GLACIAL GEOLOGY AND ENGINEERING IN ILLINOIS.

M. M. Leighton, Chief, Illinois Geological Survey.

INTRODUCTION.

Every now and then illustrations come to our attention of the results of investigations, which were purely scientific in the first place, coming to have commercial or industrial applications. Glacial geology formerly had almost entirely a purely scientific status. Recently our information on the glacial geology of Illinois has come to be in greater and greater demand by those engineering specialists who deal with earth materials or surface configuration. The reasons are partly the fatal consequences of past experience, partly increased engineering specialization and development, and partly increased information which we have gained concerning the glacial geology of the State.

COMPLEXITY OF THE GLACIAL HISTORY OF ILLINOIS.

It now appears probable that at least four ice sheets invaded Illinois at intervals separated by longinterglacial epochs during the Pleistocene period, and there is some evidence that there were as many as five different ice invasions. At least two of these reached or approached the Ozark region of southern Illinois, while the others affected the northeastern and western portions. As a consequence, most of the State is covered by glacial drift and its related materials of outwash and wind-blown origin, which have to be dealt with in many engineering projects. These drift formations have different characteristics and properties, even in some cases of till sheets which are superposed. As a result, a given engineering project may demand certain information which requires a technical differentiation of these drifts.

THE RELATIONSHIP OF MINING ENGINEERING TO GLACIAL GEOLOGY.

The coal industry of Illinois is the State's largest mineral industry. In the initial work of mine development, particularly in the sinking of shafts, the mining engineer must take into account the possible existence of sand and gravel conditions which are likely to give water trouble. He must also consider the possibility of the discontinuity of the coal bed, due to preglacial erosion, and the possible disastrous flooding of the mine if the entries are extended into the glacial fillings of an old valley. These sources of trouble necessitate systematic drilling in advance of mine development, together with the interpretation of the results of drilling and the formulation of engineering plans based on those results.

GLACIAL GEOLOGY AND MUNICIPAL WATER SUPPLIES.

In central and southern Illinois particularly, water-bearing formations lie deep and the waters in many cases are highly mineralized and undesirable for industrial and domestic use. The engineering specialist in water supplies, therefore, must look to sources either in the glacial drift or in surface streams. Local geographic relations and geologic conditions may determine which is the more desirable. In considering possible sources in the glacial drift, he will do well to interest himself in the possible existence of old buried valleys which may contain abundant water-bearing sand and gravel strata in their bottoms. The tracing of such valleys, in many cases not apparent to the layman, assumes an economic importance. We are now engaged in the collection of all available data which will reveal their existence and make possible the mapping of their courses.

In case surface water supplies are sought, there is the necessity of creating a surface reservoir by constructing a dam. The life nd success of this reservoir depend not only on the proper construction of the dam with respect to the materials which are put into it, but also upon the character of the materials on which the dam is to be built. These materials must be strong enough to support its weight and impervious enough to prevent excess leakage both beneath and at the ends of the dam. The natural sides of the reservoir must also be impervious. Such problems, involving glacial geology, abound in Illinois and in other areas north of the glacial drift boundary.

GLACIAL GEOLOGY AND THE STATE'S ROAD BUILDING PROGRAM.

The magnitude of the road building program of the State has made necessary a study of our resources in road building materials. These include the sand and gravel formations of the glacial drift. In the investigation which the State Geological Survey has carried on, it was found that the principles of glacial sedimentation in morainal building and outwash accumulation were continuously helpful in locating and outlining probable sources of suitable materials. An insight into the complexity of the glacial history of the areas covered was also helpful.

During the last glacial epoch, there was a fortunate relationship of ice lobes in the Great Lakes region which affected very definitely the distribution of the sand and gravel deposits of northern Illinois. The Lake Michigan lobe, which extended into northeastern Illinois, had a general southerly direction of movement but with radial movement toward the sides. The Green Bay lobe, which scarcely reached the northern boundary of Illinois, had a general southwesterly movement but with similar radial movement toward the sides. The result was that in the zone of juncture of these two lobes there were conflicting ice forces which caused the ice to be greatly riven and crevassed, thus facilitating melting and drainage. Consequently, the waters which issued from this portion of the great ice sheet were of sufficient volume to carry sand and gravel from the ice and deposit it in outwash plains and valley plains for many miles away from the ice border. DuPage, Fox and Rock rivers of northern Illinois contain extensive terraces of these valuable road-making materials. Another factor of consequence was the slope of the ice lobes from their central axes to their sides, thus tending to concentrate the waters in the zone where the lobes joined. The Huron-Erie lobes, and the Saginaw lobe to the east of the Lake Michigan lobe, and the east side of the Lake Michigan lobe, likewise had their effect upon the sand and gravel accumulations of eastern Illinois. At the time of the building of the Valparaiso morainic system of these lobes, most of the drainage flowed down Kankakee river. The headwaters of this stream reach into southern Michigan, where these various lobes conjoin. Enormous quantities of water therefore concentrated along Kankakee River, and having high velocity, prevented any large accumulation of sand and gravel taking place within the limits of Illinois, except in depressions, in lee of rock islands, and on the inside of the big bend of Illinois River.

RESEARCH WORK ON THE BEARING STRENGTH OF SURFICIAL MATERIALS USED IN FILLS.

Perhaps the newest need for information concerning the glacial formations of Illinois is that of the Research Division of the Highway Department in the study of the bearing strength of various surficial materials which are used in fills, and which serve as a sub-base for concrete pavement. It has too commonly been the case that contractors have paid little heed to the character of the surficial materials which are put into these fills. It is, of course, well known by geologists that our surficial materials differ greatly with respect to their engineering properties under different moisture and freezing conditions. Consequently the information which the Survey possesses on the glacial geology of the State has been sought by the above Division in the study which it is making of these materials.

GLACIAL GEOLOGY AND ELECTRICAL ENGINEERING.

Perhaps the most unique instance of the application of glacial geology was worked out by the Commonwealth Edison Company of Chicago and the U. S. Bureau of Standards in the Chicago area. It was found that in grounding the electrical current, longer ground posts were needed for the sandy belts than for the clay and silt subsoils. It was also found that these sandy belts were the old beaches of Lake Chicago, now largely destroyed within the City proper, but mapped by the U. S. Geological Survey before they were destroyed. By using these maps, the Company was greatly assisted in mapping out its program for the most desirable system of wire distribution.