SOIL STRUCTURE ASSESSMENT KIT

a guide to assessing
the structure of
red duplex soil

SHELLEY McGUINNESS
DEPARTMENT OF CONSERVATION AND ENVIRONMENT

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Shelley McGuinness
Centre for Land Protection Research,
P.O. Box 401
Bendigo 3550
(054) 446 777
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INTRODUCTION

WHAT IS THE SOIL STRUCTURE ASSESSMENT KIT?

The Soil Structure Assessment Kit enables you to assess and monitor the structure of your soil. It aims to increase your knowledge of soil, soil structure and how management practices change soil structure. Once soil structural problems have been identified, management practices can be altered to overcome them.

Seven properties of the soil are examined by digging a small hole and looking closely at the soil structure. The soil properties are rated or graded so that you can identify which soil properties are limiting crop growth. If management is changed to overcome a soil problem, the Kit enables you to monitor changes in structure over time and determine if the soil structure is improving.

The Kit doesn't provide you with specific solutions to soil problems. However, it will provide you with the information necessary to begin developing a management strategy to over-come specific problems. This may be done in consultation with a soil or cropping advisory officer. The type of management strategy will depend on the particular soil problems, farm operations, machinery type etc. so each plan needs to be worked out on an individual basis.

WHY ASSESS SOIL STRUCTURE?

Poor soil structure is one of the major factors limiting yield and therefore profit. Poor soil structure limits seedling emergence, plant root development, rainfall infiltration (and therefore causes waterlogging and runoff) and water available for crop growth. Good soil structure allows water and air to move freely into the soil and the plant roots are able to explore all the soil and use the water and nutrients stored in the soil. This is essential for achieving higher yields.

WHY RED DUPLEX SOILS?

The Kit has been designed to deal specifically with the soil structure problems of red duplex soils due to widespread structure decline on this soil type (to include other soil types would make the kit too large).

Red duplex soils can be highly productive. The productive potential is currently not being achieved because of widespread soil structure decline. The red duplex soils have a number of properties which make them very susceptible to soil structure decline. These include a low organic matter content and small earthworm populations, 'hardsetting', low porosity and fragility. Under the harsh treatment of modern tillage practices, these fragile soils develop soil structural problems such as compaction, surface crusting and poor drainage.

IS YOUR SOIL RED DUPLEX?

Red duplex soils are quite simply soils which have two distinct layers — a topsoil or A-horizon and a subsoil or B-horizon (Fig. 1).

Figure 1:
A typical red duplex soil showing two layers, a topsoil and subsoil.

They are characterised by a marked texture contrast between the topsoil and the subsoil. The topsoil has a lighter texture than the subsoil, which is usually clay. The layers also differ in colour, with the topsoil usually a darker colour than the red to brown coloured subsoil. The topsoil is darker in colour due to a higher organic matter content than the subsoil. In some cases there is a bleached zone in the topsoil which is called an A_2-horizon. These are discussed in further detail on page 7. The approximate distribution of this soil in Victoria is shown in Figure 2. There are approximately 1,000,000 hectares of red duplex soil in Victoria which are used pre-dominantly for dryland cropping, sheep grazing and irrigated agriculture.

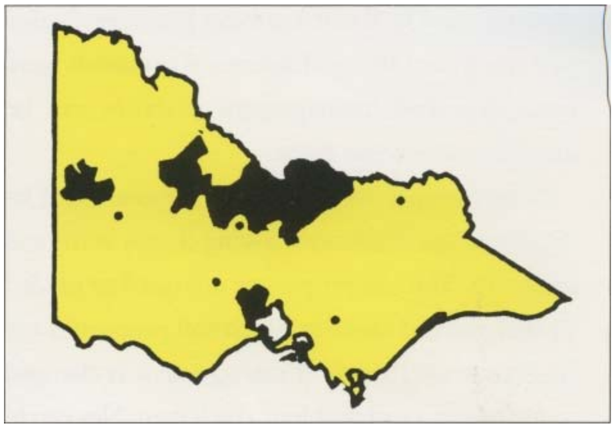


Figure 2:
Distribution of red duplex soil throughout Victoria.

USING THE KIT

I have tried as much as possible to make the Kit self-explanatory. However, you will get more out of the Kit if you are first taken through it by an advisory officer. If you are a member of a farm discussion group, ask your coordinator to organise a session devoted to the Kit including a demonstration in the field by an advisory officer.

GETTING STARTED

The best and easiest time to examine the soil is when it is moist, early spring is probably the best time of year. Wait for a shower of rain and do the work a few days later.

