GLOSSARY OF SOIL TERMS

ACIDIC: Soils with a B2 horizon in which the major part is strongly acid. This term is used as a Subgroup distinction for a number of Soil Orders in the Australian Soil Classification system (Isbell 1996)

ACIDIFICATION: The process whereby soils become acidic over a period of time as a result of factors such as the nature of the parent material; addition of nitrogen to the soil by either fertiliser or legumes (where nitrogen is converted to nitrate), and/or the leaching of the soil by rainfall.

AEOLIAN: A geomorphic process whereby soil forming material is transported and deposited by wind.

AERIC: A term used to describe Podosols and Organosols in the Australian Soil Classification system (Isbell 1996). It refers to soils that are rapidly drained. The B horizons are weakly coherent and porous.

AEROBIC: Soils in which free oxygen is abundant and chemically oxidising processes prevail. This state usually occurs in well drained soils with good structure.

ANAEROBIC: These soils are deficient of free oxygen and reducing processes are predominant. This generally occurs in poorly drained or waterlogged soils, where water has replaced the air in the soil resulting in a bluey-grey coloured soil.

ANGULAR BLOCKY STRUCTURE: A cube-shaped ped bounded by six faces.

ANTHROPOSOLS: A Soil Order of the Australian Soil Classification (Isbell 1996). This order includes man-made soils e.g. mine spoil.

APEDAL: Soils in which peds are not apparent when the soil is moderately moist.

AQUIC: These soils have stagnant water on the soil surface and/or can be saturated in some part of the upper 0.5 m of the profile, more or less continuously for 2 to 3 months. In this condition, the soil is free of dissolved oxygen. Gley (bluey-grey) colours are often an indication of prolonged saturation. The definition is used as a Suborder distinction for Vertosols and Podosols in the Australian Soil Classification (Isbell 1996).

ARENIC: Soils in which at least the upper 0.5 m of the profile is non-gravelly and of sandy texture throughout. It is also loosely or weakly coherent (see Consistence), and may have aeolian (wind-blown) cross-bedding. This term is used in the Australian Soil Classification (Isbell 1996) to describe Rudosols and Tenosols.

ARGIC HORIZON: A subsoil horizon consisting of distinct lamellae (sharply defined, horizontal to sub-horizontal layers that have a higher clay content than adjacent sandy or sandy loam material). They are usually 5 to 10 mm thick. Consistence is stronger and the colour usually darker and more reddish or brownish than the surrounding soil. This term is used as a definition for Calcarosols, Kandosols and Tenosols in the Australian Soil Classification (Isbell 1996).

AUSTRALIAN SOIL CLASSIFICATION (Isbell 1996): A soil classification developed by Ray Isbell. The classification scheme operates using a hierarchical system and is based on Australian soils data that is significant with regard to land management. The general form of the nomenclature is: Subgroup, Great Group, Suborder, Order; Family (e.g. Bleached, Eutrophic, Red Chromosol; thick, sandy)

AVAILABLE WATER CAPACITY: see Plant Available Water Capacity.

BASE STATUS: Is a ratio relating the major nutrient cations (Ca, Mg, K and Na) to the clay percentage in the soil. It is used as a general indicator of soil fertility and is expressed in cmol (+) kg^{-1} clay. It is calculated by multiplying the sum of the reported basic cations by 100 and dividing by the clay percentage of the sample. Three classes are defined: **dystrophic** - if the sum is less than 5; **mesotrophic** - if the sum is between 5 and 15 inclusive; and **eutrophic** if it is greater than 15. It is used for some Great Group distinctions within the Australian Soil Classification (Isbell 1996).

BASIC: A term used to define a Great Soil Group for Organosols and a Subgroup for Rudosols and Tenosols in the Australian classification (Isbell 1996). For Organosols, it refers to soils in which the major part of the organic material is not calcareous but not strongly acid.

Bh HORIZON: A horizon in which the organic matter/aluminium compounds are strongly dominant (with no trace of iron compounds). This term is used as a definition for the Podosol Order in the Australian Soil Classification (Isbell 1996). In the classification system, Bh horizons are referred to as humic horizons.

Bhs HORIZON: Iron and organic compounds (often referred to as 'coffee rock') are prominent within the horizon and the organic compounds are distributed as streaks, patches or lumps. This term is used as a definition for the Podosol Order in the Australian Soil Classification (Isbell 1996). In this classification system, Bhs horizons are referred to as humosesquic horizons.

Bk HORIZON: A subsoil horizon notation whereby the 'B' refers to the B horizon, and 'k' to an accumulation of carbonates within the associated horizon.

BLEACHED HORIZON: Horizons that are paler than adjacent horizons and are best seen when the soil is dry. A bleach is generally associated with the A2 horizon, although it is not restricted to it. It generally occurs over a much less permeable subsoil, pan or hard rock. A conspicuously bleached horizon is one in which 80% or more of the horizon is bleached, whereas a sporadic bleach occurs irregularly throughout the horizon or as blotches at the interface of the A and B horizons (Northcote 1979). This horizon is the most leached part of a soil . Organic matter, clay, iron, aluminium and nutrient elements have been removed leaving an accumulation of silica, which gives the horizon its whitish colour. Field observations have established that bleached horizons are often saturated with water, and their occurrence is usually an indication of periodic waterlogging. This can indicate sodic subsoils where there is a strong texture contrast between A and B horizons.

BLOCKY STRUCTURE: see Angular Blocky.

BROWN CLAYS: see Grey, Brown and Red Clays.

Bs HORIZON: Iron compounds are strongly dominant or co-dominant, and there is little evidence of organic matter. This term is used as a definition for the Podosol Order in the Australian Soil Classification (Isbell 1996). In the classification system, Bs horizons are referred to as sesquic horizons.

BUFFERING CAPACITY: The soils ability to resist change in pH. Soils with a high clay and organic matter content have a higher buffering capacity and can tolerate the addition of acidifying fertilisers over an extended period, or at a higher rate of addition without becoming too acid. But, once it is acid, the soil will require a large amount of lime or dolomite to reverse the effect. The amount of lime or dolomite required varies from soil to soil depending on the pH (Baker and Eldershaw, 1993).

CALCAREOUS: Used as a descriptive term in the Australian Soil Classification (Isbell 1996). It describes a soil that has sufficient calcium carbonate to cause effervescence on the application of a few drops of hydrochloric acid.

CALCAROSOL: An Order of the Australian Soil Classification (Isbell 1996) including soils which are calcareous throughout the solum (or at least directly below the A1 horizon or at a depth of 0.2 m; whichever is shallower) and do not have clear or abrupt textural B horizons. The carbonate must have resulted from soil forming processes.

CALCRETE: Any layer of cemented carbonate accumulation layer. The material must be hard. This definition does not describe the common soft carbonate nor the carbonate accumulated in nodules or concretions. This term is used to describe a number of soils in the Australian Soil Classification (Isbell 1996).

CALCIC: These soils have a Bk horizon or a subsurface layer containing 2-20% soft carbonate and 0-20% hard calcrete fragments and/or carbonate nodules. This term is used to describe a number of Soil Orders in the Australian Soil Classification (Isbell 1996).

CATION EXCHANGE CAPACITY (CEC): A measure of the capacity of a soil to hold the major cations: calcium, magnesium, sodium and potassium (including hydrogen, aluminium and manganese in acid soils). It is a measure of the potential nutrient reserve in the soil and is therefore an indicator of inherent soil fertility. An imbalance in the ratio of cations can result in soil structural problems. High levels of individual cations (e.g. aluminium and manganese) can also be toxic to plants.

CEMENTED: Substances such as humus, calcium carbonate, and the oxides of silicon, iron and aluminium can bind soil particles together into a hardened (indurated) layer. This hardened state persists even when wet.

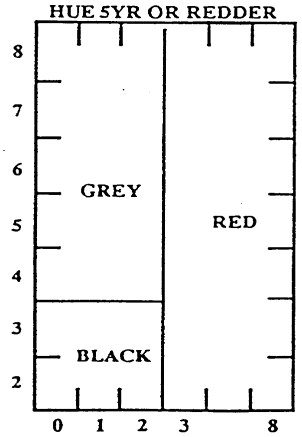
CHROMOSOL: An Order of the Australian Soil Classification (Isbell 1996) including soils with a clear or abrupt textural B2 horizon where the pH is 5.5 (water) or greater in the upper B2 horizon. The B2 horizon is often brightly coloured and can be mottled.

