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ACCRETION-GLEY AND THE GUMBOTIL DILEMMA

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ABSTRACT. Inclusion of materials of different origins under the terms "gley" and "gumbotil" has led to misinterpretations and to confusion. It is suggested that in Pleistocene geology the term "gley" be used only for the gleyed material in a developed soil profile, and the term "accretion-gley" be used to designate deposited materials. It is further suggested that the term "gumbotil" be restricted in application to materials developed *in situ*. If such a restriction is not generally accepted, the term "gumbotil" should be abandoned.

GENERALITIES

In the field of research directed toward the stratigraphy, classification, and chronology of continental glacial deposits, few concepts have exerted as far-reaching influence as the gumbotil concept. The term "gumbotil" was first introduced by Kay in 1916, and discussed in detail by Kay and Pearce in 1920. Since that time workers in the north-central region of the United States have embraced the concept so completely that it might be described as a major element of dogma among Pleistocene stratigraphers.

Gumbotil was defined (Kay, 1916; Kay and Pearce, 1920, p. 89) as

> a gray to dark colored, thoroughly leached, nonlaminated, deoxidized clay, very sticky and breaking with starchlike fracture when wet, very hard and tenacious when dry, and which is chiefly the result of weathering of drift. The name is intended to suggest the nature of the material and its origin.

This definition is both empirical and genetic. As will be explained, it is this dualism of the definition that produces the present dilemma.

During the same period when Kay and Pearce were developing the gumbotil concept, the modern form of soil science was developing in the United States. Perhaps the lack of integration between the genetic concepts of gumbotil and the rapidly developing data and concepts of pedology was fortuitous. For several decades glacial stratigraphers have commonly identified and named gumbotil on the basis of the empirical elements of its definition, but have interpreted its significance on the basis of the genetic elements of the definition.

During this period there were only rare attempts to expand and develop the genetic aspects of the gumbotil idea (Leighton and MacClintock, 1930), but the evidence that demonstrates dynamically developing soil profiles was being discussed widely by soil scientists. Many of the terms and interpretations used in explaining the morphology and genesis of soil profiles were derived from pioneering work in Russia. Among these imported terms, "gley" is particularly important to our discussion because the empirical definition of gumbotil falls within the range of materials included under the term "gley".

Some pedologists have completely rejected Kay's genetic interpretation of gumbotil. This is clearly stated by Krusekopf (1948, p. 413) as follows:

> All of the characteristics of the gumbotil clearly indicate that it is a water deposit, or lacustrine in origin. Gumbotil is always a surface formation, and is clearly differentiated from the yellow till upon which it rests. It was deposited as a gumbotil and did not become so subsequent to its deposition. It was weathered and leached when deposited.

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On the other hand, field relations at some places strongly indicate that other deposits classed as gumbotil occur as a part of a developed profile of weathering as suggested by Kay in his original definition.

The conflicting interpretations of gumbotil have been aggravated by the broad use, in a descriptive sense, of the terms "gley" and "gleyed material" in soil science. This multiple use has been defined in the Soil Survey Manual (1951, p. 184) as follows:

> Gleyed soil material may begin a few inches below the surface of hydromorphic soils and, in some instances, continue on down for many feet essentially unchanged. Such conditions can arise through the gradual filling of a wet basin, with the A horizon gradually being added to at the surface and being gleyed beneath. Finally the A rests on a thick mass of gleyed material, which may be relatively uniform, especially in sandy types. Obviously the upper part belongs to the solum, while the lower part does not. This illustration does not extend to all gleyed soils. In many the G horizon is clearly a part of the solum and has a clear lower boundary with the C.

More recently the use of the term "gley" to include clays of different origin has been illustrated in a summary by Senstius (1958, p. 362) in which he states in part:

> . . . the characteristic greenish and bluish or steel-gray color of subaqueous soils, known by the Russian name of *gley*; . . . In this example gley represents the bottom deposit of a shallow pond or swamp . . . On the left side of composite Figure 5, gley is shown to be associated with a podsol on dry land.

In his discussion, Senstius is using the same term, without modifiers, for a clayey material deposited in a swamp or pond and also for a clayey material that had developed *in situ* as part of a soil profile. If the underlying material in both places were glacial till, the term gumbotil likewise might have been applied in both situations without modifiers.

It is our contention that a gleyed material formed largely by accretion, "accretion-gley", can usually be distinguished from developed gley, and that at many places *in situ* gumbotil can be distinguished from deposited "gumbotil" by examination of the deposits and their relationships in the field. Mineralogic, petrographic, and chemical data determinable only in the laboratory are of course highly significant, but this discussion is restricted to those data determinable by ordinary field methods.