Each paddock will take approximately an hour to do. You may choose to do just a few paddocks a year and cover the whole farm in say 3 to 5 years and then return to the paddocks assessed first. This will give the soil time to adjust to any changes in management. It normally takes 2 to 3 years before visible changes in the soil occur after a major change in management. Alternatively, you may be very keen and do all your paddocks in one year. It is up to you and how it fits in with the rest of your program. Talk to your local advisory officer if you would like more advice in devising a program that suits you.

WHAT YOU WILL NEED

Figure 3: This is all the gear you will need to assess the structure of your soil.

- shovel
- mattock
- spatula (or a broad, flat flexible knife)
- ruler
- kit, recording sheet and pen
- water (about 1/2 a litre)
- glasses if you wear them
- camera if you would like a permanent record of your soil profiles
- buckets or paper bags for sample collection
- penetrometer
- fuse wire

The penetrometer (Figure 4) is quite simply constructed. The shaft is 110cm of 10mm steel rod welded at right angles to 40cm of 2cm steel rod. The tip of the shaft is sharpened to a point. If hollow rod is used (which is probably better as it is lighter), a hardened tip can be welded to the end.

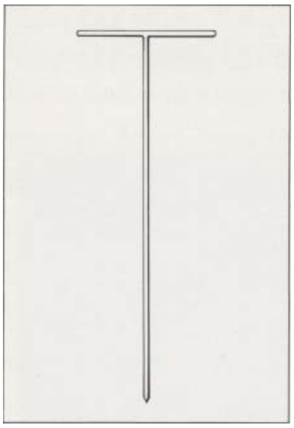


Figure 4: The penetrometer.

CHOICE OF SITE

Once you have decided on the paddock you want to assess, you need to select an appropriate examination site. Try to avoid headlands, fence lines, spots where harvest bins were sited or any other sites of unusual traffic. Otherwise, any representative site within the paddock will do.

THE HOLE

To examine the soil structure, dig a hole 50 to 60cm deep (20 to 24") and 50cm wide. You want a hole large enough to have a clear view of one face. It would be advisable to orient the hole so that the side of the hole to be examined, the `profile', faces north and receives plenty of light. If the paddock is in crop dig across the sowing lines to expose the root systems of the plants.

Try to minimise disturbance of the soil surface above the profile. Avoid standing on this side and do not heap dug soil on this side.
Use the spade or shovel to straighten the viewing face so that it is roughly vertical.

The shovel tends to smear the soil. To examine soil structure, the profile needs to be prepared without shovel smears. This is best done by carefully flicking out small amounts of soil with the spatula. Start at the top left corner and push the spatula 1 to 2cm into the profile 3 to 4cm below the surface (Fig. 5).

Figure 5:
Use the spatula to flick out soil to expose an unsmeared soil profile.

Use a flicking motion to remove the soil. Move from left to right across the hole. You will notice that the newly exposed soil is rough and not smeared. Continue moving down the profile using the same technique until the entire face is exposed (Fig. 6).

Remove the loose soil from the bottom of the hole.

Figure 6:
You should end up with a hole that has one profile like this one.