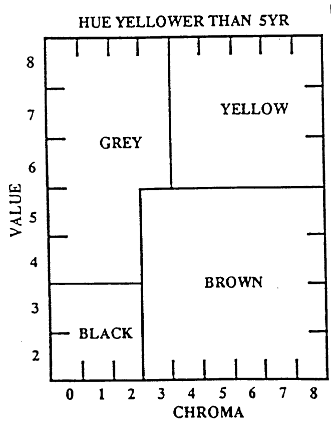
COFFEE ROCK: A compacted, cemented or indurated layer within the profile, which is comprised of humus and iron oxides.

COLLOIDS: Fine clay and organic matter material with a particle size of less than 0.002 mm in diameter. These particles tend to remain permanently in suspension unless flocculation (aggregation of particles that settle out) occurs.

COLOUR: Soil colour is assessed in a moist condition using a Munsell Colour Chart (Munsell Colour Company 1975) to assess the dominant colour. Secondary colours, bleaches and mottles are also recorded. Colour provides a useful indication of a number of profile attributes. Dark surface soils, for instance, indicate a high level of organic matter. In subsurface horizons (i.e. A2), bleached colours indicate low levels of plant nutrients and that seasonal or periodic waterlogging occurs. In subsoils, the colour sequence from red to brown and yellow to grey colours, indicate a sequence from well aerated and well drained soils to poorly aerated and poorly drained soils.

The table below is used to obtain colour classes used in the Australian Soil Classification (Isbell 1996).





COLUMNAR STRUCTURE: Soil particles are arranged around a vertical axis with flat faced peds. The tops of the columns have clearly defined domes. Columnar structure is often associated with subsoil sodicity.

COMPACTION: The process whereby soil density is increased as a result of tillage, stock trampling and/or vehicular trafficking. Compaction can lead to lower soil permeability, poorer soil aeration resulting in increased erosion hazard and poorer plant productivity. Deep ripping and conservation tillage can alleviate the condition.

Soil Compaction In Cracking Clay Soils (Vertosols)

Compaction layers (hardpans or plough pans) are layers of dense, hard soils with low porosity. They are typically found just below the soil surface in Vertosols, between depths of 5-40 cm (see figure below).

When clay soils are moist-wet, they tend to lose their strength and are then prone to compression and deformation if stresses are applied. These stresses would include regular cultivation and heavy trafficking of livestock or equipment. This leads to soil compaction and structural decline. When there is structural degradation, management options to be considered include reduction of trafficking of livestock and vehicles, or a change from a cropping to a pasture phase.

A well structured Vertosol has a large amount of fine to medium sized natural aggregates or peds. These aggregates tend to have shiny surfaces and numerous roots will be obvious throughout them.

Structural decline occurs when aggregates are excessively cultivated or compacted while in a moist condition. This causes the aggregates to be compressed into one another forming large, dense clods. When these clods dry, they are very hard and will fracture like rock when broken with an implement. The fracture faces will be 'flinty' in appearance and very few roots will be visible. As seen in Photo B below, a dense degraded layer is evident in the 10-30 cm zone of a Grey Vertosol. Note the presence of 'conchoidal' fracturing and loss of natural shiny ped faces.

The platy layers that develop just below the surface do not occur naturally in Vertosols (soils with a high clay content). Platy structure is typified by layers of flat, plate-like fragments which break along horizontal fracture planes (Photo A). This type of structure restricts water, air and root movement through the soil, resulting in lower potential yield, and hence profit. Evidence of compaction can be seen in the following photographs.

Ideally, tillage and trafficking should take place when the soil is drier than the plastic limit down to at least the tillage depth.

Compaction layers are evident in both soil profiles in roughly the 10-30cm zone

CONFIDENCE LEVELS (Isbell 1996): In the collection of soil data and information, often it is not possible to fully classify the soil primarily due to a lack of laboratory data. In such scenarios, it is forthright to indicate the level of confidence (level of chemical data) in the data collected to which a soil classification adequately describes the soil in question. There are four levels of confidence to be used in describing soil profile information (see table below).

Table 1 The four levels of classification used in describing soil profile information

Level of confidence	**Description of analytical data**
1	All necessary analytical data and/or morphological data are available.
2	Analytical data are incomplete but are sufficient to classify the soil with a reasonable degree of confidence. For example, free iron oxide data may be lacking but it is known that the soil is formed from basalt.
3	No analytical data are available but confidence is fair, based on knowledge of similar soils in similar environments, eg. presence of columnar structure is normally a reliable indicator of sodic soils.
4	No analytical data are available and the classifier has little knowledge or experience with this kind of soil, hence the classification is provisional.

Soil classification codes

The codes for Australian Soil Classification are defined in the following order:

Confidence level; Order; Suborder; Great group; Subgroup; Family criteria 1-5

However, the more commonly used code for soil profile definition is the reverse of those used for Australian Soil Classification.

Family criteria 1-5, Subgroup; Great group; Suborder; Order; Confidence level

For example:
Scenario 1

Ferric, ?, Red KANDOSOL (confidence level 4)

It would be assumed that no analytical data is available and the classifier has little experience with this soil.

Scenario 2

Bleached, Eutrophic, Red CHROMOSOL (confidence level 1)

It would be assumed that all the necessary chemical data were available and the classifier was familiar with the soil profile and morphology of the site.

CONSISTENCE: A measure of soil workability and stability (e.g. friable soils are easier to work than hard soils). Consistence is usually related to the texture and structure of a soil and is measured by the resistance of a ped to deformation between the thumb and forefinger - measured on a scale of 1 (small force required) to 7 (rigid force required). This resistance varies depending on the soil water content.

0	= *Loose*	no force required, separate particles such as loose sand,
1	= *Very weak*	very small force,
2	= *Weak*	small but significant force,
3	= *Firm*	moderate or firm force,
4	= *Very firm*	strong force but within the power of the thumb and forefinger,
5	= *Strong*	beyond power of thumb and forefinger but crushes underfoot on hard flat surface with small force,
6	= *Very strong*	crushes underfoot on hard flat surface with full body weight applied slowly,
7	= *Rigid*	cannot be crushed underfoot by full body weight applied slowly.

CRUMB STRUCTURE: Rounded peds less than 12 mm in diameter which are unstable and tend to crumble into smaller units. This type of structure is associated with surface horizons.

CRUSTY: Soils with a massive or weakly structured surface crusty horizon (3 cm or less thick) which is often lower in clay content than the underlying structured clay which is not self-mulching. This term is used as a Great Group definition for Vertosols in the Australian Soil Classification (Isbell 1996)

DERMOSOLS: An Order of the Australian Soil Classification (Isbell 1996) including soils which have B2 horizons with structure more developed than weak throughout the major part of the horizon, and which also lack a strong texture contrast between the A and B horizons.

DISPERSIBLE SOILS: Soils that are structurally unstable and disperse in water into basic particles i.e. sand, silt and clay. Dispersible soils tend to be highly erodible and present problems for earth works (see Sodicity).

DISPERSION: The process whereby clay particles break away from each other in water, forming a cloud around the aggregate. Dispersible soils generally have a high exchangeable sodium percentage.

Dispersion is an indicator of sodic soils (See Sodicity). It occurs when clay particles form a cloud around an aggregate placed in water. Dispersive soils have a high Exchangeable Sodium Percentage (ESP). This is the insoluble sodium attached to clay particles. Excessive sodium forces the clay particles apart (dispersion) when in water. The fine clay particles that have dispersed, clog up the small pores in the soil, degrading soil structure, and restricting root growth and water movement. The amount of sodium defines the sodicity level of the soil. Excessive exchangeable sodium causes the clay particles to disperse when in contact with water (CRC Technical Note 1 1994).

The effect of calcium salt (gypsum) in preventing the dispersion of a sodic soil in comparison with sodic soil in rain water.

Note: High levels of soluble salts can counteract the dispersion caused by sodicity.

