The Nature of Soil

FACT SHEET 1

The nature of soil refers to those factors that contribute to the characteristics of a soil in situ, it's components, capacity to support life, store water and provide nutrients. This factsheet introduces the key elements relating to the nature of soil, key soil properties and the importance of soil health.

Soil formation

Soil is formed as a result of the breakdown and weathering of rock. There are 5 primary factors that influence soil formation;

Parent material relates to the type of rock formed as lava cools and minerals are brought to the surface. It directly influences the amount of sand, silt and clay in the soil. The dominant types of rock are volcanic (basalt and granite), sedimentary and metamorphic.

Living organisms including plants, lichen, mosses, insects and bacteria, all produce organic acids which accelerate the weathering of rock by enhancing the solublisation of minerals.

Climate - rainfall and temperature influences the rate of mineral breakdown. High rainfall and erosive rain events over thousands of years has leached nutrients from Northern Rivers soils.

Time - the longer soil is exposed to weathering (rain and wind) and living organisms the more its mineral composition changes.

Topography - the position in the landscape, influences soil. Soil at the top of hills tends to be more shallow than soil downslope and in valleys. Minerals and clay move down slope and soil on lower slopes generally have higher clay content and fertility.

The origins and age of northern rivers soils combined with the high rainfall, high temperature environment are responsible for the characteristics of the dominant soils of the region.

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Northern Rivers soil

The dominant feature of Northern Rivers geology influencing the soils of the region is the Wollumbin/Mount Warning caldera. The largest caldera in the southern hemisphere, its most recent eruption was over 23 million years ago.

Basalts are the heavy clays formed from surface lava flow. The dominant clays in Northern Rivers soils are montmorillonite, illite and kaolinite. Montmorillonite is found in the chocolate soils on the north coast, illite is found in the podzolic soils and kaolinite is the dominant clay in the well weathered soils such as the kraznozems.

Alluvial soils formed by downslope movement of soil from surrounding hills are found in major coastal valleys. The origin of the soil determines the nature of the alluvial soil.

Sand originating from the continental shelf has accumulated in coastal barrier systems also occur along the North Coast region. On coastal dunes deep siliceous sands as well as well developed podzol soils may be found.

Properties of soil

All soils consist of a combination of mineral particles, organic matter, water and air. How these elements are combined determine the properties of a soil – its texture, structure, porosity, chemistry and colour. Texture and structure are considered physical properties but also strongly influence the chemical properties of a soil.

Soil texture refers to the proportion of sand, silt and clay in the soil. Sand particles are largest, from 2-0.05mm, silt ranges from 0.05-0.002mm and clay is <0.002mm. When rubbed through your fingers sandy soils feel gritty, silt feels silky smooth and clays tend to be sticky. Soil is described by the proportion of the different particles present (Fig 1).

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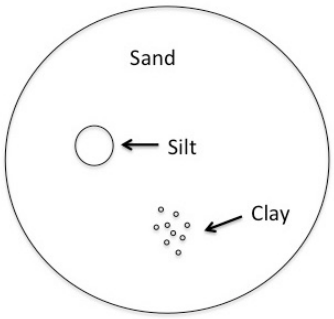

Figure 1: Relative sizes of soil particles.

Soil structure describes the way the sand, silt and clay particles are arranged. Structure is also influenced by the presence of organic matter and soil macro and micro biota.

Soil breaks up into units called aggregates, also known as peds, which contain organic matter and spaces known as soil pores. Pores may be large (macropores) or very small (micropores), the size and arrangement of aggregates result in the soil structure.

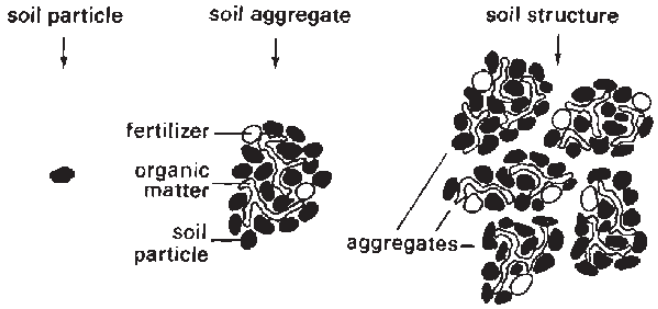

Figure 2: Relationship between soil particles, aggregates and soil structure.

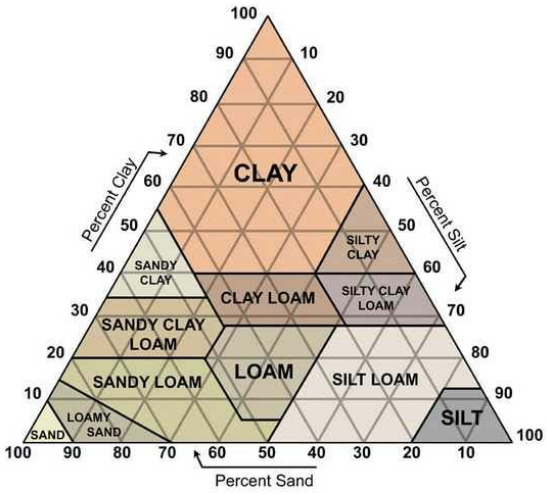

Figure 3: Soil texture triangle.

