National Cooperative Soil Survey **Newsletter**

May 2002
Issue 19

In This Issue—

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—stan.anderson@nssc.nrcs.usda.gov.

Soil Classification: Past and Present

By Robert J. Ahrens, USDA, NRCS; Thomas J. Rice, Jr., Calif. Poly. State Univ., SLO; and Hari Eswaran, USDA, NRCS.

Background and History

Although not recognized as a discipline until the nineteenth century, pedology and soil science in general have their rudimentary beginnings in attempts to group or classify soils on the basis of productivity. Early agrarian civilizations must have had some way to communicate differences and similarities among soils. The earliest documented attempt at a formal classification of soils seems to have occurred in China about 40 centuries ago (Lee, 1921). The Chinese system included nine classes based on productivity. Yellow, soft soils (soils derived from loess) were considered the best, followed by rich, red soils. Evidence suggests that the Chinese soil classification system was used to levy taxes on the basis of soil productivity (Simonson, 1962).

Cato (234-149 B.C.), a Roman scientist, contrived a soil classification system based on farming utility. His system employed nine classes and twenty-one subclasses and guided decisions about use and care of the land for production of food and fiber (Stremski, 1975). The decline of the Roman Empire coincided with a general stagnation in the field of soil science, as indicated by the low number of major contributions in the discipline until the nineteenth century.

The nineteenth century saw renewed interest in studying soil characteristics in order to relate tax assessment to soil productivity. In Russia this effort helped to establish the discipline of pedology. In 1882, the Russian Government hired V.V. Dokuchaiev to guide a program to map and classify soils as a basis for tax assessment (Simonson, 1962).

Dokuchaiev and his students launched a new era in pedology that promoted the description and characterization of soils as natural bodies with a degree of natural organization rather than as simply mantles of weathered rock. This important notion fostered the concept of the pedon from which data could be collected and compared. Even after the concept of the pedon took hold among pedologists, soil science still lacked standards for classifying soils and describing the morphology and properties of soil profiles. This lack of standards hampered pedology and resulted in classification schemes shrouded with cloudy concepts that had no operational definitions.

As an example, the U.S. 1938 classification system (USDA, 1938) followed the concepts of zonal and azonal soils, lacked operational definitions, and consequently failed to meet all the needs of the soil science community. In the 1938 system, one of the zonal soils, Reddish Prairie Soils, is described as dark-brown or reddish-brown soil grading through reddish-brown heavier subsoil, medium acid. This description is very vague. Without the knowledge that these soils occur in the southern Great Plains of the U.S., the soil scientist might find these soils in several parts of the world. Aside from the indistinct categories within the 1938 scheme, the system did not offer a means to differentiate soils both among taxa and within the same taxa. For example, table 1 illustrates the families from a card dated November 26, 1951, used presumably by correlators and field soil scientists to differentiate among the Reddish Prairie Soils. Obvious deficiencies include no definitions for column headings, such as “Stage,” and no operational definitions to differentiate any of the classes within the columns. This means that the differentiae, such as the degree of weathering, are based on judgment and experience. The terms may have valid meaning to the local soil scientists. However, soil scientists from different parts of the world converging on the southern Great Plains could engage in interesting discussions but would not likely reach agreement on whether a given soil exhibits medium or strong weathering. Furthermore, the differentiae are not defined in the *Soil Survey Manual* (Soil Survey Staff, 1951) or anywhere else. The information in table 1 is useful only to those who are already familiar with these soils. The differentiae are of little value in distinguishing the soils even for the most experienced soil scientist.

Table 2 is a card dated November 25, 1951, that attempts to provide facts about Craig soils. Again, the information is scant and is of little value to a soil scientist unfamiliar with these soils or the area in general.

Modern Soil Classification

After World War II agriculture felt the effects of economic reconstruction and the expansion of global markets, and there was a renewed interest in soil conservation and alternative land uses, which helped to invigorate soil survey activities. Soil scientists began identifying many new soils, and classification systems needed to track all the newly recognized soils. The U.S. Soil Conservation Service (now the Natural Resources Conservation Service), under the leadership of Guy Smith, accepted the challenge and made giant strides in improving soil classification. Work to develop a new U.S. soil classification system commenced in 1951.

During the same period intensive activities developed national systems in Europe. A notable contribution was that of the French pedologists, who had commenced developing their system in the early fifties and published it in 1967 (CPCS, 1967). The U.S. system saw its debut in 1960 as the 7th Approximation, which was the first operational version of soil taxonomy. Other groups developed concepts and terminology for specific uses. An outstanding contribution was the Soil Map of the World Project, for which a legend was developed by the Food and Agricultural Organization of the United Nations (FAO, 1971-1981). Another group published the Soil Map of Africa (D’Hoore, 1964). Later, the first effort towards a Soil Map of Europe was initiated (Dudal et al., 1970). Although legends were developed for these small-scale maps, the process also helped to develop units at the higher levels of classification. The maps then became a technique to validate the higher levels.