Testing for dispersion

i) **Dry state**: This test can be simply carried out in the field by placing a small dry soil aggregate in distilled or rain water. If the soil is sodic (i.e. dispersive), a cloud of clay sized particles will usually form around the aggregate. A visual assessment of the amount of dispersion taking place is made at a 2 hour interval and a 24 hour interval.

ii) **Simulation of a cultivated state**: As well as dry soil aggregates being used, soil is remoulded (worked between thumb and forefinger in a moist state or at field capacity) and then placed in water to assess dispersion in the remoulded state. This remoulding procedure simulates the effect of cultivation on a moist soil. If the soil disperses more than the initial test, care should be taken when cultivating in a moist state. This situation could be made worse by rotary hoes, disc ploughs and disk cultivators.

Problems caused by dispersion

Dispersion in the field has the following consequences:

i) Dispersed clay particles will block soil pores resulting in water and air movement being restricted. If surface soil pores are blocked by dispersed clay, the soil becomes massive and when dry may form a surface crust or hardsetting layer. This will inhibit seedling emergence and water penetration. Increased surface cloudiness can also occur after cultivation.

ii) Cultivation of soils that are wet may lead to smearing and compaction at cultivation depth. Formation of a resultant cultivation pan could further reduce water and root movement into the subsoil. Soil aggregates may not disperse immediately after wetting but may do so if cultivated or trampled by stock in a wet condition. The dispersion test on remoulded soil will simulate this condition.

iii) Subsoil dispersion will result in reduced water movement down the profile. Waterlogging of the soil above the subsoil could result following heavy rainfall. The lack of oxygen in the root zone will affect the crop (Daniels *et al.*, 1994). During hot weather, there may be excessive evaporation due to the restriction of drainage through the profile. On sloping land, lateral water movement may occur above the relatively impermeable subsoil horizon.

iv) Subsoil dispersion also results in the structural breakdown of aggregates and increased soil density and hardness. Plant root movement will also be restricted by the dense subsoils which means that much of the moisture and nutrients stored in the subsoils are not used. Water and air movement will also be retarded.

v) Dispersive soils have very little strength when wet and are therefore more readily prone to gullying and tunnel erosion. Sodic clay subsoils are a major erosional problem if exposed or if the surface soil has been removed.

vi) Reduced osmotic uptake of nutrients by plants.

Management of dispersion

Initially, the aim is to increase the concentration of calcium salts in the soil. This reduces the clay swelling and prevents clay dispersion. The long term aim is to replace exchangeable sodium with calcium and use organic matter to bind the soil and improve its structure (Daniels *et al.*, 1994).

Gypsum and lime both add calcium to a soil. Calcium overcomes dispersion as it causes the inter-particle forces to more readily hold the particles together. The calcium causes particles to form clusters (flocculate), forming a very clear puddle of water. This is often an indication of saline water/soils.

Gypsum is a good source of calcium and prevents dispersive soils from setting hard. Gypsum usually gives an immediate response as it dissolves in water, but it leaches sooner than lime. Lime gives a slower, longer lasting response. It is ideal for acid (pH less than 5.0 water) sodic soils and needs to be cultivated into the soil. When gypsum is applied to sodic clays it dissolves slowly and changes the chemistry in two ways:

i) it creates a salt solution in the soil water and the clays do not swell and disperse as much. This is a short term effect which occurs as the gypsum dissolves;

ii) the calcium cations in the gypsum replace the exchangeable sodium cations attached to the clays. This process changes a sodic clay to a calcium clay making it less prone to swelling and clay dispersion. The displaced sodium cations are leached below the plant root zone. This effect lasts long after the gypsum has dissolved.

Increasing the organic matter level of the soil will also aid in minimising clay dispersion. An increase in organic matter will have a long-term benefit whereas a gypsum application will be of benefit in the short term.

DUPLEX PROFILE FORM: A Primary Profile form of the Northcote Factual Key (1979) classification. It describes a soil where there is a sharp contrast in the texture between the A and B horizons (often sandy or loamy surface horizons with a sharp to clear boundary to clay subsoils). Duplex soils are given the notation 'D'.

DYSTROPHIC: see Base Status.

EARTHS: A Great Soil Group (Stace *et al.*, 1968) description defining a variable group of soils which are porous and sandy textured; usually have an acidic trend (i.e. the pH decreases with depth); weak profile differentiation; diffuse horizon boundaries; an increase in clay content with depth, and no A2 horizon.

EC (ELECTRICAL CONDUCTIVITY): A measure of the conduction of electricity through water, or a water extract of soil. The value can reflect the amount of soluble salts in an extract and therefore provide an indication of soil salinity. Saline soils are defined as those with an EC of greater than 1.5 dS/m for a 1:5 soil water extract and greater than 4 dS/m for a saturation extract (see Salinity). It can be interpreted in terms of the salinity tolerance of plants. Soil texture needs to be considered in this interpretation.

ENDOACIDIC: Soils in which the major part of the profile below 0.5 m depth is strongly acid. This term is used as a Subgroup distinction for Vertosols in the Australian Soil Classification (Isbell 1996)

ENDOCALCAREOUS: A term used to describe a soil in which the major part of the profile below 0.5 m+ is calcareous. This term is used as a Subgroup definition for the Vertosol Order in the Australian Soil Classification (Isbell 1996).

ENDOHYPERSODIC: These soils have an ESP of 15 or greater below a 0.5 m depth. This term is used as a Subgroup definition for Calcarosols and Vertosols in the Australian Soil Classification (Isbell 1996).

EPIACIDIC: Soils in which the major part of the upper 0.5 m of the soil is strongly acid. This term is used as a Subgroup definition for Vertosols in the Australian Soil Classification (Isbell 1996)

EPICALCAREOUS: A soil in which the major part of the upper 0.5 m of the profile is calcareous. It is used to describe Hydrosols and Vertosols in the Australian Soil Classification (Isbell 1996).

EPIHYPERSODIC: Soils with at least one subhorizon within the top 0.5 m of the profile having an ESP greater than 15. Used as a Subgroup definition for Calcarosols and Vertosols in the Australian Soil Classification (Isbell 1996).

EPIPEDAL: These soils have a pedal A horizon and no surface crust. Used as a Great Group definition for Vertosols in the Australian Soil Classification (Isbell 1996).

EPISODIC: These soils have an ESP of 6 or greater in the upper 0.1 m of the profile. This term is used as a Subgroup definition for Vertosols in the Australian Soil Classification (Isbell 1996).

ESP (EXCHANGEABLE SODIUM PERCENTAGE): Calculated as the proportion of the cation exchange capacity occupied by the sodium ions and is expressed as a percentage. Sodic soils are categorised as soils with an ESP of 6-14%, and strongly sodic soils have an ESP of greater than 15% (See **SODICITY**).

EUTROPHIC: see Base Status.

FABRIC: Describes the appearance of the soil material (under a hand lens). The difference between fabrics is associated with the presence or absence of peds, the lustre of the ped surface and the presence, size and arrangement of pores in the ped. Fabric is described based on:

EARTHY (or porous) (E): The soil material is coherent and characterised by the presence of pores, but few if any peds. Soil particles are coated with oxides and/or clay particles are clumped around the pores.

SANDY (G): Soil material is coherent, with few if any peds. The closely packed sand grains provide the appearance of the soil mass.

ROUGH-PED FABRIC (R): Peds are evident and characteristically more than 50% of the peds are rough-faced, that is, they have relatively porous surfaces. They tend to have less clearly defined faces than smooth faced peds.

SMOOTH-PED (S): Peds are evident and more than 50% of them are dense and smooth faced, although the degree of lustre varies.

FACTUAL KEY (NORTHCOTE 1979): A soil classification system used in Australia which groups soils into recognisable profile forms. These are based on visible morphological properties and simple chemical properties of a soil and are labelled using an alphanumeric code. Further details can be found in Northcote (1979).

FERRIC HORIZON: A soil horizon containing more than 20% ferruginous nodules or concretions ('ironstone' or 'buckshot') which are uncemented. The term is used as a definition for numerous Soil Orders in the Australian Soil Classification (Isbell 1996).

