The Status of Soil Mapping in Oklahoma

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The purpose of this paper is to present a brief report on the progress of soil mapping in Oklahoma, seen in reference to the larger problem of classifying and mapping soils in the United States and the world. It is intended as somewhat of a companion piece to the writer's earlier paper (Olson, 1959) concerned with topographic mapping in Oklahoma.

It should be recognized at the outset that pedology, or the scientific study of soils, is a relatively new branch of knowledge and that its techniques and even its purposes are tentative and subject to change. While the possibility of improving the productivity of certain types of soils with the controlled application of specific organic or inorganic fertilizers became clearly recognized in western Europe more than a century ago, as a result of the work of Justus von Liebig and others, the foundations for modern soil classification and mapping were established by Russian and German scientists, especially Dokuchaev, Sibertsev, Glinka, and Ramann during the last two decades of the 19th century and the first two decades of the 20th (Kellogg, 1946). Recognition of the significance of climate and vegetation, along with bedrock, slope, drainage, and acidity, as causal factors in differentiating soils, made it possible to devise useful criteria for delimiting the soils of large areas on a reasonably rational basis. Probably the first serious effort by an American to describe the nature and genesis of soils was that of Shaler (1891), a student of Louis Agassiz at Harvard, although his monograph in the Twelfth Annual Report of the U.S. Geological Survey reflects an almost purely geological point of view. While the publication of Hilgard's classic study of soils in 1906 in the United States represented a significant milestone in American soil science, especially with its emphasis on the contrasts between soils developed in humid and arid regions, it is Curtis F. Marbut, who translated Glinka's *Great Soils Groups of the World* into English in 1927, and Charles E. Kellogg, successor to Marbut in the organization of the United States government's soil mapping program, who must be credited with guiding this country's recent progress in soil cartography.

It is perhaps not surprising that the soils of the United States are not uniformly mapped when it is recalled that less than one-third of the total area is regarded as having characteristics suitable for crop production with machinery, and of this only about two-thirds, or less than 25 per cent of the total area, is actually in crops (Barnes and Marschner, 1958). As in the case of the topographic mapping program, soil mapping has been accomplished on several different scales, ranging from reconnaissance mapping at a scale of one to eight miles to the inch to detailed mapping at scales of 1/31,680, 1/21,120, and even 1/15,840. In the period since World War II there has been some discussion looking to the eventual production of standardized maps of soil and land utilization for the entire world, employing at the outset such scales as 1/1,000,000 or possibly 1/500,000 (Stephens, 1953).

The earliest classifications of soils in the United States gave particular prominence to geological origin and the texture of the surface material. The term "soil type" was initially applied to fairly broad soil groupings, with one or two properties in common, reminiscent of what is known in the present official classification, adopted in 1949, as a soil association. The first mention of the term "soil series" appears in the American literature about 1903 as a means of designating geologically similar "soil types," particular when found within what was recognized as the same physiographic unit. Among the early soil series to be described were the sandy Norfolk series of the South Atlantic coastal plain, the Miami series in the well-drained areas of older glacial drift, the Hagerstown series developed on limestones weathering in place under the humid conditions of the Appalachian valleys, and the Chester series formed on the crystalline rocks of the Appalachian piedmont. Milton Whitney (1909), director of the Division of Soils in the U.S. Department of Agriculture during the period of the early surveys, and F. H. King, an influential scholar in the field of soils and agronomy at the University of Wisconsin, both stressed the importance of surface texture in the early classifications, knowing texture to be of extreme importance in relation to receptivity to water and inorganic fertilizers. Whitney classified the soils of the United States into thirteen major groupings corresponding approximately with the major physiographic provinces, and under each of these groupings defined some of the principal series in relation to specific rock types or kinds of depositional origin.

A more modern concept of the nature of soil was suggested by G. N. Coffee when he defined it in 1913 as:

> "the superficial, unconsolidated mantle of disintegrated and more or less decomposed rock material, which, acted upon by organic agencies and mixed with varying amounts of organic matter, may furnish conditions necessary for the growth of plants. In this conception the soil is an independent, natural body, a bio-geological formation, differing essentially from the rock which underlies it, although closely related to it. It is the one great formation in which the organic and inorganic kingdoms meet and derives its distinctive character from this union."