FAO organized several working meetings to develop the legend for the world map. Field trips during such meetings were critical in testing concepts and developing criteria. Conferences and symposia of Commission V of the International Society of Soil Science (ISSS) played an important role in this process. Each national, regional, and international group reported on its progress and obtained critical evaluation of its efforts. The universities and research

Table 1.—Families of Reddish Prairie Soils in the Southern Great Plains Correlation Area

Family	Stage	Texture Class	Drainage	Degree of Weathering	Size of Solum
Craig	Maximal	Medium	Good	Strong	Medium
Dennis	Medial	Medium to moderately fine	Good to moderately good	Strong	Medium
Hockley	Maximal	Moderately coarse	Good to moderately good	Strong	Medium
Kirkland	Medial	Moderately fine	Good to moderately good	Medium	Medium
La Bette	Medial	Loamy	Good	Medium	Medium
Pratt	Minimal	Coarse	Good	Weak	Medium
Teller	Minimal	Loamy	Good	Weak	Medium
Tishomingo	Medial	Moderately coarse	Good	Strong	Thin
Wilson	Maximal	Loamy	Moderately good	Strong	Medium

Table 2.—Description of Craig Soil

Great Soil Group	**Reddish Prairie (maximal)**
Family	Craig
Series included	Craig
Drainage Class	Good
Texture Class	Loamy (medium)
Horizons	Degree of Devel.
A1	Strong
A3 & B1	Medium
B2	Strong
C	
Degree of weathering	Strong (moderately strong)
Size of profile	Medium
Kind of phases	Depth, slope, erosion
Parent material	Residuum from interbedded cherty limestone and shale
Climate	Moderately humid, temperate

communities developed methods of soil characterization and methods of testing the theoretical concepts. Thus, the sixties and seventies were a period of intensive activity in the development of soil classification systems; the activities were spurred by national needs and by gentle competition.

Perhaps the greatest modern breakthrough in soil classification is the recognition that the soil-forming processes frequently leave markers in the form of diagnostic horizons and features. The diagnostic horizons and features can be defined in terms of observable and measurable properties. One of the most difficult considerations in establishing concise definitions is the fact that soils are not discontinuous natural units. Gradual transitions of soil properties and soil bodies occur on any landscape. The choice of differentiating criteria is of paramount importance in applying the definitions of diagnostic horizons or features in the field.

When definitions based on well defined differentiating criteria are applied consistently, soil scientists with different backgrounds and experiences should arrive at the same conclusions, regardless of any contrary views on the genetic aspects of the soil. Soil genesis is important to classification because it permits us to place similar soils in the same or similar taxa. Also, it plays a major role in soil mapping because it helps us to develop our predictive model of soil-landscape segments that can be delineated on usable soil maps with viable interpretations. In summary, the diagnostic horizons represent the genetic aspects of soils, but genesis does not appear in the definitions. Well defined diagnostic horizons and features allow soil scientists with different views and experiences to describe the same horizons and features, even though all the genetic processes that produced the horizons and features are not fully understood.

The diagnostic horizons and features form the building blocks of the various taxa of a soil classification system and provide a powerful tool for communicating information about soils and differentiating among soils. The Craig series listed in table 1 is in the family of clayey-skeletal, mixed, active, thermic Mollic Paleudalfs. For those who are familiar with *Soil Taxonomy* (Soil Survey Staff, 1999), this family name indicates that the soil has a thick argillic horizon with at least 35 clay and 35 percent rock fragments and adequate bases; that it occurs on stable landscapes in a warm, humid or semihumid climate; and that its surface layer is dark, most likely because of the accumulation of organic matter. Thus, the classification of the soil provides significant information about the properties of the soil.

The classification also provides a way to compare the soils quantitatively. The Dennis series listed in table 1 is a fine, mixed, active, thermic Aquic Argiudoll (Soil Survey Staff, 1999). The Dennis series has more bases and less rock fragments than the Craig series. The Craig series is better drained than the Dennis series. The differences between the two series can be quantified. The Dennis series has a mollic epipedon 25 cm or more thick and has less than 35 percent rock fragments. The Craig series has an umbric epipedon and has more than 35 percent rock fragments in the upper 50 cm of the argillic horizon.

Soil classification systems have come a long way from their humble beginnings as a means of levying taxes based on production and have progressed through various stages, including a descriptive stage illustrated above, to a rather sophisticated quantitative stage. Most modern soil classification systems are developed to complement and support soil survey activities. They provide pedologists a means of communicating their findings about important soil properties and of differentiating among soils in a consistent manner.

Cline (1949) indicated that classifications are not truths that are discovered but are contrivances made by humans to suit their purposes. Many countries have developed sophisticated soil classification systems that meet their needs. Although Soil Taxonomy and the World Resource Base each have been adopted by several nations, one of the lingering criticisms is that there is no universal soil taxonomic system, as there is for plants and animals. The Australian (Isbell, 1996), New Zealand (Hewitt, 1998), and Canadian (Agriculture Canada Expert Committee on Soil Survey, 1987) soil classification systems, to name a few, are directed towards national efforts. Many countries that have developed national classification systems share common features. Most national systems have shifted toward the more quantitative definitions and criteria for diagnostic horizons and features that permit the formation of mutually exclusive taxa. Concepts and models of soil genesis have guided the selection of diagnostic horizons and features, and it is no surprise that many national soil classification systems share common or roughly equivalent diagnostic horizons and features that provide a means of communication among soil scientists from various countries.

Improvements Needed

The diagnostic horizons and features represent a major innovation in soil classification that has been embraced by most pedologists, but there remain issues that have not been resolved to everyone's satisfaction. Unlike discrete plants or animals, soils form a continuum over the earth's surface. Soil delineations are represented by one or more soils as a map unit, but in reality the map units contain many soils, not just the few designated in the map unit name. The confusion lies in classifying the pedon and then using the classification to represent the map unit. The concept of the pedon has been scrutinized (Holmgren, 1988), but not resolved. The map unit and pedon at first seem simple and straightforward, but they are sources of confusion or discomfort for many pedologists.

Anthropogenic soils pose another challenge. Humans have influenced and drastically changed the soil for centuries. At what point does the human influence change the classification of a soil? In areas that have been altered by plowing and additions of fertilizer, when is the soil sufficiently changed to warrant different taxa? Are there markers in the soil that capture the impact of humans on the soil resource? Or must we rely on outside sources, such as history of the area?

