

## 2.1 Introduction

The word “Wisconsin” originates from the name given to the Wisconsin River by one of the Algonquin-speaking American Indian groups living in the region at the time of European contact (Wisconsin Historical Society 2014). The Algonquian word for Wisconsin and its original meaning have grown obscure. Interpretations vary, but most implicate the river and the red sandstone that lines its banks. One leading theory is that the name originated from the Miami word *Meskonsing*, meaning “it lies red,” a reference to the setting of the Wisconsin River as it flows through the reddish sandstone of the Wisconsin Dells (Fig. 2.1). French explorer Jacques Marquette was the first European to reach the Wisconsin River, arriving in 1673, and calling the River *Meskousing* in his journal. This spelling was later changed to *Ouisconsin* by other French explorers, and over time this became the French name for both the Wisconsin River and the surrounding lands. English speakers changed the spelling to its current form when they began to arrive during the early nineteenth century. The current spelling was made official by the legislature of Wisconsin Territory in 1845.

## 2.2 Early Soil Investigations

All aspects of soil have been researched in Wisconsin, and there is a vast body of literature that goes back to the late 1800s. To list a few examples that shaped Wisconsin soil science: the agricultural physics work of F.H. King, the seminal work of M.L. Jackson on silicate crystal chemistry and radioactive isotopes, the soil fertility “revolving fund” concept of A.R. Whitson (Whitson and Walster 1918), the plant mineral nutrition work of E. Troug, and the ordination concept of Hole and Hironaka (1960) that still needs to be assimilated in the soil science community (Hartemink 2012). All these are renowned nationally and internationally, and there are several remarkable findings and characters in the

soil science of Wisconsin—some of them have been described by Beatty (1991), and Table 2.1 summarizes some of the main historical events for Wisconsin.

### 2.2.1 T.C. Chamberlin

Soils have been studied in Wisconsin for over a century, beginning with the publication of T.C. Chamberlin’s *General Map of the Soils of Wisconsin* (Table 2.1; Fig. 2.1) (Hartemink et al. 2012). Chamberlin was the chief geologist for Wisconsin, and between 1873 and 1877 he published with several co-authors four voluminous books (3035 pages) titled “Geology of Wisconsin.” Chamberlin introduced the glacial stages of North America and produced an Atlas that includes the first soil map of Wisconsin (Fig. 2.2).

Chamberlin’s map, which was the first soil map developed in the USA (Brevik and Hartemink 2010), shows eight soil textural groups: sandy soils, sandy loams, calcareous sandy loams, prairie loams, clayey loams (three types), and humus soils (Chamberlin 1882). Chamberlin had a strongly geologic view on soils, and he considered that the character of the soil will depend upon the nature of the rock, the degree of weathering, and amount lost by leaching and gained by vegetation or capillary action from beneath (Chamberlin 1877). He evidently recognized the difficulties in mapping soils as he wrote:

Map of soils. There are few natural formations more difficult to map than soils. There is an almost infinite gradation of varieties between which there are no hard-and-fast lines, and it is nearly or quite impossible to represent these gradations on a map.

It is not clear how this first soil map of Wisconsin was made, but it was most likely based on extensive travels on horseback through the state and Chamberlin’s knowledge of the surficial geology of the region. The impact of Chamberlin’s soil map has not been assessed, but it could be that his map was an argument in the establishment of the national



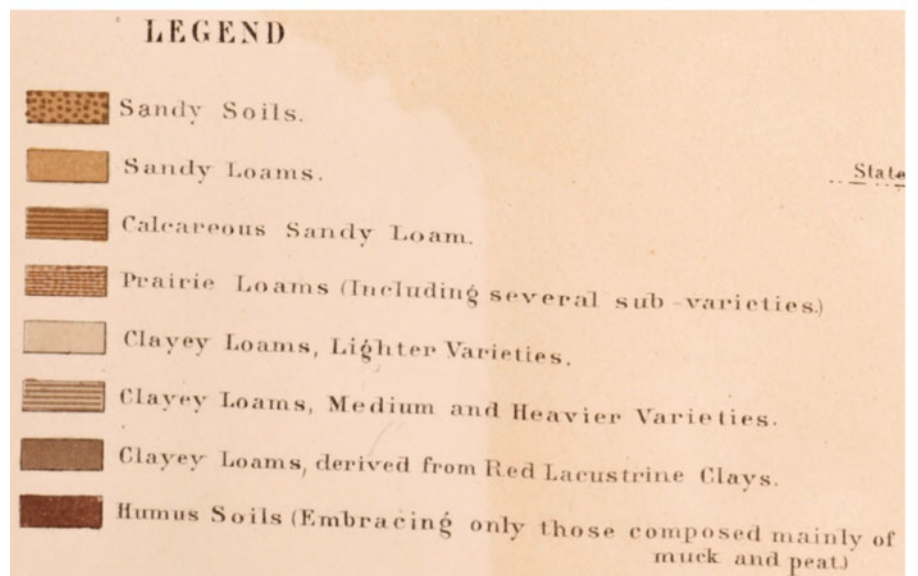
**Fig. 2.1** Sandstone bluffs at the Wisconsin River near the Dells. Pine trees are common and many soils are shallow with a folistic epipedon

