A STUDY OF CERTAIN GENETIC SOIL TYPES OF THE SWAN RIVER AREA OF MANITOBA

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A STUDY OF CERTAIN GENETIC SOIL TYPES OF THE SWAN RIVER AREA OF MANITOBA

I. INTRODUCTION:

In conducting a soil survey of the Swan River Area of Manitoba in 1950 and 1951 it was found that many of the dominant soil types presented a complex classification problem. The main reason for this problem was that the soils in two of the main landscape areas appeared to be in a state of transition and were not climax types of soil. In one area the soils showed certain morphological characteristics normally found only in soils developed under prairie-grassland conditions but where the dominant native vegetation was trees. The soils in this area showed some blackearth characteristics and some grey-wooded characteristics. The soils in the other landscape area appeared to resemble blackearths and yet, on closer inspection it became apparent that such factors as drainage and parent material may have had a profound influence on the type of soils that had developed within this area.

As the reconnaissance survey of the soils in the Swan River Area progressed it became obvious that a more detailed study was necessary before these soils could be properly understood and classified. Therefore the study herein reported was undertaken. The results have clarified the concept of the soils and enabled the author to offer a classification of some of the soils in the Swan River Area of Manitoba.

II. LITERATURE REVIEW:

There is very little published information about the Swan River Area of Manitoba pertaining to its physical features such as soils, climate, geology and vegetation. A few of the early explorers did pass through this area and wrote down their impressions. Dawson (5) in 1859 makes references to this area and says, "On June 10, the time at which we passed, the trees were in full foliage and the prairie openings presented a vast expansive green

sward." This is proof that at least one hundred years ago the vegetation was a mixture of woodland and prairie. In another account, which as far as can be determined, refers to the Upper Valley Plain, Dawson (5) states: "We pass through a beautiful country presenting an equal extent of woodland and prairie. As we proceed (up the valley) the openings become larger and the woods less frequent."

Tyrell (26) in 1887 referred to the area, now designated as the Lower Valley Plain as the "Great Meadows". Of this area he says: "They are wide stretches of rich, flat land, covered with a thick growth of long grass, separated by narrow irregular belts covered with willow, and small, sometimes large, poplars." This observation is in agreement with the fact that today the soils and vegetation in the Lower Valley Plain area show definite signs of having developed under conditions of poor drainage or meadow-land conditions.

In 1938 Ellis (11) wrote briefly on the Swan River Area and reported that in some places it appeared that deep blackearth soils had been invaded by woodland and have given place to degrading blackearth soils. This author (11) explains the term "degrading blackearth" as follows: "The degrading blackearths (or grey-blacks) are soils which were developed as blackearths with blackearth characteristics, but with the invasion of woods, the soil climate became more humid and the soil-forming processes became modified. Greyish blotches now appear in the dark portion of the soil profile and a somewhat heavier "B" horizon has developed, due to the increase in the percolation of water, and to the different feeding habits of the trees. In the heavier horizon, which develops below the surface horizon in this soil type, the granular structure gives place to a nutty structure and the lime tends to leach deeper in the profile."

Mitchell (19) states: "The term "degraded black" is used to describe a former grassland (black) soil that under the influence of later forest cover has developed some of the features of the podsols (forest) type of profile." He goes on to state also that, "The nature of the degraded black soils is determined largely by the relative length of time it has been under a tree cover, and the degree to which it has leached." These transitional soils in Saskatchewan show considerable variation; on the one hand the organic matter in the slightly degraded black soils is similar in content and distribution in the profile to that found in the blackearth soil, while on the other hand strongly degraded black soils bear a close resemblance to the grey-wooded soils especially in their low organic matter content and the presence of a leached "A_2" horizon.

Mitchell (19) also states that, "Where true black soils are found to occur under wooded cover, it is assumed that the tree invasion is of too recent occurrence to have caused leaching, or degradation of the grassland profile." This concept of degrading blackearths is also supported by Joffe (14) who quotes Ruprecht as explaining the occurrence of chernozem soils under forest vegetation by advancing the theory that forest had invaded the prairie region after the chernozem had been formed.

