FURTHER INVESTIGATIONS OF BURIED SOILS IN RELATION TO CLIMATIC CHANGES IN OKLAHOMA

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The occurrence of buried soils in Oklahoma has been reported in previous papers (1) (2). A large number of buried soils are found in the central and western part of the state and frequent exposures occur on high terraces along the larger streams and at various locations in the valleys of smaller tributaries. It is the purpose of this paper to point out the possible relation between those factors which have been responsible for the formation of buried soils and correlate the occurrence of buried soils in Oklahoma with loess formation in the central part of the United States.

Buried soils could be formed due to the elevation of the surface of the earth, but this explanation is inadequate due to the fact that the buried soils studied in this investigation occur along streams running in many different directions. Also normal aggradation would not account for the sudden change which would be required to deposit a deep layer of sediment over the surface of an area which has not been affected by erosion or deposition for a long period of time.

Soils mature slowly under the influence of prairie vegetation and low rainfall. A careful study of soil conditions shows very definitely that the western half of Oklahoma has not been leached by heavy rainfall during the present geological period consequently some other factor has been most important in producing the accelerated rate of erosion which has been necessary to produce buried soils. A high annual rainfall is not essential for rapid erosion, since torrential rains falling on sloping land not protected by vegetation causes rapid movement of soil. The location of nine different exposures of buried soils from which samples have been secured for chemical analysis is given Table I.

TABLE I

Location of buried soils in Oklahoma from which samples have been collected for analysis.

No.	County	Direction from town
1.	Alfalfa	4 mi. N.; 5 mi. W. of Burlington
2.	Garfield	2 mi. N.; 2 mi. E. of Enid
3.	Garfield	East of Waukomis on Skeleton Creek
4.	Grant	¼ mi. E. of Pond Creek
5.	Grant	¼ mi. W.; ½ mi. N. of Nash.
6.	Grady	1 mi. N.; ½ mi. E. of Tuttle
7.	Payne	5 mi. E.; 2 mi. N. of Stillwater
8.	Payne	5 mi. W. of Stillwater
9.	Payne	5 mi. N.; 2 mi. E. of Coyle

In addition to these locations many other areas of buried soils have been examined.

Stratification of alluvium in the recent flood plain of a stream should not be confused with a true buried soil which can be detected by an exami-

nation of the different horizons. A mature soil, B, which shows the old surface, subsurface and subsoil layers which have been covered by more recent alluvium, A, is illustrated in figure I. It is possible that buried soils may be immature and the best method of identification would be the presence of earthworm casts throughout the soil profile and the gradual decrease in the organic matter content from the surface downward rather than any abrupt change from dark to light colors or from coarse sand to silt or clay.

A study of the topography adjacent to areas of buried soils located along the smaller streams indicates that at some period in the development of the soil, erosion has been accelerated and smooth areas of prairie have been gullied by running water. Under the influence of a changing climate, grass gradually covered most of the eroded areas and at the present time only the outlines of previous denudation appears. A question might arise in regard to the retardation of erosion due to the gradual appearance of grasses on the weathered sedimentary rocks. If so why are the level areas of prairie mature and the eroded areas immature? Where did the alluvium originate that now appears superimposed on an old land surface which was covered with grass for a long period of time.

The correlation of buried soils in Oklahoma with climatic conditions which were responsible for loess formation may be rather difficult; however there are some very interesting clues which may be used to aid in the solution of this problem. The formation of loess in connection with glacial activity has been studied by many different investigators. There have been several periods of loess accumulation, but according to geological studies the most extensive period of deposition has been correlated with the Iowan ice sheet. A considerable amount of loess accumulated in Northeastern Iowa and in adjacent states in connection with the Iowan glaciation and a very extensive deposit was formed along the Missouri and Mississippi rivers. A small area of the Iowan drift is covered with loess derived from the ground moraine and outwash from the late Wisconsin drift indicating another period of loess accumulation. Loess accumulation may not always be associated with drouth, since the fine particles of dust in unprotected alluvium and ground moraine could be affected by wind when adjacent areas might be covered with vegetation.

Geologists have estimated the age of the different glacial periods, and it is very interesting to note that mature soils have not formed on the Wisconsin or Iowan drift or on the prairie soils of the loess which accumulated during these geological periods. Also mature soils have not been developed on the alluvium which has covered the buried soils studied in Oklahoma, but mature soils did develop on alluvium previously deposited in the flood plain of these streams. Mature prairie soils in Iowa and Missouri also occur on the Kansas drift which has been estimated at two million years of age. If climatic conditions have not been too variable, the degree of leaching of the soil would indicate that the areas under consideration are quite comparable. The alluvium which covered many "buried soils" in Oklahoma was produced at a later period than the Kansan glaciation.

The development of conditions which were favorable for the movement of large quantities of loess have evidently produced profound changes in the surface vegetation in Oklahoma since many semi arid plants occur in the eastern part of the state which is now considered a humid region. Since only one group of buried soils occurs along the smaller streams in central and western Oklahoma, it would appear that only one period of severe drought followed by a period of rapid soil erosion has occurred. The absence of mature soils in areas covered by the Wisconsin and Iowan glaciation and the absence of mature soils on those sediments which cover buried soils in Oklahoma would indicate that the development of the loess and the formation of buried soils are closely associated and similar climatic factors

have been responsible for this parallel development. Although there may have been cycles of lower and higher rainfall in Oklahoma at other periods in recent geological history, studies on buried soils indicate that there has been only one cycle which has been severe enough to reduce surface vegetation to a point where a rapid acceleration in the rate of erosion occurred on the uplands along the smaller streams. It can be shown that other severe drouth periods have occurred, it must be assumed that the increase in total rainfall was so gradual that vegetation covered the unprotected soil before any soil movement developed, and also during that period torrential rains did not occur.

REFERENCES

1. Harper, Horace J. and Hollopeter, Charles A. Buried soils and their significance. Oklahoma Acad. of Science V. 12 (1932) 63-66.

2. Harper, Horace J. Studies on the origin of the sandy land along the Cimarron River in Oklahoma. Okla. Acad. of Science V. 13 (1933) 24-27.

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