



## General state soil maps in the USA



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### ABSTRACT

The historical development of state general soil maps is examined over the time intervals of pre-1927, 1927–1960, 1960–1999, and post-1999, which correspond to major periods in the development of soil classification schemes in the USA. Eleven states developed general soil maps prior to the development of the country's first soil classification scheme in 1927, and these were created for agriculture and based primarily on soil-physiographic provinces. Twenty states prepared general soil maps during the period in which zonal soil classification schemes were employed (1927–1960). Although physiography continued to be a primary basis of soil mapping, soil associations were used in 56% of the maps. The time period between the publication of the *Seventh Approximation* (1960) and the second edition of *Soil Taxonomy* (1999) was the “golden era” for general soil maps, with 46 states (92%) making them available to the public in hardcopy format, primarily as soil series-association maps. There was a dramatic reduction in the generation of state soil maps from 1999 to 2014 (to 22 states), largely because of the digital age. Individuals with GIS expertise were encouraged to develop their own maps using STATSGO and SSURGO databases. Initiated in 2005 the Web Soil Survey has enabled the public to produce maps for areas of less than 40,500 ha. The level of detail in state soil maps has increased over time, but soil-series association maps remain a popular venue. General maps using *Soil Taxonomy* provide valuable information regarding the nature, properties, and soil-forming factors and processes of soils, as well as their geographic distribution. General state maps remain important as a natural resource data layer and for instructional purposes.

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### 1. Introduction

State soil maps were first published in the USA in the early 1880s prior to the development of a national soil classification system. The first classification system for the USA was developed by Whitney (1909) and revised by Marbut et al. (1913). However, the system by Marbut (1927) was the first classification in the USA based completely on soil properties from the highest level down (Table 1). This system classified soils into six hierarchical levels, including Pedalfers, soils with accumulation of Al and Fe, and Pedocals, soils with accumulation of calcium carbonate (Category VI); mechanical–chemical vs. mechanical weathering (Category V), and well-developed soils (Category IV) vs. less strongly developed soils (Category III); Categories II and I divided soils into series and types.

The Marbut system was revised in 1935, and the second national soil classification scheme, by Baldwin et al., appeared in 1938 (Table 1). This system divided soils into three orders, zonal, intrazonal, and azonal, nine suborders based on bioclimate, and 39 great-soil groups. Therefore, from 1927 to 1960, zonal soil classification systems were employed in the country (Bockheim and Gennadiyev, 2000).

After six iterations, the 7th Approximation was published in 1960 (Soil Survey Staff, 1960) (Table 1). This system was a major departure from zonal systems and has been described as a “natural” system that is based on actual soil properties rather than presumed soil genesis (Kellogg, 1963; Cline, 1963). *Soil Taxonomy* (ST; Soil Survey Staff, 1975) was the first comprehensive edition of the USA's natural soil classification system, followed by the 2nd edition in 1999 (Soil Survey Staff, 1999). Meanwhile, 12 editions of the *Keys to Soil Taxonomy*, outlining major changes in the system, were published between 1983 and 2014. Soil types, series, and associations are still used as soil map units in the USA today.

Hartemink et al. (2012) traced the development of soil maps in Wisconsin from 1882 until the early 2000s. Soil texture and physiography were the major diagnostic mapping criteria. They reported that the level of detail in soil maps increased over this time period. Simonson (1989) reviewed historical highlights of soil survey and soil classification over the period 1899 to 1970, emphasizing the USA, including field operations, map units, standards and terminology, previous soil classification schemes, and applications of soil surveys. In his evaluation of mainly large-scale soil maps of the USA, Salishchev (1962) reported that they were few in number and that they were not designed in a uniform manner. Glazovskaya (1966) analyzed the status of world soil cartography from material displayed an international cartographic exhibit. Two of the approximately three dozen maps were from the USA. According

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**Table 1**  
Year of major achievements in classification and mapping state soils in the USA.

Year	Achievement
1880	First general state soil map in USA, Louisiana
1883	Early general state soil map, California, prepared by E.W. Hilgard & J.W. Powell
1899	National soil mapping program established
1903	Soil types and series recognized as fundamental mapping units
1904	Early general state soil map, Missouri, prepared by C.F. Marbut
1908	Soil phases recognized as fundamental mapping units
1909	First national map soil-geologic map, M. Whitney
1912	First national soil property map, G. Coffey
1913	Revised national soil property map, C. Marbut
1927	First comprehensive national soil classification scheme, C. Marbut
1931	Soil map of the USA, C. Marbut
1935	Revised national soil classification scheme, C. Marbut
1938	Second national soil classification scheme and soil association map, Baldwin et al.
1949	Soil associations used in general state soil map, Illinois
1956	Use of 1938 soil taxa (great soil groups) in county soil survey, Grant Co., WI, F.D. Hole
1960	7th Approximation—new world soil classification system and map
1969	Use of 7th Approximation in a county soil survey, Vernon Co., WI
1975	Publication of Soil Taxonomy and national soil map
1999	Publication of Soil Taxonomy (V. 2) and national soil map
2000	Web Soil Survey

to Glazovskaya (1966) the USA maps effectively showed the soil-forming factors but did not adequately reflect genetic processes.