Unhappily, too few geologists, while applying the term "gumbotil" in an empirical sense, have considered the possibilities of diverse origins. Deposits meeting the empirical definition of gumbotil have formed by: (1) the accumulation in shallow pro-glacial lakes of the finest constituents of the debris load carried by the glacier, (2) slow accretion of fine-textured sediments in swampy or marshy places on a till plain, the materials being derived from weathering of the adjacent slightly higher parts of the till-plain surface and moved by sheet-wash, (3) slow accumulation in marshy environments of fine-textured, eolian sediments intermixed with sheet-wash accretion, (4) soil-profile development in a situation of high water-table where process of accretion and *in situ* development are both operative, and (5) processes of gleization in a developed soil profile where initial low permeability of the parent material and low topographic relief combine to create a poor drainage. Only the last of these five situations meets the genetic requirements of the original definition of gumbotil. To illustrate the divergent usages of the term "gumbotil" a few selected examples are described from Illinois, Iowa, and Kansas.

EXAMPLES

Examples of many of the various materials that have been properly and improperly classed as gumbotil are readily observable in Illinois. As preface to the description of a few selected examples from Illinois it is appropriate to observe that the extensive exposures of the Illinoian drift plain in coal strip-mines in western Illinois reveal at only a few localities material that meets all of the requirements for classification as gumbotil, even though many of the strip pits occur in flat topography well removed from valleys and though the Sangamon soil is developed on clayey till that overlies Pennsylvanian shale.

Material that is excluded from the empirical definition of gumbotil only by its moderate calcium carbonate content occurs extensively at the top of Tazewell age till in southwestern Iroquois County and areas farther north that were covered by early stages of glacial Lake Watseka. A typical sequence is exposed in cuts in the SW¼ SW¼ SW¼ sec. 29, T. 24 N., R. 14 W., 2½ miles north of Clarence. One foot of black surface soil overlies three feet of blue-gray clay and silt, massive to blocky, with a few scattered pebbles and a few small nodules of calcium carbonate. An irregular zone of silty sand and gravel separates this upper clayey layer from another massive bed of clay, silt, and pebbles which is underlain by typical till.

In Ogle County examples of accretion-gley (formerly identified as gumbotil) occur in the area mapped by Shaffer (1956) as Wisconsin Farmdale drift. Typical of these are a road-cut exposure in the NE¼ NE¼ sec. 2, T. 23 N., R. 9 E. (Shaffer, 1956, p. 22), and exposures in building excavations and cuts in the SW¼ NE¼ SE¼ sec. 9, T. 23 N., R. 8 E. At the latter locality auger holes penetrated at least 12 feet of accretion-gley without reaching till below. The material is massive, noncalcareous, silty clay. Dark irregular zones of humus occur in the upper 1½ feet, and the remainder of the deposit is dove-gray to blue-gray with local, irregular mottling of tan and brown throughout. In the lower half there are some silty zones but no pebbles. The locality is at the crest of a shallow valley wall and within a mile of the front of the Shelbyville drift.

The fact that this material is accretion-gley rather than a developed clay in a soil profile is clearly attested in the field by the character and occurrence of the humic streaking in the upper part, by its uniformity throughout a 12-foot thickness, by the suggestion of rudimentary bedding in the lower part, by the absence of siliceous pebbles in an area of generally pebbly till, by the distribution of the silt content, and by the complete lack of soil structure.

In the area where Illinoian till is the surficial drift, examples of accretion-gley that was once considered gumbotil are common in the vicinity of Kewanee, Henry County. Such a deposit, below thin Peorian loess, was observed in road cut and auger hole in the NE cor. SE¼ sec. 26, T. 15 N., R. 5 E. The *upper* foot is gray, silty clay, irregularly streaked with humus, that grades downward into two feet of massive, gray, noncalcareous, silty clay. The underlying two feet of massive, gray, silty clay is distinguished by the presence of scattered pebbles. Below this the auger penetrated four feet of brown, pebbly, silty clay resting on tan, calcareous till. That at least the uppermost three feet is an accretion deposit is attested in the field by the scarcity of pebbles, by the distribution and character of the humus streaks, and by the texture.

An excellent example of the sharp localization of accretion-gley is exposed in a fresh road cut in the SE¼ NE¼ NW¼ sec. 36, T. 8 N., R. 2 E., Fulton County. The general downward succession consists of 10 feet of Peorian loess, a foot or two of Farmdale loess, Sangamon soil, and Illinoian till. A lens of accretion-gley with a maximum thickness of three feet occurs in a shallow depression on the Illinoian drift plain. This lens is sharply limited; it consists of massive, blue-gray, silty clay, with irregular humus streaks in the upper part. It lacks pebbles although they occur in the adjacent Sangamon soil B-horizon. The B-horizon can be traced laterally under the accretion-gley lens, but it is thinner and is mottled with gray, suggesting some gleying of the weathered till below the accretion deposit. Although the material in this lens meets the requirements of the empirical definition of gumbotil, its depositional origin is clearly evident from field relationships.