EXAMINING THE SOIL

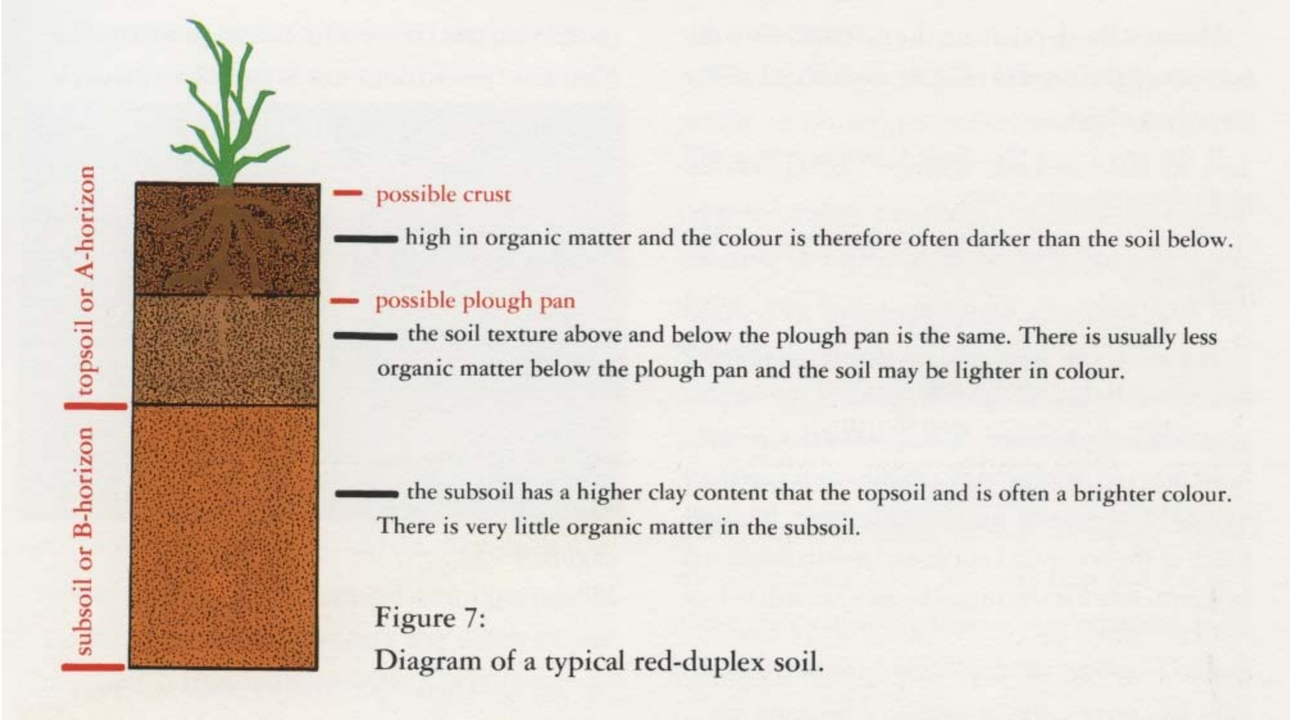


Figure 7:
Diagram of a typical red-duplex soil.

When a hole is dug into a soil, the exposed face is known as the soil profile. Look at the soil profile. Can you see the topsoil and subsoil layers? Try to distinguish them by the difference in colour and by the change in texture (refer to the glossary at the back of the booklet for an explanation of texture). The topsoil is often (but not always) darker and has a lighter texture than the subsoil which has more clay. In cropping areas with red-duplex soils, the profiles should show the following layers (Fig. 7).

In some red-duplex soils there is a zone in the topsoil called an A_2-horizon (Fig. 8).

The A_2-horizon may be very pale in colour compared to the other layers. This is known as a bleached A_2-horizon. If you have a bleached A_2-horizon, then the soil has special properties and can make soil management difficult. Bleaching of this layer can indicate that the soil is susceptible to water-logging and of poor structure. In red-duplex soils, this layer has little silt or clay. When this soil becomes wet, the A_2-horizon loses all its strength. This makes spraying, cultivation and sowing almost impossible during wet periods without getting bogged. On drying, the A_2-horizon sets like concrete and forms a hard concreted layer. Roots find such a layer relatively inhospitable for growth. Apart from being difficult to explore (this layer has few pores and channels), it is low in oxygen and nutrients. A soil with a bleached A_z-horizon needs particular attention to management practices to develop and maintain good topsoil structure.


Figure 8:
A red duplex soil with a bleached A_2-horizon.

EXERCISE 1. TOPSOIL DEPTH

Measure the depth from the soil surface to the bottom of the topsoil (Fig.9) and record **in** the recording sheet.
If the soil has a bleached A_2-horizon you will make two measurements:

(i) from the soil surface to the top of the A_2-horizon
(ii) from the top to the bottom of the A_2-horizon

Topsoil depth does build-up slowly over time if not eroded, but so slowly that it is almost impossible to measure. Wind and water erosion however, can readily and rapidly strip layers of topsoil. The topsoil is a valuable asset. It stores much of the water and nutrients used by crops and pastures. Any loss of topsoil by erosion will reduce production and farm profit. It is important to use farm practices which prevent loss of soil.

Figure 9:
Measuring topsoil depth.

EXERCISE 2. COMPACTION LAYERS

Compaction layers (sometimes called hard pans or plough pans), are layers of very dense, hard soil within the topsoil. We will use two methods to look for compaction layers.

(i) Penetrometer

Choose a site near the hole (a couple of metres away will do) and push the steel penetrometer into the ground. Feel for any differences in strength required to push the penetrometer in to the ground and note the depth at which this occurs. NB. compaction layers are usually found 5 to 10 cm below the soil surface. The subsoil is denser than the topsoil and could be mistaken for a compaction layer. Compare the depth to the compaction layer with the topsoil depth.

Repeat the penetrometer measurements a couple of times around the hole.

Record the depth of the compaction layer in the recording sheet.

The depth to which an average person can push the rod into the soil, is a good indicator of compaction.

