Soil development: using annotated profiles

John Payne recommends a systems approach at A-level

The study of soils has been a much neglected topic in most A-level physical geography courses. When courses and examinations allowed a greater degree of choice than is usually the case today, the study of soils was generally the least popular topic. The growth of courses which have a core syllabus, and the usual inclusion of sections on ecosystems in that core syllabus, has increased the number of teachers who have had to reassess their knowledge and understanding of the topic.

The most difficult aspect of the subject appears to be the development of soils in relation to the processes taking place within the soils and the external factors which affect these processes. The starting place for any A-level study of soils must be the formula which sees the soil as a function of the soil forming factors:

S = f(C O R P T...)

Soil is a result of the complex interaction of:

Climate

Organisms and vegetation

Relief

Parent material

Time

Climate is the prime factor and broad belts of soil related to particular climate types are found around the world. These major, climate-dependent soils are called Zonal soils. Soils whose formation is dependent upon another special factor such as the parent material are called Intra-zonal soils, and those which have not had time to develop fully are Azonal soils.

In relating the soil profile to the factors and processes at work in the soil, the following diagrams take a systems approach to soil formation. A simple systems model of soil formation (see Figure 1) may be used after the soil forming factors equation as an introduction to the topic. Pupils can then be asked to relate the annotated profiles to the systems diagram by producing a fully annotated version of the systems diagram for each of the three named soils.

Annotated soil profiles stress the importance of climate in general and the rainfall regime in particular. Movements of water within the soil are determined by the rainfall regime and it is these movements of water which cause the processes of translocation of materials which are so important in producing the layers/horizons of the soil profile.

The soil profile as a model is an excellent basis for the study of soils. At its simplest the profile has three basic horizons or layers (see Figure 2).

1. The **A horizon** which is a combination of the mineral grains produced by processes lower in the soil and humus incorporated by the decay of organic matter produced by plants growing in the upper part of the soil.
2. The **B horizon** which is the main mineral matter and which may be influenced by the translocation of materials from the upper part of the soil.
3. The **C horizon** which is composed of the parent material and the weathered remains of the parent material rock supplying the soil with the mineral grains which make up the bulk of the soil.

In an attempt to make it easier for pupils to understand the inter-relationships between the factors affecting soils and the processes at work within them, I have developed a number of simple annotated soil profiles which have proved useful in my teaching of the topic. The aim of the diagrams is to relate processes and factors to each other and to the development of the soil profile in a way that combines compactness with a common format. The annotated soil profiles shown here are for three very commonly studied Zonal soils, the Podsol and the Chernozem of North America and our own Zonal soil, the Brown Earth (see Figure 3-5).