FERROSOLS: Soil Order of the Australian Soil Classification (Isbell 1996). These soils lack strong texture contrast and have a B2 horizon with structure more developed than weak, **and** a B2 horizon with a fine earth fraction which has a free iron oxide content greater than 5% Fe (as opposed to a Dermosol).

FIELD CAPACITY (FIELD MOISTURE CAPACITY): The percentage of moisture remaining in a soil horizon 2-3 days after being saturated (by rainfall or irrigation) and after free drainage has ceased.

FLUVIAL: A geomorphic process whereby soil forming material is transported and deposited by flowing river water.

GILGAI: Surface undulations in the soil, forming small rises or ridges and depressions.

GRADATIONAL PROFILE FORM: A Primary Profile Form of the Factual Key (Northcote 1979). It describes a soil with a gradual increase in texture (i.e. becomes more clayey) as the profile deepens. Gradational soils are given the notation 'G'.

GRANULAR STRUCTURE: Rounded peds that are porous, stable and less than 12 mm in diameter. They usually occur in the surface horizons.

GREAT SOIL GROUPS (Stace *et al*., 1968): A soil classification system which is based on the description of soil properties such as colour, texture, structure, drainage, lime, iron, organic matter and salt accumulation, as well as on theories of soil formation. The profile to be classified is assigned to a Great Soil Group based on its description. The system is limited in that central concepts are inadequately defined making confident identification of some described profiles difficult.

GREY, BROWN AND RED CALCAREOUS SOILS: These soils are shallow, soft, powdery or weakly structured loams to light clays containing finely divided carbonates throughout the profile and showing very little horizon development. They tend to develop from highly calcareous rocks which underlie them at depths up to 50 cm. Fragments of limestone may also be found in the profile. The surface texture may be a loam or a clay loam, with a weak platey or a fine blocky structure. Below this the structure is massive or more clayey with a medium blocky structure of rough faced peds. The clay content tends to increase about one texture class throughout the profile.

GREY, BROWN AND RED CLAYS: This is a broad group of clayey soils in the Great Soil Group Classification, Stace *et al.,* (1968) which have a moderate to very deep profile. These soils crack deeply on drying and have a high clay content throughout. Subsoil clays range from grey to brown or red in colour gradually becoming paler with increasing depth. In Victoria, these soils are typically alkaline throughout much of the profile and carbonates may also be present.

GYPSIC: These soils contain more than 20% visible gypsum with a minimum thickness of 0.1 m that is of apparent pedogenic origin. If the upper boundary of the horizon occurs below the 1 m depth it is disregarded in the classification. It is used as a definition for a number of Orders in the Australian Soil Classification (Isbell 1996).

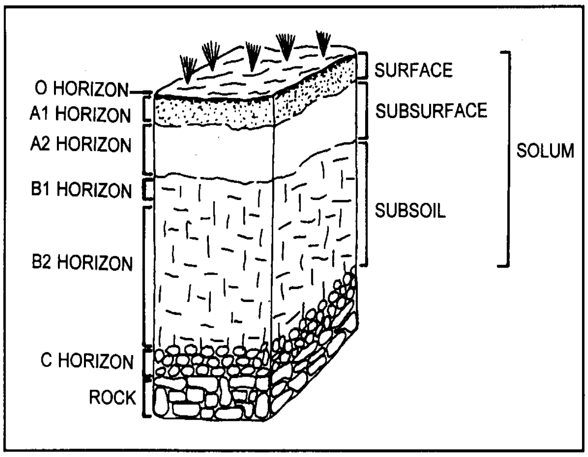
GYPSUM: A naturally occurring soft crystalline material which is a hydrated form of calcium sulphate. Deposits occur naturally in inland Australia. Gypsum contains approximately 23% calcium and 18% sulphur. It is used to improve soil structure and reduce crusting in hard setting clayey soils.

HAPLIC: A term used in the Australian Soil Classification (Isbell 1996) which indicates that the major part of the upper 0.5 m of the soil profile is whole coloured. It is used as the lowest order Subgroup distinction for a number of Soil Orders (note: by lowest order, it is meant that the soil described matches none of the other Subgroup classes; e.g. for Vertosols the soil is not acidic, sodic, calcareous etc..).

HARD: A general term indicating strength, used to describe a number of soils in the Australian Soil Classification (Isbell 1996). Hard nodules or segregations cannot be broken between thumb and forefinger (ie. strong, as in McDonald *et al*. (1990) p. 147). Pans are classified as hard if they are moderately cemented or stronger (McDonald *et al*. (1990), p. 143). The substrate is classed as hard if they are moderately strong or stronger (McDonald *et al*. (1990), p. 157).

HARDSETTING: The condition of a dry surface which is compact and hard with no apparent pedal development. These soils are not disturbed by pressure of a finger. These harder setting soils tend to result in high runoff.

HORIZONS: A layer within the soil profile having morphological characteristics and properties (e.g. colour, texture, and structure) differing from the layer above and/or below it.



1) The **O horizon** consists of plant material in various stages of decomposition, which has accumulated above the soil surface (A horizon). The O horizon can be subdivided into:

   i) **O1** horizon: undecomposed organic material e.g. leaves and twigs.

   ii) **O2** horizon: organic debris in various states of decomposition.

2) The **A horizon** consists of one or more surface mineral horizons and can be subdivided into:

   i) **A1** horizon: this is the mineral horizon at or near the surface, usually with some accumulation of organic matter making the colour darker than the underlying horizon. This horizon is usually high in biological activity. The A1 horizon can be further subdivided into the A11 horizon: more organic matter, darker colour with relatively high amounts of biological activity; A12 horizon varies in colour (i.e. hue, value or chroma) usually lighter, but not pale enough to be an A2 horizon. A13 and A14 horizons are further options if necessary.

   ii) **A2** horizon: this is the mineral horizon having either: less organic matter; less sesquioxides; and/or less silicate clays than the surrounding horizons. It can be differentiated from the A1 by its paler colour. The A2 can be differentiated from the B horizon by its colour value being 1 unit higher than the B, chroma units being 2 lower than the B horizon, by a coarser texture in the A2 horizon than the B, or a combination.

   iii) **A3** horizon: this is a transitional horizon between the A and B horizons which is dominated by A horizon properties.

3) The **B horizon** consists of one or more mineral soil layers characterised by one or more of the following: a concentration of silicate clays, iron, aluminium, and/or organic matter; a structure and/or consistence unlike the A horizon or any horizon below; stronger colours (i.e. higher chroma and/or redder hue) than the above or below horizon. The B horizon can be subdivided into one or more of the following:

   i) **B1** horizon: A transition between the A and B horizons where the underlying B2 horizon properties dominate (as opposed to the A horizon properties).

   ii) **B2** horizon: the dominant feature is one of the following: an illuvial, residual or other concentration of silicate clays, iron, aluminium, or humus; maximum development or pedological organisation within the profile i.e. different structure; consistence and/or stronger colours than the A horizon or any horizon below. The B2 horizon can be further divided into subhorizons: B21, B22, and B23 horizons etc.

   iii) **B3** horizon: a transition between B and C where the B2 horizon characteristics dominate.

4) The **C horizon**: the layer below the solum (A and B horizons) that consists of consolidated or unconsolidated parent material that is not significantly affected by soil forming processes. It is easily recognised by its lack of soil characteristic development and its visible geologic structure.

HORIZON SUFFIXES: These are lower case letters or numbers used as further descriptors for the main horizons. The suffixes describe the genetic processes operating in the soil, for example, humus in the A1 horizon is indicated by A1h, and significant calcium carbonate in the B2 horizon is indicated by B2k.

HUMIC: Soils with a Bh horizon (see Semiaquic and Bh Horizon). This term is used as a definition for the Podosol Order in the Australian Soil Classification (Isbell 1996).

HUMOSE HORIZON: A humus rich surface or near surface horizon that is at least 20 cm thick and has an organic carbon content of more than 4% for sandy soils and greater than 6% for clayey soils. This term is used as a Subgroup distinction for a number of Soil Orders in the Australian Soil Classification (Isbell 1996).

HUMOSESQUIC: Soils with only a Bhs horizon (see Semiaquic and Bhs Horizon). This term is used as a definition for the Podosol Order in the Australian Soil Classification (Isbell 1996).

