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Till Project: Groundwater Contribution

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by

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Introduction

The following summary of groundwater occurrence and movement in the area of study, townships 53 and 54, ranges 18 and 19, west of 4th meridian is taken from a groundwater reconnaissance report of the Lamont-Chipman area to be published in 1967. For convenience of studying groundwater movement, the area was divided into three topographic regions: one, Elk Island Park, a high markedly undulating region; two, Chipman Hills, a region moderately well dissected by glacial drainage channels; three, Star Plain, a flat area separating the former two regions (Fig. 1).

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Groundwater movement

Groundwater movement was studied within the framework of the Toth theory of groundwater motion (1962, 1963) (Fig. 2). The main principles underlying Toth's theory are that topography is the predominant factor and that geology is an important modifying factor controlling the movement of groundwater. Recharge of groundwater occurs on the upper half, and discharge over the lower half of regional and local slopes.

Within the specific area covered by this study, the theoretical model (Fig. 21-o, Freeze, 1966) may very appropriately be used. For the purposes of this contribution to the 'till project,' this figure has been adapted (Fig. 3) to illustrate groundwater movement in the area. In this topographic-geologic situation, the Bearpaw Formation (shale) becomes the impermeable bed of Freeze's diagram. The Bearpaw Formation does not outcrop at ground surface as in the theoretical model. It subcrops beneath drift of varying thickness somewhere along the steep or gentle slope from the east side of Elk Island Park. The effects of drift of varying thickness overlying the subcrop area of the impermeable bed may slightly modify the groundwater flow pattern. Figure 4, drawn from well-inventory data and chemical analyses of water samples shows two superimposed flow systems overlying the regional flow system. The superimposed flow system along the east half of the profile is generated where the subcrop of the Bearpaw Formation may be assumed to occur, and where the drift is about 15 feet thick. There are no apparent anomalies in the data to invalidate this interpretation. Also, surficial phenomena, saline soils, and zoning of phreatophytic vegetation around depressions (sloughs) indicate groundwater discharge from the capillary fringe zone or as spring seepage at the land surface.

Strictly in accordance with Freeze's theoretical picture, groundwater discharge should occur on the upstream side of the Bearpaw Formation. However, in figure 5 it is known from springs and spring seepage, and associated phreatophytic vegetation and salt deposits that groundwater discharge occurs most of the way down the regional slope to Norris Creek. This is in conformity with Toth's theory that groundwater discharge occurs halfway down regional and local slopes. These phenomena do occur, though in an area where the drift is slightly thicker, from 25 to 50 feet thick.

The influence of groundwater motion upon the till in the area can be considered within three main zones:

(1) Adjacent to Elk Island Park and over the elevated parts of the land surface(recharge area) where the till is also thickest, groundwater movement is mainly down into the ground. In accordance with this flow picture these findings might be anticipated: non-saline soils, calcium- and magnesium-carbonate type groundwater, little or no zoning of vegetation around depressions, and only temporary bodies of surface standing in most depressions. This is generally what is observed.

(2) For a short but unknown distance on the upstream side of the subcrop of the Bearpaw Formation, groundwater flow is directed towards the surface. This is demonstrated in figure 4, but is more complicated in regard to figure 5. Along this discharge zone the following results may be expected: saline or slightly saline soils, sodium or calcium-magnesium sulfate groundwater (depending on depth of flow path – mainly through bedrock or drift materials) and phreatophytic vegetation. There is some evidence to support the foregoing points. However, virtual absence of geologic data regarding the extent of the Bearpaw Formation and insufficient information concerning groundwater within this zone prevents its delineation.

Theoretically, the outcrop area of an impermeable bed in this topographic-geologic situation should become a recharge area. The apparent differences in the observed field phenomena and well data along profiles (Figs. 4 and 5) show the effect of the Bearpaw Formation subcropping beneath the drift may give rise to apparently conflicting results. On the slope in figure 5, discharge is observed to be taking place (spring seepage or salt deposits) over the lower half of the slope.

(3) The major part of the flat-lying region (regional discharge area) is underlain by a superimposed flow system (Fig. 4) with almost entirely sodium-bicarbonate water. The drift cover in much of this area is thin – less than 15 feet thick. In this region the following results might be anticipated: saline till and saline soils, semipermanent to permanent surface waters of sodium-bicarbonate type and zoning of the phreatophytic vegetation in response to fairly stable water-table conditions. These results are again generally supported by field data.

Summary

It is apparent from the foregoing discussion and figures that the occurrence and movement of groundwater in the drift, which is less than 25 feet thick in much of the area, cannot be adequately discussed without reference to the wider aspect of superimposed flow and regional flow of groundwater through the drift, bedrock, and back into drift materials. From the aspect of groundwater influence upon the till, soil and vegetation conditions, the information and observations available within the area must be viewed in the above perspective.

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