T9.1 SOIL-FORMING FACTORS

To some, soil is debris that covers valuable deposits of ore, gravel, gypsum or coal. To others, it is a building material. Still others think of soil as any substance which supports plant growth. These are all valid concepts. Soils are natural, three-dimensional bodies consisting of mineral material, organic matter, water, air and living organisms. The characteristics of an individual soil are the result of soil-forming factors (parent material, climate, topography and organisms) interacting over time.

The development of soil depends upon the interaction between the following factors: parent materials, climate, topography, living organisms and time.[1,2]

The distinctive red colour of the soils in the Triassic and Carboniferous lowlands in Regions 500 and 600 is inherited from the local parent material.

PARENT MATERIAL

Parent material is the geological material from which a soil is derived. It determines the mineral content and, to a large extent, the particle size of a soil. It influences soil fertility, internal drainage, colour, and the rate at which weathering takes place.

Glacial Till

Most of the soil parent material in Nova Scotia is coarse- to medium-textured glacial till closely related to the underlying bedrock. Where the bedrock is hard and crystalline, the soils tend to be coarse and stony, while soils derived from shaly tills are somewhat finer. Till depth is most commonly one to two metres and rarely exceeds seven metres. However, tills which make up the drumlins between Lunenburg and Canso are thicker and originate further away, perhaps the Bay of Fundy or northern New Brunswick.

Glaciolacustrine and Glaciofluvial Deposits

Glaciolacustrine (lake) and glaciofluvial (outwash, ice contact) deposits occur in association with the till. The lakebed material is somewhat fine in texture and often occurs in depressions, resulting in restricted drainage. Outwash deposits of gravel and coarse sand tend to be rapidly drained.

Marine Deposits

Marine deposits have given rise to nutrient-rich, usually fine-textured soils in estuarine environments. Recent alluvium, material deposited on the floodplains of modern rivers, is also nutrient rich and stone free but is subject to periodic flooding. Organic deposits are found mainly in poorly drained depressions.

CLIMATE

Climate determines the temperature-moisture regime of an area. This influences the rate of weathering and the amount of leaching that occurs in soils. Climate also influences vegetation, which in turn influences the kind and amount of organic material that accumulates. Nova Scotia's modified-continental climate results in a cool, moist soil environment conducive to the soil-forming process known as podzolization. Organic matter accumulates on the surface and organic acids leach downward, carrying iron and aluminum to a depth of 20–50 cm. This leaves the upper part of the soil very acid and devoid of plant nutrients (see Table 9.3).

TOPOGRAPHY

Topography affects temperature, rainfall and drainage. On a local scale, level areas collect water, and soils formed on them may be heavily leached, sporadically waterlogged or both. Slopes shed water, which may hinder chemical weathering and slow soil development. The runoff may erode surface layers.

Topography can also be described on a broader scale. For example, the configuration of the Cobequid Hills (Unit 311) results in higher rainfall and cooler temperatures than in adjacent areas. More organic matter accumulates under these conditions and more of it leaches downward.

ORGANISMS

Both plant and animal organisms are abundant in soil. They play an important role in soil chemistry (practically all soil reactions are biochemical) and by physically mixing soil layers. Plant roots bring up nutrients from deeper soil layers, eventually depositing them on the surface through litter fall. The extent of leaching is partly governed by the type of litter. Leaching is greatest under coniferous and moss litter, less under deciduous and least under grass. Most of Nova Scotia's soils have developed under coniferous or mixed-wood forests, which contributes to acid soils, low in nutrient status.

Under ideal conditions, the earthworm population can be as high as two million per hectare, with a live weight of just over one tonne. This population can process thirty tonnes of soil per hectare annually.

Organic matter incorporated in the mineral soil helps to develop soil structure, affecting soil aeration, root penetration, moisture storage and drainage. Organic matter also affects the activity of microorganisms, which in turn play a vital role in breaking down organic matter and mobilizing plant nutrients. Soil organic matter contains a significant proportion of the world carbon supply, an important consideration in balancing the amount of carbon dioxide in the environment.

Most of the parent materials in Nova Scotia are slightly to strongly acid. Newly cleared land in Nova Scotia requires 15–30 tonnes of lime per hectare to raise the topsoil pH to near neutral. The initial treatment is carried out in several stages — all the lime is not added at once. About 500 kg of lime per hectare is required annually to maintain the pH.

Human activity has had a strong influence on soil characteristics. Some examples are the clearing of forests, stone removal, drainage, tillage, dyking and the addition of lime, manure and fertilizer.

TIME

The maturity of a soil is usually reflected in the development of distinct layers or horizons (see Figure T9.2.1). Nova Scotia's soils have developed since the glaciers melted 10,000 years ago, a relatively short span of geological time. However, most of the soils can be considered mature, because soil-forming processes have been highly active. Reasons for this include the effects of glaciation breaking down the bedrock to unconsolidated material, the humid conditions and the warm post-glacial period. Soils formed on more recent marine and alluvial deposits are "younger," and exhibit little or no profile development.

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Associated Topics

T2.1–T2.6 Geology, T3.1–T3.4 Landscape Development, T4.1 Post-glacial Climatic Change, T5 Climate, T9.3 Biological Environment, T10.1–T10.12 Plants, T11.16 Land and Freshwater Invertebrates, T12.9 Soil and Resources

Associated Habitats

H2.5 Tidal Marsh, H2.6 Dune System, H3.3 Bottom Lotic (Rivers and Streams), H3.4 Bottom Lentic (Lakes and Ponds), H3.5 Water's Edge Lotic (Rivers and Streams), H3.6 Water's Edge Lentic (Lakes and Ponds). H4 Freshwater Wetlands, H5 Terrestrial Unforested, H6 Forests

References

1 Buckman, H.O, and N.C. Brady (1969) *The Nature and Properties of Soils*, 7th ed. Macmillan, London.
2 Jenny, H. (1941) *Factors of Soil Formation*. McGraw-Hill, New York.