

Soil structure

Types of soil

There are three main types of inorganic (mineral) particles: sand, silt and clay. Different types of soil are mixtures of these particles in different proportions. For example, loamy soil is roughly 40% sand, 40% silt and 20% clay. Some soils are said to be chalky because they contain higher proportions of limestone and chalk. This makes them alkaline.

Elements present in Earth's crust

Inorganic particles in soil are formed by the breaking down of minerals by various chemical, physical and biological processes. The minerals make up Earth's crust.

About ninety elements are found in Earth's crust, usually as compounds. The most abundant elements are:

Element	Symbol	Abundance (ppm)
Oxygen	O	460 000
Silicon	Si	270 000
Aluminium	Al	82 000
Iron	Fe	63 000
Calcium	Ca	50 000
Sodium	Na	23 000
Magnesium	Mg	29 000
Potassium	K	15 000

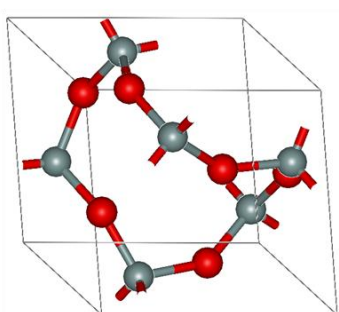


Figure 1 Silicon dioxide is made from atoms of the two most abundant elements in Earth's crust. Grey spheres represent silicon, red spheres represent oxygen.

All other elements are present at less than 10 000 ppm. Nonetheless the presence of many is essential for healthy plant growth and, therefore, their availability to plants is of huge importance. Scientists need to understand the mechanisms by which nutrients get from soil particles, through the soil water and into plant roots.

More about clays

Clays are hydrous aluminium silicates, often with small amounts of impurities such as potassium, sodium, calcium, magnesium, or iron. They consist of interconnected silicate sheets with a second sheet-like grouping of metallic atoms, oxygen, and hydroxyl, forming a two-layer mineral such as kaolinite.

The main groups of clay minerals are:

- kaolinite: layers held together by fairly weak bonds;
- illite: layers held together by strong bonding due to the presence of positively charged potassium ions;
- montmorillonite: layers held together by strong bonding due to the presence of positively charged calcium and sodium ions.

Organic compounds in soil

Organic material starts as carbon dioxide and water, both of which are inorganic compounds.

Autotrophs are organisms that synthesise organic compounds from inorganic compounds. In food chains they are known as producers. The food chain is:

Producers → **Consumers** (primary → secondary → tertiary etc) → **Organic material**

There are two types of autotrophs. Photoautotrophs are plants, algae and some bacteria that photosynthesise. Chemoautotrophs are certain bacteria and archaea (also called extremophiles) that use the energy transferred from the *in situ* oxidation of some inorganic compounds.

The organic material consists of organic compounds. These have large molecules with complex structures and many functional groups, the most common being carboxylic acids and phenols (also acids, but very weak ones). Others include aldehydes, ketones, alcohols, phenols, amines and others.

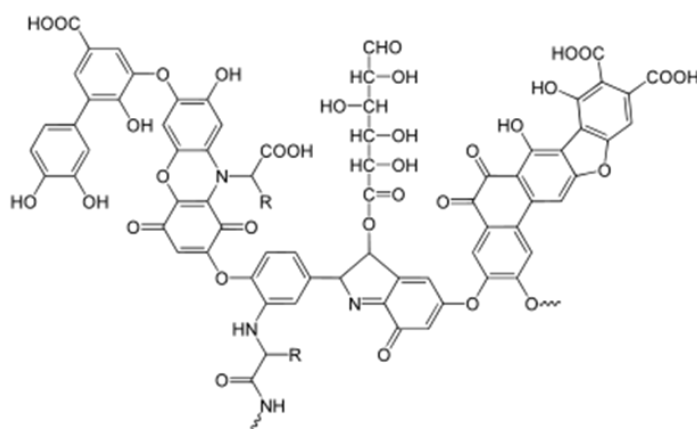


Figure 2 The organic material in soil consists of complex molecules with many various functional groups.

Although organic material does not provide micronutrients, it does affect the mechanisms by which nutrients get from soil particles, through the soil water and into plant roots.

Finding out

Soils are described in many ways, such as silty loam, sandy loam and sandy clay. Find out how measurements of the percentages of sand, silt and clay in a soil can be used to work out what type of soil there is in a field or garden. The 'soil triangle' on the right is a clue.

Find out more about the structures of clays and how this affects their properties.