Historical summaries of state soil surveys have been prepared for Pennsylvania (Eckenrode and Ciolkosz, 1999), Indiana (Wiggenton, 2007), Illinois (Olson and Fehrenbacher, 1998), Maine (Kalloch, undated), and North Dakota (Thompson, 1992). These summaries are useful for tracing the history of state soil maps in the USA.

State soil maps traditionally have been considered to be less important than the larger-scale county maps. Whereas state soil maps have lacked a unified methodology, county maps have had a relatively consistent methodology over the past half century. Despite their lesser importance, an analysis of historical trends and priorities of state soil maps could enable an understanding of developments in soil geography, soil genesis, and the role of soil properties in soil classification in the USA.

The objectives of this study are to locate general soil maps for each of the 50 states (38 states prior to 1880 when the first state soil map was produced; 48 states from 1927 until 1959; and 50 states after 1960; and to determine how they have changed over four major time intervals of soil classification in the USA, including pre-1927, 1927–1960, 1960–1999, and from 1999 to the present.

## 2. Methods and materials

We used three approaches for locating general state soil maps. We located digitized versions of state soil maps from the World Wide Web. Non-digitized soil maps were identified by searches in the Web of Science and examination of the map collections of G.B. Lee and F.D. Hole in the Department of Soil Science and in the Arthur H. Robinson Map Library at the University of Wisconsin–Madison. A third approach was to write to state soil scientists requesting electronic copies of historical and modern general soil maps, or information as to the availability of these maps. We were particularly interested in knowing the availability of these general soil maps to the public. Letters were sent to 35 state soil representatives; letters were not needed for 15 states for which state soil maps were readily available. Twenty-five of 35 (71%) individuals responded to our survey, with several individuals sending hard copies or scanned copies of historical soil maps. We were able to locate 129 general state soil maps published over the period 1880 to 2015.

## 3. Results

### 3.1. Pre-1927

Eleven of the eventual 48 states (~23%) prepared general soil maps between 1880, the year of the first soil map, and 1927, the year of Marbut's soil classification system in the USA (Table 2). The first state soil map appears to have been developed in Louisiana in 1880. Individuals who were to become important in the development of soil classification systems in the USA were involved in the production of early state soil maps, including E.W. Hilgard (along with the explorer Major John Wesley Powell) in California (1883), Milton Whitney in Delaware (1903), C.F. Marbut in Missouri (1904), and G.W. Coffey in South Dakota (1909). Although all of the maps published prior to 1927 were intended to evaluate soil suitability for agriculture, six of them were based on physiographic provinces (IN, MS, MO, OR, and TN), two were based on physical soil properties, especially texture (CA, WI), and three showed soil types (DE, MO, and SD).

### 3.2. 1927–1960

Although three zonal soil classification systems were prepared during 1927–1960, only 20 state soil maps (42% of the states) were prepared during this interval (Table 2). Ten of these maps were based on soil associations (AK, AR, FL, GA, IL, IA, MI, NY, NC, and OK), five on physiography (AL, CA, CT, NJ, and ND), four on soil types (IN, MO, VT, and WI), and one unknown (TX). Three of the general state soil maps (AK, FL, and IA) used the Baldwin et al. (1938) classification system in their legends, i.e., soil associations by great-soil group.

Soil associations were used in the general state soil map of Florida in 1938, a tradition that has continued to the present time. The soil-association map for Michigan by Veatch (1953) included 23 texture and drainage groups, 64 soil associations each containing 2 to 3 soil series, and brief descriptions of land character (topography) and geological-pedological relations (landform, parent materials, vegetation, great-soil group, and key soil-forming processes). The soil texture/soil type map of Wisconsin prepared by A.R. Whitson (1927) contained a mixture of soil types, such as the Miami silt loam, and texture classes, such as red clays and sandy soils (Hartemink et al., 2012). It is surprising that more state soil maps were not prepared in view of the availability of the soil series map maps of Marbut (1935) and the soil association map of Baldwin et al. (1938) (see Figs. 6 and 7 in Brevik and Hartemink, 2013).

### 3.3. 1960–1999

The period 1960–1999 was the most productive in terms general state soil maps, and at least 46 maps (92% of states) were prepared over this interval (Table 2). Of these maps, 28 showed soil-series associations. Soil map units were based on ST for the first time as the general soil map of ten states (CA, KS, MT, ND, NE, NM, NY, SD, TN, and TX) included great-group associations. The ID general soil map showed ST subgroups; the ID and UT maps showed subgroup-associations; the MN state soil map depicted suborders; and the MS general soil map showed orders. The AL map was based on physiography, the AK map on Major Land Resource Areas, and the OR map on soil "regions."

### 3.4. 1999–2014

The proportion of states with a published, publicly available general soil map declined sharply after the 2nd version of *Soil Taxonomy* was published in 1999. Of the 22 modern general soil maps (44% of states), eight were published at the order level (CA, FL, HI, IL, MO, OK, TX, and UT), seven continued to employ soil associations (GA, IN, KS, NJ, NM, OH, and VT), two used suborders (AK and MN), two used great groups

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