Coffee's Preliminary Soil Map of the United States, first published in 1911 on a scale of 1/7,000,000, divided the soils of the country into three major groups, arid soils, dark-colored prairie soils, and light-colored timbered soils, with twenty-two subdivisions relating essentially to geological origin. His broad category of "arid soils, undifferentiated" barely reached into the northwestern corner of the Oklahoma panhandle. Except for some broad strips of dunesand and sandhills along the principal river courses, the western and central portions of the state east as far as to include most of Lincoln and Pottawatomie counties is shown as falling within the zone of dark-colored prairie soils derived from sandstones and shales, with the notation, however, that this "Oklahoma Group" of prairie soils includes much timbered area. The Oklahoma Ozarks, an area corresponding approximatey with the currently recognized Baxter and Lebanon series, falls within Coffey's Ozark Group of light-colored timbered soils, while the remainder of forested eastern Oklahoma is divided about half and half between the Kansas Group of dark-colored prairie soils and the undifferentiated soils of the light-colored timbered grouping indicated as similar throughout the Ouachitas, southern Ozarks, and practically all of the dissected Appalachian plateaus. Four parallel soil belts, one of a prairie type, extend eastward from Marietta along the north side of the Red River.

Further refinements in soil classification making particular use of the soil profile and its characteristics, a concept borrowed from Glinka, were introduced by Curtis F. Marbut in 1920. Working with tremendous vigor and in close communication with soil scientists in Europe, Marbut (1935), after much field observation, evolved a scheme of soil classification which attracted wide attention, especially through the long delayed publication of Part III, Soils of the United States, in the *Atlas of American Agriculture.* In the text accompanying the soils atlas, which included a sectional map of the soils of the United States on a larger scale than had been attempted up to that time, Marbut outlined a hierarchy of six categories in which he subdivided the soils of the country, starting with the two-way division of all soils into "pedocals" and "pedalfers," depending upon whether or not there was a lime-accumulating zone somewhere in the soil profile. The six categories of soils recognized by Marbut were as follows:

VI. Solum composition groups (pedocals and pedalfers)
V. Inorganic colloid composition groups (a category applicable only to the pedalfers)
IV. Broad environment groups (great soil groups)
III. Local environment groups (family groups)
II. Soil series groups
I. Soil units or types (commonly further subdivided with a phase designation, as "stony phase", "eroded phase", etc.)

The death of Marbut, from pneumonia acquired while riding the Trans-Siberian Railroad on his way to China, where he had been invited to help organize a government soils survey (Soil Sc. Soc. of Amer., no date), was followed soon by some refinements in his classification system. Younger colleagues working under his successor in the Bureau of Chemistry and Soils, Charles E. Kellogg, felt it necessary to remove some of the immature soils from inclusion in either of Marbut's pedocalic or pedalferic groups. It had become increasingly apparent that many soils, such as degraded chernozems, alluvial soils, and lithosols, simply did not fit well under Marbut's system, and a new first-order subdivision into zonal, intrazonal, and azonal soils was adopted (Baldwin, et. al., 1938). Pedocals and pedalfers were still considered the two main subdivisions of the zonal soils, but these two terms were dropped entirely from the latest general classification scheme of the Division of Soil Survey, that described by Thorp and Smith in the 1949 volume of *Soil Science.* Intrazonal soils are those which have attained approximate equilibrium with the environment, but have developed under conditions of poor drainage or parent material of extreme character, while azonal soils are those which are too young to have attained equilibrium with the environment such as lithosols, regosols (recent wind-laid sand or loess), and alluvium.

Instead of Glinka and Marbut's eight Category III soil divisions, widely familiar to geographers through the writings of Marbut, Wolfanger (1930) and various textbooks in physical geography, the Division of Soil Survey now employs only six major divisions of the zonal soils: (1) soils of the cold zone, (2) light-colored soils of arid regions, (3) dark-colored soils of semiarid, subhumid, and humid grasslands, (4) soils of the forest-grassland transition, (5) light-colored podzolized soils of the timbered regions, and (6) lateritic soils of forested warm-temperate and tropical regions. These six suborders are divided into twenty-one "great soil groups," but further changes in some of these suborders are under study. Farther down the scale of the classification hierarchy are soil families, soil series, soil types, and soil phases, all of them subject to refinement and change as study of them proceeds.

