

as to physique, general intelligence, and mental ability. They seem to appreciate the nobility of agriculture, and manifest a determination to raise their profession to an equality with any and every other, which is highly commendable. Spite of all opposition, the College is growing into public favour and, as it demonstrates its value and usefulness by turning out high-class farmers, will continue to become more and more popular, until one such institution, however expanded, will be found insufficient for the wants of the Province of Ontario. I shall not live to see the day, but it will come, when every county in this Province will have such an institution, and be justly proud of it.

There were "walks and talks" not only within the college walls, but in the barn-yards, cattle-stables, sheep-sheds, and other appurtenances of the College. At the close of this already long paper, these must be dismissed in brief. The stock looks well. The recent importations form a very valuable addition to this department, especially the Hereford and Devon bulls. The Devon is the most completely typical representative of the breed I have ever seen anywhere, and I predict a career of distinction for him. The feeding cattle repaid study and close observation, in connection with the experiments now in progress. A large number of early lambs were to be seen, for the most part doing uncommonly well, and showing that, even in our rigorous climate, and during an unusually severe winter, lambs can be had without any more than the average spring casualties. An inspection of the siloes was not calculated to inspire one with much admiration of ensilage. The ensilage was perfectly preserved, and looked as green and fresh as when put into the siloes, but the stench was horrible, and suggestive not only of "saur kraut," with which it has often been compared, but of "Limburger cheese" as an accompaniment. I should much prefer well-cured clover, and so, I think, would all sensible cattle and sheep.

W. F. C.

THE ORIGIN, FORMATION, AND CLASSIFICATION OF SOILS.—WITH SPECIAL REFERENCE TO ONTARIO.

BY PROF. J. HOGES PANTON, M.A.

Soil may be defined as the loose material covering rocks from which it has been principally derived, and the source from which plants obtain a large proportion of their food. Some have defined it as the earthy matter in which plants grow.

It is a sort of storehouse for plant supplies, and a laboratory in which some of the most interesting chemical changes take place in the preparation of compounds suitable for plant-food.

Soil is largely made by the disintegration of rocks immediately below it, in it, and also to some extent of those at a distance.

These, together with substances derived from the decomposition of animal and vegetable remains, which have existed from time to time upon it, constitute the soil of our fields.

The examination of soil, especially in Ontario, generally shows:

1. Numerous stones bearing a marked resemblance to rocks lying in a northerly direction from the place under examination. These may be of two kinds, (a) more or less hard and crystalline; (b) fossiliferous and generally limestone.

2. Stones of the same nature as the rock below, usually limestone, bearing fossils.

3. Ground-up material derived from rocks of which these boulders are fragments.

4. Organic matter, largely derived from the decomposition of plants.

Rock is reduced to the disintegrated condition by various agents, chiefly—

1. The atmosphere, by the action of its oxygen.

2. Frost.

3. Rain, acting chemically on carbonates, mechanically dissolving the soil, and carrying it in different directions.

4. Vegetable growth and decay.

5. Some have credited the formation of soil in several cases to earth worms bringing particles to the surface and admitting air and water into the soil. From what has been remarked, it will be seen that the composition of a soil depends upon the nature of the rocks below and those of regions at a distance.

In Ontario the principal series of rocks represented are:

1. Laurentian, forming a great belt from the lower side of the St. Lawrence north-west to the Arctic regions. Along the river it lies between Brockville and the vicinity of Kingston, extending through the back townships of Frontenac, Addington, Hastings, Peterborough, Victoria and Simcoe, and thence to the North-West. These are among the earliest known rocks, and seem to have undergone great changes since first formed. They are usually hard and crystalline, presenting a much disturbed condition, and frequently rich in minerals. The term metamorphic has been applied to them on account of the change from their original form. This likely resulted from the action of heat, moisture and pressure. The following table will give some idea of the principal constituents of these rocks, and their chemical composition:

Rocks.	Silica.	Alumina.	Potash.	Soda.	Lime.	Iron.	Magnesia.	Carbonic Acid.	Phosphoric Acid.
1. Gneiss.—									
Quartz,	100								
Felspar,	66	19	16	1.45	traces	27			
Mica,	47	36	10			4			
2. Limestone Cryst.					56				
3. Dolomite, "					32		22	46	
4. Iron,						100			
5. Hornblende,	1	11	6		13	traces	18		
6. Apatite,					55				42

2. Silurian, extending from Kingston to the western side of Ontario, in the vicinity of the county of Welland, to Lambton. These rocks are chiefly limestones, both carbonate and sulphate, dolomites and sandstones.