HYDROSOLS: An Order of the Australian Soil Classification (1996). These are soils where a greater part of the profile is saturated for at least several months in a year.

HYPERCALCIC: These soils have a Bk horizon or a subsurface layer containing more than 20% of mainly soft, finely divided carbonate, and 0-20% of hard calcrete fragments and/or carbonate nodules, and/or carbonate coated gravel. The term is used as a definition for a number of Orders in the Australian Soil Classification (Isbell 1996).

HYPERNATRIC: The major part of the upper 0.2 m of the B2 horizon has an ESP greater than 25. This term is used as a Great Group definition for the Sodosol Order in the Australian Soil Classification (Isbell 1996).

HYPOCALCIC: Soils in which the carbonate in the B or B/C horizon is evident only by using acid treatment, or is in the form of a few soft visible segregations with few if any hard nodules or concretions. This term is used as a definition for a number of soils in the Australian Soil Classification (Isbell 1996).

INDURATED: Hardened soil particles (see Cemented).

INFILTRATION: The movement of water through the soil surface. Soils with a high infiltration capacity allow more rain to enter the soil than soils with a low capacity. Runoff will occur when the rate of rainfall exceeds the soil's infiltration capacity. Surface soil structure and texture are important determinants of the infiltration capacity of a soil.

KANDOSOLS: An Order of the Australian Soil Classification (Isbell 1996). These soils lack strong texture contrast and have massive or only weakly structured B horizons. The B2 horizon is well developed and has a maximum clay content in some part of it which exceeds 15%. These soils not calcareous throughout.

KRASNOZEM: A Great Soil Group (Stace *et al*, 1968). These soils are typically red, deep, well-structured, acid and porous soils. They have relatively high clay contents and tend to display a gradual increase in clay with depth.

KUROSOLS: An Order of the Australian Soil Classification (Isbell 1996). These soils have a clear or abrupt textural B horizon which is strongly acidic i.e. less than 5.5 (water) in the upper B2 horizon.

LACUSTRINE: A geomorphic process whereby soil forming material is deposited in lakes.

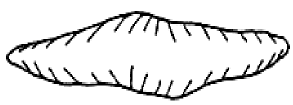
LATERITE: Refers to a soil profile with horizon/s rich in iron oxides. This is usually associated with deeply weathered profiles. The process whereby Laterite is formed is referred to as laterization. Laterization occurred especially in the early Tertiary period when Australia experienced a warm, wet climate.

LATERITIC PODSOLIC: Great Soil Group Classification, Stace *et al.*, (1968). These soils are strongly leached with a strong texture contrast between thick sandy A horizons and mottled yellow-brown and red clay B horizons. Nodular pisolitic or massive ironstone occurs at the base of the bleached A2 horizon and in the upper B2 horizon. The pH trend is acid throughout the profile.

LEACHING: The removal in solution of soluble minerals and salts as water moves through the profile.

LEVEE: A natural levee is a deposit of alluvium which is raised above the general level of the banks of a stream and its flood plain. Man-made levees may be constructed along the course of a river or stream in order to contain flood waters.

LENTICULAR STRUCTURE: Soil particles are arranged around an elliptical or circular plane and bounded by curved faces i.e. lens shaped. This structure often occurs in subsoils of Vertosols and can be associated with slickenside development.



LIME: A naturally occurring calcareous material used to raise the pH of an acidic soil and/or supply calcium for plant growth. It is effective for treating acidic soils.

LUNETTES: Crescent shaped aeolian deposits of fine sediment located on the eastern sides (or the lee sides) of lake beds or playas in semi-arid areas of southern Australia.

MAGNESIC: Soils with an exchangeable Ca/Mg ratio of less than 0.1 in the major part of the B2 horizon. This term is used as a definition within a number of Soil Orders in the Australian Soil Classification (Isbell 1996).

MANGANIC: A horizon that contains 20% or more (by weight or visual estimate) of black manganiferous nodules or concretions which are generally uncemented and have a minimum thickness of 0.1 m. Most nodules contain some iron. This term is used as a Subgroup definition for a number of Orders in the Australian Soil Classification (Isbell 1996).

MASSIVE: This term applies to soil horizons which appear to be coherent or solid and devoid of peds. It should be greater than 6 mm in thickness. When displaced, the soil separates into fragments which may be crushed into individual particles.

MELACIC: A subgroup of the Australian Soil Classification (Isbell 1996). These soils are similar to Melanic horizons, but the pH is less than 5.5 and there is no structure requirement.

MELANIC: These soils have either a dark coloured (i.e. Munsell value 3 or less and chroma 2 or less) surface or near surface horizon that has insufficient organic carbon to qualify as a humose horizon, with little or any evidence of stratification. To be considered Melanic, a horizon needs to be at least 20 cm thick; have more than a weak grade of structure and a pH (water) of greater than 5.5. It is used as a Subgroup definition for a number of Orders in the Australian Soil Classification (Isbell 1996).

MESONATRIC: In these soils, a major part of the upper 0.2 m of the B2 horizon has an ESP between 15-25. Used as a Great Group definition for Sodosols in the Australian Soil Classification (Isbell 1996).

MESOTROPHIC: see Base Status.

MOTTLING: The presence of more than one soil colour in a horizon. The soil may differ in colour either within peds or aggregates, or between them. Mottling occurs as blotches or streaks of subdominant colour throughout the main (i.e. matrix) colour. It does not refer to stains or coloured deposits on ped faces. Mottling is often an indication of poor profile drainage but may be caused by the weathering of parent material. Diffusely mottled implies that neighbouring colours are only slightly different.

MYCORRHIZAE: These are soil fungi which act as rootlets and increase the amount of nutrients (particularly phosphorus and zinc) available to plants. Fallowing, excessive tillage and soil fumigation can cause mycorrhiza to die out. Some plants such as rapeseed do not need mycorrhiza and therefore they tend to die out of the soil. Plants growing with mycorrhiza are generally healthier and more resistant to root disease and root rot.

NORTHCOTE FACTUAL KEY (1979): see Factual Key (Northcote 1979).

NUTRIENT STATUS: This is calculated as the sum of exchangeable calcium, magnesium and potassium (in milliequivalents per 100g) and can be used as a rough guide to availability of nutrients in general. The categories used are: very low (0 - 3.9); low (4 - 7.9); moderate (8 - 17.9); high (>18) (Lorimer and Rowan, 1982).

ORGANIC MATERIALS: Plant derived organic accumulations that have at least 12% or more organic carbon (the amount of organic required depends on the clay percentage).

ORGANOSOLS: An Order of the Australian Soil Classification (Isbell 1996). These are soils that are dominantly made up of organic materials.

ORTHIC: A term used to describe a Suborder for Tenosols in the Australian Soil Classification (Isbell 1996). Describes Tenosols with a tenic B horizon, or a B2 horizon with 15% clay (SL-) or less, or a transitional horizon (C/B) occurring in fissures in the parent rock or saprolite which contains between 10 and 50% of B horizon material.

PANS: Hard or cemented layers interfering with water and root penetration.

PARALITHIC: Soils in which the organic materials directly overlie partially weathered or decomposed rock or saprolite. Used as a definition for Subgroups of Organosols and Great Groups of Calcarosols, Rudosols and Tenosols within the Australian Soil Classification (Isbell 1996).

PARAPANIC: A term used as a Subgroup definition for Podosols in the Australian Soil Classification (1996). It refers to soils with a strongly coherent (i.e. consistence 4-5) B horizon, e.g. Parapanic, Pipey, Semiaquic PODOSOL.

PARENT MATERIAL: The rock from which a soil profile develops.

PARTICLE SIZE ANALYSIS: The measurement of the relative amounts of coarse sand, fine sand, silt and clay size particles in a soil sample (as determined in the laboratory). Also called 'mechanical analysis'.

PED: The natural unit of soil structure formed by the soil's tendency to fracture along planes of weakness.

PETROCALCIC: Soils with a B horizon which directly overlies a calcrete pan. This term is used as a Great Group or Subgroup distinction for a number of Soil Orders in the Australian Soil Classification (Isbell 1996).

