CHEMICAL AND PHYSICAL PROPERTIES

The analyses of 49 profiles taken from representative sites of the principal soil types are given in Appendix I. This appendix, therefore, provides a reference to the more important measurable features of the soil types. However, readers are warned against making detailed comparisons between the physical and chemical attributes of the soil types on the basis of one or two profiles. A single profile in itself can only indicate broadly the attributes of a particular soil type, since it represents only part of the range of any of the characteristics that constitutes the type. The analytical methods employed are given in Appendix II.

Particle Size Distribution.

The analyses in Appendix I relate the proportions of sand, silt and clay to field texture assessments, and their main purpose is to enable a better understanding of the textures given in the morphological descriptions of the soil types. The particle size data show that textures described as light clay and medium clay frequently have clay contents of 50-70 per cent which is higher than would be expected from field assessments.

Fine sand is the dominant constituent of the non-clay fraction of all profiles. However, there are differences in the ratio of coarse to fine sand, and in the magnitude of the silt fraction, which are related to the parent materials. The following generalizations are made from consideration of subsoil horizons thought to represent the parent materials. In the profiles of soil types derived from riverine materials, i.e., the soils associated with the prior stream woodland, treeless plain and low woodland landscape units, the coarse to fine sand ratio is usually less than 0.1 and is often below 0.05, while silt, with few exceptions, is in the range 12-25 per cent. On the other hand, in profiles derived from aeolian materials and from granite, i.e., in soils associated with the mallee plain, ridge and lake complex, ironstone gravelly ridgeland and granite highland lands-cape units, the coarse to fine sand ratio is always more than 0.1 and most commonly is about 0.6, while silt is only 2 to 9 per cent.

The particle size data illustrate the claypan nature of some of the soil types, and the uniformly high clay level throughout the profiles of others. These characteristics, as well as the over-all texture profiles of the principal soil types, can be envisaged more readily from the clay contents of the selection of profiles presented in Table 4.

Table 4 – Clay content of Principal Soil Types

Landscape Unit and Soil Type	Profile No	Surface.		Subsoil		Deep Subsoil	
		Depth in.	Clay %	Depth in.	Clay %	Depth. in.	Clay
Prior Stream Woodland							
Yarrowalla fine sandy loam	7186	0-3	13	3-18	48	18-60	26
Yarrowalla loam	19611	0-4	18	4-26	43	26-68	29
Lyndger loam	13385	0-3	15	10-23	57	23-56	42
Mologa loam	19590	0-4	23	4-14	63	14-58	46
Mysia loam	5533	0-6	27	6-28	62	28-60	52
Loga clay loam	19623	0-3	35	3-40	65	40-60	61
Treeless Plain.							
Macorna clay	5487	0-1	21	1-28	65	28-60	61
Kerang clay	7193	0-2	46	2-26	67	26-60	52
Tragowel clay	5494	0-2	69	2-32	69	32-66	69
Fernihurst clay loam	5526	0-3	33	3-24	62	24-60	58
Kinypanial clay loam	5519	0-3	34	3-31	65	31-54	60
Kinypanial friable clay	7717	0-6	68	6-20	73	20-60	72
Towangurr clay loam	19605	0-4	36	4-32	64	32-72	60
Low Woodland							
Boort clay	5541	0-6	55	6-36	67	36-57	61
Wandella clay ..	11613	0-5	55	5-23	67	23-54	62
Ridge andLake Complex							
Catumnal loam	9250	0-9	14	10-32	46	32-57	35
Coombatook sandy loam	5474	0-4	11	5-33	48	33-56	40
Woolshed sandy loam.	11572	0-7	13	8-29	43	29-50	33
Mallee Plain							
Marmal loam ..	13353	0-3	28	5-32	57	32-60	52
Ironstone Gravelly Ridgeland							
Wychitella loam	11605	0-5	23	5-15	66	18-28	42
Granite Highland							
Terricks sandy loam	18151	0-12	13	12-36	63	36-57	52

Calcium Carbonate.

Calcium carbonate is present in some part of all of the profiles illustrated in Appendix I, but there is considerable variation in its amount and form.

The soil types derived from the aeolian materials of the mallee plain, ridge and lake complex, and ironstone gravelly ridgeland contain the most calcium carbonate, both fine and concretionary forms usually occurring by 12 in. from the surface, and increasing to appreciable amounts with depth in the profile.

