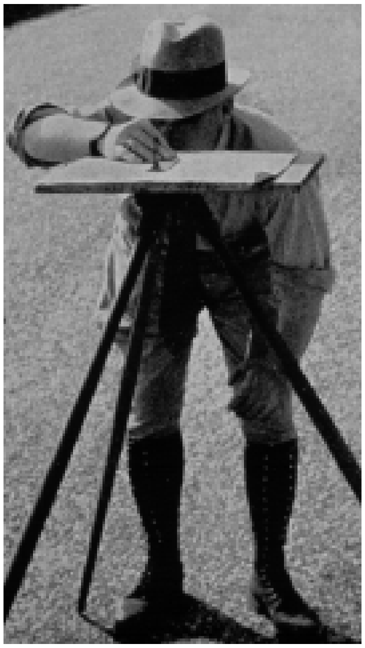
usually without provision for correcting errors in the original U. S. Land Office Surveys. Bearings were determined by compass, and courses were plotted by protractor and scale. Topographic quadrangles of the U.S. Geological Survey, where available, were made use of as base maps; but these were frequently on small scale or of earlier publication, and required a great deal of revision in bringing roads and other cultural features up to date.

Transportation in the field was usually afforded by hired horse and buggy; at times this was supplemented by a saddle horse. Distances were measured by an odometer attached by a metal clip to the front axle of the buggy. This consisted of a dial traversed by yellow, red, and blue hands actuated by a spur or sprocket wheel turned by a metal pin driven into the wooden hub of the vehicle. This projecting pin engaged the spur wheel with each revolution of the buggy wheel. The dial was calibrated in units of number of revolutions of the wheel. With a standard-size wheel of 42 inches diameter, 100 revolutions were equivalent to a mile; the number of revolutions in multiples of 100 up to 40,000 were recorded. Careful determination of the wheel diameter was necessary. It was usually necessary to dismount from the vehicle and read the instrument from the ground for accuracy, though much of the time this could be checked from the seat for approximate distance traveled. A bell mounted on the back of the instrument was struck by a small hammer on completion of each 100 revolutions of the wheel. It often became necessary, even in those horse and buggy days to "get out and get under" (to fix the equipment). In extremity we could resort to the simple expedient of tying a bit of cloth to one of the buggy spokes and recording the revolutions with a tally register.

Field parties were expected to obtain accommodations with farmers or in local towns and villages near enough the scene of operations to avoid undue expense and interruption in fieldwork necessitated by long drives. In the thickly settled Mormon communities of Utah this was usually not difficult; but the problem presented grave difficulties in other areas.

Lapham talks about using a plane table and alidade while mapping in the Salinas Valley during 1901:

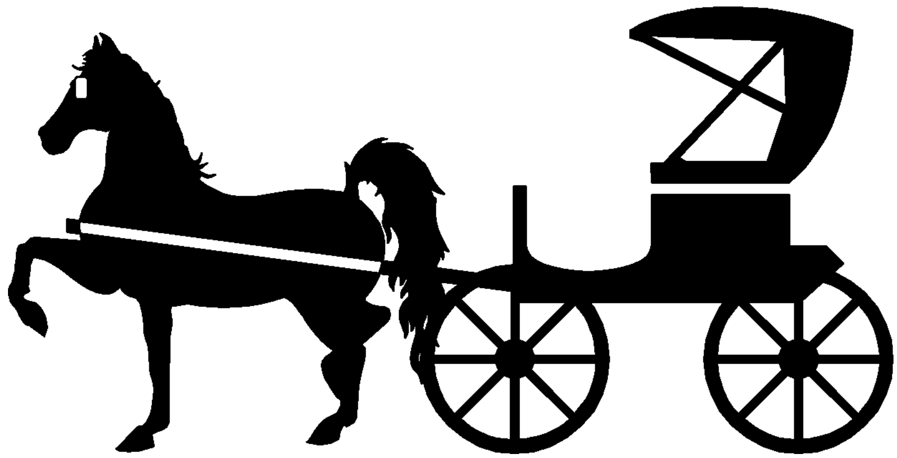
At the time of this early soil



> survey, some simple equipment had been acquired by the Bureau with which we undertook our first experience in plane-table surveying in the construction of a base map upon which soils were delineated. This consisted of a tripod upon which was mounted a detachable board, in one side of which was fixed a small brass box containing a compass needle. With a piece of heavy drawing paper attached to the board, and when set up in the field and oriented with the compass needle, sights were taken by means of a simple alidade; this permitted the sketching of roads . . . windmills, courses of streams, [etc.]. At the end of the day these were inked in, and soil types indicated by colored pencils. With latitude in recognition and mapping of soil types at the time, a half dozen colored pencils in the vest pocket might take the place of a hundred or more mapping units in the complicated soil map legend of today.
>
> These early plane-table surveys were crude; but with experience in technique, they have served well for many years, and are still serving a useful purpose in the absence of suitable topographic or aerial base maps.