PETROFERRIC: These soils have ferruginous or ferromanganiferous nodules or concretions cemented in place into indurated blocks or large irregular fragments. Used as a Great Group definition for a number of Orders in the Australian Soil Classification (Isbell 1996).

pF: A logarithmic expression of soil suction, whereby pF 2.5 is equivalent to a suction of 30 Kilopascals and represents field capacity for a prepared sample. pF 4.2 is equivalent to a suction of 1500 Kilopascals and represents permanent wilting point.

pH (SOIL): A measure of soil acidity and soil alkalinity on a scale of 0 (extremely acidic) to 14 (extremely alkaline), with a pH of 7 being neutral. It gives an indication of the availability of plant nutrients and relates to the growth requirements of particular crops. Acid soils are usually deficient in necessary nutrients e.g. calcium and magnesium.

PIPEY (B HORIZON): These horizons are associated with some Podosols and are characterised by 'pipes' of bleached A2 horizon that penetrate (mostly vertically) into the B horizon, giving a tongued boundary on a profile face. The presence of a pipey horizon is used at the Great Group level within the Podosol Order of the Australian Soil Classification (Isbell 1996), e.g. Parapanic, Pipey, Semiaquic Podosol.

PLANT AVAILABLE WATER CAPACITY (PAWC): The amount of soil water that can be extracted by the plant. It is defined as the difference in soil moisture content between the field capacity and the wilting point (see Field Capacity and Wilting Point). It is expressed as millimetres of plant-available water within the root zone.

(PAWC) is a measure of the maximum amount of water that a soil can store and which is able to be used by plant roots. It is expressed as millimetres of plant available water held in the root zone. Plant available water is related to:

- soil texture (e.g. up to 230 mm of water can be held in clay-rich alluvial soils, whereas only 50 mm may be held by sandy soils)

- Rooting depth (PAWC is reduced in shallow soils over bedrock or in soils with dense sodic subsoils)

- Soil structural damage PAWC is reduced when plough pans restrict root and water movement) (SOILpak, 1994).

In this survey, PAWC is calculated for the pit sites using a model developed by Littleboy (1995). This model uses a computer program to estimate PAWC from soil survey data (i.e. % clay, % silt, % fine sand, % coarse sand, wilting point and horizon depth). Effective Rooting Depth (ERD) has been estimated based largely on soil profile morphology and an assessment of roots in soil pits. Generally, it is assumed that effective rooting depth will be restricted by dense and coarsely structured subsoil horizons (particularly if these are sodic and dispersive); hardpans; high levels of soluble salts). Other factors can include extremes of pH and occurrence of frequent waterlogging.

Unavailable Water

After a soil has reached permanent wilting point it will continue to lose water until it becomes air dry. The water between the Permanent Wilting Point and air dry is not available to plants.

Factors Affecting The Water Holding Capacity Of Soil

The amount of soil water available is limited by the depth of soil that roots can explore, and the nature of the soil material. Since the total and available moisture storage capacities are linked to porosity; the particle sizes (i.e. texture) and the arrangement of particles (i.e. structure) are critical factors. Organic matter and coarse fragment content of the soil also affect the moisture storage.

PLASTIC LIMIT: The water content of the soil above which the soil will compress and shear when compacted; i.e. structural degradation occurs.

Plastic Limit Test

The following test can be done in the field prior to tillage, and provides a guide for determining whether the soil is at a moisture content suitable for cultivation. It is designed for soils with a relatively high clay content (e.g. Vertosols). The soil should be tested to just beyond the depth of tillage.

Take a lump of soil and squeeze it into a ball. Firmly roll the ball out on a flat surface and attempt to mould it into a 3 mm diameter rod *(SOILpak b, 1*990).

- If the soil is too hard to roll or if it crumbles before a 3 mm diameter rod can be formed, then the soil is drier than the plastic limit.

- If the soil can just be rolled into a 3 mm diameter rod (and requires considerable pressure) without crumbling, then the water content is at the plastic limit.

- If the soil is easily shaped into a 3 mm diameter rod (without crumbling), then it is wetter than the plastic limit

- If the soil is pliable and can be ribboned out between thumb and forefinger, then it is wetter than the plastic limit.

- If the soil sticks to your hand, then it is considerably wetter than the plastic limit.

Tillage of cracking clay soils should be avoided if the soil is wet (i.e. wetter than the plastic limit). At such moisture conditions tillage and excessive hardsetting or overstocking can result in soil structural damage (e.g. compaction, smearing) occurring. Ideally, tillage and trafficking should take place when the soil is drier than the plastic limit, and tested to at least the depth of tillage.

PLASTIC SOILS: A soil capable of being moulded or deformed permanently in shape without a change in volume, rebound or texture.

PLATY STRUCTURE: Peds are layered in plate-like (laminar) sheets. This type of structure is usually associated with soils which have been subjected to compaction and does not normally occur in undisturbed soil profiles.

PLAYA: A large, shallow closed depression which is intermittently filled with water, but mainly dry due to evaporation. These are often former lake beds. A lunette will be present on the eastern margin of the playa if the prevailing winds at the time of formation were westerlies.

PODOSOL: Soil Order of the Australian Soil Classification (Isbell 1996). These soils have a B horizon dominated by the accumulation of compounds of organic matter, aluminium and/or iron. These horizons may occur individually or in combination within a profile.

PODZOLIC: A Great Soil Group, Stace et al. (1968). These soils display a strongly differentiated profile with a bleached subsurface horizon overlying a horizon rich in sesquioxides relative to those above and below it. The solum is acid throughout.

POLYHEDRAL STRUCTURE: Soil particles arranged around a point and bounded by more than six relatively flat but dissimilar faces.

POROSITY: The degree of pore space in a soil (i.e. the percentage of the total space between solid particles).

PRAIRIE SOIL: A Great Soil Group (Stace et al. 1968).

PRIOR STREAM: The course of a former stream responsible for the nearby sediments, and which now does not carry water other than local drainage.

PRISMATIC STRUCTURE: Soil particles are arranged around a vertical axis and bounded by relatively flat faces. The top of the prisms are also relatively flat. Prismatic structure is often associated with subsoil sodicity.

PROFILE: The vertical section of the soil from the soil surface down through the horizons including the parent material. It consists of two parts: the solum, and the parent material.

RED-BROWN EARTHS: Great Soil Group Classification, Stace *et al.*, (1968). The characteristic features are: grey-brown to red-brown loamy sand to sandy clay loam A horizon which is weakly structured to massive; an abrupt to clear boundary between the A and B horizons; a brighter brown to red clay B horizon with a well developed medium prismatic to blocky structure. The surface soil is moderately thick and mildly acid to neutral, and the B horizons are usually alkaline and may contain carbonates. These soils are typical of semi-arid to sub-humid climates and can develop on various parent materials.

RED CLAYS: See Grey, Brown and Red Clays.

REDOXIC: A term used as a Suborder definition for Hydrosols in the Australian Soil Classification (Isbell 1996). These are soils with a seasonal or permanent water table and in which the major part of the solum is mottled.

RUDOSOLS: Soil Order of the Australian Soil Classification (Isbell 1996). These soils have limited pedological organisation apart from minimal development of the A1 horizon.

SALINITY: A measure of the total soluble salts in a soil. A saline soil is one with an accumulation of free salts at the soil surface and/or within the profile affecting plant growth and/or land use. It is generally attributed to changes in land use or natural changes in drainage or climate which affects the movement of water through the landscape. Salinity levels of soil or water can be tested using Electrical Conductivity (see EC).

SAPRIC: A soil profile in which the organic materials are dominated by sapric peat. This term is uses as a definition for a Suborder of Organosols and a Great Soil Group of Intertidal Hydrosols in the Australian Soil Classification (Isbell 1996).

SAPRIC PEAT: Consists of strongly to completely decomposed organic material with plant remains being indistinct to unrecognisable. The degree of decomposition and distinctness of plant remains can be tested using a modification of the von Post Field Test, in which a sample of the wet peat is squeezed in the closed hand and the colour of the liquid expressed, the proportion extruded between the fingers and the nature of the plan residues are observed. For sapric peat, amounts ranging from half to all escape between the fingers and any residue is almost entirely resistant remains such as root fibres and wood.