Beyond the limit of this lens the developed profile is similar to the Sangamon soil exposed in strip pits less than a mile away and of which the mineralogy has been described by Brophy (1959). It contains a red-brown, clayey B-horizon with well developed clay-skins, manganese pellets, and well preserved structure, which grades downward into tan-brown, calcareous Illinoian till, which in turn overlies blue-gray, calcareous till with irregular zones of sand and gravel.

Sangamon County, Illinois, contains excellent examples both of accretion-gley that has been classed as gumbotil and of developed Sangamon soil profiles that meet all of the requirements for gumbotil. Typical of the former is a roadside exposure in the NW¼ SW¼ NE¼ sec. 5, T. 14 N., R. 4 W. Eight feet of silty clay that is blue-gray with some tan mottling, massive, noncalcareous, and has irregular humus streaks in the upper 1½ feet is exposed below tan Peorian loess. It is underlain by six inches of weakly calcareous, tan silt, below which an auger hole penetrated 3½ feet of tan and gray, weakly calcareous, medium-grained sand and 1½ feet of brown and gray, noncalcareous, silty sand.

A fresh road cut on the south side of a valley in the NW¼ NW¼ SW¼ sec. 3, T. 14 N., R. 4 W., exposes Sangamon soil, developed on Illinoian till, that we judge meets both the empirical and genetic requirements for gumbotil. Below Peorian and Farmdale loesses the A-horizon, approximately two feet thick, silty with only a few pebbles, and gray-tan in color, rests on six feet of B-horizon—the middle half of which can be classed as gumbotil. The upper part of the B-horizon is very clayey, has well developed soil structure, contains pebbles, clay-skins and manganese pellets, and is dark reddish brown with gray mottling. The color grades downward through greenish gray to yellow-brown; the clay content, soil structure, and mangaense pellets and streaking diminish, and the sand content increases downward. Below the B-horizon is four feet of oxidized and leached till, five feet of oxidized and calcareous till, and four feet of blue-gray calcareous till.

In Iowa, an example of accretion-gley on Kansan till is well exposed in a fresh road cut in the SE¼ SW¼ sec. 7, T. 82 N., R. 4 E., Clinton County. Below thin, tan loess is exposed 4½ feet of gray, noncalcareous, silty clay resting on six feet of light gray, weakly calcareous till, grading downward to tan and gray, calcareous, Kansan till. The accretion-gley is irregularly streaked with humus in the upper part and has tan streaks in the lower part. Indistinct bedding with somewhat more silty zones is present in the lower part. The gleying effect of the local environment is illustrated by the blue-gray streaks and pendants extending as much as five feet into the till.

Two localities in Kansas exemplify two types of gleyed material. A soil developed in Nebraska till and overlain by Kansas till is exposed in the NE¼ SE¼ sec. 6, T. 2 S., R. 20 E., Doniphan County, Kansas (Frye and Leonard, 1952, p. 55 and 69). The soil has been classed as a gumbotil and is largely developed *in situ* from till parent material. It is leached, highly clayey, dark gray, massive, and in general will meet the requirements of the original definition of gumbotil. Siliceous pebbles are present throughout although they are less abundant and smaller in the upper part, the contact of the B-horizon with the underlying material is gradational, the leached zone is little more than three feet thick, and the unleached till below the gley contains not only siliceous pebbles but also pebbles of limestone and igneous rocks.

An example of accretion-gley occurs in upland situations in Atchison, Jackson, Jefferson, and Shawnee Counties in northeastern Kansas. In the NE¼ sec. 12, T. 7 S., R. 18 E., Atchison County, a gleyed layer attains a thickness of 30 feet and has been informally called the "Nortonville clay" (Frye and Leonard, 1952, p. 81). This massive clay layer, which has been called gumbotil, is gray, free of pebbles and cobbles, and noncalcareous; it rests with a sharp contact on oxidized and cobbly Kansas till, and where not overlain by thin loess it contains a heavy planosol in its top. Its regional and topographic relationships, its lack of siliceous pebbles and cobbles so common in the till immediately below, its uniformity throughout such a thickness, its sharp basal contact, as well as its chemical and mineralogical composition, clearly indicate that it is not the product of *in situ* weathering but is an accretion deposit on the initial surface of the Kansan till plain.

CONCLUSIONS

The diverse origins of deposits classed as gumbotil must be recognized, as has been done in the case of gley or gleyed materials. Our terminology needs clarification so that a deposit named empirically on the basis of physical features will not be automatically and unquestioningly given genetic significance.

We suggest that when used by Pleistocene geologists the term "gley" be restricted to clayey gleyed material in a developed profile and the term "accretion-gley" be used for reference to the several types of slowly accumulating deposits of surficial clay. It is apparent that to be meaningful, the term "gumbotil" must be restricted to material resulting from *in situ* development, because the indiscriminate use of this term for materials of different origins has produced more confusion than clarification. If such a restriction is not generally accepted, it is our judgment that progress will best be served by abandoning the term "gumbotil." Such deposits should then be described lithologically the same as other parts of the succession of sediments. It is appropriate in geological literature to use pedologic terms in describing a soil profile.

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