In most of the heavily forested areas of the Swan River Area a podzolic type of profile has developed and these soils have been called grey-wooded. According to Ellis (11): "The virgin (grey-wooded) soils (of Manitoba) are characterized by a leaf mat of forest litter, and a grey platy structured ash-like "A_2" horizon varying in thickness from 4 to 7 inches. Between the leaf mat and the "A_2" horizon, a grey-black crumbly "A_1" horizon may be present where the organic matter from the leaves has been mixed with the upper few inches of soil by organisms. In some cases the grey-black crumbly "A_1" horizon is absent. Below the ash-like "A_2" horizon a well

developed nutty structured "B" horizon occurs. This is the zone of accumulation of clay and humus materials leached from the "A" horizon. Below the tough "B" horizon, which varies in color from reddish-brown to grey-black, there is also a zone of lime carbonate accumulation. This grades into the underlying parent material. ..... These soil characteristics indicate a more moist condition than is found in the black earth regions of Manitoba and that there is sufficient moisture to cause leaching of the upper part of the profile but not enough to cause leaching of the lime carbonate completely out of the profile."

According to Mitchell (20) and Ellis (11) meadow soils are commonly associated with flat depressional topography where surface and profile drainage conditions are very poor. These soils have a mucky surface horizon very high in organic matter. Another characteristic of meadow soils is the iron-stained sub-soil. Free lime carbonate may occur at or near the surface in these soils. The native vegetation consists largely of swale grasses and, as these meadows dry up or are drained, willow and poplar tend to invade the area.

The transitional or intergrade soils referred to above usually have rather complex profile patterns because more than one soil-forming process has been responsible for their development. These soils require considerable study in order to comprehend the operative processes. Marbut (18) concluded that field examination cannot supply all the data needed to determine the character of a weathering process or the extent to which the process has gone. The degree of weathering is measured by the amount of loss or shifting of constituents, while the character of the process is indicated by the constituents that have been made mobile.

Mitchell (21) cautions that the value of laboratory studies depends upon how well the samples obtained represent the soils under discussion. In a study of soil genesis and classification he states that field observations are of paramount importance.

III. INVESTIGATIONAL PROCEDURE:

A. Outline of Field Studies:

The field investigations were made by the author while working with the Manitoba Soil Survey when it carried out a reconnaissance soil survey of the Swan River Area in 1950 and 1951. The procedure employed by this type of survey involves making a traverse around every section. The primary objective of these traverses is to observe, to classify and to map the soils as they exist in the field. The secondary objective of the traverses is to note any feature of the landscape which has a direct or indirect influence on the soils occurring in that location. It was while engaged in this survey that the author was able to make the necessary field investigations and with the aid of the information secured by the survey, to map the distribution and location of the problem soils.

The field investigations involved; (a) observations of the area as a whole and (b) investigation of the soils within the respective landscape areas. Observations were made of the Swan River Area as a whole with respect to such features as; location and extent, surface geological deposits, relief, drainage, climate and native vegetation. The area was divided into natural landscape areas, each of which was then studied in greater detail. Notations were made of all features that appeared to have a direct or indirect influence on the soils developed within each landscape area.

The investigation of the soils in the field showed that marked differences in soils occurred between the different landscape areas. The soils in the Mountain Landscape Area are all mature grey-wooded soils and are easily classified. Nevertheless, one of these mature soils was selected for this study to show the degree of weathering which has occurred in a grey-wooded soil under forest conditions, and to provide a basis for comparison with the other less severely weathered soils which present problems in classification.

(a) Reaction;

(b) Total Exchange Capacity, Exchangeable Cations;

(c) Nitrogen;

(d) Organic Carbon and Organic Matter;

(e) Calcium Carbonate;

(f) Ammonium Tartrate Extractable Iron.

IV. FIELD INVESTIGATIONS:

A. General Description of Swan River Area:

1. Location and Extent:

The area designated in this thesis as the Swan River Area of Manitoba includes all the land lying within Townships 32-38, Ranges 24-29, W 1 inclusive, except that which is in the Porcupine and Duck Mountain Forest Reserves. (See accompanying maps.)

This area embodies approximately 579,840 acres.