The first government soil survey parties began field mapping operations in 1899, and by 1957 approximately 1,700 county or area reports had been released. The first Oklahoma soil survey reports to be published were those of the Tishomingo Area in Indian Territory and of Oklahoma County in Oklahoma Territory, both appearing in 1906, the year before statehood, with colored maps on a scale of one inch to the mile. The Tishomingo Area was done by Thomas D. Rice and Orla L. Ayrs, and that of Oklahoma County by W. E. McLendon and Grove B. Jones. Up to 1957 soil survey reports of 32 of Oklahoma's 77 counties had been published, in addition to the Tishomingo Area report which covered parts of Bryan, Johnston, and Marshall counties. At least five other county surveys have been completed, for Creek, Harmon, Harper, Logan, and Pawnee counties, but the reports had not yet been published by late 1958.

Some of the later Oklahoma reports, of which those for Cleveland and Noble counties are typical, have been published on a scale of 1/31,680, or two inches to the mile, making possible the mapping of soil phase variations in considerable detail. In most of the reports published to date the soils have been mapped in the field, using as a base the standard topographic quadrangles of the U.S. Geological Survey. Air photos were first used as bases in soil survey work in 1929 by T. M. Bushnell, with Hennings County, Indiana, being photographed specifically for the purpose of preparing the county soil survey (Rourke and Austin, 1951). Today air photos are regarded as essential in soil survey operations, and most detailed soil mapping is being done in the field on aerial photographs at scales between 1/15,840 and 1/20,000. The original planimetric maps are usually prepared with a scale of 1/20,000, although the final soil maps may be somewhat enlarged or reduced. Some of the recent soil survey reports, of which that for Watauga County, North Carolina, is a good example, have been issued with the soil boundaries drawn directly on the air photos, but the very latest ones seem to have returned to the use of the colored map.

Increasing attention is being given to making the soil survey reports and maps more useful to farmers through enlarging the scale enough to identify individual fields and through relating the various soil types and phases to the soil management groups and land capability classes which have been in use for some time by the Soil Conservation Service (Hedge and Klingebiel, 1957). It is anticipated that by 1960 most of the reports issued will have a special chapter on engineering applications, a reflection of substantial use already being made of them by county, state, and federal highway planners.

The current index to published soil survey reports (Nat. Acad. Sci., 1957) gives a quality rating from one to five for each of the 1,700 or so county surveys which have been completed. In July, 1956, only two of the Oklahoma surveys, those for Cleveland and Harmon counties, had a number 1 rating, that is, had soil maps with soil names and boundaries in accord with present day standards. The new Noble County survey no doubt raises the number in this quality class to three. Soil maps with a number 2 rating, with soil names mostly in accord with recent correlations, but with a smaller scale or soil boundaries less precise than present day standards, were available for Woods, Alfalfa, Major, and Okfuskee counties. More than half of the Oklahoma surveys, seventeen in all, fall in class 3, that is, they were made mostly before 1930, have soil boundaries somewhat generalized, or follow a classification not entirely in accord with present day correlations, or both. In class 4, with rather general soil maps but some significant boundaries accurately located, are the surveys of Kay, Canadian, Oklahoma, and Tillman counties. Finally, in Class 5, with soil maps considered of little current value because of incorrectly drawn boundaries or inadequate classification, are the reports of Roger

Mills, Payne, Muskogee, and Bryan counties, and in the same quality class is the old 1906 survey of the Tishomingo Area.

Soil maps have been a useful tool for American geographers since the beginning of this century and, as the soil survey reports increase in number and improve further in accuracy, we can expect them to find ever widening applications in geographic research. Perhaps we can hope, as many of us do in the case of the U.S. Census Bureau studies, that some day the government experts will find a scheme of classification that will endure forever, or at least for five or ten years.

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