The soils on the granite highland are also appreciably calcareous, but only in the deep subsoil part of the profile.

The profiles of the soil types on the riverine plain vary from being slightly to lightly calcareous. In the structured, friable clays, the calcium carbonate occurs throughout the whole profile, and a few fine concretions are usually present. In other clay soils and in soils of the claypan type, the calcium carbonate is in the subsoil horizons below about 15 in., and concretions may be either absent or present. The profiles with very small amounts of calcium carbonate in them are those representing the Yarrowalla series on the prior stream levee and Macorna and Kerang clays on the treeless plain.

pH

The pH of the surface soils is related to the presence of calcium carbonate. The majority are non-calcareous and 36 out of the 39 recorded in Appendix I vary from slightly acid to slightly alkaline within the pH range 6.2-7.8. The calcareous surface soils are moderately alkaline, and 7 out of the 10 recorded have pH values in the range 8.2-8.6.

The trend in practically all of the profiles for the pH to increase with depth to about 3 in. The subsoils immediately below non-calcareous surfaces are mainly slightly and moderately alkaline (pH 7.1-8.5), although in 5 of 9 profiles representing soil types on the aeolian materials of the ridge and lake and the mallee plain landscape units the subsoils are strongly or very strongly alkaline (pH 8.6-9.5) . Nearly all of the subsoils below calcareous surface are also strongly or very strongly alkaline, as are most of the horizons below about 36 in. all of the 49 profiles.

The pH data indicate that liming practice are unnecessary on the soils in the Mid-Loddon Valley area unless acid-forming fertilizers such as sulphate of ammonia have been used liberall.

Exchangeable Cations.

The exchangeable calcium, magnesium, potassium and sodium and the sum of these cations are given in Appendix I for selected horizons in twelve profiles. The cation exchange capacity has not been determined, but, in the case of subsoils with pH values of 8.0 or more, subsoil is saturated with the four metal cations and the sum of these is then approximately equal to the cation exchange capacity. The cation exchange capacity of the clay fraction in the soil is a broad guide to the mineralogy of the clay and may be calculated for the cation saturated subsoil horizons. Such values, representing B and C horizons in the profile illustrated, all fall in the range 42-64 m-equivalent per 100 g of clay, while about 75 per cent of them are in the range 48-58 m-equiv. per 100 g

This is the usual order of magnitude for mixed, but dominantly illitic and montmorillonitic clay minerals. There are insufficient determinations to decide whether there is a difference between the clays of the aeolian and riverine parent materials. However, the range 48-58 m-equiv. per 100 g of clay is comparable with that found in soils on the riverine plain elsewhere in northern Victoria (Skene and Freedman 1944, Skene and Poutsma 1962, Skene 1963, Skene and Harford 1964).

Exchangeable calcium and magnesium in the surface soils together comprise 80-90 per cent. of the total metal ions. These cations are present in approximately equal amounts in most cases, although in three profiles calcium is 2 to 3 times the magnesium.

As has been found repeatedly in similar soils elsewhere in Australia, calcium decreases and magnesium increases with depth in the profile. Although the increases in magnesium are not large in most of the profiles, the ratio changes such that magnesium in the deeper subsoil horizons is usually 2 to 3 times the calcium.

The exchangeable sodium percentage (ESP) is of agricultural interest since it is one of the soil factors controlling dispersion of the clay, and hence the permeability of the soil when irrigated. Most of the profiles representing the soils on the riverine plain have ESP values of 7 to 10 in the surface horizons. This may well be sufficient sodium to impair the permeability of these soils. In regard to the subsoil horizons, all except two profiles are appreciably sodic, ESP values ranging from 12 to 33. Values of this order are indicative of probable poor permeability and, in fact, low subsoil permeability is a problem experienced with many irrigated soil types on the riverine plain. Tragowel clay, however, is one of the soil types on the plain with better infiltration characteristics, and it is significant that one of the exceptions mentioned with low ESP in the subsoil is from this soil type, and the other is from Fernihurst friable clay which is similar in having a strongly structured profile.

Nitrogen, Phosphorus, Potassium.

