SOME WATER SUPPLY PROBLEMS OF THE WEST.*

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Owing to the gentleman who had arranged to read a paper to-night finding he had to leave the city, and would, therefore, not be able to fulfil his engagement, and, as the time was too short for others to fill the breach, it is to be hoped that the following note will furnish topics for discussion:—

Every country, district and town has water supply problems to solve. It is rare to find nature so generous as to furnish abundant, pure supply of water without leaving some difficulty, more or less great, for the engineer to surmount. We have only to study the conditions in Canada, which, perhaps, possesses the most bountiful supply of water of any country, to observe that a number of towns and cities are combatting with one difficulty or another. The supply of water is either difficult to procure, or it is limited in quantity, or it is not pure.

Whilst in the East and extreme West of Canada there is abundance of water, the problem in many places in the Middle West is to find a copious and pure supply, and it will be well to consider why it is often so difficult.

The author has during his career had a number of water problems to deal with, but when he visited Regina and was asked by the corporation, through your president, who was then City Commissioner, to conduct investigations with the view to augmenting the supply, he found new conditions, which had to be carefully studied.

Geological Formation.—One of many interesting features which had to be studied was that of the geological formation of the country, and in this connection it may be useful to describe the agencies which primarily contributed to form the topographical features of this part of the country.

The present surface is entirely of glacial origin. When the first great ice invasion of the glacial epoch moved southwards the surface of the country was doubtless much more rugged than it is to-day, and the valleys possibly drained in other directions. The great sheet of ice, many hundreds of feet in thickness, advanced slowly southwards, stripping loose material, crushing and levelling rocky hills; stones, gravel and mud became frozen to the ice, and increased the power of the glacier to wear down other rocky excrescences, etc. Enormous masses of crushed rock of many kinds were thus picked up and conveyed from the northern parts across this country into the United States. When the climate became warmer the ice gradually melted back, and huge streams of water, which flowed down from the ice sheets, and brought with them great quantities of detrital material, depositing the same in uneven masses, filling up valleys and forming the plains and hills which constitute the principal features of the prairies.

Where this great ice sheet halted from time to time terminal moraines were formed.

The second ice invasion again changed the surface of a large part of the country, disturbing the deposits left by its predecessor and redepositing the same.

These ice sheets advanced across Canada into the United States in the form of a huge tongue, and the glacial deposits can be found over vast territories. These masses of glaciated material vary in thickness, magnitude, shape, character, and distribution, and were laid in a most chaotic manner. The districts around Regina, for instance, are from 1,900 to 2,400 feet above sea-level, and about 600 to 1,100 feet above the Lake Agassiz, which was formed in the glacial period. This lake and other glacial lakes extended westwards as far as the Elbow on the South Saskatchewan River.

The channels or ravines cut out by the streams flowing from the ice sheets have been gradually or partially filled in by sand, silt and gravel washed out of the morainic deposits, building up the gentle slopes and flat plains between the banks. During the ages that have since elapsed the streams have eroded passages through these outwash plains, and in places undercutting the beds of drift, thereby tapping the underground water-bearing stratas and causing springs to appear on the surface.

The fine silt or mud, composed of disintegrated cretaceous rocks, which were carried by the ice sheets, formed the flat or very slightly undulating land surface of the prairies, which constitute the major portion of the country south of Regina. This material, called till, consists of pulverized rock forming impalpably fine clay mud, often intermixed with gravel, boulders and rock. This till, bluish-grey in color, although oxidized on the surface and underneath for a few feet to yellowish clay, is to be found over the country, extending to the Central States of America. It usually underlies the gravel deposits, and forms a more or less impervious substratum. The upper portion of this till is commonly softer and easily dug, while below it there is a sudden change to a hard and compact deposit, locally called hardpan. The probable cause of this (according to Mr. Upham) was the pressure of the enormous weight of the ice sheet upon the lower and older till, while the upper till was dropped loosely as the ice melted. The boulders, which are more or less plenty on the ridges and in valleys, are generally granite, gneiss, and schists brought from the northwest, and also limestone—the latter, being softer and more easily crushed, has been largely reduced to gravel, etc.; hence it is that the substratum consists mostly of limestone and clay.

It is important to note that the glacial till, consisting of a matrix of clay with pebbles and boulders, and, forming a more or less watertight mass, has intermingled and interbedded with it in a most extraordinary manner, and often lying above and below it porous water-laid sands and gravels, which constitute the water-bearing strata. In many places these beds of sand and gravel lie between two beds or till of different epochs of formation, but in a greater number of districts gravel beds of varying depths, thickness and character are to be found under the clay bed drift. It is, however, not possible to trace these beds for a great distance. The calcareous matter has been leached out of the older formation, but in the more recent accumulation it virtually remains without change; consequently, the water obtained for the latter beds are heavily charged with mineral salts.

The surficial layer of drift is generally open and fairly loose, with the result that water percolates rather freely into the subsoil. Owing to the uneven manner in which the glacial materials were deposited and to the undulating nature of the surface, it is inefficiently drained; there is a plexus of pools, sloughs, and swamps. The drift is often saturated nearly or even to the surface; hence it is that so many farmers are able to obtain a fairly abundant supply of water from shallow wells. In times of drought, however, the water table will be considerably reduced, and in some instances it will probably sink below the bottom of such wells. This is also the main reason why sloughs appear to dry up in seasons of drought.

In the case of the outwash sands and gravels to be found stretching out from the moraines, these beds, being very porous, readily absorb the rain falling upon them.

Sand dunes are found in some places, like Pilot Butte. These were formed by sand from the plains drifting with the winder and heaped up in cones or dunes or drifting sandhills. The time of formation of these dunes was probably

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