(i) (ii)

Figure 10:
(i) Using a penetrometer to feel for compaction layers.
(ii) **Measuring depth from the soil surface to the compaction lay**er.

(ii) Excavation

This technique is just like picking back the profile to get an unsmeared surface. Using the spatula, gently remove thin sections of soil (approximately 1 cm deep) from the top edge of the hole (a width of 20 cm will do) and work down the face continuing to remove 1 cm sections.

You will find that the top few centimetres are loose and friable. Lower down the profile it is more dense and less friable. If you find a layer that is very dense and quite difficult to remove, this is the compaction layer. You will find that the soil above the compaction layer usually separates quite readily to expose a smooth dense surface. The soil in the compaction layer is often arranged into horizontal layers compared to the soil around it which is arranged into aggregates.

Figure 11:
A compaction layer exposed by removing thin sections of soil with the spatula.

If you found no compaction layer before reaching the top of the subsoil, then you have no compaction layer in the topsoil.

Note the depth from the surface to the top of the compaction layer. Does this match the observations made with the penetrometer probe?

Compaction layers are often caused by heavy equipment travelling across the soil surface (especially when it is moist) and also from the tynes of cultivating equipment cutting at the same depth year after year.

Plant roots find it difficult to push their way through compaction layers. Water, air and nutrient movement into the subsoil is also restricted. This may result in stunted root growth and instead of growing down, the roots tend to grow horizontally on top of the compaction layer (Fig. 12). The plant suffers indirectly because it cannot develop a full root system and make use of the water and nutrients stored in the subsoil. This lowers crop growth, yield and profit.

The depth from the soil surface to the compaction layer indicates the amount of soil the crop will depend on for most of its water and nutrients. As soil management changes, so will the thickness of the compaction layer eg. with reduced tillage such as minimum tillage or direct drill, the compaction layer will disappear as the amount of traffic decreases and the soil structure improves.

Figure 12:
Faba bean and lupin roots growing horizontally across the top of a compaction layer. These plants will depend mainly on the soil (5 to 8cm deep) above the compaction layer for water and nutrients. Very few roots can penetrate the compaction layer and grow into the subsoil.

EXERCISE 3 POROSITY

For adequate aeration and good drainage, soils need pores and channels large enough to be readily seen by eye eg. worm burrows or old root channels.

Using a piece of fine fuse wire as a gauge, estimate the number of visible pores per square inch in a large clod of soil (ignore cracks in the clod) (Fig. 13). Estimates should be made separately for the topsoil and the subsoil. It would be best to do this twice to improve the accuracy of the test.

Figure 13:
Counting visible soil pores & using a piece of fuse wire as a gauge.

Note the number of pores per square inch in the recording sheet.

Good porosity	5 and greater
average porosity	3
poor porosity	1 or 2

If the topsoil is very crumbly, then the macro-porosity is good, even though it is difficult to count the pores.

There are two types of pore space in soil; macro-pores and micropores. The visible pores you counted are called macropores. The macropores allow ready movement of air and water through the soil and therefore are very important for drainage. Micropores are too small to be seen by the naked eye and the movement of water and air through them is very slow.

For good plant growth, soils need a balanced distribution of micropores and macropores. Too many micropores and the soil will drain poorly resulting in waterlogging and poor aeration (Fig. 14)
.

Cultivation of the soil will destroy soil pores especially the large continuous ones which are important for moving air and water from the soil surface into the topsoil and subsoil.

(i) (ii)

Figure 14:
(i) A dense soil with very few visible pores or macropores. Water and air will move very slowly through this soil and roots will find it difficult to grow.
(ii) **An open soil with many visible pores. Water and air will move freely through this soil**.

EXERCISE 4 EARTHWORMS

Earthworms are major builders of macropores in the soil. They also play an important role in stablizing soil structure. Their numbers are best assessed during winter or spring when the soil is wet.

Move away from the hole and take a shovelful of soil (approximately 20cm square and 10 cm deep) and separate out the worms (Fig. 15). You will need to do this several times to get reliable numbers. Calculate the average earthworm number by totalling the number of earthworms and dividing by the number of shovelfuls tested.

Figure 15:
Separating earthworms from a shovelful of soil.

Note the average number of earthworms in the recording sheet.

Generally:

0-5 earthworms per shovelful	poor
6 - 10	good
> 10	great

Earthworms hibernate deep in the soil over summer and they become active when the soil moistens in autumn. They move up to the topsoil where the supply of organic matter, their food, is more plentiful. To extract the organic matter, they ingest the soil and the unwanted solids are left behind as faeces. The faecal pellets are very stable and contribute to stabilizing the soil structure.