2. Surface Geological Deposits:

According to Tyrell (26) the Swan River Area consists largely of a preglacial valley cut through the Cretaceous plateau of the Duck and Porcupine Mountains. The exact age of the valley is uncertain but Tyrell considers it may be of Pliocene Age. He states (26) that, "During the glacial period the valley was ascended by a lobe of the great glacier of the Winnipeg basin, and after retirement of this glacier most of the lower portion of the valley was occupied by a wide bay of Lake Agassiz, and is now generally covered with lacustrine or alluvial sands and clays."

When the glacier withdrew it left a relatively thin deposit of glacial till on the valley plain. However, since glaciation, a great deal of the till has been buried under deltaic and shallow lacustrine deposits.

Presumably most of these deltaic and shallow lacustrine deposits were carried in from the west by a large flow of water down the Swan River channel. The deltaic and lacustrine nature of the deposits is due to the fact that the area where the deposits now occur was inundated by Lake Agassiz at the time of their deposition. Although most of these deltaic deposits were carried in from the west, some of them are products of erosion from the neighboring mountains.

The former inundation of this area by Lake Agassiz is evidenced by the occurrence of numerous old lake beaches. In some places these beaches are quite distinct although not continuous.

Since the recession of Lake Agassiz, the topography of the deltaic deposits has been changed by erosion. In the Upper Valley Plain the deltaic deposits have been eroded by many stream channels until now the area has the form of a much bisected plain. The surface geological deposits found in the mountain areas consist largely of glacial till and modified shale clay drift deposits.

In the Lowlands Landscape Area the surface geological deposits consist mainly of glacial till modified by wave action. Considerable tracts of peat cover the glacial till in this region. (See Map No. 2.)

3. Relief:

The general relief of the Swan River Area is shown by the Contour Map.(See Map No. 1.) The lowest elevation is in the northeast portion of the area where it is 900 feet A.S.L. The valley plain rises gradually toward the southwest and at the Manitoba-Saskatchewan border (Range 30, W 1) the elevation is between 1300 and 1400 feet A.S.L. This gradual rise is interrupted in some places by the occurrence of an escarpment. This escarpment is especially noticeable in Township 35, Range 27 and Township 35,

Range 28 and here serves as the dividing line between the Upper and Lower Valley Plains. The whole valley plain is about three miles wide at the Manitoba-Saskatchewan border (Range 30, W 1) and gradually broadens out to about twenty miles in width as the eastern limit of the Swan River Area is approached.

To the northwest the relatively smooth valley plain landscape grades into the steep slopes of Porcupine Mountain. The Porcupine Mountain rises up to over 2200 feet A.S.L. To the west, in Township 36 and 35, Range 29, the valley plain is interrupted by Thunder Hill. (See Figure No. 1.) To the southeast the valley plain grades into the relatively steep northern slopes of the Duck Mountain. To the northeast the land surface of the valley plain continues to flatten out and gives place to, or merges with, the Manitoba Lowlands.

4. Drainage:

The drainage generally is towards the northeast conforming with the general slope of the area. (See Map No. 2.) The Swan River and the Woody River constitute the two main drainage systems of the area. These two systems are separated by a height of land which is, in many places, a deposit of till extending from Thunder Hill northeastward across the area between the two rivers. The Swan River drains the larger part of the area as well as the run-off from the north slopes of Duck Mountain. The Woody River drains the northwest portion of the area and collects the run-off from the southern slopes of Porcupine Mountain. For the most part the drainage can be considered as good. However, as the lower elevations (1000 and 900 feet A.S.L.) are approached, surface drainage into the river channels is somewhat impeded and poor drainage conditions are common in the Lower Valley Plain.

5. Climate and Vegetation:

The meteorological data for the Swan River Area is very meagre and incomplete. Some data have been recorded at the town of Swan River which is

situated in a more or less central location in the valley. These data have been well summarized by W.A. Ehrlich (10) as follows: "The precipitation records for twenty-four years show a variation in summer rainfall (April - October) ranging from a low of 5.7 inches in 1926 to 20.5 inches in 1901. These variations indicate that the area is subject to periodic dry periods as well as periods in which excess moisture conditions prevail. Only five years data on winter precipitation are available and their range for the months of November to March was 2.7 to 5 inches. The information on total annual rainfall at Swan River is incomplete and too uncertain to be reliable."