Lapham chronicles the first attempt to use an automobile in mapping:

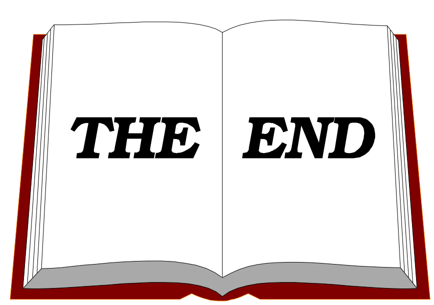
> [Sacramento Valley, California, 1904] . . . the auto was making its bid as a practical means of transport. I foolishly became infected with ambition to substitute one for the old slow moving horse drawn vehicle [and] engaged in an abortive attempt to introduce auto to soil survey. . . . This consisted of a narrow-gauge vehicle powered by a single



> cylinder air-cooled motor mounted on rear. Chain and sprocket connected it to the rear axle. When started with crank . . . usually at expense of blisters, it made a terrible clatter, and would maintain speed of 15-20 mph on smooth oiled road [of which there were few]. It was without speedometer, but with ingenuity . . . I installed odometer . . . and finally succeeded in mapping a few miles of highway with its bordering soils. I believe this to be the first instance in which any form of auto transportation was used in the soil survey. Invention is, however, at times the mother of necessity and we soon returned to the slower and more dependable horse and buggy.

The history of soil survey during its infancy is truly rich, and as we approach the centennial celebration of the soil survey, it is good to reflect. I hope that this abbreviated look back has captured your interest and has provided knowledge that can be used as we carry the work forward. Certainly, the excerpts from Macy Lapham's *Crisscross Trails: Narrative of a Soil Surveyor* have enhanced the storytelling. It is only fitting to close with this end quote from Macy's book:

> When the old horse and buggy stepped out of the picture and was replaced by the automobile, and when Dr. Marbut brought to us the principles of modern soil science, a new era was ushered into the Soil Survey. Modern field equipment and modern methods of observation and record have relegated the soil surveys of yesterday to a background of historical interest and of outmoded pedological and agricultural significance. Nevertheless, to one who has served through a pioneering period of slower tempo, recollection of the old horse and buggy jogging along a dusty country road with plane-table by side of the driver and a feed of oats and hay in the rear, brings nostalgic memories of many peaceful, pleasant country scenes. ■



Sequence of Soil Orders for the Centennial Calendar

By Loyal A. Quandt, Soil Scientist, USDA, Natural Resources Conservation Service, National Soil Survey Center.

The centennial calendar, which shows the 12 soil orders in the current system of soil taxonomy, will be distributed before the end of this calendar year. Climatic conditions, primarily moisture and temperature, have played a major role in the processes of soil formation. Following is a description of the rationale for the sequence of soil orders assigned to the individual months in the calendar.

January is associated with Entisols, which are young soils at an early stage of development.

February, a very cold month, is associated with Gelisols, which are the coldest soils and have a layer of permafrost.

March, one of the wettest months, is associated with Histosols, which are wet soils.

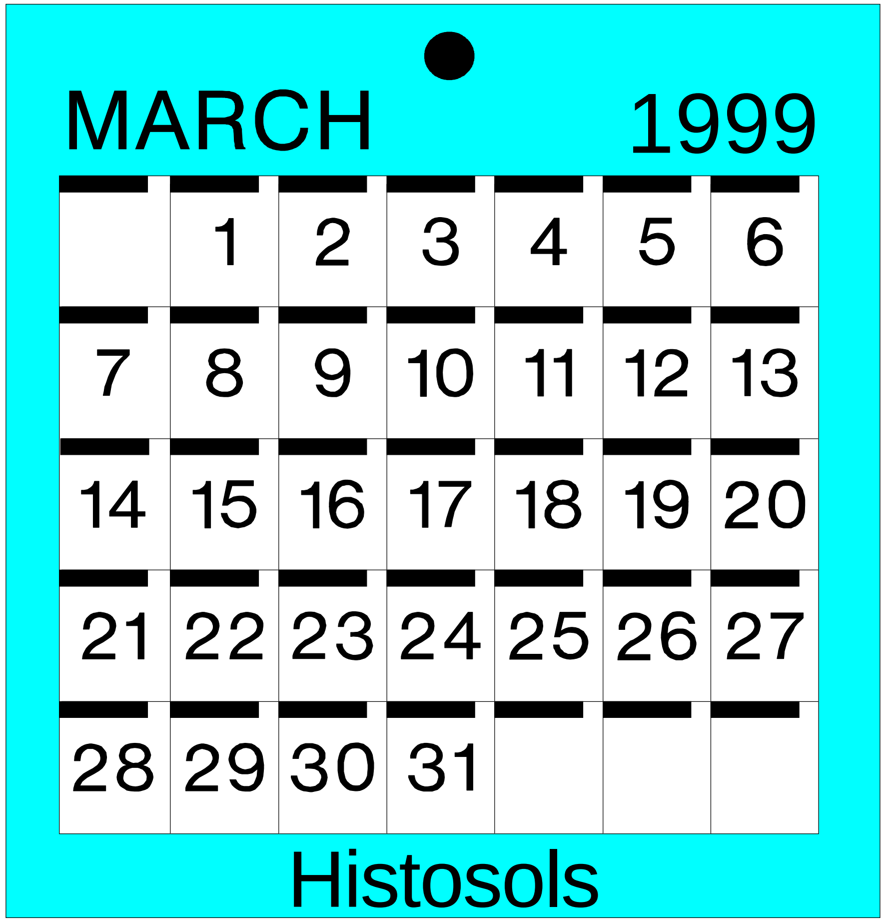
April, which is a month of transition from colder to warmer temperatures, is associated with Inceptisols, which are characterized by incipient change in soil development.

