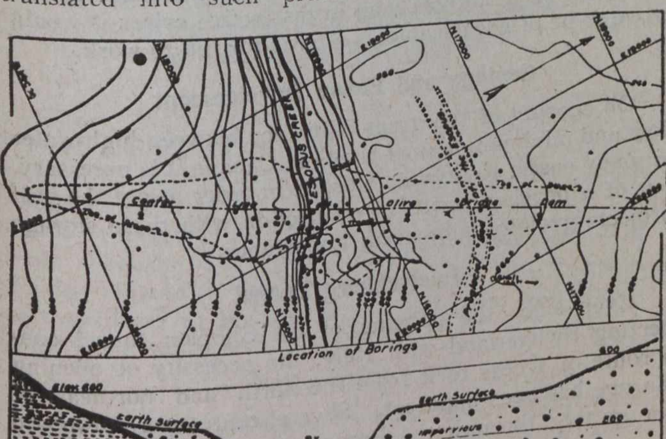
A steel tube might be laid to carry the water across and deliver it again at flowing grade, but here one is met with the fact that it would require a tube of unprecedented size and strength, and if divided into a number of smaller ones the cost would be greater than that of a tunnel in solid rock.

The other alternative is to make a tunnel deep enough in bed rock to lie beneath surface weaknesses and superficial gorges and in it carry the water under pressure to the opposite side of the valley. This is the plan that seems best suited to the magnitude of the undertaking and would seem to promise most permanent construction. But no sooner is this conclusion reached than it is realized that there are now several hitherto unregarded features that assume immediate and controlling importance. Some of these, for example, are (1) the possibility of old stream gorges that are buried beneath the soil, (2) the position of these old channels and their depth, (3) the kinds of rock in the valley, (4) their character for construction and permanence, (5) the possible interference of underground water circulation, (6) the possible excessive losses of water through porosity of strata, (7) the proper depth at which the tunnel should be placed, (8) the kinds of strata, and their respective amounts that will be cut at the chosen depth, (9) the position and character of the weak spots with an estimate of their influence on the practicability of the tunnel proposition. Then, after these have all been considered, the whole situation must be interpreted and translated into such practical engineering terms as



Location of the Ashokan Dam at Olive Bridge Site and a Geological Cross-section

The small dots in the plan indicate exploratory borings. The section shows the rock profile indicating a preglacial channel of the Esopus. The present Esopus flows in a new postglacial channel at a higher elevation.

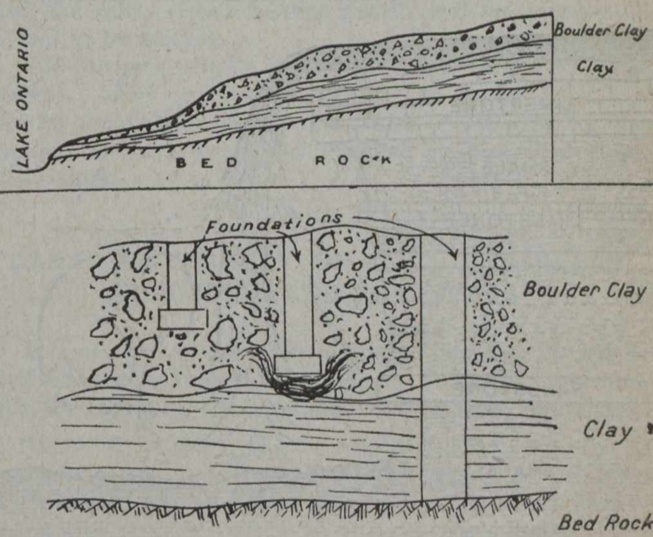
whether or not the tunnel method is practicable, and at what point and at what depth it should cross the valley, and at what points still further exploration would add data of value in correcting estimates and governing constructions and controlling contracts.

This is a general view of one case, the first one of any large proportions in following down the aqueduct. There are many others. In nearly all of them the importance of geologic questions is prominent. Many of them, of course, are of the simplest sort, but, on the other hand, some are among the most obscure and evasive problems of the science.

The deepest channel was that of the Hudson Valley in the Highlands, where the tunnel had to be carried 1,000 feet below sea level to get under the buried gorge of the Hudson.

Foundations

In Canada we have been long accustomed to building two, three or four story buildings designed for light loads. The modern tendency is toward the construction of so-called sky-scrapers, consequently the question of securing foundations to withstand the greater load upon



Condition of Subsoil at Toronto

them is of great importance. In Toronto, for example, it was customary to place the foundations very little below the floor of the basement, but in the construction of the modern high buildings in that city it is often found necessary to carry the foundations down some 60 feet to the solid rock.

Geology of Montreal and Ottawa

The influence of geology on the erection of foundations in Montreal and Ottawa will now be briefly discussed.

Montreal: The mantle of drift covering the island of Montreal allows of separation into the following divisions:

Recent—Lake deposits, including lake clays; shell marls, peat, etc.; river gravels.

Pleistocene—Saxicava sand and gravel; leda clay; boulder clay.

Boulder Clay—This material was formed from the continental ice sheet and has the characteristics before mentioned.

Leda Clay—This material was laid in an arm of the sea which extended up to Montreal. The beaches formed during the lowering of level of the water until the St. Lawrence became fresh, are marked by the saxicava sand deposits. There is no definite information as to the exact level at which the St. Lawrence became fresh in the Montreal district, but it would appear that this level is represented to-day by the 100-foot contour.

The island of Montreal is characterized by an almost flat surface, due to pleistocene deposits. The exposed surface of the boulder clay is produced by erosion and is fairly uniform, but the surface of the boulder clay on which the leda clay was deposited was very uneven. While the boulder clay usually affords good foundation, it sometimes passes into a variety which has the appearance of an unstratified leda clay. Again, by the suppression of the boulders and of the clayey part of the matrix, a variety is produced which may be called a quicksand.