Figure 1. **The soil formation system.**

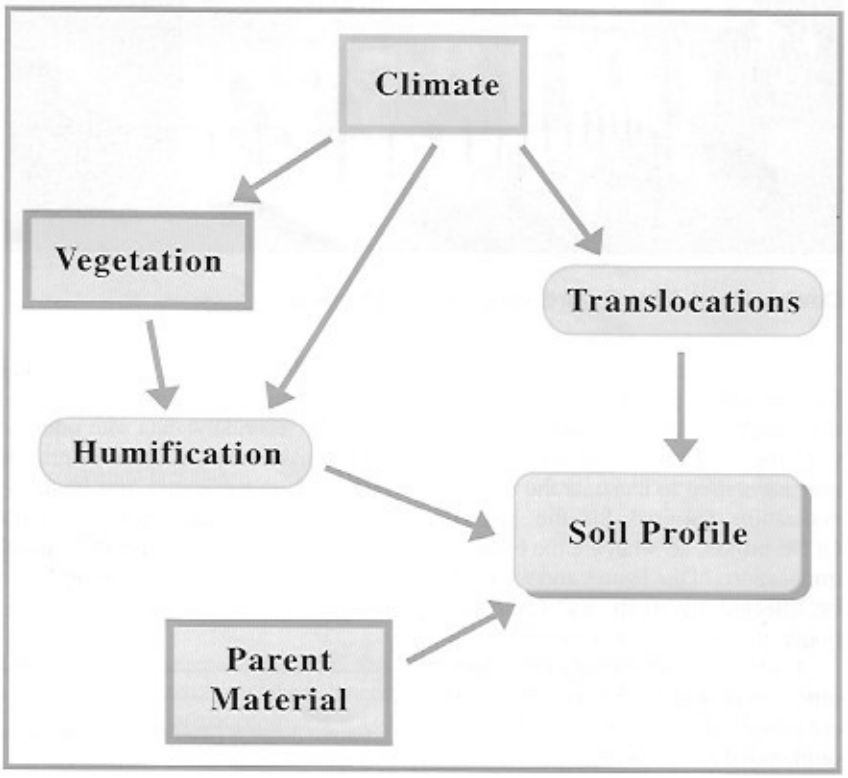


Figure 2. **The soil system.**