SAPROLITE: Decomposed rock that has maintained characteristics that were present as an unweathered rock.

SEGREGATIONS: Accumulations of minerals in the soil due to the concentration of constituents. They occur as a result of chemical or biological action. They can develop *in situ* by either current or relict pedogenic processes. Segregations are described by their nature, abundance and form:

1) ***Nature*****:** e.g. calcareous (carbonate), gypseous (gypsum), manganiferous (manganese) and ferromanganiferous (iron-manganese).

2) ***Abundance:*** e.g.:

• Very few	(Trace and Occasional)	<2%
• Few	(Slight)	2-10%
• Common	(Light)	10-20%
• Many	(Moderate)	20-50%
• Very many	(Heavy)	>50%

3) ***Form:*** e.g.:

• C	concretions	Spheroidal formations (concentric in nature).
• N	nodules	Irregular rounded formations (not concentric or symmetric). Can have a hollow interior.
• F	fragments	Broken pieces of segregations.
• X	crystals	Single or complex clusters of visible crystals.

• S	soft segregations	Finely divided soft segregations. They contrast with surrounding soil in colour and composition but are not easily separated from the soil as separate bodies.

SELF-MULCHING: A structural condition of soils, notably found in the surface soils of Vertosols, where there is a high degree of pedality and the peds naturally fall apart as the soil dries to form a loose surface mulch.

SEMIAQUIC: Soils with short term saturation in the B horizon. This term is used as a definition for the Podosol Order in the Australian Soil Classification (Isbell 1996).

SESQUIC: Soils with only a Bs horizon (see Bs Horizons). This term is used as a definition for the Podosol Order in the Australian Soil Classification (Isbell 1996).

SILICEOUS SANDS: These are a broad group varying in colour but are characterised by their uniform sand to clayey sand texture, deep profiles, massive single-grain structure and the absence of any distinct horizons except for a minimal accumulation of organic matter in the A1 horizon, making it slightly darker. This horizon can be absent when there is no vegetation to hold it in place.

SLAKING: The breaking down of soil aggregates when immersed in water into smaller sized micro-aggregates. These aggregates may subsequently disperse (see Dispersible Soils).

When a soil becomes wet, the aggregates swell and some of the fragments fall off. This is caused by entrapped air within the aggregate escaping when the soil is rapidly wet. This causes the aggregate to explode into smaller aggregates (i.e. microaggregates).

Slaking can result in soil surface crusting and is particularly severe in soils with low organic matter and those that are frequently cultivated. This can be overcome by increasing the organic matter of the soil. The organic matter reduces slaking by slowing the rate of aggregate wetting and by binding soil particles together. The organic matter levels can be increased by retaining the stubble of crops, by growing a grass/legume pasture or by adding manure or organic by-products.

Slaking and dispersion are two processes which degrade the soil's structure. When the soil is wet, slaking occurs within minutes and causes the breakdown of aggregates into microaggregates. Dispersion can take hours and results in the breakdown of aggregates into individual clay, silt and sand particles.

SLICKENSIDES: Subsoil structural features which develop as a result of two masses moving past each other, polishing and smoothing the surfaces. These are common in Vertosols.

SODICITY: A measure of the exchangeable sodium in relation to other exchangeable cations. It is expressed as the Exchangeable Sodium Percentage (see ESP). A sodic soil contains sufficient exchangeable sodium to interfere with the growth of plants, including crops. A soil with an ESP greater than 6 is generally regarded as being a sodic soil in Australia (Northcote and Skene, 1972). ESP levels are further classified in the Australian Soil Classification (Isbell 1996).

The sodicity level of a soil can be quantitatively tested in the laboratory by determining the proportion of sodium (Na%), present in the Cation Exchange Capacity (see CEC). That is:

$$\text{ESP (or Na\%)} = \frac{\text{sodium}}{\text{calcium + magnesium + sodium + potassium}} \times 100$$

This provides an Exchangeable Sodium Percentage value (See ESP in Glossary) which determines the sodicity of the soil. If the ESP value is less than 8, the soil is non-sodic, from 8-15 the soil is sodic, and greater than 15 the soil is strongly sodic.

These sodium dominated clays have a tendency to swell on wetting. High levels of exchangeable magnesium can also promote clay dispersion, whereas calcium dominated clays do not readily disperse. The presence of significant soluble salts in the soil can reduce dispersion (Lines-Kelly, 1994).

SODOSOL: A Soil Order of the Australian Soil Classification (Isbell 1996). These soils have a clear or abrupt textural change between A horizons and sodic B horizons. Soils with a subplastic B2 horizon are excluded.

SOLODIC SOIL: Great Soil Group, Stace *et al.*, (1968). These soils have a strong contrast between the texture of the A and B horizons and a bleached A2 horizon (which may contain a few sesquioxidic nodules). The A horizons are usually acidic and the B horizons are alkaline grading to strongly alkaline at depth. The B horizon has medium to coarse blocky peds (which may be arranged in a coarse columnar fashion). These soils are typical in semi-arid and subhumid climatic zones and tend to be very dense soils with low permeability. The difference between solodic soils and solodized solonetz soils occurs in the structure of the B horizon: solodics have a medium to coarse blocky structure, whereas solodized solonetz soils have a coarse columnar structure with clearly defined domes on the tops of the columns.

SOLODISED SOLONETZ: Great Soil Group, Stace *et al.*, (1968). These soils are identical to solodic soils except for the structure of the B horizon. Solodic soils have a medium to coarse blocky structure and solodized solonetz have a coarse columnar structure with clearly defined domes on the tops of the columns.

SOLONETZ SOILS: Great Soil Group, Stace *et al.*, (1968). Typically, there is weak differentiation between the A horizons. The A2 horizon may be sporadically bleached just above the clay subsoil. There is an abrupt boundary and a strong texture contrast between the A and B horizons. Surface soils are typically neutral to alkaline with a strongly alkaline subsoil. The subsoil clays are high in sodium and magnesium ions and usually have a prismatic structure.

SOLONIZED BROWN SOILS: These soils have large amounts of calcium and magnesium carbonates in the profile. Soil properties show gradual change down the profile; the most evident is the increase in carbonates down the profile. Texture becomes finer with depth, and the pH changes from a neutral/slightly alkaline surface horizon to an alkaline subsoil. The soluble salt content of the subsoil also increases significantly. Dark manganiferous nodules can also occur in the subsoil.

SOLOTH: Great Soil Group, Stace *et al*., (1968). Similar to a solodic soil but acidic throughout the profile. Tends to be a more typical soil of the humid regions where the exchangeable cations in the B horizon of the solodised soils are leached.

SOLUM: The soil profile (i.e. A and B horizons) which has developed from the parent material by the processes of soil formation.

STRUCTURE: Describes the way the soil particles are arranged to form soil peds. Peds are units of soil structure which are separated from each other by natural planes of weakness. They differ from clods which are formed as a result of soil disturbance such as ploughing.

Structure is defined by three characteristics: grade, size and type.

> 1) ***GRADE*** measures the degree of development and the distinctiveness of the peds. It varies depending on the soil water status and can be divided into five groups: 1) ***SINGLE GRAIN***, loose and incoherent mass of individual particles; 2) ***MASSIVE***, when displaced the soil separates into fragments which may be crushed into ultimate particles; 3) ***WEAK***, peds indistinct; 4) ***MODERATE***, peds are well formed and visible but not distinct in undisplaced soil, adhesion between peds is usually firm and when displaced between one third and two thirds of the soil material consists of peds, and; 5) ***STRONG***, peds distinct in undisplaced soil, adhesion between peds is firm, and when displaced, two-thirds or more of the soil material consists of peds.
>
> 2) ***SIZE*** is measured and described based on the average least dimension of the peds. A guideline is provided in the Australian Soil and Land Survey Field Handbook (McDonald *et al.* 1990) pages 126 to 131.
>
> 3) ***TYPE*** of structure has been described throughout the glossary. For example, platy, prismatic, columnar, angular blocky, subangular blocky, polyhedral and lenticular.

A number of different grades and sizes of peds may occur within a horizon. This is referred to as **compound pedality**. An example of this is when prismatic structure parts into smaller blocky peds.