The World Resource Base (WRB, 1998) and other classification systems have made bold attempts to capture the human influences. The Anthrosol order in WRB groups all the agricultural soils that are significantly impacted by humans. This order is required to have diagnostic horizons that are influenced by human activities. For example, the terric horizon is one of the diagnostic horizons used to key to the Anthrosol order. According to WRB (1998), "The terric horizon develops through additions of earthy manure, compost or mud over a long period of time. It has a non-uniform textural differentiation with depth. Its color is related to the source material or the underlying substrate. Base saturation is more than 50 percent." The requirement of base saturation is quantitative. The criterion of non-uniform textures requires some judgment on the part of the pedologist and may not be applied uniformly by all. "Additions of earthy manure, compost, or mud" refers to the mode of deposition and may be difficult to differentiate from non-human eolian and alluvial deposition. Does the mode of deposition affect use or management of the soil? Should soils like this have separate taxa because of the anthropogenic influences? These questions will be debated and depend largely on the purposes of the classification system. The soil science community is discussing these issues, but it will not likely reach agreement.

Summary

Soil classification systems have evolved into sophisticated communication tools. The diagnostic horizons and features and their associated quantitative definitions are probably the greatest contributions in the last 50 years. They allow pedologists with different experiences to classify soils in a consistent manner.

Many countries have developed their own classification systems, depending on the needs and soils of the country. Although there is no one soil classification system that is used by all countries, most pedologists are familiar with diagnostic horizons and features and have used them as an international means of communication.

Even with all the advances in soil classification, there are still difficulties between the soils that we classify and the soils that we map. Soils influenced and forever modified by humans present one of the greatest classification challenges. Although some classification systems have developed taxa for these soils, there are still questions about their utility.

References

Agriculture Canada Expert Committee on Soil Survey. 1987. The Canadian system of soil classification. 2nd edition. Agric. Can. Pub. 1646.

Cline, M.G. 1949. Basic principles of soil classification. Soil Sci. 67, p. 81.

CPCS. 1967. Commission de Pédologie et de cartographie des sols. Classification des sols. Lab. Geol. Pedol., Ecole Nat. Supr. Agron. (Grignon, France).

D'Hoore, J.L. 1964. Soil map of Africa, scale 1:5,000,000. Joint Project No. 11. Commission for Technical Cooperation in Africa Publ. Ceuterick, Louvain, Belgium.

Dudal, R., R. Tavernier, and D. Osmond. 1970. Soil map of Europe, 1:2,500,000; explanatory text. FAO, Rome, Italy.

FAO. 1971-1981. FAO/UNESCO Soil map of the world, 1:5 million. Vols. 1-10. FAO/UNESCO, Rome, Italy.

Hewitt, A.E. 1998. New Zealand soil classification. Manaaki Whenua Press.

Holmgren, G.G.S. 1988. The point representation of soil. Soil Sci. Soc. Am. J. 52: 712-716.

Isbell, R.F. 1996. The Australian soil classification. CSIRO Publishing.
Lee, M. Ping-Hua. 1921. Columbia University studies in history, economics, and public law, 99.
Simonson, R.W. 1962. Soil classification in the United States. Sci. 137: 1027-1034.
Soil Survey Staff. 1951. Soil survey manual. U.S. Dep. Agric. Hanb. 18.
Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. U.S. Dep. Agric. Hanb. 436.
Stremski, M. 1975. Ideas underlying soil systematics. Polish Edition. TT73-54013, Foreign Scientific Publ. Dep. National Center for Scientific, Technical and Economic Information, Warsaw.
USDA. 1938. Soils and men. Yearbook of Agriculture.
World Reference Base for Soil Resources. 1998. FAO. Rome. ■

Soil Taxonomy International Committees

By Craig Ditzler, National Leader for Soil Classification and Standards, National Soil Survey Center, Lincoln, Nebraska.

Some of the most significant improvements in Soil Taxonomy have been due to the work of international committees organized around a specific topic. For example, ICOMAQ (International Committee on Aquic Moisture Regimes) introduced aquic conditions and redoximorphic features (among other things), and ICOMAND and ICOMPAS (International Committees on Andisols and Permafrost-Affected Soils, respectively) introduced Andisols and Gelisols as the 11th and 12th soil orders.

Recently, two committees have been reactivated under new leadership. Dr. Wayne Hudnall, Louisiana State University, has assumed the chair of ICOMMOTR (International Committee on Moisture and Temperature Regimes), and Dr. John Galbraith, Virginia Polytechnic Institute, has assumed the chair of ICOMANTH (International Committee on Anthropogenic Soils).

Charges for ICOMMOTR:

1. Develop a statement describing why soil climate is an appropriate soil property to be included in Soil Taxonomy. This conceptual statement will serve as the guide to evaluate ICOMMOTR proposals for Soil Taxonomy.
2. Define standard procedures for measuring soil moisture and temperature. In addition to sensors, depths, etc., site conditions are important. Consider defining a standard condition and provide guidance on correlation of other conditions to the standard. Also, consider methods for measuring moisture in Vertisols.
3. Use existing data to test the use of measurements at fixed points at standard depths to replace the concept of the moisture control section.
4. Define moisture and temperature regimes separately from one another, including seasonal concepts (moist/dry and warm/cool seasons). Utilize combinations of the regimes to define appropriate taxa. Explore the use of near-surface measures of moisture and temperature for further defining some taxa, such as very cold soils and very dry soils.
5. Plan a correlation tour, to be conducted in 3 to 5 years, that will address the most pressing problems.