**Table 2.1** Historical events in the study of Wisconsin soils

Year	Event
1882	First soil map in USA of WI by T.C. Chamberlin
1889	Department of Agricultural Physics established, UW-Madison
1895	First soil science book published in USA by F.H. King, <i>the soil—its structure, relations, and fundamental principles of management</i>
1902	First published soil survey, Janesville Area
1906	First published county soil survey, Racine Co.
1909	Renamed Agricultural Physics into Department of Soil Science, UW-Madison
1919	Wisconsin Geological & Natural History Survey established, began mapping the first of 50 counties in the state
1926	Second general soil map of WI, A.R. Whitson
1927	Publication of first book of WI soils, <i>Soils of Wisconsin</i> , A.R. Whitson
1930	<i>Preliminary study of the profiles of the principal soil types of Wisconsin</i> , (included soil map) C.E. Kellogg
1947	Publication of <i>Soils of Wisconsin</i> , R.J. Muckenhirn & N.P. Dahlstrand
1965	Renamed Department of Soils into Department of Soil Science
1968	Color version of map, Major Soil Regions of WI, F.D. Hole
1973	Publication of F.D. Hole's <i>Soils of Wisconsin</i>
1980	<i>Soil Guide for Wisconsin Land Lookers</i> , F.D. Hole
1983	Antigo silt loam established as Wisconsin state soil
1993	Revision of soil regions map of WI, F.W. Madison & H.F. Gundlach
2000	Soil survey digitized and available as SSURGO
2006	Completion of mapping in WI with Iron Co.



**Fig. 2.2** First soil map and its legend in the USA prepared by T.C. Chamberlin (1882) for Wisconsin



soil survey in 1899. After Chamberlin's map, it would take 40 years before the next reconnaissance soil map of the entire state was produced (Whitson 1927).

### 2.2.2 Soil Research

When the first French settlers arrived in 1634, most of the state was still covered with forest (Campbell 1906). At the beginning of the twentieth century, most of the natural forest had been logged (Whitson 1927). Soil science as a subject for study did not receive much attention in the early years of settlement. Systematic soil research was more or less started by F.H. King of the University of Wisconsin, who wrote one of the first soil science text books for the USA, *The Soils—Its Nature, Relations, and Fundamental Principles of Management* (King 1895). A section of a terminal moraine near Whitewater and an early topographic soilscape is reproduced in Fig. 2.3 from King's book from 1895.

The Department of Agricultural Physics was established in 1889, with F.H. King as its first chair, at a time when scientific studies relating to agriculture were beginning to be recognized as valuable. It was one of the founding departments for University of Wisconsin College of Agriculture and Life Science (CALS), which was established in the same year. King Hall was built in 1894. In 1909, the Department of Soils was established from the Department of Agricultural Physics, and in 1915 the Soils Annex was erected. King Hall is now part of the UW Department of Soil Science (Fig. 2.4). The Department celebrated its 125-year history in 2014. The first student with a BS degree graduated in 1905, the first MS in 1906, and the first student with a PhD degree graduated in 1918. Between 1906 and 2015, the Department has graduated 2364 students (1296 BS, 577 MS and 491 PhD degrees). In the USA, there are only very few soil science departments left; the others having merged with crops, water, and environmental or natural resources. Considerable pedological research has also been conducted at UW Stevens Point. The pedology section of the UW-Madison department has a long tradition of research, teaching, and outreach in soil morphology, genesis, classification, mapping, geography, and more recently, in digital soil mapping and digital soil morphometrics (Fig. 2.5).