SUBANGULAR BLOCKY STRUCTURE: A ped bound by six faces intersecting with round edges (i.e. like a rounded cube).

SUBNATRIC: In these soils a major part of the upper 0.2m of the B2 horizon has an ESP between 6 and less than 15. These soils are considered to be sodic (see **SODICITY**). Used as a Great Group definition for Sodosols in the Australian Soil Classification (Isbell 1996).

SUBPLASTIC: These soils have a consistence or textural property suggesting less clay sized particles than the soil actually contains. The soils increase in field texture after 10 minutes of kneading i.e. the soil texture becomes more clayey and harder to work. It is a feature of relatively deep subsoils and much energy is required to break down the soil aggregates. Also, these soils do not shrink/swell greatly when wet.

SUBSOIL: The B horizon, not including the C horizon (see Horizons).

SURFACE CRUST: Soils with a massive or weakly structured surface crust which is lighter in texture than the underlying pedal clay. This condition should not be confused with self-mulching behaviour.

TENIC B HORIZONS: A weakly developed subsoil (B horizon) in comparison with horizons above and below; in terms of texture, colour, structure and/or presence of segregations (including carbonate). This term is used in the Australian Soil Classification (Isbell 1996)

TENOSOLS: Soil Order of the Australian Soil Classification (Isbell 1996). These soils generally have weak pedological organisation throughout the profile apart from an A horizon. They display more profile development than Rudosols, which may include a weakly developed B horizon with 15% clay or less (See Isbell 1996, for a detailed definition).

TERRIC: Soils with a layer (or layer) of unconsolidated mineral material within or below the organic materials, but within 80 cm of the surface. This term is used as a Subgroup determination for Organosols within the Australian Soil Classification (Isbell 1996).

TEXTURE (FIELD): Field texture is determined by measuring the behaviour of a small handful of soil when moistened and kneaded (1-2 minutes) until it does not stick to the hand. It provides an estimate of the relative amounts of coarse sand, fine sand, silt and clay size particles. Soil texture influences many soil physical properties such as water holding capacity and hydraulic conductivity. Numerous soil properties affect the determination of texture such as type of clay minerals, organic matter, carbonates, etc. Texture is determined by the behaviour of the moist bolus and length of the ribbon when sheared between thumb and forefinger, as described by McDonald *et al.*(1990).

Texture symbol	Field texture grade	Behaviour of moist bolus	Approx. clay content (%)
S	Sand	Coherence nil to very slight, cannot be moulded; sand grains of medium size; single sand grains stick to fingers.	less than 5%
LS	Loamy sand	Slight coherence; sand grains of medium size; can be sheared between thumb and forefinger to give minimal ribbon of 5 mm.	approx. 5%
CS	Clayey sand	Slight coherence; sand grains of medium size; sticky when wet; many sand grains stick to fingers; will form a minimal ribbon of 5-15mm; discolours fingers with clay stain.	5%-10%
SL	Sandy loam	Bolus coherent but very sandy to touch; will form a ribbon of 15-25 mm; dominant sand grains are of medium size and are readily visible.	10-20%
FSL	Fine sandy loam	Bolus coherent; fine sand can be felt and heard when manipulated; will form a ribbon of 13-25 mm; sand grains are clearly evident under a hand lens.	10-20%
SCL-	Light sandy clay loam	Bolus strongly coherent but sandy to touch; sand grains dominantly medium sized and easily visible; will form a ribbon of 20-25 mm.	15-20%
L	Loam	Bolus coherent and rather spongy; smooth feel when manipulated but with no obvious sandiness or 'silkiness'; may be somewhat greasy to the touch if much organic matter present; will form a ribbon of 25 mm.	approx. 25%
Lfsy	Loam, fine sandy	Bolus coherent and slightly spongy; fine sand can be felt and heard when manipulated; will form a ribbon of about 25 mm.	approx. 25%
ZL	Silty loam	Coherent bolus; very smooth to often silky when manipulated; will form a ribbon of approx. 25 mm.	approx. 25% and with silt approx. 25% or more
SCL	Sandy clay loam	Strongly coherent bolus; sandy to the touch; medium sized sand grains visible in finer matrix; will form a ribbon of 25-40 mm.	20-30%
CL	Clay loam	Coherent plastic bolus; smooth to manipulate; will form a ribbon of 40-50 mm.	30-35%
CLS	Clay loam, sandy	Coherent plastic bolus; medium sized sand grains visible in finer matrix; will form a ribbon of 40-50 mm.	30-35%

Texture symbol	Field texture grade	Behaviour of moist bolus	Approx. clay content (%)
ZCL	Silty clay loam	Coherent smooth bolus, plastic and often silky to the touch; will form a ribbon of 40-50 mm.	30-35% and with silt 25% or more
FSCL	Fine sandy clay loam	Coherent bolus; fine sand can be felt and heard when manipulated; will form a ribbon of 38-50 mm.	30-35%
SC	Sandy clay	Plastic bolus; fine to medium sands can be seen, felt or heard in clayey matrix; will form a ribbon of 50 mm - 75 mm.	35-40%
ZC	Silty clay	Plastic bolus; smooth and silky to manipulate; will form a ribbon of 50 mm-75 mm.	35-40%
LC	Light clay	Plastic bolus; smooth to touch; slight resistance to shearing; will form a ribbon of 50-75 mm.	clay: 35-40% silt: 25%+
LMC	Light medium clay	Plastic bolus; smooth to touch; slight to moderate resistance to forming a ribbon; will form a ribbon approx. 75 mm.	40-45%
MC	Medium clay	Smooth plastic bolus; can be moulded into a rod without fracturing; has moderate resistance to forming a ribbon; will form a ribbon of 75 mm +.	45-55%
MHC	Medium heavy clay	Smooth plastic bolus; can be moulded into a rod without fracturing; has a moderate to firm resistance to forming a ribbon; will form a ribbon of 75 mm or more.	50%+
HC	50%+	Smooth plastic bolus; can be moulded into rods without fracturing; has firm resistance to forming a ribbon; will form a ribbon of 75 mm +.	

Source: McDonald *et al.* (1990).

Note: The field textures listed above can be qualified further; for example, a medium clay (MC) can be assigned the qualifier Sandy (S). The texture can then be described as a medium clay, sandy (MCS).

TSS (TOTAL SOLUBLE SALTS): A measure of the soluble salts in the soil (mainly sodium chloride, sulphate and carbonate). It is a calculated value derived using the Electrical Conductivity reading (see <u>EC</u>) where, Total Soluble Salts % = Electrical Conductivity (dS/m) x 0.33. TSS needs to be considered relative to profile water movement.

UNIFORM PROFILE FORM: A Primary Profile Form of the Factual Key Classification, (Northcote 1979). These soil profiles have limited, if any texture change throughout the profile. There is generally no textural boundaries found within the profile, except for possibly a surface crust. Uniform soils are given the notation 'U'.

VERTIC PROPERTIES: This term is used to describe a subsoil with a field texture of 35% or more clay which experiences significant shrinking and swelling resulting from drying and wetting. This often results in the development of features such as surface cracking and gilgai formation. Evidence of vertic properties include the presence of slickensides and/or lenticular peds in the subsoil. The amount of swelling is dependent on the type of clay present. These features are of significant importance for engineering purposes such as road construction. This term is used as a Subgroup definition for a number of Soil Orders in the Australian Soil Classification (Isbell 1996).

VERTOSOLS: A Soil Order of the Australian Soil Classification (Isbell 1996). These are clay soils with shrink/swell properties that display strong cracks when dry and have slickensides and/or lenticular structural aggregates at depth.

WATER REPELLENT: Soils that are fairly resistant to wetting (from a dry state). It is a condition usually associated with sandy surface horizons and is generally caused by organic coatings on sand grains.

WIESENBODEN: A Great Soil Group (Stace et al. 1968). These are dark clay to clay loam soils with uniform to gradational texture profiles and varying development of gley features in the deeper subsoil due to intermittent partial saturation associated with seasonal seepage and perched water.

WILTING POINT: (Measured at approximately pF 4.2) It defines the amount of water remaining in the soil when a plant wilts and does not respond to added water.