Charges for ICOMANTH:

1. Develop a collection of soil descriptions representing an array of anthropogenic processes and resulting soil profiles. These can be used to propose new horizon nomenclature, terms for describing anthropogenic properties, and landscape features for these soils.
2. Based on existing soil descriptions, propose new diagnostic horizons and features and revisions to the current anthropogenic diagnostic horizons and features. Follow-up on suggestions from previous circular letters to revise the definition of buried soils and to propose new particle-size substitute classes to handle such materials as coal-ash and iron ore slag.
3. Propose new taxa for Soil Taxonomy.
4. Plan a correlation tour in conjunction with the 2006 International Union of Soil Scientists meetings.

To be successful, the committee Chairs need your input in the form of ideas, sharing of data, and review of proposals. To be included in their mailings, send a message with your contact information to either Dr. Wayne Hudnall, Chair of ICOMMOTR (whudnall@agctr.lsu.edu), or Dr. John Galbraith, Chair of ICOMANTH (ttcf@vt.edu). ■

Personnel Changes

The following people were selected as State Soil Scientists/MO Leaders: Charles Love in Auburn, AL; Cleveland Watts in Salina, KS; and Dave Smith in Davis, CA.

Neil Peterson was selected as the State Soil Scientist in Spokane, WA.

Linda Bouc selected as the Administrative Assistant to the Director of the NSSC.

Steve Peaslee selected as the GIS Specialist at the NSSC. ■

Risks Associated With Permafrost-Affected Soils[1]

By Joe Moore, State Soil Scientist/MLRA Office Leader, NRCS, Palmer, Alaska.

Permafrost takes many different forms in soils. Thin ice lenses are disseminated throughout some soils. Other soils, especially old soils that have fine grained textures and are on high terraces and footslopes, have large blocks and wedges, or massive ice (fig. 1). The permafrost in many areas of Alaska is relatively warm, just below 32 degrees F. These soils are insulated by the surface cover of vegetation. If the vegetative cover is disturbed by wildfire or cultural practices, the insulation is lost and the permafrost will begin to melt. If a soil contains large amounts of sand and gravel, there will be no change in the strength or stability of the soil as the permafrost thaws. The stability of the soil is nearly the same, whether the soil is frozen or thawed. A soil that has finer textures (silt and clay) and disseminated ice can become supersaturated and liquefy as the permafrost thaws. Such a soil will lose all strength and stability unless the meltwater eventually drains off. If the soil contains large blocks and wedges of ice, large voids and pits will appear in the soil as the blocks of ice melt. The resulting pitted landscape is known as thermokarst (fig. 2) and is very disruptive to almost all land uses.

Permafrost-affected soils can be managed for many uses. It is critical, however, to understand the properties of each soil type (fig. 3). In some cases, it is desirable to design management practices that will maintain insulation of the soil and will allow it to remain frozen and stable. Other soils, however, can be successfully thawed and allowed to naturally drain, resulting in land suitable for agriculture. It is critical that those soils containing massive ice be

Figure 1.—Massive ice in the form of a wedge buried in a permafrost-affected soil. This wedge-shaped feature is relatively pure ice. The surface is dirty because of the fine materials melting out of the overlying soil. (Photo by Joe Moore, USDA, NRCS.)

Figure 2.—A large pit called "thermokarst" in an agricultural field. The thermokarst results from the melting of massive ice several feet below the soil surface. After the soil surface is disturbed, it may take many years for the buried blocks of ice to melt.

[1] In 2003, the Soil Survey Division will focus its marketing campaign on using soil surveys to identify areas with risks and hazards for particular soils or land uses. The campaign will heighten the public's awareness of these risks and hazards. Presentations, displays, and brochures will help to send the message "Consider the soil first."

identified before any land use decision is made. Conventional development on such soils is likely to end in failure as the ice blocks eventually melt (figs. 4 and 5). Well designed engineering practices which keep the soils insulated will allow for successful development. Onsite drilling is often necessary to identify the location of individual ice blocks. ■

Figure 3.—Permafrost-affected soils with loamy textures become saturated and unstable if allowed to thaw. In areas that include these soils, the trans-Alaska oil pipeline is elevated above the ground.

Figure 4.—Collapse of a section of the Alaska Highway in 1982 resulting from melting of massive ice under the roadbed. (Photo by Joe Moore, USDA, NRCS.)

Figure 5.—The result of building a conventional foundation on permafrost-affected soils containing massive ice. Heat transfer from the house resulted in melting of the ice and displacement of the foundation.

Notes on C.E. Kellogg by a Junior Staff Member

By R.B. Grossman, Research Soil Scientist, NRCS, National Soil Survey Center, Lincoln, Nebraska. Prepared for presentation at an upcoming meeting of the Soil Science Society of America.

It is fitting that we have this commemoration in the Soil Science Society because the political support of Agricultural Experiment Stations was vital in the early 1950s to establishment of the current soil survey program.

I joined the Federal soil survey in 1958 directly from graduate school. I was one of several new Ph.D.'s hired in the investigations group in the late 1950s and early 1960s. The intent was to provide people for future leadership positions. One of those hired was Klaus Flach, who did rise to a major management position. The objective of hiring through the investigations group was to increase Kellogg's control of the people from whom leadership would be drawn in the future. The hiring practices somewhat short-circuited the personnel program in the Soil Conservation Service.