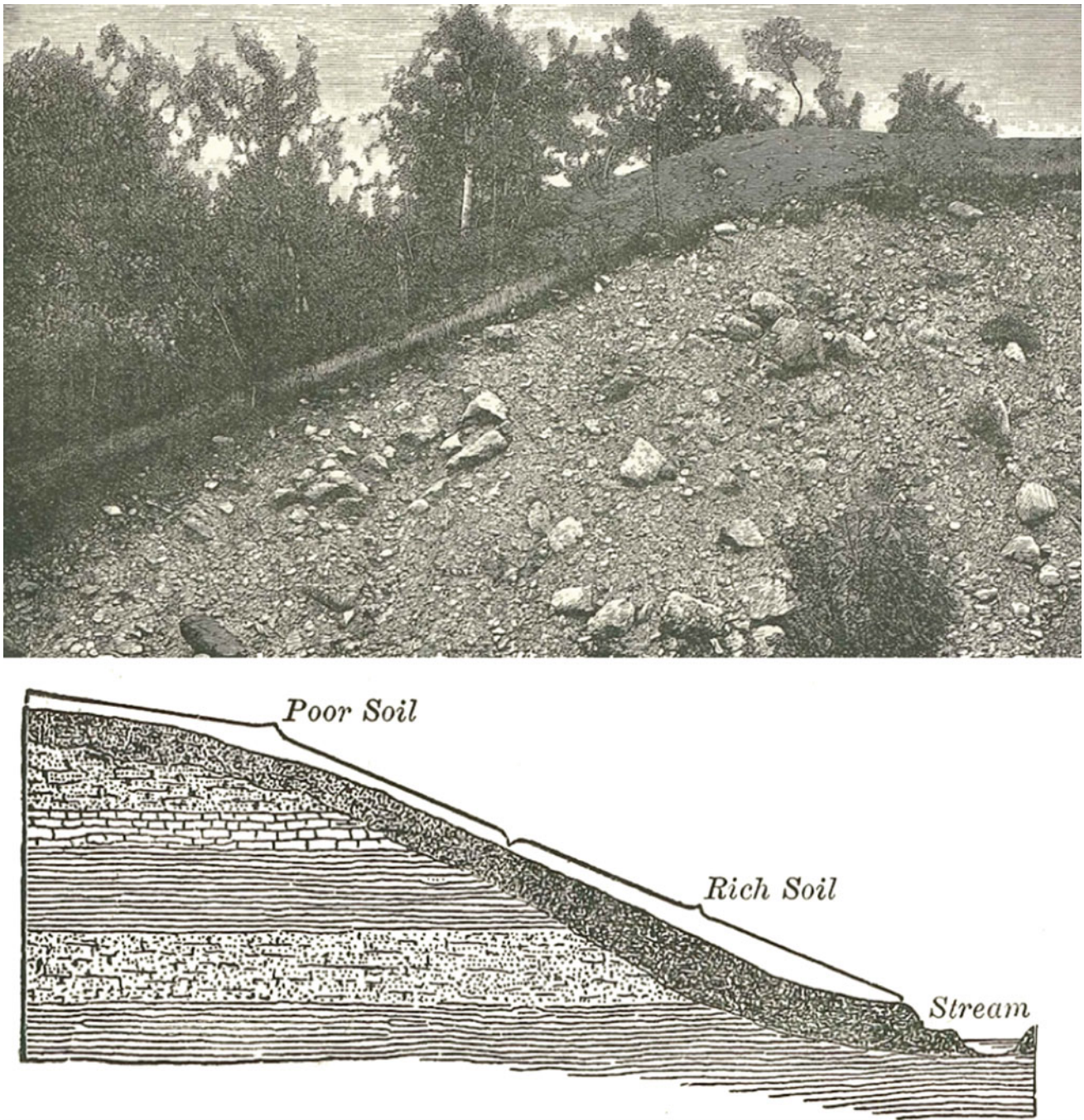
Soil erosion was massive in the early days of settlement in Wisconsin, but there was no sense of urgency in developing soil conservation practices. That changed in the 1930s in which a US President and a soil scientist were confronted with an economic and ecological disaster. That scientist was H.H. Bennett, whom with the backing of President Franklin

Roosevelt, established in 1933 a New Deal agency: the *Soil Erosion Service*. It was succeeded by the *Soil Conservation Service* in 1935. Bennett ("Big Hugh") grew up on a cotton farm in North Carolina, and his soil survey work in Virginia and the paper by T.C. Chamberlin on *Soil Wastage* influenced his research direction. As he wrote later about Chamberlin's paper: "...it fixed my determination to pursue that subject to some possible point of counteraction" (Helms 2010). Bennett developed the idea of a soil conservation district for the implementation of soil and water conservation. One of the first soil conservation districts was the Coon Creek watershed in the non-glaciated part (the Driftless Area) of Wisconsin. As the land is sloping and much of the forest was logged, there was massive soil erosion in the Driftless area, and over 60% of the cropped land had lost 10–15 cm of its topsoil (Clark 1940). The Coon Creek watershed in Wisconsin has become a landmark for soil erosion research (Fig. 2.6).

Another area of soil research that has been developed in Wisconsin is research on soils under forest. Research on soils in forests was well developed in Germany in the mid-1900s, and German scientists brought the study of soils into the forestry discipline. Studies were conducted on tree–soil interactions and the role of soils in increasing wood production. Also in the USSR, soils under forest received research attention (Tiurin 1930). In the USA, some forestry schools' students took classes in soils, but these were usually given in the agricultural departments. This lasted until the 1940, after which several national institutions took a leading role in soils research in the USA. These were Yale, Cornell, Penn State, Duke, and the University of Wisconsin (Gessel and Harrison 1999).

The person that brought soil research under forest to the forefront in Wisconsin was S.A. Wilde. Sergei Alexander Wilde (1898–1981) was born in 1898 near Moscow, Russia, where he was introduced early to the boreal forest ecosystems he came to love. He arrived at Ellis Island in May 1929 and joined the Soils Department of the University of Wisconsin in 1934 (Fig. 2.7). He aimed to interpret forest soils as carriers of definite floristic associations, as media for the growth of nursery stock or forest plantations, and as dynamic systems that react to different forms of silvicultural cuttings. His primary aim was to enhance the production of wood without depleting the soil fertility or contaminating the environment. Wilde authored one of the classical and most widely used reference books on forest soils (Wilde 1946). His work on the site–soil requirements for successful establishment, and development of planted species is acknowledged as a classical