Aspects of soil structure and porosity are covered in more detail in Factsheet 9 of this series.

Clays, organic matter and material produced by soil biota bind soil particles into aggregates. In a well structured soil, large aggregates will break into smaller aggregates. Such a soil is described as friable, with good crumb structure.

Aggregate stability refers to the ability of aggregates to maintain their structure under stress. Unstable aggregates slake (fall apart) or disperse when placed in water.

Soil structure influences root development and nutrient availability, it effects the movement of air and water through and therefore is critical for plant growth. Management actions can result in loss of soil structure and alternatively management can have the effect of building soil structure.

Soil texture is a characteristic of the soil and cannot effectively be changed by management

Soil structure is strongly influenced by management

Examples of activities that effect soil structure.

Improve structure	Damage structure
Increase organic matter	Decrease organic matter
Perennial plants	Excessive tillage
Green manure crops	Heavy traffic when wet
Biological activity	Overgrazed plants

Soil porosity refers to the spaces between soil aggregates. The level and continuity of macropores determines the rate at which water can infiltrate the soil and will influence plant root growth.

In a well structured soil the porosity of the top 10-15cm will be 50%. That is, for a given volume of dry soil the mineral and organic matter component occupies half the space and the remainder is air. When wet, these air filled spaces can potentially hold water. Optimal porosity enhances soil water infiltration and the potential water holding capacity of that soil. It also increases potential root growth and biological activity in the soil.

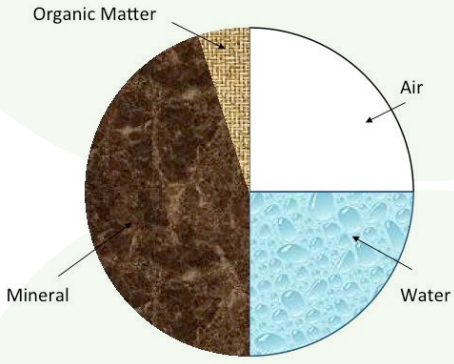

Figure 4: In a well structured soil pores contribute 50% of the total volume. Pores can potentially be occupied by air or water depending on soil moisture content.

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Figure 5: Well structured soil.

Soil structure, characterised by porosity, effects soil water infiltration rate, soil water holding capacity, biological activity, root growth and plant production.

Soil chemistry - The origins of a soil, it's parent material and other factors involved in its formation combine to determine the inherent chemical fertility of the soil. Soil texture, a product of these formative factors, also influences soil chemistry most particularly through the type of clay and percentage of clay in a soil.

The type and amount of clay present in a soil will influence the capacity of that soil to 'hold' nutrients and is often indicated by what is known as the cation exchange capacity (CEC) of the soil. Soil type may also influence the natural levels or availability of particular nutrients.

More detail on soil chemistry is provided in Factsheet 3 of this series and explanation of the soil cation exchange capacity is covered in Factsheet 4.

Soil texture and structure will also influence the tendancy of a soil to compact, reduce porosity and inhibit nutrient availability. Soils with higher clay content have a relatively higher potential for compaction which may limit nutrient availability.

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Holistic soil health

The origins and formative processes occurring over millenia have combined to produce our most critical and basic natural resource – the soil. As ubiquitous as it is in providing 'the skin' of the earth the variability in soil characteristics, often across relatively small distances, is vast. The one constant is the need for a holistic approach to soil health and effective function.

From a purely primary production perspective soil is the - basis of our food supply

- primary source of human and animal nutrition
- habitat for most of the worlds biodiversity
- primary carbon sink
- greatest source of terrestrial water storage

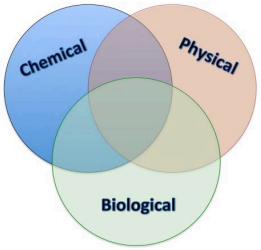

Figure 6: The three aspects of soil health.

For soil to function effectively and produce to its potential the three aspects of soil health need to be considered and actively managed for optimal outcomes.

Soil physical characteristics such as soil structure, water infiltration and water holding capacity will influence plant growth and root development which will influence biological activity and natural nutrient cycling. Increased plant growth improves soil carbon, soil structure and biological activity. The process is interdependent and cyclical and depending on management can either be either a positive or negative feedback system.

This is the first of a series of 12 Factsheets which cover a range of topics detailing the critical elements for soil health and a range of soil processes. They are designed to help you achieve effective soil function and increase productivity.

More Information

This factsheet has been prepared by Judi Earl
Agricultural Information & Monitoring Services
Email: judi@aimsag.com.au Phone: 0409 151 969

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