The period from the 1950s to the early 1960s was an active period. It included the following activities:

• 1951—publication of the *Soil Survey Manual*
• 1960—publication of the *Soil Survey of Louden County, Virginia* (Porter and others, 1960), which includes nonagricultural interpretations
• 1956—400 surveys in progress using standards of the Bureau of Soils (Gardner, 1957)
• late 1950s—initiation of soil-geomorphology studies and an increase in the number of soil survey laboratories from one to three
• 1960—publication of the 7th Approximation, Soil Taxonomy

These activities must be viewed against the short time since the conclusion of WWII in 1945. The senior staff of the soil survey program prior to WWII served in various capacities during the war. Most were in the military, but some conducted trafficability studies as civilians. Most returned to the soil survey program after the war.

The soil survey program was fueled by the money that became available through the 1952 reorganization of the USDA by Secretary of Agriculture Brannan.[1] Brannan transferred all personnel and funds of the Bureau of Soil Survey (the organization headed by Kellogg) to the Soil Conservation Service (which had a competing soil survey program) and made Kellogg responsible for all soil survey activities (Gardner, 1957). As a result, Kellogg had more money and personnel than when he was head of the Bureau of Soils. The Soil Conservation Service of the late 1950s was only 20 to 25 years from its inception in the 1930s as a well-funded agency (for the time) with the mission of combating the Depression. The funding in the early 1950s was enough to mount a much larger effort in soil survey than would have been possible by the Bureau of Soils. Soil Conservation Service surveys were called utilitarian as they used interpretive property sets to separate soils, whereas the criteria for soil separation of the Bureau of Soils were naturalistic with the taxonomic principles having originated in Europe, particularly Russia. Through Kellogg's leadership, this naturalistic approach was installed throughout soil survey and the prior utilitarian systematics were replaced.

In the early to mid 1950s, Kellogg established the organizational and senior staff structure that remained in place for much of the time until his retirement. R.W. Hockensmith, who had been in charge of the SCS utilitarian soil survey, was Kellogg's chief of staff. People said that Hockensmith was the representative of the SCS survey program in Kellogg's organization and was not sympathetic to the technical directions of the soil survey program. In my contacts with him during meetings, Hockensmith seemed to be moderating, consensual, and gentle. R.W. Simonson was in charge of correlation or perhaps more accurately national systematics. Simonson was a student of Kellogg in North Dakota. He is a brilliant man with strong verbal and writing skills. A.A. Klingebiel managed the interpretations effort. He came from the prior Soil Conservation Service soil survey, in which he had been a state soil scientist and worked on documentation of physical soil properties. Klingebiel was extremely hard working. For a number of years he spearheaded the effort on nonagricultural interpretations. G.D. Smith was in charge of investigations. He hired R.V. Ruhe, established a soil-geomorphology program, and led the taxonomy effort. L.T. Alexander ran the laboratories under G.D. Smith.

The country was divided into five regions, each of which had a Principal Correlator. Kellogg's control of the senior technical program staff, including the Principal Correlators and the Washington staff, was exerted through biannual meetings. The reports of these meetings show the progression of issues in the national soil survey program. Kellogg chaired these meetings, and Hockensmith acted as the facilitator. At the end of this paper, I have included a portion of one of Kellogg's statements concluding a technical meeting. It shows the quality of his writing.

Dr. Kellogg had a strong work ethic. I think he drove his senior staff by example. The meetings we attended lasted for a full week and commonly included evening sessions. There were none of the sexist and racial jokes then current in the Soil Conservation Service. We gave formal reports, and he personally provided criticism. These reports had strong technical substance. During several meetings, I presented many ideas for changes in the 1951 *Soil Survey Manual* which were incorporated in the 1993 manual. Dr. Kellogg was fair. Once, a Principal Correlator gave a report showing incomplete command of the material. Dr. Kellogg publicly criticized the person. Later, Kellogg apologized before the meeting.

The whole senior staff had great respect for science which I think came from Kellogg's influence. We young Ph.D.'s were treated with warmth, and our ideas were received at least

---

[1] Secretary Brannan was the author of the Brannan Plan of the Truman Administration, by which farmers would produce to the maximum and sell cheaply. People would have cheap food, and the Government would make up the difference by paying the farmers. The plan was extremely controversial and was not adopted. It is interesting to speculate on what the health of our Nation might have been if the plan had been adopted.

tactfully and often accepted. Senior staff differed intellectually, but they all respected scholarship. They wanted to advance the technical program of soil survey. Responsibility was given with little attention to age or experience. Here there was a similarity to the German General Staff of WWII, in which lower ranked officers with special expertise were given major responsibility. Some of the senior field staff could be rather authoritarian with field people, but they were not with the young Ph.D.'s.

The most important example of acceptance of innovation was the rapid adoption by the senior field staff of the new soil taxonomy developed largely by G.D. Smith. The senior staff was open to having the young Ph.D.'s involved. An example is the basis for recognition of clay skins, a feature of a key diagnostic subsoil horizon in the new taxonomy. Examination of thin sections became the accepted basis for clay skin recognition. As a result, the new Ph.D.'s brought into the laboratories became the arbiters of a key property. An alternative would have been to make recognition of clay skins a field determination. The decision was to make clay skins a laboratory measurement and hence reduce the authority of the field staff and enhance that of the new Ph.D.'s, who could make the thin section examination.