3. Devonian, in the counties around Lake Erie, and the County of Lambton, composed largely of limestone and argillaceous shales.

These rocks at a distance and beneath the soil of our fields contain the very ingredients necessary to plant life and were disintegrated by agencies about to be described, and thus formed into a finer state of division. The deposits which Ontario received after these, were not laid down till thousands of years afterwards.

A great blank occurs in the geological history of Ontario after the deposition of the Silurian and Devonian rocks. While other parts of the world were receiving large additions, nothing was being added to our rocks. But throughout long ages they were being more or less disintegrated by the effects of frost, rain, wind, and water, and some soil formed which afforded a starting place for rudimentary forms of plant life, capable of growing under such adverse conditions. But towards the close of what is known as the Cretaceous Age in geology, a great change took place in the climate, hitherto of a semitropical, if not a tropical nature.

In the beginning of the next age phenomena occurred which played an important part in the

formation of soil throughout this Province. At this time boulder clays, sands, graveles, and loose rock material were scattered over the surface. The climate became of a more Arctic character, immense glaciers, rivers of ice, having their origin in regions to the north of us, wended their way to localities farther south. These immense masses of ice as they passed over the rocks smoothed the rough surface and ground up much of the rock below them. As they moved on, fragments would be continually falling upon them from the sides of ravines through which they passed, and gradually become imbedded in the ice; and thus by their weight and motion, together with these imbedded stones, the abrading power of the glaciers would be immense.

The glacier may have been many miles wide and thousands of feet thick. Where it ended great heaps of ground rock, pebbles, and rounded fragments, formed in its course, must have collected, and as it receded back, by thawing away at its extremity, the materials deposited would be scattered over a more or less extensive district. A change in climate again occurred and the glacier or glaciers passed away and left a rich legacy to the tiller of the soil, viz., all the deposits which they had formed and collected during the one hundred and sixty thousand years of their existence. This, improved by the addition of organic matter derived from the plants which have grown upon it from time to time, is the soil now covered by verdant pasture lands and fields of waving golden grain.

The boulders scattered over the surface of Ontario are silent monuments of these great scenes.

In the early part of the melting, the water from the glacier would be less, and coarse materials would be deposited. At this stage the boulder clays were deposited, while coarser materials dropped farther back, e.g., clays to the south and west of Ontario known as the "Erie clays," while farther north are the boulder fields of Owen Sound. These stratified deposits were laid down, along valleys and flooded streams, and in and about lakes.

River and lake deposits are much alike, except that the latter are of a more clayey nature and usually levelled off on the top, e.g., western peninsula.

Clay beds were the prevailing kind about the lakes and in the river valleys, where the waters moved slowly.

It has been inferred from certain facts in connection with the deposits of Western Canada that the region of the present great lakes was an immense body of water extending to Ohio, Illinois, etc., and that it emptied into the Mississippi, and thus formed an outlet in the opposite direction to the outlet of our present lakes.

Remembering the course and origin of the glacier, the material which it carried would be chiefly those derived from the rocks to the north. Such is the case, for the boulders in our fields are foreign to the rock below and are of the same composition as the metamorphic rocks already referred to, and also in some cases resemble fossiliferous rocks in regions to the north.

Further, the rocks below the soil, when uncovered, generally present an abraded surface, with well-defined markings, (striæ), indicating some great grinding mass from the north, which scratched the surface as it glided southward. See shores of Lake Erie near Welland, also at Grimsby. Such results are now observed in regions where glaciers exist. See Alps.

Since these wonderful scenes took place, the deposits in many places have undergone marked changes; but, taken as a whole, these facts seem to bear out the view generally adopted regarding