**Fig. 2.3** Section of a terminal moraine near Whitewater, and relation between soils and their landscape position; both illustrations from one of the first textbooks on soils in the USA (King 1895)

research effort (Gessel and Harrison 1999). Wilde's investigations had an enormous impact on the forest economy of the state. Practicing foresters in Wisconsin, managing private and public lands, state and federal forest services, private nurseries, the pulp and paper industry, and owners of Wisconsin's private woodlots benefited from the

insight and approach to sound forest management (Wilde et al. 1949). His work in the field of forest soils research included important studies on soils, woody-plant nutrition, tree-mycorrhiza relationships and reforestation. Wilde was not only able to bring some soil science into forestry, but also brought forestry and vegetation knowledge back into



**Fig. 2.4** King Hall in the early 1900s, now Department of Soil Science, University of Wisconsin-Madison. In addition to studying soil physics, F.H. King studied windmills, round bars, and a whole range of

practical and theoretical subjects. He can be viewed as the Benjamin Franklin of US soil science

soil science. He was a vivid reader, a musician, and also wrote poems:

‘Ode to Forest Soils’

With a face most hair and glassy stare  
Like a dog whose day is done  
I juggle some pink stuff in a flask,  
as the drops fall one by one.  
Ours not to question why—  
Ours but to weigh and dry,  
What does it matter that someone has a buffer  
We are the ones who must titrate and suffer.  
Aye, bury me deep in the mouldy earth  
And sprinkle me well with lime,  
Where I can rest in deep sweet peace  
Until the endpoint of time.  
No more shall I cringe to the crash of glass  
Nor gag at the brimstone’s smell  
I’ve a cleaner, sweeter haven  
In the very depths of the grey horizon.

### 2.2.3 Soil Survey and Mapping

The Soil Conservation Service, now the Natural Resources Conservation Service (NRCS), published the first published soil survey for Wisconsin of the Janesville area in 1902. The Wisconsin Geological and Natural History Survey was established in 1919 and began mapping its first of 50 of Wisconsin’s 72 counties.

The first book of Wisconsin soils, *Soils of Wisconsin*, was written by A.R. Whitson in 1927. Whitson included a general soil map of the state in 1926 (Fig. 2.8). In 1930, Charles Kellogg, who was instrumental in developing *Soil Taxonomy*, published his *Preliminary Study of the Profiles of the Principal Soil Types of Wisconsin*. The bulletin provided detailed accounts of 25 soil series and a soil zone map for Wisconsin (Fig. 2.9). This map shows the Gray-Brown





**Fig. 2.5** Pedology classes at UW Madison: Kemp station (above) and field investigations at O'Briens farm in Brooklyn and the Wallendal farm in Westfield. Fieldwork includes the use of paper maps, digital information on iPads, and proximal soil sensors such as vis-NIR and pXRF





**Fig. 2.6** Agricultural fields and forest in the Driftless area of Wisconsin

(Podzolic) Forest Zone with intermixed prairie soils, a Transitional Zone, and a Podzol Zone. We recognize Alfisols (Hapludalfs) in the Gray-Brown Forest Zone, Alfisols (Glossudalfs) in the Transition Zone, and Spodosols in the Podzol Zone.

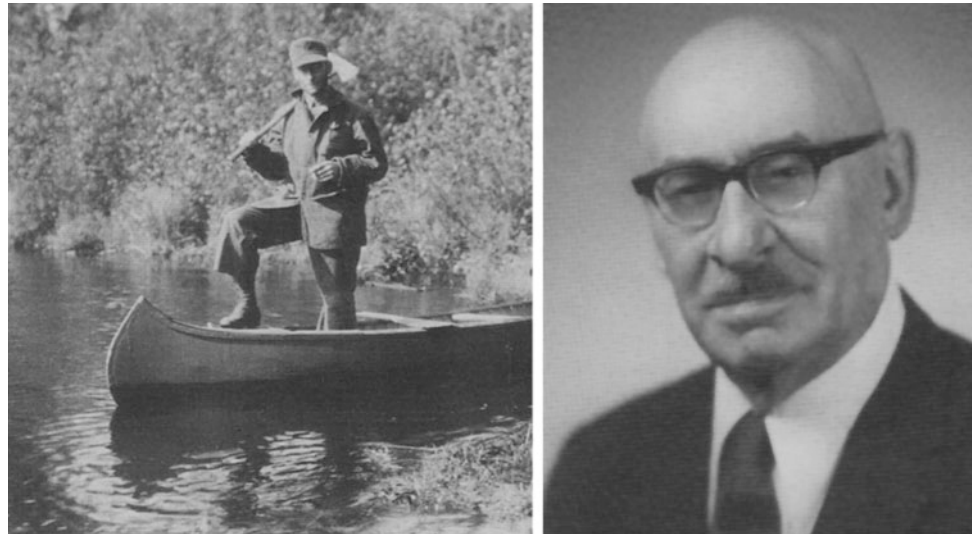
In 1968, F.D. Hole published the first soils map of Wisconsin. This was followed by a third version that was

included in the books *Soils of Wisconsin*, by F.D. Hole in 1976 (Fig. 2.10). A popularized version, named *Soil Guide for Wisconsin Land Lookers*, was published in 1980. A “land looker” was defined as a speculator who travels around looking for parcels of land that can be developed.