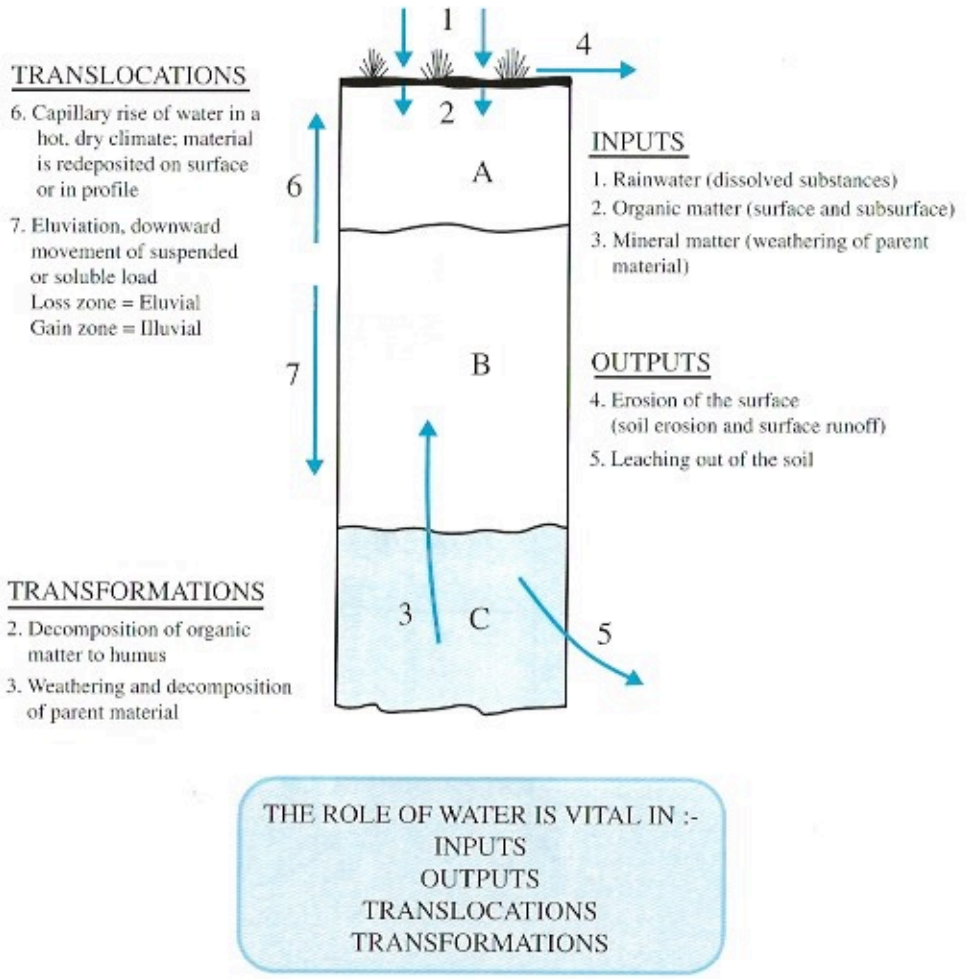


Figure 3. **Podsol.**

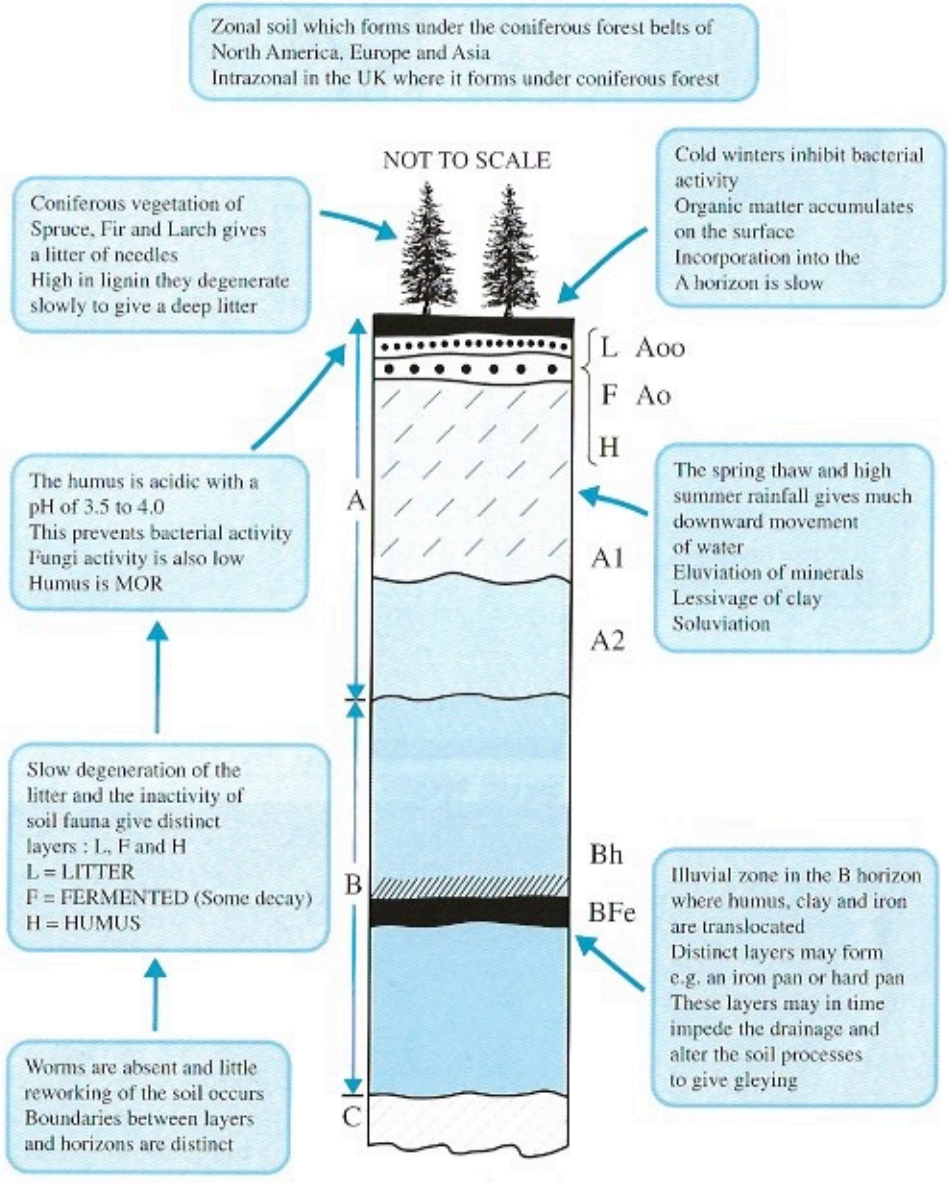