May is associated with Alfisols, in which effective rainfall results in clay leaching and enrichment in the subsoil.

June is associated with Mollisols, in which accelerated vegetative growth results in the development of a dark surface soil.

July is associated with Ultisols, in which hot and humid conditions have resulted in a clay-enriched subsoil and lower fertility.

August is associated with Oxisols, in which very hot and humid conditions



have resulted in maximum soil weathering.

September is associated with Aridisols, which formed under hot and dry conditions in arid areas.

October, a month of color changes in plants, is associated with Spodosols, which are dominantly in areas of cooler soil temperatures.

November is associated with Vertisols, in which soil cracks are very pronounced in late fall prior to precipitation.

December is associated with Andisols, which are volcanic soils in the Northwestern States.

This sequence of soil orders will enable the user of this calendar to associate soil climatic conditions with soil properties and soil development. Brief descriptions of the soil orders are included on the calendar. Technical descriptions of the orders are included in *Soil Taxonomy*, which will be published within the next few weeks. ■

Stories, Tales, and Bald-Faced Lies

Edited by Henry Mount, Soil Scientist, USDA, Natural Resources Conservation Service, National Soil Survey Center.

Following are two stories from Henry Mount's collection of folklore about soil scientists during the first 100 years of the soil survey program.

Paha

Contributed by Ken Hinkley, Soil Scientist (retired), USDA, Soil Conservation Service (now the Natural Resources Conservation Service).

Dr. Wayne Sholtes was the leading instructor for the Soil Science Institute at Ames, Iowa, during the 1960's and 1970's. Before that time, I was one of his college students at Iowa State who took a field tour. We rode in a bus over the glaciated landscapes of Iowa looking for pahas.

"Today, I will buy a cup of coffee for the first student that identifies a paha," he told us during the ride.

We students powwowed and decided to play a trick on our professor. One soil scientist knew this territory well. He would give a signal to us when he spied one. The signal was given that morning, and all 30 students yelled "Paha!"

We thought sure that Dr. Sholtes would buy each of us a cup of coffee. Instead, we were surprised when he came out of a coffee shop with one cup of coffee and 30 straws. ■

Pit Implosion

Contributed by Fred Minzenmayer, Soil Scientist, USDA, Natural Resources Conservation Service.

I was on a sampling trip to south-central Kansas during the 1980's. We had a backhoe operator who dug a deep pit in sandy material. Five or six soil scientists scrambled into the pit, and only I was left on solid ground.

"Guys," I warned, "that pit doesn't look too safe."

"Fred, get your butt down here!" Cleveland Watts yelled.

I got into the pit, and it immediately imploded, covering all of us to our waists. We could not extract ourselves from the sandy material. We were stuck.

The backhoe operator immediately jumped onto his machine and yelled, "I'll free yuh!"

As the steel teeth from the backhoe came at us, I yelled, "Don't try to scoop us out. You'll slice off our arms and legs if you try. Dig a hole beside us!"

The backhoe operator worked and worked until each of us was able to crawl like ants onto the surface of mother earth. The price had been heavy, however. He had totally mucked up an area that must have been 50 by 50 feet.

About that time the landowner came walking up and yelled at us. "What the heck is going on! I thought you were only going to dig a little hole." ■

John Kimble and Maurice Mausbach Honored

At the 1998 annual meeting of the Soil Science Society of America (SSSA) held in Baltimore, Maryland, Dr. John Kimble, Research Soil Scientist, USDA, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska, was given the International Soil Science Award and Dr. Maurice J. Mausbach, Deputy Chief for Soil Survey and Resource Assessment, Natural Resources Conservation Service, was named a Fellow of SSSA. ■