In 1993, F.W. Madison and H.F. Gundlach revised the soil regions map of Wisconsin (Fig. 2.11). Table 2.2



**Fig. 2.7** Sergei (“Doc”) Wilde (1898–1981) in 1935 (with axe) and 1970. Professor of Soil Science and Forestry at the University of Wisconsin-Madison, 1934–1969. He was born in the western part of Moscow to parents of Tartar and Dutch ancestry, and his childhood home was about a mile from the Kremlin. Doc Wilde is one of the founders of the forest soils discipline



contains the legends of the maps by Chamberlin (1882), Whitson (1927), Hole (1968), and Madison and Gundlach (1993) (Hartemink et al. 2012).

In 2000, the NRCS began scanning and digitizing soil surveys. These surveys were made available at the state level as STATSGO and SSURGO. The State Soil Geographic (STATSGO) dataset is a broad-based inventory of soils and non-soil areas that occur in a repeatable pattern on the landscape and that can be cartographically shown at a scale of 1:250,000. The SSURGO database contains information that can be displayed in tables or as maps and is available for most areas in the USA. The information is collected at scales ranging from 1:15,840 or 1:20,000 and is intended for natural resource planning and management. In 2006, soil-map coverage was completed for Wisconsin with the completion of the soil map of Iron County.

#### 2.2.4 The State Soil

Since the official start of the soil survey program in the USA, many thousands of soil series have been mapped and named. The soil series is the most homogenous category, and as a class it is a group of soils or polypedons that have horizons similar in arrangement and in differentiating characteristics (Soil Survey Division Staff 1993). The series

name is typically taken from a town, village, or stream near the area where the soil is first defined. In the 1970s, some soil scientists started to advocate the concept of State Soils. They drew a parallel that many states already have natural state symbols like, for example, a bird, flower, tree, or rock.

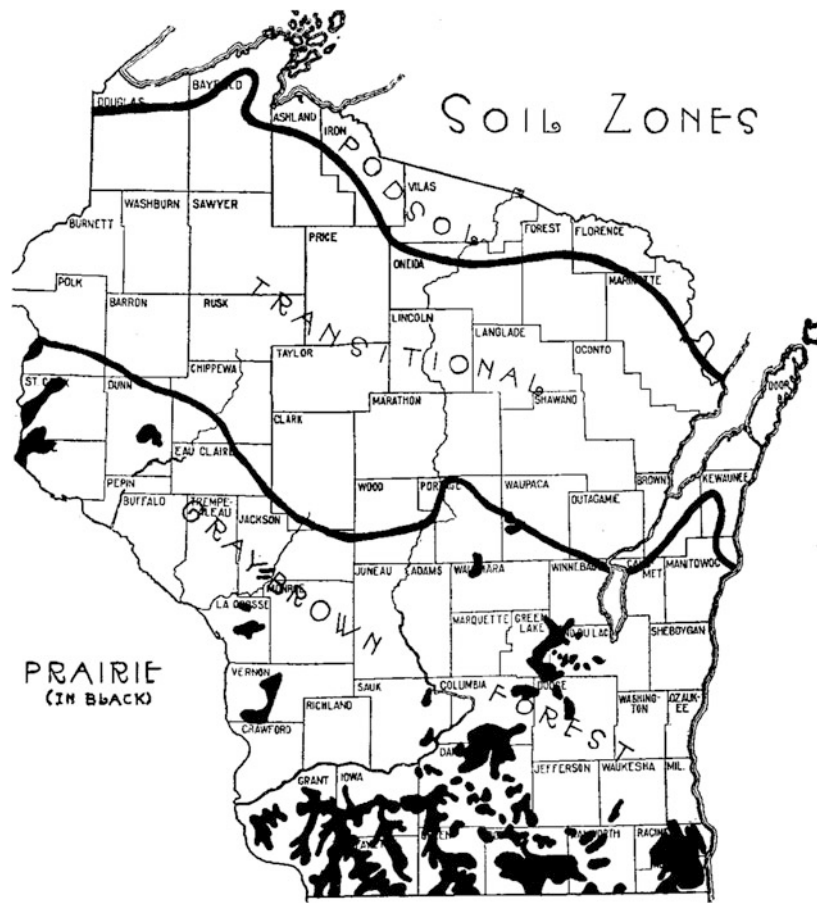
It is not known who introduced the State Soil concept, but according to R.W. Arnold (pers. comm., 2011) it was probably Professor F.D. Hole from the University of Wisconsin-Madison. Nebraska was the first to have a State Soil (Holdredge silt loam) in 1979, followed by Wisconsin in 1983 and Vermont in 1985. By 1991, 10 states had a State Soil (Quandt and Watts 1995), and presently each state has selected a State Soil, but only twenty have been legislatively established. In Wisconsin, the State Soil shares the same level of distinction as official state flowers (viola), rock (red granite), tree (sugar maple), and bird (robin).

The establishment of the State Soil of Wisconsin (Antigo silt loam—Typic Glossudalfs) was a long and tedious process and it took Hole, with the help of several key legislators, seven years to accomplish his aim (Devitt 1988). The Antigo soil is not the world’s richest soils, but it is not the world’s poorest either. The Antigo silt loam occurs nearly entirely in Wisconsin (a small portion occurs in Minnesota) and is important for crops (in particular potatoes), pastures, and forestry (Fig. 2.12).