The earthworms secrete an important mucus-like substance through their skin. It forms a lining on the wall of the burrows and makes them very stable. These burrows may last in the soil for decades if undisturbed.
Earthworms are therefore a good indicator of the health of the soil and its structure. The more organic matter a soil contains the greater the potential number of earthworms and macropores.

Cultivation and stubble burning reduce earth-worm numbers by reducing their food source (organic matter). Stubble on the soil surface encourages earthworms to burrow up to the soil surface and open channels from the subsoil to the soil surface as they go (Fig. 16).

Figure 16:
The entrance to an earthworm burrow.

Earthworms aren't the only soil animals that build up soil structure. Ants and termites are also good for the soil. Note in the comments section of the recording sheet if you see any.

EXERCISE 5 SOIL TEXTURE

Soil texture is a measure of the relative proportions of sand, silt and clay in the soil. The size range (measured as a diameter) of the different particles are:

clay	< 0.002 mm
silt	0.002 - 0.02 mm
sand	0.02 -2 mm
gravel	> 2 mm

Depending on the proportions of these particles, the soil is characterised into different texture classes.

The texture of the topsoil and subsoil are deter-mined separately.

1. Using the spatula, remove a small handful of soil from the side of the hole (do not use material removed from the bottom of the hole as it is likely to be a mixture of topsoil and subsoil).
2. Remove any gravel, stone or organic litter. Break up the aggregated material.
3. Knead the soil to make a ball approximately 4.0 cm in diameter. Add water a drop at a time to make it more kneadable. Stop adding water as soon as the ball starts to stick to the hand. Knead for a further half a minute (Fig. 17).

Figure 17:
Kneading the soil to form a soil texture ball.

4. To determine the texture class you need to manipulate the ball and feel whether the soil is:
   1. gritty - indicating fine and coarse sand *The grinding of fine sand can he heard if you manipulate the hall near your ear.*
   2. silky - indicating silt
   3. plastic (like plasticine)/sticky - in-dicating clay
5. The texture class is determined also by ribboning the ball. Ribboning is done by pressing out the soil ball between thumb and forefinger (Fig. 18). Measure the length of the ribbon (Fig. 19). The higher the clay content of the soil, the longer the ribbon length.

Figure 18:
Ribboning the soil ball between thumb and forefinger.

Figure 19: Measuring the length of the ribbon. Use the table over the page to determine the texture of the topsoil and subsoil.

Note the texture class in the recording sheet.

Soil texture changes little with different management practices. Therefore, it will only need to be determined once and not in successive years. Soil texture does affect other soil properties such as water holding capacity, porosity, permeability and the soils' behaviour in water.

The clay fraction is perhaps the most important as it enables the soil to hold water and nutrients. Clay therefore can be considered to be an active particle. Silt and especially sand however are much less active and hold little water and nutrients.

Use the table to determine the texture of the subsoil and topsoil.

Ball	Ribbon	Feel	Texture
will not form ball		single grains of sand stick to fingers	sand
ball only just holds together	0.5 cm	gritty	loamy sand
ball just holds together	0.5-1.3 cm	sticky, sand grains stick to the fingers	clayey sand
ball just holds together	1.3-2.5 cm	very sandy to touch, visible sand grains	sandy loam
ball holds together	1.3-2.5 cm	fine sand can be felt	fine sandy loam
ball holds together strongly	2-2.5 cm	sandy to touch sand grains visible	light sandy clay loam
ball holds together	2.5 cm	spongy, smooth but not gritty or silky	loam
ball holds together	2.5 cm	slightly spongy, fine sand can be felt	loam, fine sandy
ball holds together	2.5 cm	very smooth to silky	silt loam
ball holds together strongly	2.5-3.8 cm	sandy to touch, medium sand grains visible	sandy clay loam
ball holds together	3.8-5 cm	plastic, smooth to manipulate	clay loam
ball holds together strongly	7.5 cm	plastic, smooth, handles like plasticine and can be moulded into rods	clay

EXERCISE 6 CRUSTING

Soil crusts are commonly seen on the surface of most cropping soils.

Move away from the hole and compare the crust on your soil with those shown in the photos and give it the appropriate rating. Note the rating in the recording sheet.

(i) SEVERE CRUST

The surface of this soil is smooth. The aggregates have broken down and the fine grains have washed into the soil to form a crust. The coarser grains remain behind loose on the surface. There are no visible macropores in the surface. The lichen or moss growing on the soil indicates very wet conditions. This would be due to poor drainage through the crust resulting in ponding of water on the soil surface.