Figure 4. **Chernozem.**

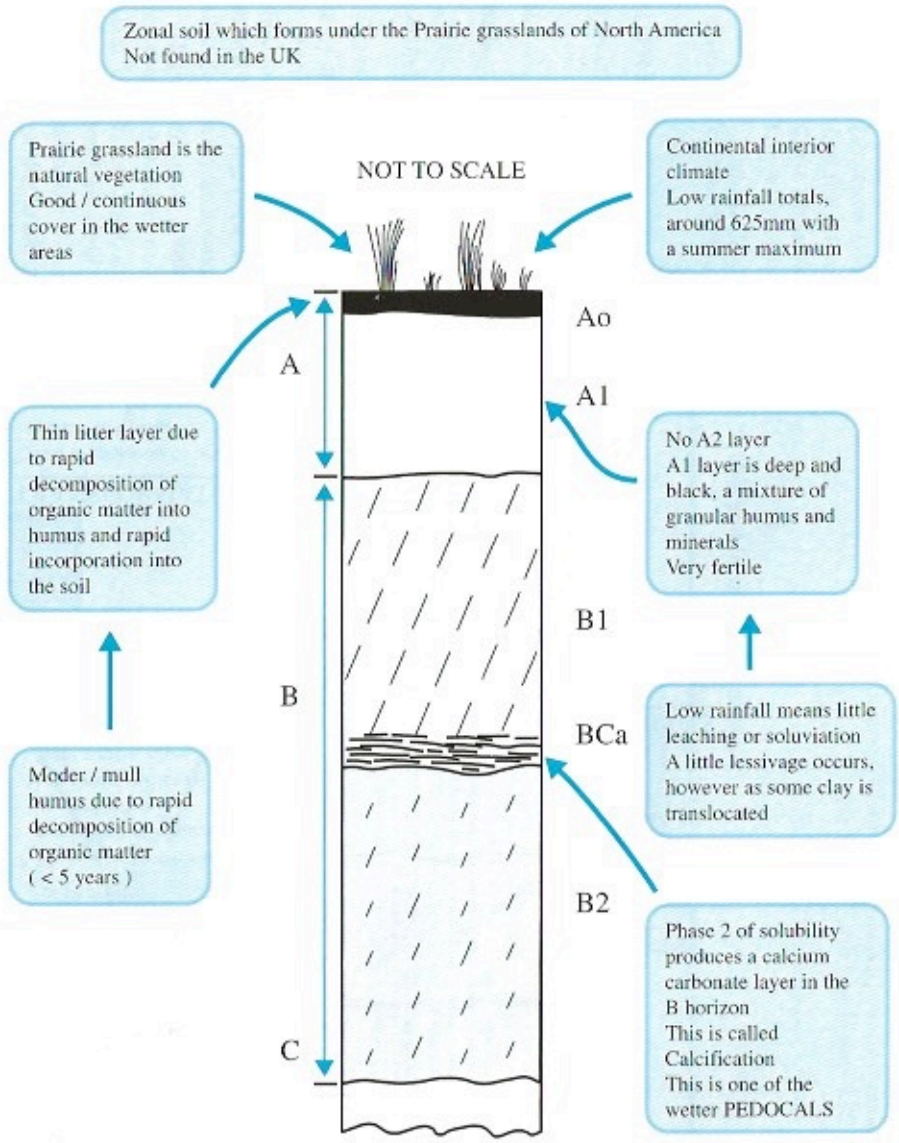
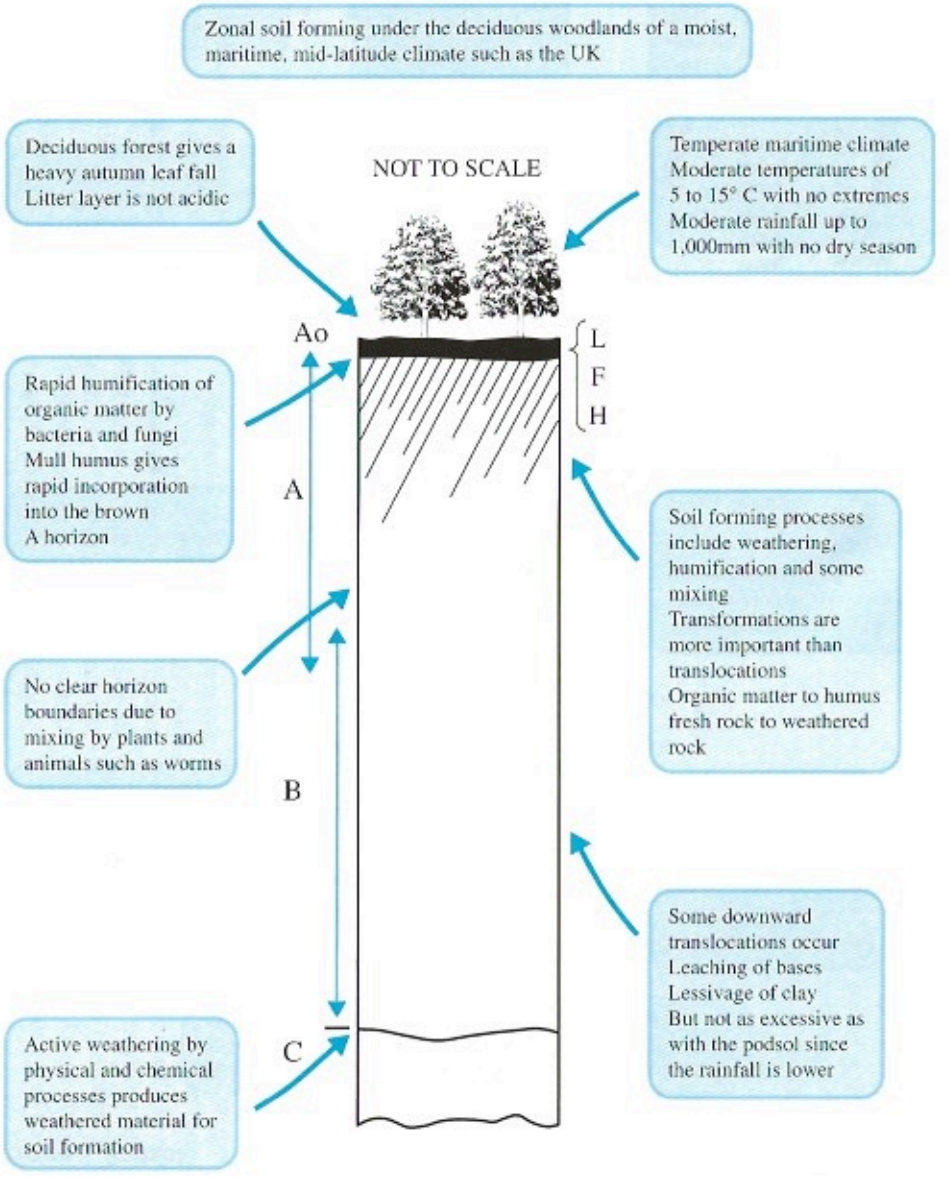