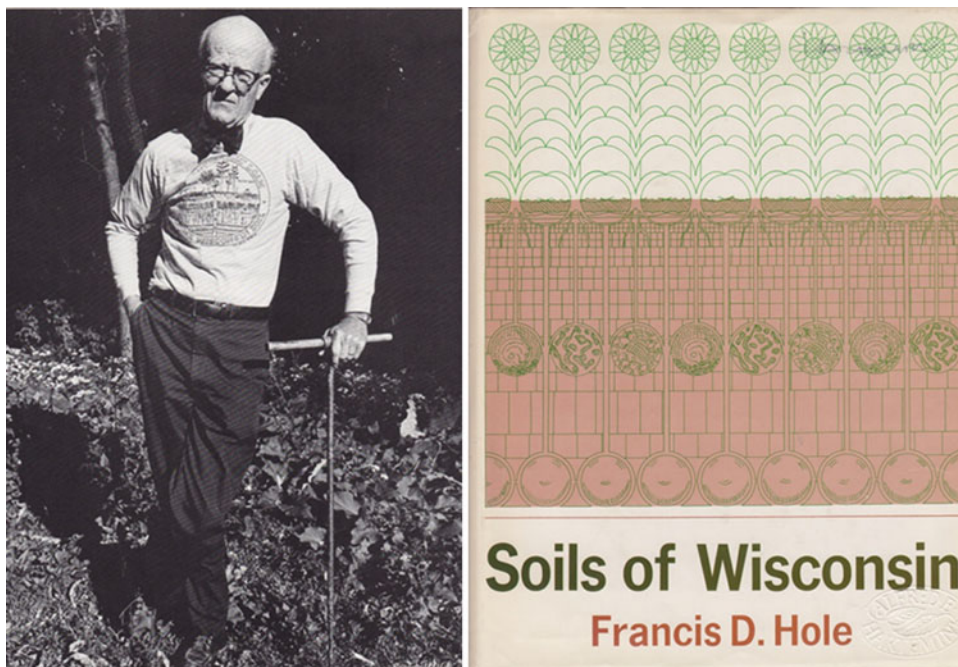


**Fig. 2.8** Second soil map of Wisconsin, prepared by A.R. Whitson in the 1920s





**Fig. 2.9** Map prepared by C.E. Kellogg in 1930 showing the main soil zones in Wisconsin



**Fig. 2.10** Francis Hole (1913–2002) and his book (1976)

## Soils of northern and eastern Wisconsin

- E** Forested, red, sandy, and loamy soils
- Dr** Forested, red, sandy, and loamy soils over dolomite
- T** Forested, silty soils
- G** Forested, loamy soils
- II** Forested, sandy soils
- I** Forested, red, clayey or loamy soils

## Soils of central Wisconsin

- C** Forested, sandy soils
- Cm** Prairie, sandy soils
- Pr** Forested, silty soils over igneous/metamorphic rock

## Soils of southwestern and western Wisconsin

- S** Forested, silty soils
- Am** Prairie, silty soils
- Ds** Forested soils over sandstone

## Soils of southeastern Wisconsin

- P** Forested, silty soils
- Sp** Prairie, silty soils

## Statewide

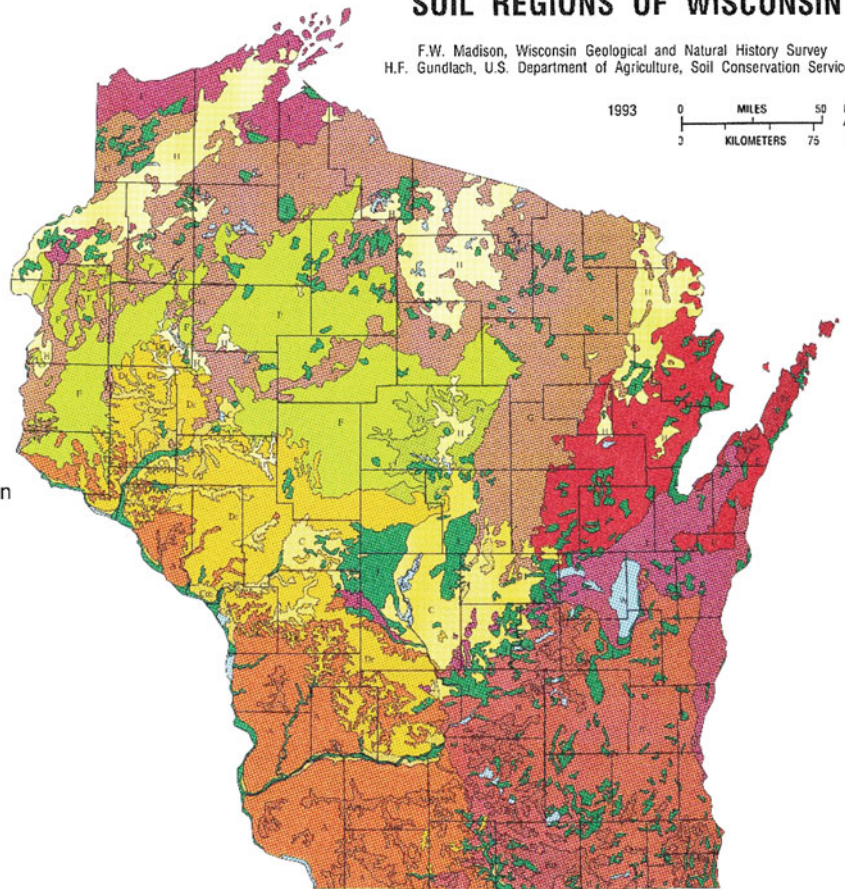
- S** Streambottom and major wetland soils
- W** Water