(ii) INTERMEDIATE CRUST

Some aggregates are intact though they have a smoothed appearance due to some breakdown. Some macropores are visible (ignore the cracks. These are caused by shrinkage of the crust on drying). There has been some sorting of the fine grains on the soil surface. There is no lichen or moss growth.

(iii) MINIMAL CRUST

Aggregates are intact, quite a few macropores are visible, there has been no sorting of grains and there is no lichen or moss growth.

Crusts are a significant soil structural problem because.

1. they restrict water movement into the soil and cause ponding, waterlogging and increase runoff;
2. they restrict air movement into and out of the soil;
3. they may prevent seedling emergence.

Crusts can form through two processes 1. clay dispersion and 2. aggregate slaking. Each process usually contributes to crusting on red duplex soils.

1. CLAY DISPERSION

Clay dispersion occurs when individual clay particles separate from one another in moist soil and freely move about in water. As we discussed earlier, clay is the active particle in soil and under different conditions they will behave differently. When the clay contains a lot of sodium (a constitutent of common table salt) it tends to readily disperse in water (Fig. 20). You often see dispersed clay in puddles and wheel ruts (Fig. 21).

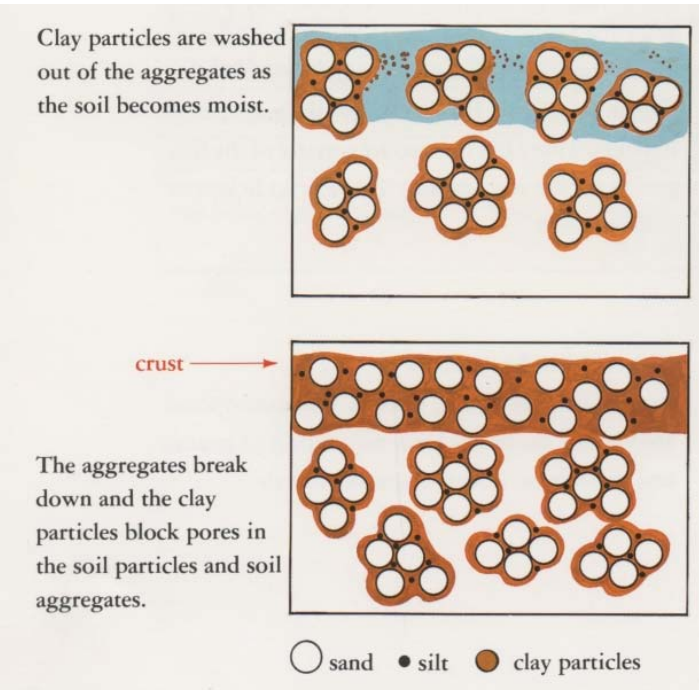


Figure 20:
Sodium in the clay causes it to disperse in water.

Very cloudy water is a good indicator of dispersion. The cloudiness is dispersed clay. The dispersed clay settles into pores and forms a seal over the soil surface (Fig. 22). On drying the seal forms a crust. Red duplex soils quite often contain large amounts of sodium (sodic soils) and dispersion and crusting commonly occur.

Figure 21:
Dispersed clay in a puddle.

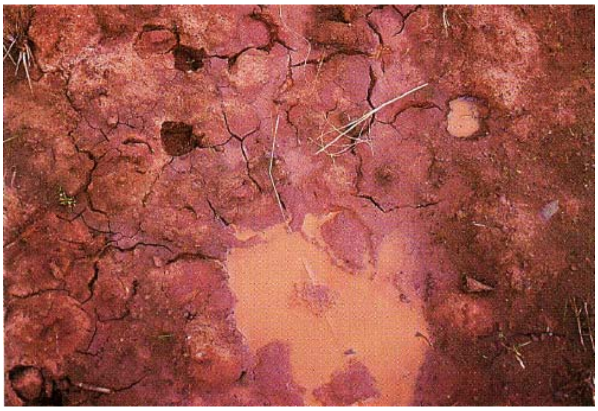


Figure 22:
When the water in the puddle eventually evaporates or drains away, the clay particles settle on to the soil surface forming a crust. In extreme cases, such as this one, the crust may be up to one cm thick.

Gypsum is used to treat soils with dispersive clays. Gypsum contains large amounts of calcium. The calcium replaces the sodium in the clay. A clay that contains a lot of calcium does not disperse when it becomes wet.