Whilst chemical analysis as carried out on the soil type profiles is not a guide to fertilizer practices, it does provide a broad indication of the inherent fertility of the soils of the area in respect to nitrogen, phosphorus and potassium.

Nitrogen – Total nitrogen varies from 0.07 to 0.16 per cent in 42 out of 45 surface soils, while the average value is 0.11 per cent. In the same soils, organic carbon ranges from 0.56 to 2.29 per cent with an average value of 1.23 per cent. The average carbon-nitrogen ratio is 11.

In 19 subsoils, total nitrogen varies from 0.04 to 0.11 per cent (average 0.08 per cent) and organic carbon from 0.31 to 1.21 per cent (average 0.66 per cent.). The average carbon-nitrogen ratio is 8.

In terms of organic matter, these figures represent an average amount of 2.1 per cent in the surface soils, and 1.1 per cent in the subsoils. Such figures are low, but are normal for soils in the drier parts of the State which have not had their fertility raised by clover-based pastures.

Phosphorus.—The total phosphorus status of 17 surface soils ranges from 0.007 to 0.032 per cent (average 0.022 per cent). Such values illustrate the low phosphorus status of the soils of the Mid-Loddon Valley, and are typical of many Australian soils. The few analyses of the clay subsoils show that these also have a low phosphorus status.

Potassium.—The exchangeable potassium contents are high in both the surface and subsoil horizons. There is also evidence from the composition of the soluble salts in a number of subsoils (Table 6) that water-soluble potassium is high. These data indicate that potash is not likely to be needed in fertiliser programmes.

Soluble Salts.

Total Soluble Salts.

The profile data in Appendix I illustrate that only the profiles representing the Terricks and the Wychitella series have really low levels of soluble salts. In all of the others soluble salts, although low in the surface horizons, increase appreciably in the subsoils. Values of 0·3 to 0·5 per cent are common in the horizons below about 18 in. in the profiles from the prior stream woodland, ridge and lake, and mallee plain landscape units. More than 0·5 per cent of soluble salts occurs before 12 in. in most of the profiles from the treeless plain and low woodland landscape units. The analyses illustrate in particular the high level of salinity commonly found in the Macorna clay and Kerang clay soil types.

Table 5 – Analysis of Soluble Salts

-	Sample No.	Depth	Ca	Mg	K	Na	Cl	SO_4	HCO_3	CO_3	Total salts*
		in	Milli-equivalents per 100 g of soil								%
Marmal clay loam	11588	18-33	0.3	0.3	0.9	4.6	3.5	0.8	1.6	0.2	0.42
Catumnal clay loam	11594	17-28	0.8	1.3	1.4	7.4	7.9	1.8	1.1	0.1	0.69
Boort clay	5544	16-36	0.6	0.6	0.9	6.8	6.6	1.5	0.9	0.0	0.57
Kerang clay	5503	29-40	17.6	3.9	0.9	17.2	13.2	26.0	0.4	0.0	2.57
Kinypanian clay loam	5523	23-31	0.6	1.0	1.1	9.6	7.7	3.5	1.0	0.1	0.79
Fernihurst clay loam	5530	24-35	11.1	3.6	0.8	10.5	4.9	20.5	0.7	0.0	1.74

* Summation of cations and anions

The constituent cations and anions are shown in Table 5 for selected subsoil horizons from six soil types. In the Kerang clay and Fernihurst clay loam, high values for calcium and sulphate reflect the presence of gypsum in these profiles. Sodium and chloride are clearly the dominant ions of the soluble salts in the other four soil types.

All of the soils contain about 1 m-equiv. of water soluble potassium per 100 g of soil; this is considered to be an unusually high amount.

Sodium Chloride.

Chlorides have been estimated in all of the profiles shown in Appendix I and are reported as sodium chloride. Levels in general parallel the total soluble salt values. In most horizons, sodium chloride comprises from 30 to 70 per cent. of the total salts, the higher proportions being common where the total salt levels are high.

The data for soluble salts indicate that sodium chloride is present in significant quantities below 2 ft. This confirms that soil samples from the 2 to 3 ft. depth analysed for chloride, as has been done in the general salt survey of the whole area, are appropriate to evaluate potential salinity hazards. These hazards are dealt with in the section, "Soil Features and Irrigation".