"The temperature records at Swan River indicate an annual mean of 32.8°F and a seasonal mean temperature for the summer months of 51.1°F (i.e. 23 years average for April to October inclusive)."

Although these meteorological data are incomplete it is significant that it indicates a wide range in precipitation between wet and dry seasons. It can be readily understood that if there was a period of approximately five years or more when the rainfall was well above normal it would have a definite effect on the native vegetation. In these periods of above average rainfall the woods start to invade and grow on what was formerly a grassland area. Once the trees have established themselves they tend to create a more humid climate. The deep ravines in the area naturally have a moister climate than the upland and it is here that a mature type of woods, both coniferous and deciduous, are found. It is from these ravines that the woodland invasion has come when the climate on the upland became favourable. (See Figure No. 2 and Figure No. 3.) The mountain areas also may be a source of tree invasion.

B. Landscape Areas:

The Swan River Area as a whole forms a number of natural landscape areas which have been designated as follows:

1. Mountain Landscape Area;
2. Valley Landscape Area;
3. Lowlands Landscape Area.

1. Mountain Landscape Areas:

(a) Porcupine Mountain:

The Porcupine Mountain is the most northerly section of the Manitoba Escarpment in this province. The striking characteristic of this mountain is that the eastern and southeastern slopes are steep. To the east the slopes fall quickly to the Manitoba Lowlands and, to the southeast they drop quickly to the Swan River section of the Manitoba Lowlands. To the west there is little drop in elevation but rather the mountains level out and merge with the till area of Saskatchewan. Only a very small portion of the Porcupine Mountain occurs in the area under discussion. This portion is designated on Map No. 3 as 1 (a).

The surface geological deposits (see Map No. 2) in the portion of the mountain surveyed consist almost entirely of glacial till of limestone origin together with some gravelly outwash. The general topography is quite rough and hilly, and the area is well provided with fast running streams that flow along the bottom of deep ravines.

There are no meteorological data but the vegetation and soils indicate a more humid climate here than in the Valley Landscape Area. There is a heavy forest type of vegetation which, in the well-drained areas, is made up largely of white poplar, black poplar, and white spruce; while in the poorly-drained depressions, which are swampy, the dominant species are black spruce and tamarack with an underbrush of alder and willow. The well-drained soils occurring here are of the grey-wooded type commonly associated with forest vegetation and humid climatic conditions in Manitoba.

(b) Duck Mountain:

The Duck Mountain also forms a part of the Manitoba Escarpment. The northern and eastern slopes are quite steep and drop quickly to the Lowlands Region of Manitoba. The portion designated on Map No. 3 as area 1(b) lies partly on the mountain itself and partly in the northern mountain slopes. The lower line of division for this area is along a crest that constitutes the lower escarpment of the mountains. For the most part the topography is quite rough, characterized by hills with steep slopes and numerous deep ravines. In some parts, as in Townships 33 and 32, Range 29, the mountain area is relatively smooth and rolling. The surface geological deposits (see Map No. 2) consist largely of glacial till. The till here is largely of limestone origin intermixed with shale clay. In the areas where the topography is relatively smooth, the surface deposits consist generally of shale clay. The origin of this shale clay has not been definitely established but it is quite probable that the shale clay is derived from local Cretaceous shale, the surface contact of which roughly coincides with the occurrence of the shale clay deposits delineated on the map. These shale clay deposits have been modified by glaciation and by subsequent erosion.

The climate of this landscape area, as reflected by a well-established forest of both coniferous and deciduous trees and by the grey-wooded soils, is quite similar to that of the Porcupine Mountain referred to above.

(c) Thunder Hill:

Thunder Hill is an outlier of the Porcupine Mountain which it closely resembles with respect to vegetative cover and soils. It is a striking topographic feature of the western end of the Upper Valley Plain of the Swan River Area. It rises abruptly from the Upper Valley Plain to a height of over 1800 feet A.S.L. (See Figure No. 1.)