Figure 5. **Brown Earth.**



THE TERMINOLOGY OF SOIL FORMATION

Humification	The breakdown/decomposition of organic matter by bacteria and fungi and its incorporation into the A horizon.
Mull	Humus formed by rapid humification in a free-draining aerated soil. The process is rapid, 2-3 years, and the humus is well mixed.
Mor	Humus formed by slow decomposition in an acid soil. The process is slow, taking over ten years, and with little mixing distinct layers form. There may be a Litter layer (L), a Fermented or transitional layer (F) and a Humified layer (H).
Moder	An intermediate form of humus where decomposition has been quite rapid at around five years and with some degree of layering.
Transformation	Changes which take place within the soil such as the weathering of the parent material to produce the mineral matter.
Translocation	A movement or transfer of materials either upwards or downwards in the soil by the movement of water.
Leaching	A downward transfer of soluble materials through the soil and beyond to the water table.
Eluvial Zone	Part of the A horizon from which materials have been lost by the downward transfer. The process of eluviation.
Illuvial Zone	Part of the B horizon which has gained the materials transferred from the upper layers of the soil.
Lessivage	The mechanical movement of suspended clay downwards in the soil in a humid free-draining environment.
Soluviation	The downward transfer of soluble salts in a humid free- draining environment. Typically, the transfer of iron and aluminium gives a pedalfer soil.
Calcification	A process occuring in semi-arid areas with a marked dry season. Upward movements of water may deposit calcium carbonate as a crust or as nodules in the upper soil to give a pedocal soil.
Gleying	In the anaerobic conditions of a waterlogged soil the process of reduction produces a gley soil.

The annotated diagrams attempt to review the factors, particularly climate and vegetation, and show:

- how these factors influence the soil forming processes that are important in the three soils;
- how the processes influence the development of specific horizons in the soil profile.

On each diagram the arrows show the horizon in the soil which is directly influenced by the factor or process concerned. In some areas I have also attempted to show the inter-relationships between factors and processes, as in the Podsol where the acidity and high lignin content of the organic matter cause slow humification and the production of distinct L, F and H horizons in the upper part of the soil. Brief details explaining the processes mentioned and terminology used in the annotated profiles are included in the table for teachers who are relatively new to this topic. ■

John Payne teaches geography at Lindsey School, Cleethorpes.

A Podsol from Lyndhurst New Forest

Photo: Stephen Nortcliffe BSSG