PRIMARY EARTH SCIENCE TEACHING

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SOILS

Alternative Views

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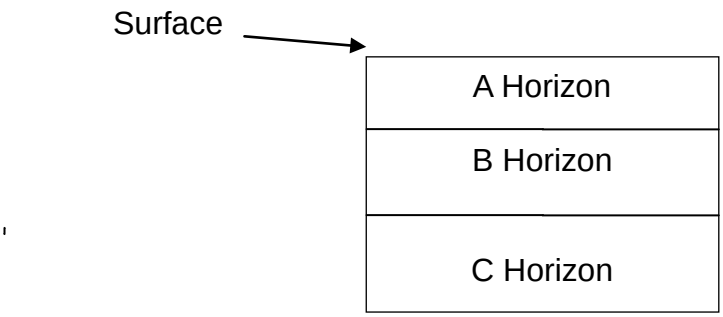
Introduction

This is the fourth issue within our anniversary year that is revisiting and updating early issues. As this is being written the draft documents for primary Science and Geography have been published and there is little specific reference to work with soils. However, soils are inextricably linked to work on many areas such as rocks, rivers, coasts, plant growth, and settlements – to name but a few. Plant growth, farming and food production have been important for thousands of years and work on this can be linked to science - requirements for growth and history - where settlements grew up related to fertile productive land. This issue will explain some of the basics relating to soils followed by ideas that could be used within the new Curriculum in a creative and cross curricular way.

What is Soil?

Soil covers much of the land surface of the world and falls into three main groups, within which there is infinite variety; sands, loams and clays. These groups are broadly based on the size of the grains that comprise the soil. But that is not all that differentiates the soils as there are five main components - rock fragments + organic materials + living organisms + water + air, and these can be found in many different ratios and compositions. A typical soil is also layered into horizons, although not all horizons are present in all soils, and layers may be indistinct. Depths of the horizons also differ greatly.



The Five Components.

When soils are formed they originate from a parent rock by weathering, which may be by the action of water, ice, changes in temperature or chemical reaction. Rock fragments are broken off the parent rock and break down further into particles to form the soil. Some minerals in the rock are released and dissolve over time to form mineral nutrients in the soil. The variations in the proportion of the different minerals in the parent rock are one of the contributors to the characteristics of the soil that forms. Actual fragments of the original rock are found mostly in the C horizon, but also to some extent in the B horizon.

Organic matter is composed of dead and decaying plant material, (such as leaves and grass), dead animals and animal waste products. The amount and type of this will depend on the vegetation growing in the soil, together with the amount and rate of decomposition. This is called humus, and is found mostly in the top layer of the soil or the A horizon. The breakdown of this matter provides nutrients to the soil.

Living organisms such as bacteria plus mini beasts such as worms, centipedes, millipedes and woodlice. These mini beasts will change depending on the type of soil, with wetter locations having more plants and fewer animals. Presence or absence of specific mini beasts can also demonstrate the health of the soil. These are found mostly in the A horizon with some in the B horizon.

Water is found in the spaces between the soil particles and contains the dissolved minerals mentioned above. The amount of water present can differ a great deal and can be related to the level of the water table. Water is an important component of the soil forming process which tends to cause layering to develop in the soil profile from the ground level downwards, forming the three layers called horizons on previous page. Movement of the water up and down through the soil, due to capillary action, is linked to the type of soil and thus the original rock type. This can affect the amount and type of minerals retained (or not) within the soil.

Water passes through soils at different rates, those with larger spaces between particles (e.g. sandy ones) permit easy passage of water whereas soils with small spaces between finer particles (e.g. clay ones) slow the flow. Thus clay soils tend to become waterlogged whereas sandy ones dry out very quickly. Where water only flows downwards minerals and nutrients can be more easily leached from the soils. Where the water tends to flow both downwards and upwards more are retained in the soil, particularly in the upper layers. The flow of water can also make the layers difficult to define.

The spaces between the soil particles not filled with water are filled with air. Again this is related to the level of the water table and thus there is often more air within the higher level horizons where they are above the water table.

Good examples of soil profiles can be found in stream banks, hillsides or other eroded locations. They can also be seen at some places on coastal cliffs.

Working with the Soil.
Now you know what is in the soil, try to obtain several different samples and then follow the ideas below to find out what types you have and test this by growing things.

How do you know what type of soils you have?
As mentioned on previous page, soil falls into three main groups: sands, loams and clays. Between these you can find combinations of the basic types in a variety of mixtures.