I have certain reservations about Dr. Kellogg's technical emphasis. These reservations do not, however, pertain to the core of soil survey activities—soil mapping. One question is the lack of agronomic concerns in interpretations. Kellogg told us that he did not want to be in competition with the Extension Service. He had the interpretations program emphasize engineering and the related nonagricultural questions, which kept us at a distance from the agronomic programs of the Extension Service. It was a time of rapid suburbanization, and there was a strong need for nonagricultural interpretations. I think, however, that soil survey lost a lot by not having a stronger agronomic program. Another matter is the distance between the skimpy information on soil water in the 1951 *Soil Survey Manual* and the SCS soil water program. At the time of the reorganization, SCS was the world leader in hydrology. The Curve Number method (Haan et al., 1994) for runoff estimation was developed by SCS hydrologists. In 1952, as part of the reorganization by Secretary Brannan, the SCS hydrology program was transferred to what is now ARS. In the late 1940s and early 1950s, SCS ran thousands of permeability measurements and developed a system of prediction based on soil morphology (O'Neal, 1952). The sophistication of permeability estimates then current in SCS is absent from the 1951 manual. The matter is larger. Measurement generally was of much less importance to the people central to the soil survey than it was to the people involved in taxonomy and other aspects of systematics. Major parts of the soil description protocols were simplistic as pertains not only to water, as mentioned earlier, but also to other properties. Suppose 50 years ago we had initiated penetration resistance measurements and water state classes. Today, we would have a large database for quantification of consistence.

On the other hand, Kellogg was very supportive of our work on linear extensibility (LE), which is the change of moist to dry fabric length divided by the dry length. LE is ascertained by a simple calculation from our natural clod bulk density method. In 1959, Lindo Bartelli told Kellogg of our early fumbling attempts. Within a very few months, the criterion was throughout the soil survey. In passing, linear extensibility measurements are the basis for the Vertic taxa of soil taxonomy and a number of interpretations. Perhaps the method appealed so much to Kellogg because of its inherent engineering nature.

Sometime in the 1960s, Dr. Kellogg asked us for suggested changes in the 1951 *Soil Survey Manual*. I was quite full of myself and wrote a page or so, single space. I got back a one-line memo from Dr. Kellogg saying that they did not plan to make major revisions. In the 1970s and 1980s, I spent much time on major revisions of the 1951 manual in the areas of consistence and water, areas that I had written Dr. Kellogg about a decade or so earlier.

I will conclude with a couple of rather subjective comments and a personal story.

Dr. Kellogg was supportive of the New Deal. I think that this support went deeper than his success in a bureaucracy that had been created as part of the New Deal. I think that he intellectually supported the Left in the U.S. Some of the senior field staff were conservative, and there were comments that Dr. Kellogg was of the Left. I suspect that Dr. Kellogg knew he was thought to be of the Left and modified his statements accordingly. I thought that Dr. Kellogg's rolling speech had some similarities to FDR, and I remember once musing during a talk he gave that he seemed to have modeled himself to an extent on FDR.

Ed H. Templin was a senior correlator. We both lived in Lincoln. Ed kept pigeons, and I would occasionally visit his home in the evening and watch the pigeons. While so engaged, he once told me that he aspired in the 1930s for Dr. Kellogg's job as Chief of the Bureau of Soils. (He called Dr. Kellogg "Charlie.") Despite the competition, Ed never had a negative personal word to say about Dr. Kellogg. He, of course, had disagreements on technical issues. I think here is a window into the respect that people had for Dr. Kellogg. A man with desires in the past for Dr. Kellogg's job said nothing negative about him.

Management in the early 1960s wanted me to become head of the Soil Survey Laboratory in Lincoln, Nebraska. I declined. I was brought to Washington to talk to Dr. Kellogg. We had tea (he made it personally) and spent several hours talking mostly about literature, in particular the novels of C.P. Snow, which I had recently been reading. We did not really talk about the position until the end of the meeting, about the time I left. He asked me if I was willing to be acting head for a time. I said "Yes" and was the head of the laboratory for the next 13 years. I think that Dr. Kellogg decided to get me to agree by indirection. I was staying in Washington with L.T. Alexander, the Chief of our three laboratories. The next day at breakfast, Dr. Alexander told me that Dr. Kellogg had called in the evening. I had made a very positive impression, and he was particularly complimentary of my language skills—a bit of a poet he said. Such skills as I may have had subsequently never mattered in my dealings with senior administrators.

Following is an excerpt from the summary of the 1963 soil survey conference (Kellogg, 1963). The ideas are, of course, excellent and more intellectual than those of the next 40 years of my experience in the Federal soil survey. There is also the sentence pacing—a mixture of short and long sentences. The short sentences act as a kind of beat and spacing between the denser, longer sentences:

> We have had a good conference here. These conferences always lift my morale. Some of us were talking about the reasons this morning. We hear a lot nowadays of the importance of inter-disciplinary conferences, with economists and natural scientists together, and groups of natural scientists from different disciplines. Yet we must never fail to appreciate that every scientist also needs close communication with his peers. Unhappily, I once had to get quite well acquainted with the Mayo Clinic. The leaders explained that they never set up a new department of medicine or new specialization unless they had the finances to hire at least two top people in that field. They never had just one alone. Their experience had shown that the lone expert begins to become overconfident or to lose confidence if he has no one to talk to at his level of competence. I realize that many of our soil scientists do have rather lonesome positions. It is important that all of us have opportunities to talk with our peers—with people of nearly equal competence and equal responsibility.

Literature Cited

Gardner, D.R. 1957. The National Cooperative Soil Survey of the United States. Ph.D. Thesis. Harvard University, Cambridge, MA.

Haan, C.T., B.J. Barfield, and J.C. Hayes. 1994. Design Hydrology and Sedimentology for Small Catchments. Academic Press, San Diego, CA.

Kellogg, C.E. 1963. National Technical Work Planning Conference of the Cooperative Soil Survey. Summary of the Conference.

O'Neal, A.M. 1952. The Key for Evaluating Soil Permeability by Means of Certain Field Clues. Soil Sci. Soc. Am. Proc. 16: 312-315.