2. AGGREGATE SLAKING

Unlike dispersion, slaking is a mechanical process and occurs when the soil structure is weak. When a dry soil is wet rapidly (eg. with rapid rain), water moves into the pores within the aggregate and forces air out. If the aggregate is weak, the force of the escaping air causes the aggregate to burst (Fig. 23). If the aggregate is strong, then it resists the force of the escaping air and holds together. (Raindrops falling on to the soil surface can also cause weak aggregates to fall apart). The aggregates break down after slaking into smaller particles called microaggregates (Fig. 24). These are washed into the soil and block soil pores and form a crust on the soil surface.

Organic matter plays an important role in determining the structural strength of the soil. It is a most important binding agent or soil glue. Cropping soils generally contain little organic matter for a number of reasons including stubble burning and cultivation, both of which increase the rate of organic matter destruction. Increasing the organic matter content of the soil will increase the soil strength and prevent slaking.

In the next exercise we will test the soil to see if it slakes or disperses.

Figure 23:
Water moving into an aggregate forces the air out. If the aggregate is weak, the force of the escaping air causes it to burst and slake.

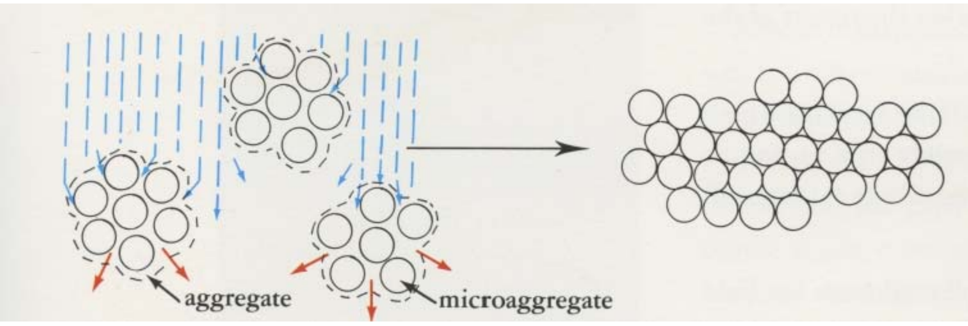


Figure 24:
An aggregate that has slaked into smaller aggregates or microaggregates.

EXERCISE 7 SOIL STABILITY TEST

This is a simple test used to determine if your soil is dispersive and if it slakes. It is a modification of a test used in the laboratory called the Emerson Dispersion Test. As we have modified the Emerson Dispersion Test, the rating you give the soil would be different to the "Class" that a laboratory test will give the soil. Please note that you should not try and compare the two and that the two test results will be quite different.

This test is best carried out at home.

You will need two shallow, flat bottomed, clear containers (eg. saucers) and about a cup of rainwater or distilled water. Do not use bore, river or dam water as this will alter the results of the test.

1. Collect a couple of handfuls of soil from each soil layer and place separately in a bucket or cloth bag. Avoid using plastic bags as these will cause the soil to sweat.
2. Samples need to be collected from the field and carried back to the house or shed with a minimum of disturbance.
3. Store the samples in a warm dry place until the samples dry. If the soil is wet, this may take a couple of days. It is very important that the soil is dry before carrying on with the test.
4. Select 3 aggregates approximately pea-sized from each horizon. Put enough water in each dish to cover the aggregates (6 to 10 mm deep) and then place the aggregates carefully into each dish. Use one dish for the topsoil aggregates and the other for the subsoil.
5. Watch the aggregates carefully for the first few minutes. Slaking will occur almost immediately if it is going to happen at all. You will see small bits of soil fall off the side of the aggregate, small bubbles of air escaping from the aggregate and eventually the entire aggregate may fall to bits (refer back to Fig. 24).

Note in the recording sheet if slaking occurred.

6. Leave the samples for 20 hours before checking for dispersion. In some soils, it will take this long for dispersion to be visible. Dispersion is indicated by a cloudiness or milkiness around the base of the aggregate.

If dispersion is complete, then the bottom of this dish will be covered by the cloud. If dispersion is incomplete, then the cloud will just surround the aggregate (Fig. 25).

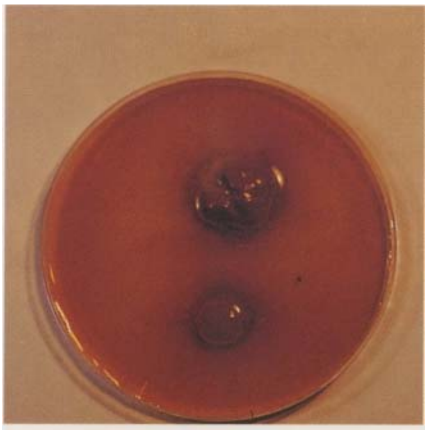


Figure 25:
(i) Complete Dispersion

A cloud of dispersed clay covers the bottom of the dish and the aggregate has almost disappeared.