**SOIL REGIONS OF WISCONSIN**

F.W. Madison, Wisconsin Geological and Natural History Survey  
H.F. Gundlach, U.S. Department of Agriculture, Soil Conservation Service

1993

0 50  
MILES  
0 75  
KILOMETERS



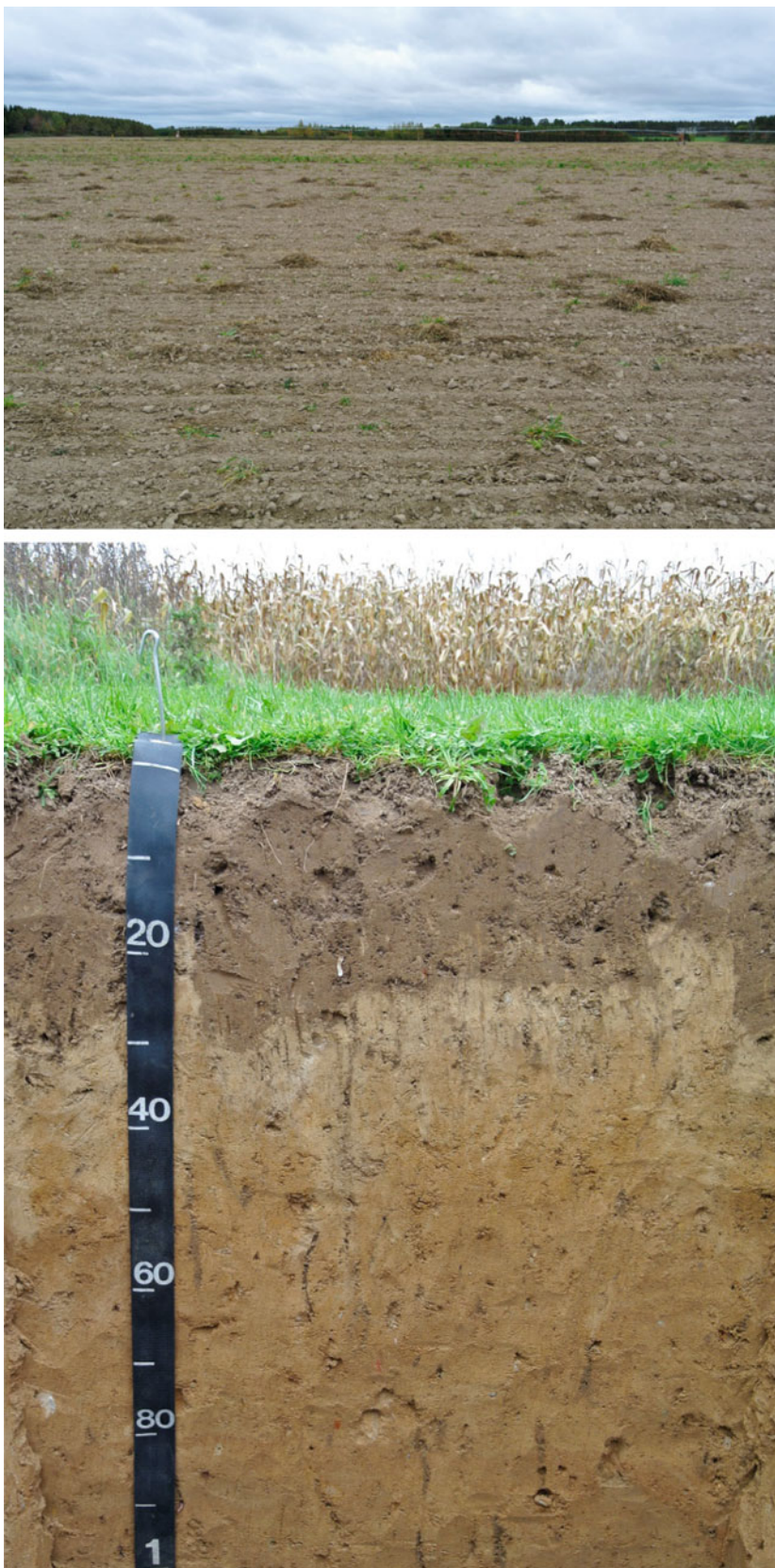
**Fig. 2.11** Fourth general soil map of Wisconsin, prepared by F.W. Madison and H.F. Gundlach



**Table 2.2** Legends of the Wisconsin soil maps from Chamberlin (1882), Whitson (1927), Hole (1965), Madison and Gundlach (1993) from Hartemink et al. (2012)