Porter, H.C., and others. 1960. Soil Survey Louden County, Virginia. USDA, Soil Conservation Service, Washington, D.C. ■

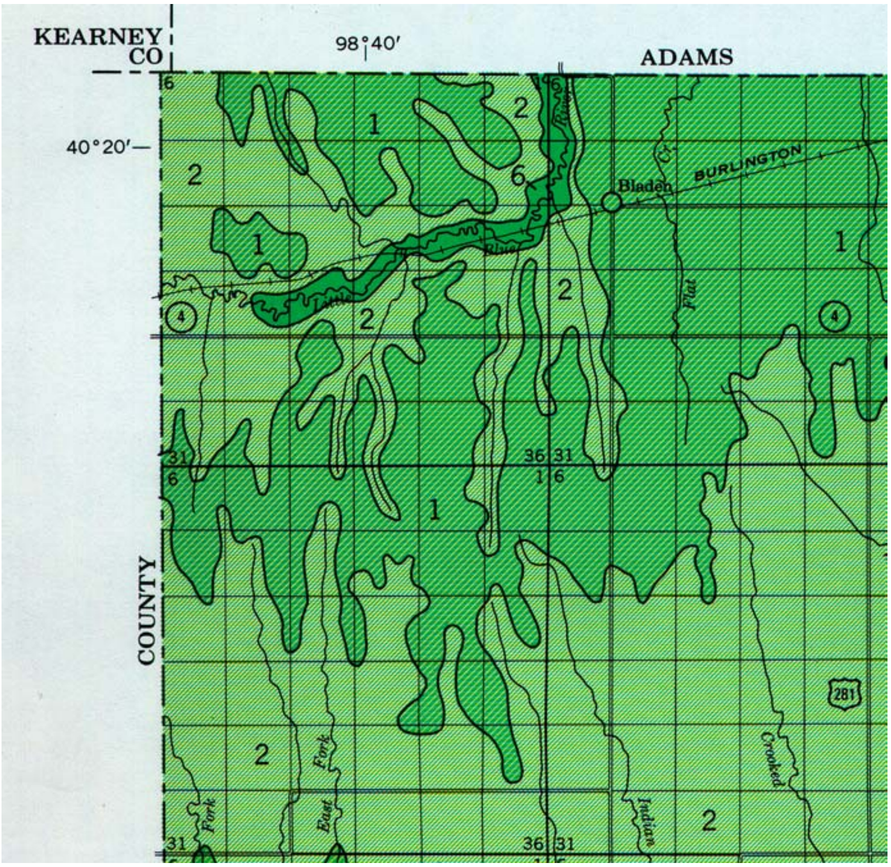
A Well, a Book, and a Prairie Dog Town

By Stanley P. Anderson, Editor, NRCS, National Soil Survey Center, Lincoln, Nebraska.

In an article in *Nebraska History* entitled "Catherton Post Office" (winter issue of 1973, pages 625-632), Charles Wesley Cowley notes that the home of Isaac Cowley (his father) served as a post office from 1876 to 1887. The post office was located in Batin Township (SW$^{1}/_{4}$ sec. 6, T. 3 N., R. 11 W.) rather than in Harmony Township, which was renamed Catherton Township (T. 3 N., R. 12 W.). After submitting new names and having them rejected by Washington a number of times, George P. Cather, Willa Cather's uncle, decided to name the township after himself. George Cather homesteaded a couple of miles to the west (sec. 2, T. 3 N., R. 12 W.), and Willa spent some of her childhood years on her grandparents' farm (NE$^{1}/_{4}$ sec. 22, T. 3 N., R. 12 W.) before her parents moved to Red Cloud, about 9 miles south and 5 miles east of the grandparents' farm and 2 miles north of the Republican River. The homestead locations specified in this paragraph are shown in figure 1.

Well

In his reminiscence, Charles Wesley Cowley, noting the scarcity of water in the area, describes (on page 627) how his father hired a man to dig a well on a hilltop on their farm, which was on the



R. 12 W. R. 11 W.

Figure 1.—The northwest corner of the general soil map in the *Soil Survey of Webster County, Nebraska* (1974).

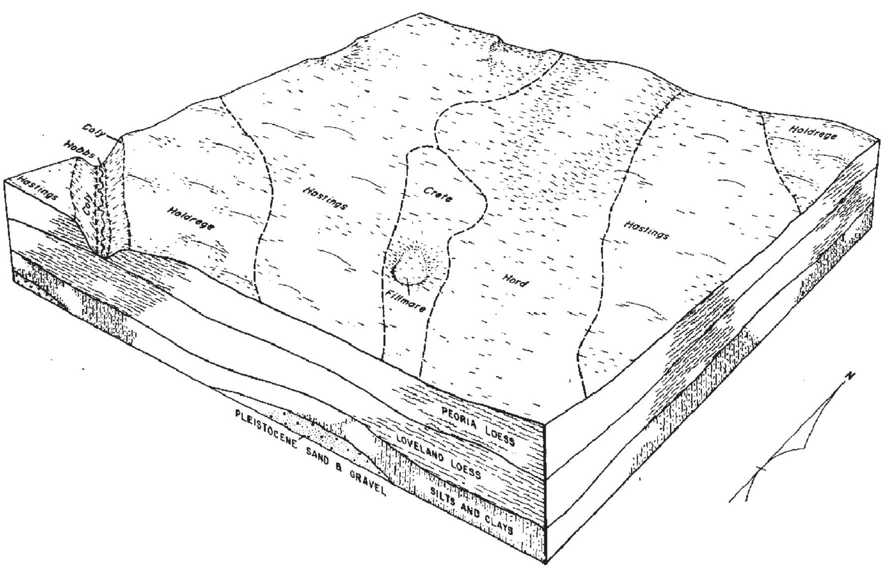


Figure 2.—Diagram of association 1 (the Hastings-Hord-Holdrege association) in the *Soil Survey of Webster County, Nebraska*.