(ii) Incomplete Dispersion The dispersed clay spreads in thin streaks and crescents on the bottom of the container.

Note in the recording sheet if complete, incomplete or no dispersion occurred.

8. If no dispersion occurred, move on to step 9. Otherwise, use the table below to determine the stability of your soil.
9. If no dispersion occurred, then the soil requires a further test. Make a moist ball using exactly the same procedure for making the texture ball in Exercise 5. Out of this, make 3 pea-sized balls (Fig. 26) and place them in a dish of water prepared **as in** step 4 above.

Figure 26:
Pea sized balls used for testing moist soil for dispersion.

10. Repeat points 6 and 7 above. (Slaking does not apply to a moist aggregate).
11. Use the table below to assess the stability of your soil.

TYPE 1
A cloud will cover the bottom of the dish in a very thin layer. The only thing left of the aggregate will be a small heap of sand grains.

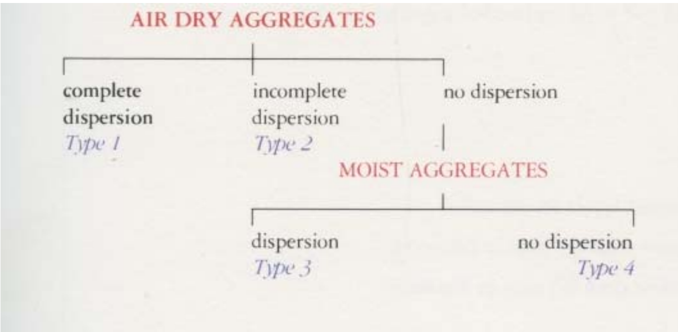
In the field this soil may suffer from severe crusting, erosion and poor drainage. It is not a condition suited to regular cropping. Gypsum application will probably be necessary if it is to be used for cropping. A laboratory test will be valuable to determine how much gypsum to put on.

TYPE 2
A cloud of dispersed clay around the aggregate which usually spreads in thin streaks and crescents on the bottom of the container.

In the field, a Type 2 topsoil will have similar problems as the Type 1 soil but not to the same degree. Again, it would be advisable to get the soil tested by a laboratory.

TYPE 3
This soil type only disperses after clay has been worked when moist. This means that very sound management practices can avoid crusting and erosion but there is not much room for error. Gypsum again could well be useful to change the soil from a Type 3 to Type 4.

TYPE 4
The aggregate structure of the soil is pretty stable. This soil should not crust and should have good rates of water entry. It will still be susceptible to compaction layer development and hence has potential for root growth limitation and erosion.



COMPLETION OF THE ASSESSMENT

The assessment of your soil is now complete. Check that you have filled in all the details in the recording sheet. Also, add any comments or observations you have made while examining the soil.

If this is the first time that the soil has been assessed, it would be best to go through the results with a soil advisory officer or your own consultant. Together, you can determine the soil structure problems limiting crop growth and develop a program to overcome them.

If you have used the kit before, compare this years results to that collected in previous years. Look for improvements or deterioration. Remember that it may take a number of years for the soil to respond.

CONTACT OFFICES

Below is a list of Department of Conservation and Environment and Department of Agriculture offices where soil and cropping advisory staff are located. These staff are familiar with the kit and will endeavor to assist you as much as possible.

Department of Conservation and Environment

Alexandra	(057) 721 63
Ballarat	(053) 370 78
Benalla	(057) 611 61
Bendigo	(054) 446 66
Charlton	(054) 911 56
Heathcote	(054) 446 63
Horsham	(053) 811 25
North East (Wodonga)	(060) 242 78
St Arnaud	(054) 951 11

Department of Agriculture

Bendigo	(054) 40 3777
Benalla	(057) 62 2588

GLOSSARY OF SOIL TERMS

soil structure	arrangement of soil particles (sand, silt, clay) and the spaces or pores between them
soil texture	the feel of damp soil which is determined by the proportions of sand, silt and clay in the soil eg. sand, loam or clay
microaggregates	collection of sand, silt and clay particles bonded together. Approximately 0.5mm or less in diameter
aggregates	collection of microaggregates and soil particles bonded together eg. clods or crumbs. Larger than 0.5 mm
duplex	two layered soil
A-horizon	topsoil
B-horizon	subsoil
penetrometer	probe used for identifying compacted layers in the soil
macropores	soil pores visible to the eye (greater than 0.3 mm in diameter)
micropores	soil pores not visible to the eye (less than 0.3 mm in diameter)