1882 T.C. Chamberlin	1926 A. R. Whitson	1976 F.D. Hole	1993 F.W. Madison and H.F. Gundlach
Sandy soils Sandy loams Calcareous sandy loam Prairie loams (including several sub-varieties) Clayey loams, lighter varieties Clayey loams, medium and heavier varieties Clayey loams, derived from red lacustrine clays Humus soils (embracing only those composed mainly of muck and peat)	Miami silt loam Knox silt loam Prairie soils Red clays Sandy soils Colby silt loam Boone Fine Sandy loam Miami fine Sandy loam Kennan loams Rough land Wet land Peat	<b>Soils of the southwestern ridges and valleys</b> Forest and prairie soils; Alfisols, Mollisols, Entisols; Gray-Brown Podzolics, Brunizems, Lithosols, and Humic Gley soils <b>Soils of the southeastern upland</b> Forest, prairie, and wetland soils; Alfisols, Mollisols, Entisols, Inceptisols, Spodosols, Histosols; Gray-Brown Podzolics, Brunizems, Lithosols, Regosols, Humic Gleys, Podzols, and Bog soils <b>Soils of the central sandy uplands and plains</b> Forest, prairie and wetland soils; Alfisols, Entisols, Mollisols, Spodosols, Inceptisols, Histosols; Gray-Brown Podzolics, Regosols, Brunizems, Humic Gleys, and Bog soils <b>Soils of the western sandstone uplands, valley slopes, and plains</b> Forest and wetland soils; Alfisols, Entisols, Inceptisols, Mollisols, Spodosols, Histosols; Gray-Brown Podzolics, Regosols, Lithosols, Humic Gleys, Podzols, and Bog soils <b>Soils of the northern and eastern sandy and loamy reddish drift uplands and plains</b> Forest and wetland soils; Alfisols, Entisols, Inceptisols, Mollisols, Spodosols, Histosols; Gray-Brown Podzolics, Regosols, Lithosols, Brunizems, Humic Gleys, Podzols, and Bog soils <b>Soils of the northern silty uplands and plains</b> Forest, prairie, and wetland soils; Spodosols, Alfisols, Mollisols, Inceptisols, Histosols; Podzols, Gray-Brown Podzolics, Brunizems, Podzols, Humic Gleys, and Bog soils <b>Soils of the northern loamy uplands and plains</b> Forest and wetland soils; Spodosols, Alfisols, Entisols, Inceptisols, Histosols; Podzols, Gray-Brown Podzolics, Regosols, Lithosols, Acid Brown Forest soils, Humic Gleys, and Bog soils <b>Soils of the northern sandy uplands and plains</b> Forest and wetland soils; Spodosols, Entisols, Alfisols, Histosols; Podzols, Regosols, Gray-Brown Podzolics, Brown Podzolics, and Bog soils <b>Soils of the northern and eastern clayey and loamy reddish drift uplands and plains</b> Forest and wetland soils; Alfisols, Mollisols, Spodosols, Inceptisols, Histosols; Gray-Brown Podzolics, Gray Wooded soils, Podzols, Humic Gleys, and Bog soils <b>Soils of stream bottoms and major wetlands</b> Stream bottom, marsh and bog soils; Entisols, Histosols, Mollisols, Spodosols, Inceptisols, Alfisols; Alluvial soils, Bog soils, Regosols, Humic Gleys, Podzols, Brunizems, and Gray-Brown Podzolics	<b>Soils of northern and eastern Wisconsin</b> Forested, red, sandy, and loamy soils Forested, red, sandy, and loamy soils over dolomite Forested, silty soils Forested, loamy soils Forested, sandy soils  <b>Soils of central Wisconsin</b> Forested, sandy soils Prairie, sandy soils Forested, silty soils over igneous/metamorphic rock <b>Soils of southwestern and western Wisconsin</b> Forested, silty soils Prairie, silty soils Forested soils over sandstone <b>Soils of southeastern Wisconsin</b> Forested, silty soils Prairie, silty soils <b>Statewide</b> Stream bottom and major wetland soils Water

**Fig. 2.12** Wisconsin's state soil, the Antigo silt loam (Haplic Glossudalfs) and landscape (irrigated potato field near Antigo, Wisconsin). The Antigo series consists of very deep, well-drained soils formed in 50–100 cm of loess or silty alluvium and in loamy alluvium and in the underlying stratified sandy outwash





## 2.3 Summary

Soils have been studied in Wisconsin since the 1880s, beginning with the publication of T.C. Chamberlin's *General Map of the Soils of Wisconsin*. It was the first soil map developed in the USA and showed eight soil groups based on texture of the parent material and plant cover type. Systematic soil research was more or less started by F.H. King of the University of Wisconsin, who wrote of the first soil science text books for the USA. The first book of Wisconsin

soils, *Soils of Wisconsin*, was written by A.R. Whitson in 1927. In 1930, Charles Kellogg, who was to become a key in developing *Soil Taxonomy*, published his *Preliminary Study of the Profiles of the Principal Soil Types of Wisconsin*. In 1968, F.D. Hole published the first color soils map of Wisconsin, a map that is still used. This was followed by a third version of *Soils of Wisconsin*, by F.D. Hole in 1976. In 1983, the Antigo silt loam (Haplic Glossudalfs) was legislatively established as Wisconsin's state soil. In 2006, traditional soil mapping was completed for Wisconsin.

The Soils of Wisconsin

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