divide between the Little Blue and Republican Rivers:

> . . . there was a lot of fellas wandering around looking for jobs, so it was easy to hire help. But they was out there like babes in the woods. Nobody had any idea how far it was to water up there on the top of the hill, so father made this kind of a bargain with the guy: He was to pay him 20 cents a foot for each foot that he dug, but if he tried to quit before he got water, he wasn't to have anything; if father stopped him, father was to pay for all the man had dug. The man that was digging, he got down about thirty-forty feet. He begin to want to squeal out. I guess father reminded him of their bargain; anyway he kept on. He got down eighty feet before they struck sand. Of course they had a couple of men to work on it because they had to curb the well the rest of the way down. . . . Finally, when they had about eighty feet of curbing in, they struck water—160 feet to water from the top.

Figure 2 indicates that the Hastings soils in association 1 are underlain by Pleistocene sand and gravel. The site for the well is probably in an area of Hastings silt loam, 0 to 1 percent slopes, map symbol Hs (fig. 3). According to the *Soil Survey of Webster County, Nebraska* (1974), a significant acreage of this soil is irrigated by water drawn from deep wells (page 17). Also, the supply of water for pump irrigation in the region north of the Republican River is “uncertain” (page 68), some areas having “no water-saturated sands and gravel” and other areas having sand and gravel at a depth of 50 feet or

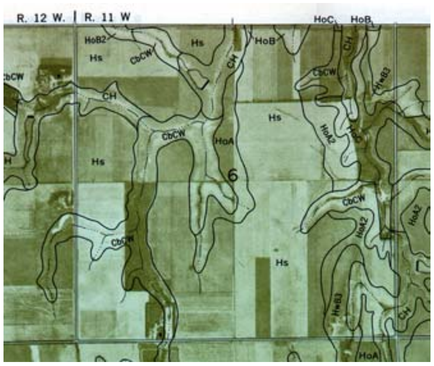


Figure 3.—Part of map sheet 13 in the survey of Webster County. The Catherton post office was in the SW¼ of section 6 in Batin Township. The map symbol Hs is for Hastings silt loam, 0 to 1 percent slopes.

more. Depth to "the static water level" is as much as 200 feet.

According to the official series description, the Hastings series consists of very deep, well drained soils that formed in silty loess on uplands. Typically, the surface layer is slightly hard, friable silt loam 6 inches thick. The next 8 inches is slightly hard, friable silty clay loam. The upper part of the subsoil is hard, firm silty clay loam 23 inches thick, and the lower part is slightly hard, friable silty clay loam 11 inches thick. Below this to a depth of 80 inches is soft, friable silt loam.

Book and Prairie Dog Town

The book is Willa Cather's *My Antonia* (1918), and the prairie dog town is described in the novel (book 1, chapters 4 and 7). In chapter 4, Jim Burden describes trips in which he (a boy about 10 years old) and Antonia (3 or 4 years older than Jim) ride his horse Dude north of his grandparents' farm to a prairie dog town, where they observe not only the prairie dogs but also earth-owls, which nest underground with the prairie dogs, and where Jim and Antonia have to watch out for rattlesnakes. The prairie dog town is upslope from a draw, in an area far away from any creek or pond. It is about 10 acres in size.

Otto Fuchs, who works as a hired hand for Jim's grandfather, says that he has seen well-populated prairie dog towns in desert areas 50 miles from any surface water and claims that some of the holes in the towns "hereabouts" extend almost 200 feet to water. Antonia says that she does not believe him.

In chapter 7, Jim and Antonia decide to dig into one of the holes in the town. Jim notes that there are "little patches of sand and gravel" that the prairie dogs "scratched up, we supposed, from a long way below the surface." In places there are "larger gravel patches, several yards away from any hole." Jim has to use his spade to kill a rattlesnake (called "the biggest snake I had ever seen" and "a circus monstrosity") lurking on "one of those dry gravel beds." Antonia is impressed with Jim's courage on this occasion.

If, as is likely, the prairie dog town is based on a real town from Cather's own childhood, it would have to be located in an area where the deposit of loess is much thinner than the loess in which the Hastings soils formed and the sand and gravel are much closer to the surface. According to *Grzimek's Encyclopedia of Mammals* (1990), prairie dogs dig to a maximum depth of about 16 feet (vol. 3, page 54).

Coda

Grzimek's Encyclopedia of Mammals indicates that the purely vegetarian diet of prairie dogs is dominated by grasses (vol. 3, page 56). Their food provides the water that they need. Meriwether Lewis was among the first to observe that prairie dogs can survive without water. In *The Journals of the Lewis and Clark Expedition*, volume 4 of the Moulton edition (pages 183-184), Lewis describes "a large assemblage" of prairie dogs that he observed on May 23, 1805, in north-central Montana, noting that, in this and other areas along the Missouri, they:

> . . . never visit the brooks or river for water; I am astonished how this anamal exists as it dose without water, particularly in a country like this where there is scarcely any rain during ¾ of the year and more rarely any due [dew]; yet we have sometimes found their villages at the distance of five or six miles from any water, and they are never found out of the limits of the ground which their burrows occupy.

Lewis could have provided Antonia a basis for disbelieving Otto's claim that prairie dogs dig as much as 200 feet for water. ■