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sand sandy loam loamy sand **loam** loamy clay clayey loam **clay**

To discover what type of soils you have take a small handful of damp soil, and press it together to form a ball. If it readily forms the ball without breaking up it is a clay; if it tends to break up a little it is a loam; if it does not stick together it is a sand.

A way to visualise the ratios of the amounts of different sized particles is to use water settling. Take a sample of your soil, place in a clear plastic container with a stopper, add water until about ¾ full, place the top on the container and shake well. Allow the container to stand and the particles to settle - this may take some time. They will form distinct layers with the coarsest at the bottom the finest at the top. By measuring the thickness of the layers a ratio can be calculated.

What plants will grow?
Once you have some idea of what basic soil type you have, you are one step towards knowing what will grow best in it. This knowledge can be refined by trying some of the activities below.

Water Content.
Some plants tolerate a higher water level than others, so knowing the water content of a soil can help decide what to grow.

Activity. Two different ways you could test this are:-
1. Weigh a freshly collected sample of soil, record the weight then dry out the sample and reweigh, record the weight. The difference in weight is equivalent to the water lost, test a different sample and compare.
2. Add measured amounts of water to equal sizes of dry soil samples, to see which absorbs the most. Space additions out so that pupils can see what happens to the water.

Drainage.
Another property of soil related to water is how well it drains. Some plants need well drained soil others are more tolerant. As mentioned above clay soils tend to retain more water than sandy soils. To test the flow of water and thus which type of soil you have to use two different samples of soil and obtain a comparison.

Activity.
Cut the top off two lemonade bottles and invert the tops to form a funnels. Place a paper towel or coffee filter in the funnel and using equal amounts of the two soils place one soil in one funnel and the other in the second funnel. Pour equal amounts of water, carefully, into the two funnels and observe how much passes through the soil and collects underneath in a given time. This will show you which of your two soils drains better.

Acidity/Alkalinity (pH)
The pH (acidity) of a soil also affects plant growth, this can be tested using litmus paper or a garden testing kit. Some plants prefer acidic soils others grow best in alkaline soils. This is also true of some crops and vegetables.

Making Your Own Varieties of Soil.
If you do not have several soils available then you can use your basic soil and combine it with e.g. sand, clay, or compost, using a variety of computations and ratios. There are many variations you could produce using your own soil plus combinations of the three basics above (16 computations) and your choice will depend on your aims. You could try:-

A. 1/4 of each soil	1 version
B. 1/3 of each of three of the components omitting 1 in turn	4 versions
C. 1/2 of each of two of the components omitting 2 in turn	6 versions
D. using only one component in turn	4 versions

Testing Your theory

Having worked out what type of soil samples you think you have you can then test your theory by growing plants in them to see which type of soil produces the healthiest plants.
Growing seeds or plants in the classroom can aid understanding of what different plants need to grow. This can be done in a simple way for KS1 using activity A below or can be developed into a more detailed study for KS2 as in activity B below.

Activity A.
Use 2 different soils for this, such as a sandy one and a compost based one to show very obvious results. You will also need plant pots (say 12), dishes or saucers to place the pots on (12) labels, and seeds (cress works well and grows quickly).
Fill 6 pots with mixture 1 and 6 pots with mixture 2. Sow seeds; label.
Place in a sunny spot in the classroom and water with the same amount of water each day (or when needed).
Record (photos are useful here) and see which grows best.
Can the pupils suggest why? If a sandy one is used it will probably drain too well and not enough moisture be retained.

Activity B.
This can be varied depending on the circumstances and aims. You may have two or three types of soil that you wish them to test or you may decide to make your own (as on previous page). With older children you could ask them to decide which possible mixes they should use to produce the best plants, and groups may chose different ones. You could use seeds (broad beans work well) or small seedlings (for more immediate results). Whichever you chose this needs to be a fair test, with pots kept in the same place and watered as above. Again record the growth or otherwise - a chart is a good idea for this together with photographs which can be added to it. Discussions on the results can be linked to the information above in relation to the components of the soil.

Alternatives and Extensions.

- After an initial investigation the pupils may wish to take it further and vary the components of their soil in order to produce better plants.
- The above could be likened to a scenario where a farmer wishes to know what sort of soil his crop will grow best in,
- Should you wish to give them your own selection of mixtures, this could be linked to a project to decide where a farmer should sow the specific crop you are testing as he has a choice of fields with these various types of soil.

More ideas for activities with soils can be found in “Working with Soils” a work pack produced by the ESTA Primary team, below.

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